

Faculty of Engineering of the University of Porto



**From Social Media Knowledge to Innovation
Opportunities – A model proposal**

Graziela Borges Weber

Orientador: João José Pinto Ferreira

July 2020

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Dissertation submitted to the Faculty of Engineering of the University of Porto for
the master degree in Innovation and Technological Entrepreneurship

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Abstract

Social media networks' usage is increasing exponentially. This study aims to explore the potential that the usage of social networks similar to Facebook, Instagram, and Twitter have for enterprises do uncover innovation opportunities for publicly shared knowledge. We performed extensive literature research and retrieved building blocks from 41 articles in the fields of the lead user, social media platforms, social networks, business intelligence, and open innovation. We explored the key actors and their relationship and created an artifact, the ontology, following the design science approach. The ontology is divided into three sections, the knowledge creation phase, the dynamics of social media, and the social media knowledge extraction and analysis. Our ontology follows the inspirational approach; it presents a new conceptual description of knowledge creation in social media. To evaluate it, we applied the descriptive methodology that used *informed arguments* using the building blocks retrieved from the research in the literature and a detailed *scenario* constructed to demonstrate the utility of our ontology. The scenario describes the interaction of one post on social media, similar to a Facebook account of a fictional company. It offers an overview that a company could use to understand what functions it has, and which roles could be encoded inside the organization in order to find innovation opportunities within its social media.

Resumo

O uso de redes de sociais está aumentando exponencialmente. Este estudo tem como objetivo explorar o potencial que o uso de redes sociais semelhantes ao Facebook, Instagram e Twitter têm para as empresas, descobrindo oportunidades de inovação com o conteúdo compartilhado publicamente. Realizamos uma extensa pesquisa bibliográfica e retiramos blocos de conhecimento de 41 artigos nos campos de *lead user*, plataformas de mídia social, redes sociais, *business intelligence* e *open innovation*. Exploramos os principais atores e os seus relacionamentos, criamos um artefacto, a ontologia, seguindo a abordagem do *design science*. A ontologia é dividida em três secções, a fase de criação de conhecimento, a dinâmica das mídias sociais e a extração e análise de conhecimento compartilhado nas mídias sociais. A nossa ontologia segue a abordagem inspiradora; apresenta uma nova descrição conceptual da criação de conhecimento nas mídias sociais. Para avaliá-la, aplicamos a metodologia descritiva que utilizava argumentos informados usando os blocos de conhecimento extraídos da pesquisa na literatura e um cenário detalhado construído para demonstrar a utilidade da nossa ontologia. O cenário descreve a interação de uma postagem nas mídias sociais, semelhante a uma conta do Facebook de uma empresa fictícia. Ele oferece uma visão geral que uma empresa pode usar para entender quais as funções que ela possui e quais funções podem ser codificadas dentro da organização para encontrar oportunidades de inovação nas suas mídias sociais.

Contents

Acknowledgment	v
Abstract	vii
Resumo.....	viii
Contents	ix
List of Figures	xi
List of Tables	xiii
1. Introduction	15
1.1 Motivation	15
1.2. Objective of the research	15
1.3. Overview of the methodology	16
1.4. Structure of this dissertation	16
2. Review of Literature	17
2.1. Introduction	17
2.2. Approach to the Literature searching	17
2.3. Synthesis.....	19
2.4. Analysis of the literature	26
2.5. Conclusion.....	30
3. Methodology	33
3.1. Introduction	33
3.2. Research Question	33
3.3. Research design.....	33
3.4. Conclusion.....	36
4. An ontology for analyzing knowledge in social media.....	37
4.1. Introduction	37
4.2. Proposed Ontology	37
4.2.1. The knowledge creation	38
4.2.2. The customer roles and dynamics in social media	40
4.2.3. The company's social media knowledge extraction.....	43
4.3. Exploratory Scenario and discussion.....	48
4.4. Replying the research question.....	52
4.5. Limitation of the research.....	52
4.6. Conclusion.....	53
5. Conclusion	55
6. References	57
Appendix A – FEI2O Ontology	64
Appendix B – Building block glossary	66

List of Figures

Figure 1 - Knowledge Creation Sub-ontology proposed by this study.....	39
Figure 2 – Customer roles and dynamics in social media sub-ontology proposed by this study.	42
Figure 3 – The Sub-Ontology for enterprise social media knowledge extraction. ...	45
Figure 4 - Scenario Application.	49
Figure 5 - The scenario in the sub-ontology of the customer roles and dynamics of social media.	50
Figure 6 - The scenario in the sub-ontology of the company's social media knowledge extraction.	51
Figure 7 - FEI2O Actor sub-ontology.....	64
Figure 8 – FEI2O Actor sub-ontology	65
Figure 9 – FEI2O Purpose sub-ontology.	65

List of Tables

Table 1- Literature Review on how knowledge is shared in social media.....	19
Table 2 - Literature review with discussion about social networks.	21
Table 3 - Social Media Research Compilation.	27
Table 4 - The ontology development process.	34
Table 5 - Ontology requirements specification.....	35
Table 6 - Building blocks glossary	66

1. Introduction

1.1 Motivation

Social media networks usage is increasing exponentially, the relationship of their intensive usage with new social behaviors, and how it affects the customer-company relation has been deeply explored by scholars (Ashraf & Javed, 2014). The number of industries that use social media networks as a channel to increase productivity and *knowledge sharing* is continuously growing (Mourtzis et al., 2019). According to McKinsey research, companies could increase the level of productivity from 20 to 25 percent by using social media as a direct channel of communication with customers (Culnan et al., 2010).

The knowledge creation theory can be understood as a transcending process where old boundaries become new ones, created through the synthesis of contradictions raised based on constant collaboration (Nonaka & Toyama, 2003; Nonaka & Takeuchi, 1995). Combining this to the dynamics of communication and *knowledge sharing* provided by the use of social media, new knowledge can be created at all moments through discussions and conversations made by users. With the current popularity of social media, researchers have already recognized social media as an enabler and driver of innovation (Bhimani et al., 2019).

This study aims to explore the potential that the usage of social networks, like Facebook, Instagram, and Twitter, can provide for the customer-company relation. More specifically, we intend to understand the key actors and roles that must be performed by the companies to profit from the customer-company relationship and recognize innovation opportunities using the knowledge publicly shared.

1.2. Objective of the research

Our objective was to build a conceptual framework, describing with the building blocks found in the literature review, knowledge sharing, and how innovation opportunities could be recognized in the company's social media. We performed extensive literature research in the fields of the lead user, social media platforms, social networks, business intelligence, and open innovation. Our objective in this study was to understand the actors and their roles in the *knowledge creation* within the company's social media network.

1.3. Overview of the methodology

Using the design science approach, we performed extensive research of literature to understand the social media networks and its customer-company relationship. After careful analysis, we identified our gap in the study and formulated the research question as follows:

How can one use the knowledge shared in a company's social media to identify innovation opportunities?

Focused on answering the research question, we developed an ontology demonstrating how knowledge is shared in social media and how companies can identify innovation opportunities. Using the building blocks retrieved from the review of literature, we explored key actors and their relationship dividing it into three sections, the knowledge creation phase, the dynamics of social media, and the social media knowledge extraction and analysis.

To evaluate the ontology, a detailed scenario was built to demonstrate the ontology in a situation similar to reality. Specialists from different research fields evaluated the ontology and the scenario, providing the most valuable feedback and validation.

1.4. Structure of this dissertation

The study is divided into five chapters, briefly described in the following paragraphs:

Chapter 1 describes the motivation and objectives of this study, as well as the methodology used.

Chapter 2 describes the literature research process performed and the discussions generated from the encountered information. It presents a synthesis table with the relevant papers encountered and the gap to be explored by this study.

Chapter 3 presents the methodology used in this dissertation, the research question that motivated this study. The research design is described along with the characteristics of the designed ontology, and the description of the fictional company that generated the scenario used in the ontology evaluation.

Chapter 4 presents the proposed ontology and its evaluation. The components of the ontology are described, along with the relationship among the concepts itself. The ontology is divided into three sub-ontologies that are explained within the chapter, followed by its discussion. A descriptive scenario is used to evaluate the preferred model. It concludes with an overall analysis of the ontologies and the scenario.

Chapter 5 presents the conclusion and the limitations of the study and provides suggestions for future research.

2. Review of Literature

2.1. Introduction

This chapter presents the review of literature that explores the usage of social media networks by companies and customers, the actors involved, and what roles they perform. Different sets of keywords were used in an online database of scientific articles to find relevant research and discussions. This study explored the thematic of the lead user, customers, and companies in social media networks and how they could be connected to innovation creation and opportunity recognition.

Moreover, this chapter describes the methodology used to explore articles and presents a synthesis table with the relevant discussions found in the literature. It is performed an analysis of the content to identify the gap that motivates in this study.

For this discussion to continue, complementary concepts need to be explored, beginning with social media, that can be described as a platform driven by the user-generated contents based on the internet usage (Zhou & Wang, 2014; Xiang & Gretzel, 2010). In this study, we only considered publicly available information displayed on social media. The user can be differentiated according to their roles and interactions performed on social media platforms. Eric Von Hippel classified one type of user: the *lead uses* that are “individuals, or firms, that are experiencing needs that are ahead of the targeted market” (Churchill et al., 2009, pp. 3). Therefore, the lead users share their knowledge with companies highlighting new customer needs and innovation opportunities to be explored.

The innovation opportunities can be continually produced and improved to fulfill the users’ needs continuously. Henry Chesbrough classified as open innovation “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” (Chesbrough & Bogers, 2014).

2.2. Approach to the Literature searching

We performed searches using different sets of keywords to encounter relevant articles published in Scopus¹. The search was done in two steps:

- The first search was to find the most relevant papers regarding social media usage and its relationship with customers and companies.

¹ Online database of scientific articles (www.scopus.com)

- The second search was to understand the building blocks of knowledge creation in social media.

To meet the first step, we focused on: (1) the relation with innovation behavior; (2) the relationship between lead user identification and social media networks; and (3) the relationship between knowledge sharing and social media networks.

For the relation with innovation behavior, we used the keywords knowledge sharing, social media, and innovation following the combination: (KEY (*knowledge AND sharing*) AND KEY (*social AND media*) AND KEY (*innovation*)) to understand the knowledge created regarding the relationship between social media networks and innovation contexts. We found 10 papers, and from those, 3 articles were considered relevant to the discussion due to its contribution to the understanding of how innovation could be analyzed and extracted from social media networks.

For the relation between lead user identification and social media networks, we used the keywords lead user and social media following the combination: (KEY (*lead AND user**) AND KEY (*social AND media*)). We found 11 papers, and from those, 4 articles considered relevant to the discussion due to its contribution to how lead users, could identify opportunities for improvements or new innovative ideas through their interaction with the company's social media network.

For the relation between knowledge sharing and social media networks, we used the keywords knowledge sharing and social media following the combination: (KEY (*knowledge AND sharing*) AND KEY (*social AND media*)) to understand the ways knowledge can be constructed and shared through social media network. We found 274 papers in which 4 articles were considered relevant for this discussion.

In the second step of this literature search, we aimed to understand how knowledge could be analyzed and used to create innovation opportunities for companies and customers using social media. We focused on: (1) the knowledge creation in social networks that thrived to innovation and (2) the relation of knowledge creation and co-innovation.

For the knowledge creation in social networks that thrived on innovation, we used the keywords knowledge creation, social network, or social media and innovation. Following the combination: KEY (*knowledge AND creation*) AND KEY (*social AND (media OR network)*) AND KEY (*innovation*)), we aimed to understand the building blocks of knowledge creation in the relationship of customers in social media and social networks. We found 25 papers, in which 23 articles were considered relevant for the discussion.

For the relation of knowledge creation and co-innovation, two types of searches were made. One using the keywords knowledge creation, co-innovation and innovation following the combination: KEY (*knowledge AND creation*) AND KEY (*co-innovation*) AND KEY (*innovation*)) to understand the building blocks of knowledge creation, co-creation and co-innovation in the relationship of customers and companies expressed on social media and social networks. We found 4 articles considered relevant for the discussion. The other search was made using the keywords social business intelligence and social media following the combination: KEY (*"social business intelligence"*) AND KEY (*social AND media*) to

understand how enterprises could use the knowledge created in social media. We found 7 papers from which 1 article was relevant to the discussion.

In addition to the papers considered above, we added two articles encountered from the documents found using Scopus. The first paper was from Papa et al. (2018), and the second paper was from Vollenbroek et al. (2013).

2.3. Synthesis

In total, 41 articles were analyzed and summarized in the following tables. Here, we presented a synthesis of the author and year of publication, the paper's contribution, and the author's indication for future research. For a better understanding, we divided the articles into two groups, one with papers that referred directly to how knowledge was shared in social media (Table 1), and another with papers that offered discussions on the relations of customers, companies and social networks (Table 2).

Table 1- Literature Review on how knowledge is shared in social media.

Author and Year	Paper Contribution	Future Research
(Chen & Kuo, 2017)	Through <i>Innovation Resistance Theory</i> , the researchers highlighted 27 aspects that should be addressed to increase user's knowledge sharing behaviors. By satisfying those aspects, the company can increase the relation and <i>trustability</i> between customers and services/products provided. By fulfilling those aspects, the customer's knowledge sharing can expand, allowing more significant possibilities of addressing user needs, therefore, allowing service/product possible innovation.	The study analyzed resistance factors for user's knowledge sharing behaviors on companies' social media without including the perspectives of media usage. Hence future studies must include those into the analysis. The research was focused on enterprise social media websites in Taiwan.
(Ponomarev, 2016)	The research defined a series of criteria to select cells, photos on the social media used as a case study, to understand the relevance and usage of the specified objective. Those criteria could be further explored and used to replicate the analysis over different aspects, on various social media networks, and with different goals.	Further studies must consider other parameters of the algorithm, add context to support each analysis, integrate with tourism information systems, and experiment with other social media.
(Pajo et al., 2015)	By developing FLUID (Fast Lead User Identification) methodology, the authors utilize data mining techniques to identify lead users on the Twitter social network. The method can be, maybe, applied to other social networks using data mining techniques to determine the company's lead user and, therefore, identify innovation opportunities provided by lead users.	The researchers used only results found in Twitter and used cross-validation principles. Therefore, to use in more generalized cases, further studies should be performed using different sources of data.

Author and Year	Paper Contribution	Future Research
(Gourova & Toteva, 2011)	The research explored the relationship between lead users and open innovation and how the usage of social media can potentialize it. By highlighting the self-benefits of this relation, it can be developed strategies to motivate the knowledge sharing of customers on the company's social media.	The research did not use a case study to base the discussion; therefore, it opens spaces for improvements over the analysis presented.
(Aromaa et al., 2020)	The research proposed a knowledge sharing platform with multiple social media features to measure the interaction between employees of a company. They highlighted essential aspects that stimulate knowledge sharing and construction.	The research was executed as a case study in one company. Further studies must be done to fully understand the potentials of social media technology usage by industrial employees to improve knowledge sharing.
(Glogowska et al., 2016)	The research evaluated the relation between knowledge shared, feedback, and reputation of users while using social media networks. This study explained the behavior of user interaction with social media and enlightened with aspects is essential to be considered when analyzing the information provided by the user to share knowledge.	The research highlighted different variants that could be further explored in future studies to effectively analyze the influences of the individual on the knowledge shared on social media networks.
(Andersen & Morch, 2016)	The researchers identified four patterns of mass collaboration in knowledge development: gatekeeping, bridge building, general development, and user-user collaboration. It was also determined that <i>champions</i> are also vital contributors, together with lead users, for user-driven innovation.	Further studies could maybe identify new patterns and refine the models presented. Other software and products should be explored, it must also include managers and stakeholder contributions, and it should explore other "threads" that were excluded from the presented study.
(Papa et al., 2018)	The paper explored the effects of social media usage for innovation in SMEs on four knowledge creation processes: socialization, externalization, combination, and internalization. It has encountered that social media has a positive and significant influence on the knowledge creation process and could help drive the innovation process.	Future studies should apply qualitative analysis on how and why social media managers relate ideas and knowledge in online platforms. It should also analyze moderating variables between social media, knowledge creation, and innovation in small, medium, and large enterprises.
(Vollenbroek et al., 2014)	This paper constructed a model identifying the social media influencers and the impact	Future research could explore improvements in the constructed model as the

Author and Year	Paper Contribution	Future Research
	of these influencers on the reputation of a corporate organization.	construction of indices or a combination of indicators that influences the proposed model. More empirical research should be done to provide more reliable evidence of the corporate organization's reputation.

Source: Own production.

Table 2 has a summary of other articles that provide discussions considering social networks in general aspects. Their users or lead users and their dynamics, purposes, key functionalities, the relationship between users and companies, advantages regarding their use, and the knowledge created, among other aspects.

Table 2 - Literature review with a discussion about social networks.

Author and Year	Paper Contribution	Future Research
(Khan & Khan, 2019)	Through the <i>Diffusion of Innovation Theory</i> framework, it analyzed the explanation, prediction, and interpretation of factors that may increase or spread innovation in the public sector. Key elements that work as mediators are transformational leadership, knowledge sharing, organizational learning, and as a fundamental moderator is the use of social media.	The study indicated the need to explore further the subject regarding other leadership styles and attributes of managers in the public sector.
(Brem & Bilgram, 2015)	The study proposes the use of Netnography and <i>Crowdsourcing</i> methodology to identify and analyze lead user contributions and shared knowledge insights. It is highlighted the purposes and ways to identify those lead users and, therefore, a method to identify innovative ideas and improvements provided by those users.	The research considered a single embedded case study with 24 different lead user projects of a company in Germany. Future research should also consider the ethical aspects of lead user research.
(Ernst & Brem, 2017)	The research provides an overview concerning lead user research and how to identify it through social media. It gives a better understanding of lead users' habits and considerations regarding the share of knowledge in online platforms. Building blocks: Lead user dimensions, opinion leadership, innovation-related benefit, and level of expertise and commitment to product field.	The research highlights that additional studies must be done to test the main findings and, therefore, develop a practical and reliable tool to identify lead users in social media platforms.

Author and Year	Paper Contribution	Future Research
(Ernst et al., 2013)	By using the conceptual framework developed, the lead users could be identified on the company's social media networks. It provides knowledge on how to identify lead users and benefit from their inputs to develop innovation.	The researchers highlighted the need for more profound research to prove the applicability of the concept. A concrete process model should be developed and integrated into the existing process maps.
(Mourtzis et al., 2019)	By developing social analytics methods for industrial social networks, this research developed a way to analyze the knowledge creation and construction.	Further research could be developed to include user's sentiment analysis and support to share knowledge regarding department improvement.
(Culnan et al., 2010)	The research developed a guideline to use social media better to increase business relevance by analyzing three major U.S. companies and their use of social media.	The guideline was made by analyzing U.S. companies in specific contexts; therefore, this should be taken into consideration for implementing the suggestions in other countries or regions.
(Simon & Tellier, 2019)	This research understands the importance of new and already-established relationships between company and customer for the development of <i>explorative</i> and <i>exploitative</i> innovation. It is recognized as a fundamental element, the reactivation of central actors in social media, to provide innovation.	Further research should apply the developed knowledge in different case studies.
(Aboal et al., 2018)	The research understood that innovation in multinational firms follows three main strategies to increase knowledge creation and diffusion in developing countries, cooperation among companies, the establishment of links with international research centers, and a strong network of technology suppliers.	Further research should consider other local forestry firms and the potential risk of <i>hollowing out effect</i> .
(Pohjola & Puusa, 2016)	The research analyzed the dynamics of a community of practice. It understood that the knowledge and tangibility of the problem played a fundamental role in the operations and dynamics of the community. "This paper argues that the ideological basis for this kind of community should be openness. All information should be available for everyone who registers to the community platform on the internet. This community was working in the mindset of open innovation." (p. 14).	Further studies should be done to understand the complexity of this topic; it should include external resources, tangible and intangible outcomes. It also should be considered a long-term analysis.

Author and Year	Paper Contribution	Future Research
(Binz et al., 2014)	The research presents an analytical framework for a Technological Innovation System that is explicitly spatial but, at the same time, avoids a fixation on a specific territory.	Further studies could use the developed framework in other spatially sensitive studies and could be used to create similar analyses on other technological fields.
(Guetat & Dakhli, 2013)	The research contributes to the creation of the SIKIT organization model by adding three components to Leavitt's model of organization: strategy, knowledge, and innovation. It shows that to help organizations face constraints due to changing economic, political, social, and technological environment, it is not enough only to obtain information about technology.	Further analysis should be executed to transform the proposed model in a useful tool.
(Michaelides et al., 2013)	The research demonstrated that the effort of collaboration is amplified when it is presented on Web 2.0 tools. Parameters such as trust, perception of usefulness, enhancement of collective knowledge are understood as supporting the collaboration network dynamic.	Further studies could investigate the network users that do not contribute to the content and to explore the value of collaboration tools in the private sector and service industries.
(Nieves & Osorio, 2013)	The research developed a framework that could establish information for a better understanding of what is the most appropriate networks to be implemented to create innovation activities successfully.	Future research should use recent data to test the efficiency and effects of the suggested framework. It would also be expected that further empirical studies could explore the different levels of analysis proposed by the structure.
(Li & Gao, 2012)	The research proposed a preliminary framework to analyze university co-authorship networks and their relationship with innovation. For better results, it is empirical to the university to have deeper and intense collaboration between other universities and with research institutes.	Further empirical studies must be executed to accomplish a more in-depth analysis.
(Kayakutlu & Laurent, 2012)	This study presents a discussion to design a framework to evaluate the requested abilities and impacts of the knowledge cultivators.	Future works should include validation of the framework and test applicability of it in different industries.
(Shu et al., 2011)	The research investigated the relationship between managerial ties and knowledge creation, discovering that business ties, and political ties at some level, have substantial	Future research should use multisource data to test and compare the results, also utilize data from different

Author and Year	Paper Contribution	Future Research
	impacts on organizational knowledge creation process and company's innovation. For product innovation, there is a more significant need for knowledge creation activities, including knowledge exchange and knowledge combination.	regions and countries to explore if there are standard parameters. It should also integrate external network strategies and internal innovation strategies.
(Chu & Lin, 2011)	The research used the organization ontology-based mediation mechanism to understand problems of service creation and governance. Four necessary conditions need to be fulfilled: access to parties holding resources, the anticipation of values, motivation to act, and sufficient capability to perform the transformation.	
(Bjork et al., 2011)	The research analyzed the impact of social capital on the quality of ideas generated by individuals at work. By comparing the degree of an individual's network of work relations and the gaps between these relations, it was discovered that collaborative arrangements could improve the creation and usability of new ideas. "The possibility of interacting with other people should be supported and facilitated." (p.16).	Further investigation must be executed to explore the consequences of social relationships for idea generation.
(Mors, 2010)	This research explores how individual managers in global firms create knowledge. It is highlighted the innovation benefits from separating the local and global knowledge domains, performing a low network density. Due to the heterogeneity of the knowledge shared, managers encounter barriers to synthesize it and create knowledge to innovate.	Further studies should explore the knowledge flows simultaneously by analyzing the inside and outside ties of the firm in a separate and unified form.
(Pattanaik & Chatterjee, 2009)	The research executed the DEAL experiment, revealing that to develop a successful knowledge networking, one must use commonly understood language and trust in knowledge sharing cultures. It also highlights the importance of providing tools for the construction of conversational relationships.	
(Schutte & Preez, 2008)	The research developed a methodology to create, develop, and operate innovation on knowledge networks. The ability to analyze, synthesize, and share knowledge is the key to innovation. It also uncovered that to stimulate or restrain innovation	Further studies could address the collaborative environment and its relationship with knowledge work, explore the roadmap with different innovation initiatives, and the

Author and Year	Paper Contribution	Future Research
	effectively and sustainably; the company must encourage sharing, integration, and storage of knowledge among the company's employees.	relation with public domain technology knowledge.
(Kärkkäinen et al., 2011)	The research explored the differences between the relation business-customers and business-business. It was uncovered that social media in business-business relation need focus on more in-depth management and knowledge creation about its customers and its need.	Further research would describe and analyze in more detail the management and knowledge creation of customers and customer needs.
(Wright et al., 2015)	The research focuses on the utilization of social media, precisely the Twitter platform, to incentivize knowledge management. It was understood that the knowledge management community is not convinced of the potentials of the usage of social media due to the beliefs that the risks of using it outweigh its advantages.	Further research could explore deeper why social media is utilized in some areas by companies, and in other, they are not perceived as a valuable asset.
(Vollenbroek et al., 2013)	The research explores the concept of <i>online co-innovation</i> and his role in educational settings. It is understood that this concept will become "the new mantra of the new product and service development in educational settings" (pp. 4). Therefore, implementing it to the dynamics and relationships of an educational setting will provide an opportunity to create innovation.	
(Klen, 2009)	The research presents the evolutionary steps concerning customer behavior from the last five centuries. It was highlighted that the new collaborative networked environment represents a future tendency, and it should be further explored.	
(Romero & Molina, 2009)	The research presents a framework to create experience-centric networks. It is recognized as a trend, and a continuable behavior for the future, that companies implement the co-creation methodology with customers, seeing them as valuable partners in innovation creation, development, and implementation.	Further studies should address the gaps left on the obstacles for the active involvement of customers and communities when executing collaborative networks.
(Silva et al., 2012))	The research presents a reference ontology of user profile representation in a community of practice framework. It provides virtual community action to	Further studies should refine the ontologies to evaluate the concepts and relations proposed genuinely.

Author and Year	Paper Contribution	Future Research
	develop collaborative learning by using technology tools.	
(Zhang et al., 2013)	The research characterized information provided on Twitter by its users to distinguish the talking behavior and provide an organized overview of the classification of the information offered.	Further studies should improve the methodology developed and experiment with it on other social media networks.
(Pereira et al., 2020)	The research proposed an ontology for the front end of innovation (FEI20) in a comprehensive and commonly understood vocabulary.	Further studies could investigate the remaining unanswered questions and relations left by the FEI20.
(Lofty et al., 2016)	The research proposed a framework that integrates sentiment data, extracted from customer's opinions, and corporate data, obtained from an organization.	Further studies could include customers' opinions as well as refined techniques to filter features and the inclusion of the content analysis of opinions.

Source: Own production.

After a careful reading of the 41 papers, it was perceived that several researchers had explored the relationship between users, enterprise, and social media networks. It is well known that social media offers a diversity of opportunities that can be explored to increase business effectiveness in internal relations with employees and external relationships with customers.

2.4. Analysis of the literature

Intense studies have been done by researchers on the dynamics of social media networks and discussing the opportunities it has to improve customer-company relations (Wijnhoven & Wang, 1998; Hendriks, 1999; Gourova & Toteva, 2011; Zhou & Wang, 2014; Ponomarev, 2016). Despite the difficulty of thoroughly analyzing how the dynamic customer-company happens due to its constant improvement, and to new technologies being continuously released, as well as new types of social media, it is mostly understood that the correct exploration of a company's social media can bring different benefits. As Chen and Kuo (2017) highlighted, "the popularity of the internet has digitalized the messages in the communication process and allowed real-time transfer and sharing of information." (pp. 57)

Knowledge creation is a transcending process of transforming old boundaries of knowledge into new ones (Nonaka & Toyama, 2003). *Knowledge sharing* is a type of knowledge transfer and can be understood as a communication process (Hendriks, 1999). As Nonaka and Takeuchi (1995) said, *knowledge* occurs dynamically with social interaction. *Virtual knowledge sharing media* has become more frequent due to its capability to "convey new information, instant feedback, the usefulness of clues and

communication channel, degree of personalization and linguistic diversity” all in one place, in one network (Chen & Kuo, 2017, pp. 57).

This research aims to explore the usage of the company’s social media by customers’ direct interaction with the company. To explore those relations, we divided the discussion into two areas, the relationship between social media and customers and the link between the enterprise social media and its employee’s usage. As Chen and Kuo (2017) states, “if the enterprise can effectively utilize social media, then they will be able to host two-way communications, respond to the market quickly and directly, as well as achieve the purposes of relationship management and product designs and feedbacks” (pp.56). It is understood that for a company to generate innovation, all actors should be involved in *knowledge exchange* and *knowledge conversation*; therefore company’s employees and customers need to be engaged with each other to develop innovation (Papa et al., 2018; Chen & Kuo, 2017; Brem & Bilgram, 2015; Nieves & Osorio, 2013; Gourova & Toteva, 2012; Shu et al., 2011; Culnan et al., 2010).

The relation between social media and customers

Social media can be seen as a platform channel that can be used by the customer to generate content (Chen & Kuo, 2017). Extensive research has been done to explore the depth of this relationship as well as the benefits and potentials it could have. Marketing campaigns through social media are the most common use of the company’s social networks. The objective is to increase the awareness of the enterprise, make the customer-company relationship more profound and more likable. Chen and Kuo (2017) summarized in a table some of the findings in the literature (Table 3).

Table 3 - Social Media Research Compilation. Retrieved from Chen and Kuo, (2017), pp.57.

Research	Related Studies
Companies utilizing social media strategies	Kane et al. (2009); Dunn (2010); Dutta (2010); Piskorski (2011); Kaplan and Haenlein (2010); Mangold and Faulds (2009)
The operation mode of social networking sites	Enders et al. (2008)
Concerns associated with social media usage	Mansfield-Devine (2008); Danciu and Grosseck (2011)
Effectiveness of using social media	Xiang and Gretzel (2010); Smith (2010); Kaplan and Haenlein (2012); DeAndrea et al. (2012); Purdy (2011)
User acceptance levels toward social media	Correa et al. (2010); Cheung and Lee (2010); Parra-López et al. (2011); Lee and Ma (2012)
Enterprise acceptance levels toward social media	Michaelidou et al. (2011); Alikilic and Atabek (2012); Fischer and Reuber (2011); Liu and Kim (2011)

Source: Own production.

The interaction between user and company using social media networks as a channel of communication can provide fundamental knowledge created through collective wisdom and creativity by *knowledge sharing* between users on the same platform (Culnan et al., 2010). This interaction has been intensively studied; researchers explored what are the customer's motivations when sharing their experiences on virtual platforms and how this could be incentivized, what are the fears and risks for sharing information and what could be the purpose of the insights collected (Gourova & Toteva, 2011; Brem & Bilgram, 2015; Glogowska et al., 2016; Ernst & Brem, 2017; Mourtzis et al., 2019).

It is also well determined that the head of this sharing movement is usually a lead user (Ernst & Brem, 2017). The lead user theory presented by Von Hippel in 1986 helped identify the engaged user, that was ahead of time in terms of the perception of future needs and trends of the market. Applying this theory on user's interactions in companies' social media networks, it could identify improvements or new ideas based on demands not yet addressed by the company's products. As Romero and Molina (2009) presented the discussion that "mass-customization, personalization, customer interaction, and open innovation trends will continue as early-strategies of value co-creation" (Romero & Molina, 2009, pp.411). Companies should explore interactions with customers on online networks to increase relevance and customer satisfaction.

The phenomena of identifying new opportunities based on knowledge shared by a community, or lead users or customers, can open new opportunities for the development of innovative concepts. Those innovative concepts, when emerged by community knowledge, can be understood as an open innovation phenomenon (Ernst et al., 2013). Recently, the perfect space for this discussion and co-creation to happen are social media networks due to its characteristics of providing *knowledge sharing* and therefore, *knowledge creation* in an open space, easy to be accessed and with no costs to the customer (Pohjola & Puusa, 2016; Gourova & Toteva, 2011).

In social media networks, there is no longer a fixed role as who can publish feedback or *share knowledge* in a shared space (Vollenbroek et al., 2013). That virtual open space allows free interaction from its users, where anyone can contribute to anything, create topics, or start new trends discussions. Ernst et al. (2013) discussed that in this "wiki-based system," no distinction is made between authors and readers; all of them have the same rights for creating, editing, and reading any content. Vollenbroek et al. (2013) argued that in some cases the *knowledge co-created* in those environments could be so "rich and abundant" that business would not need to offer innovative solutions to their customers because they, themselves, would be already creating and demanding it.

The user, or customer that is deeply engaged in discussions and share its opinions with other users can be considered a *lead user*. On the search viewing lead user and knowledge sharing as keywords, we found a diversity of papers that developed models of analysis or conceptual frameworks to find this type of user, as netnography and crowdsourcing approaches, to analyze their contributions to companies. As Churchill et al. (2009) determine, "*lead users* are facing needs for products and services that don't yet exist on the market" (Churchill et al., 2009, pp. 7).

Scholars deeply discuss the relation between lead users' feedbacks and open innovation concepts. Different researchers recognize that this relation can be more efficiently observed over the manifestation of it through the usage of social media as a channel of communication (Ernst et al., 2013; Zhou & Wang, 2014). Therefore, we found a diversity of conceptual models used to determine who are the lead users, what actions companies can do to motivate users to become lead users and share their thoughts, and why it is profitable for companies to invest in the relationship with them.

The most common way of interaction and understanding this collective knowledge is through focus groups. The usage of social media networks to identify those lead users are an affordable alternative. Still, it can only work if the company's lead users utilize social media networks to share their knowledge (Ernst & Brem, 2017). There is an extensive literature that seeks to understand the factors that can instigate or inhibit lead user shared knowledge on social media; we can highlight two main elements: how trustful is the environment where the lead user will share its opinion, and what is the purpose of that interaction user-company-product-service in question (Brem & Bilgram, 2015; Michaelides et al., 2013; Pattanaik & Chatterjee, 2009).

As Ernst and Brem (2017) discussed, the company's lead users are fundamental to drive innovation because they can "simultaneously offer insights into both product trend and future user needs." Those users can provide and encourage user-user discussions on improvements to existing products and services as well as identify new opportunities for investment for the company's offer.

Another aspect that is also explored in this discussion is the relation of the company's social network and its employees, the communication inside the company it is also fundamental for creating and implementing innovation.

The relation between enterprise social network and employees

The enterprise social media is the usage of similar social media tools to obtain an active communication channel between employees and managers to increase knowledge sharing (Chen & Kuo, 2017). It is also intensely discussed the real consequences of this relationship between employees and employers, as well as the real potential it can offer to companies are.

Some researchers provide an interesting discussion on the relevance and the correct usage of the enterprise social media network (Wijnhoven & Wang, 1998; Ashraf & Javed, 2014; Mourtzis et al., 2019; Aromaa et al., 2020). We found a diversity of studies that explored different ways of stimulating the employee to increase participation and knowledge sharing performance on social media networks (Gourova & Toteva, 2011). Others explored the motivation behind this behavior and how it could be changed to increase its potentials (Ernst & Brem, 2017). It is also intensely discussed that motivation is vital to produce relevant knowledge sharing, and it should be promoted for all the individuals involved on the co-creation of this new knowledge, from customers or non-customers to employees and managers (Gourova & Toteva, 2011; Khan & Khan, 2019)

By exploring the motivation behind each individual or group of individuals, the employee and the user have a fundamental role for the contribution of knowledge and *knowledge creation* to the development of the new concepts or products (Mourtzis et al., 2019; Aromaa et al., 2020). Different researchers argue that to drive innovation, the company must explore knowledge provided by the user in a direct exchange, as well as the expertise brought from their external and internal perspectives (Simon & Tellier, 2019; Khan & Khan, 2019; Ashraf & Javed, 2014; Vollenbroek et al., 2013; Shu et al., 2011; Shutte & Preez, 2008).

Social media networks represent the ideal place to collect this knowledge. As Chen and Kuo (2017) discussed “if the enterprise can effectively utilize social media, then they will be able to host two-way communications, respond to the market quickly and directly, as well as achieve the purposes of relationship management and product designs and feedbacks” (Chen & Kuo, 2017, pp.56-57). This dynamic can be applied for user-company and employee-company relationship, and it should be stimulated by the company (Shutte & Preez, 2008).

Considering an employee as an individual, its personal and professional relationship with surrounding individuals can generate the dynamics highlighted by Nonaka and Takeuchi (1995) that provide *knowledge creation*. The interactions of managers with outsiders and insiders allow the recognition of new knowledge and insights that can be adapted and shared with other managers to create knowledge and innovation (Shu et al., 2011). To control or synthesize this *shared knowledge*, companies can also invest in private social media networks. Therefore, employees can share among themselves their thoughts and updates on internal processes and give valuable feedback to improve the internal systems (Aromaa et al., 2020; Mourtzis et al., 2019).

It is commonly understood that exchange and a combination of existing knowledge and new knowledge can drive innovation. By combining knowledge provided by employees and users, a company can offer integration and personalization of its services and, therefore, gain engagement. As stated by Gourova and Toteva (2011), “nowadays, social media is increasingly supporting innovation and is behind most open innovation processes, and user co-creation activities” (pp. 231). Social media represent the perfect place for employees and users to share and develop a closer relationship with the company.

2.5. Conclusion

Despite the existing discussion on lead users and the usage of social media, its relations with innovation, the potential to co-create, and co-innovate inside the community of users, there is still a diversity of questions that remain unanswered and uncertain. A recent area of study can be considered social business intelligence that explores the knowledge created on social media by the interaction enterprise-customers (Lofty et al., 2016). Companies can execute this service or contract a specialized company to provide the analysis and reports considering the knowledge created on the company’s social media. Despite intense research, it was not possible to find a consistent model that describes how knowledge is shared in social media, how this knowledge is used for

innovation, and who are the actors involved in this process. Therefore, it represents a gap to be explored and investigated.

3. Methodology

3.1. Introduction

This chapter presents the approach used to conduct this study while exploring the encountered gap: the lack of a consistent model that describes how knowledge is created in social media and how this knowledge could be used for innovation opportunities. Following a multi-disciplinary approach, we performed a review of the literature analyzing 41 papers retrieved from Scopus. Then we used a qualitative methodology to design a solution to answer the gap.

3.2. Research Question

In the literature concerning social media, we understood that in the process of knowledge, creation, and innovation was related to lead users, social networks, and social media platforms. To fully understand the perspective of the knowledge creation process in social media, we advanced on the literature reading and formulated one main question we would like to explore:

How can one use the knowledge shared in a company's social media to identify innovation opportunities?

3.3. Research design

The design science approach presents the described environment and its possible usability (Hevner et al., 2004). The review of the literature highlighted four themes: social media, lead users, social networks, and innovation. We searched which building blocks underlined the knowledge sharing in the company's social media networks and how those components fostered innovation opportunities. Therefore, this study explored those blocks to create an artifact following the Design Science Process presented by Peffers et al. (2006). We created an ontology as the artifact, representing a consistent model to describe how knowledge is created in the company's social media, their key actors present in this relationship, and how their co-created knowledge could be used to recognize innovation opportunities.

There are different methodologies for the development of ontologies, widespread and mostly used, and normally task-specific (Zhou et al., 2004). Following the 101 Ontology Development Methodology presented by Noy and McGuinness (2001) which considers the influence of the environment and surroundings that affect knowledge creation and the knowledge base explored in the literature, we aimed to extract and build our social media knowledge ontology (Peffers et al., 2006; Noy & McGuinness, 2001).

A descriptive enterprise can be understood as a philosophical ontology that is focused on taxonomy and is essential to develop and use knowledge-based systems (Zhou et al., 2004). As Pereira et al. (2020) explain, “an ontological model is much more than a classification of knowledge into categories,” it is the visual map of concepts from different terms, organized to construct new knowledge. Therefore, the creation of an ontology could provide a consistent model to describe knowledge creation in a company’s social media.

The process for the development of the proposed ontology considered the definition of the domain proposed and the scope was defined by the competency questions, that are “a list of questions that a knowledge base based on the ontology should be able to answer” (Noy & McGuinness, 2001, pp.5). Then, it was also used the integration and refinement methodology used by Zhou et al. (2004) to explore the users and the language used in the ontology. The content was based on the evaluation of documentation found in the literature. A high-level skeleton of the ontology was initiated, conceptualized by the acquired knowledge found in the literature research. To demonstrate the consistency of the ontology, a scenario was created. We aimed to demonstrate the usability of the ontology and to make it available for further use by society.

The ontology construction

As described in Table 4, we constructed our ontology in the following steps: (1) defined a theme to be explored in literature, (2) elaborated two research questions to be answered, (3) performed a conceptualization of the knowledge blocks found, (4) designed an ontology skeleton of the integration of the building blocks found, (5) asked for specialists to evaluate the proposed ontology and (6) performed the implementation of the ontology in a scenario also assessed by specialists.

Table 4 - The ontology development process. Source: Adapted from Pereira et al. (2020) and Noy & McGuinness (2001).

Explored theme	Social media, lead user, social networks and innovation
Research questions	Based on the knowledge acquired from the initial literature
Conceptualization	Building blocks extracted from the literature review
Integration	Initiate a high-level skeleton ontology
Refinement	Analysis and refinement of the ontology skeleton
Ontology in use	Documentation and implementation of the ontology created

To develop a framework using a common language to conceptualize the different thematic explored in this study, following the Ontology Requirements Specification suggested by Suárez-Figueroa et al. (2009), we elaborated five competence questions to be answered. Table 5 describes the specifications of the ontology created by this study.

Table 5 - Ontology requirements specification. Source: Adapted from Suárez-Figueroa et al. (2009).

Identified purpose	Visual conceptualization of the relationship between social media, lead users, social networks, and innovation.
Identified scope	Create a conceptual map for knowledge creation in social media and understand how it could be used to thrive innovation opportunities.
Identified implementation language	The Unified Modelling Language (UML) using building blocks of concepts found in the literature review with inputs given by specialists on the field.
Identified intended end-users	User 1: Scholars. User 2: Enterprises and Consultants.
Identified intended uses	Use 1: Have a clear visualization of the dynamics of knowledge creation in the company's social media network. Use 2: Visualize how this knowledge may be used to produce innovation inside the enterprise.
Identified requirements: Groups of competency questions	Q1: Does the Ontology explain the dynamics of knowledge creation between individuals? Q2: Is the Ontology describing how knowledge is created in social media networks? Q3: Does the Ontology explain the role of the customer in social media networks? Q4: Is the Ontology describing how knowledge can be extracted from social media networks? Q5: Does the Ontology explain how the extracted knowledge can be used by enterprises for innovation?

The objective of the designed ontology is to provide a visual understanding of how knowledge is created when using social media networks. Following Holsapple and Joshi (2002) categorization of ontology design, this study uses three different approaches, (1) the inspirational approach discussing the need of the ontology, (2) the synthetic approach that uses a base set of ontologies. No base ontology was used for the elaboration of the presented ontology. Still, this study performed a synthesis of the building blocks available in the literature review and some of the concepts of the Front End of Innovation Ontology (FEI2O) produced by Pereira et al. (2020). It was also performed (3) the collaborative approach that considers multiple specialist's points of view about the thematic.

The ontology evaluation

Our ontology follows the inspirational approach; it presents a new conceptual description of knowledge creation in social media. To evaluate it, we applied the descriptive methodology suggested by Hevner et al. (2004) that used *informed arguments* using the building blocks retrieved from the research in the literature and a detailed *scenario* constructed to demonstrate the utility of our ontology.

The scenario describes the interaction on the social media of a fictional company. The company is specialized in bakery and sells frozen products for medium companies as supermarkets and small companies as coffee shops. During the COVID-19 pandemic, it started to sell its products in their social media networks, also allowing end-customers to buy directly from their website. Since it was a very recent change in the company's selling

structure, the company asked its customers for feedback about the product and, if any, what changes the company could execute to provide more satisfaction for the customers.

The application of the designed ontology in the scenario simulates how this study could be applied in different companies and situations.

3.4. Conclusion

This study aims to facilitate and support the interaction between users and companies. A stronger customer-company relationship can provide knowledge co-creation and innovation opportunities as well as improvements for existing elements offered by the company. Using social media networks as a channel for this relationship and knowledge sharing provides an easy and low-cost place for this interaction to happen.

This chapter describes how our ontology was designed and what were the questions we aimed to answer with it. The company used in the fictional scenario created for the evaluation of the ontology is described.

4. An ontology for analyzing knowledge in social media

4.1. Introduction

This chapter describes the designed ontology, divided into three sub-ontologies according to their perspective of analysis. This study considers that for a company to innovate, it needs to produce or create something new or different, aiming to provide improvement for the user or the society. As described by Khan and Khan (2019), “innovation has become a necessary condition to bring change” (pp. 1) and improvement to our society. There is a diversity of ways for companies to find innovation opportunities, and the usage of social media is one of those. This study explores this channel of communication by creating an ontology that explores the role of the customers and companies when co-creating and sharing knowledge on the company’s social media.

Social media networks offer a possibility to retrieve innovation opportunities, representing a solution that can be used by any company due to its reduced cost and low complexity usage (Gourova & Toteva, 2011). To properly employ the usage of the company’s social media, the enterprise only needs to invest time and dedication to construct its presence in social media networks (Culnan et al., 2010).

4.2. Proposed Ontology

The developed ontology explores three concepts from different perspectives; the first one is the knowledge creation in the individual perspective, connecting the various actors and their relationship to share and create new knowledge. The second concept explores the customer and its role in social media networks from the individual perspective, the production of knowledge, and its interactions with other individuals.

The third concept explores the knowledge created in social media from the enterprise perspective, how it may be extracted, and which actors are involved in the process. The objective of our study was to unify the concepts found in the literature review to understand where innovation may happen, which actors are involved, and what dimension they operate.

We proposed an ontology using common language and identify critical blocks of knowledge using colors. The colors demonstrate that the fundamental concepts can appear in more than one section, and they can connect in the sub-ontology schemes. The proposed ontology focused on describing how innovation may be encountered in a

company's social media, and what relationship it has with the company's customers. For this theoretical exploration, the ontology was divided into three sections: i) knowledge creation process, ii) customer roles and dynamics in social media, and iii) enterprise social media knowledge extraction. We discussed the actors of the knowledge creation process in the company's social media and what type of role they performed.

We focused on finding innovation opportunities from the customer-company interaction on social media. Our study used concepts defined in the FEI2O, the Front End of Innovation Ontology developed by Pereira et al. (2020). We aimed to understand where innovation could be found in social media and how companies may use this information to apply in the innovation process.

4.2.1. The knowledge creation

The actor was identified as the central point of the knowledge creation process; therefore, we explored the roles performed by this actor, using the definition of the FEI2O: Actor developed by Pereira (2017) and, thus, represented by Actor. We explored the role of the actor in the knowledge sharing process on the company's social media and how this interaction was performed with the company's social media. Once the exploration of the actors and their relationship with the company's social media was completed, we investigated the internal role of prospecting knowledge from the company's perspective on its own social media network.

We elaborated on a domain model of the different relationships between customers and employees, how the knowledge could be created and extracted from the company's social media and what types of roles the companies should play to incentivize the knowledge sharing process.

As proposed by Nonaka and Toyama (2003), knowledge creation is the capability to “transcend the boundary of the old into a new self by acquiring new knowledge” between individuals, groups, organizations, and others. The creation of knowledge is constructed through interactions between parties, where everything can influence these dynamics. From the environment to the common language used in this process, one can find a diversity of barriers to sharing knowledge and, therefore, influence by limiting the process of knowledge creation.

The conceptual blocks illustrated in Figure 1 were extracted from the literature. The knowledge creation sub-ontology proposes a hypothesis of the relationship between the individual, their groups, and the community. The knowledge created and shared, the barriers that could be encountered and the different roles that a user can have when creating new knowledge (Pereira et al., 2020; Papa et al., 2018; Chen & Kuo, 2017; Andersen & Morch, 2016; Pohjola & Puusa, 2016; Brem & Bilgram, 2015; Silva et al., 2012; Chu & Lin, 2011; Kozinets, 2010; Nonaka & Toyama, 2003).

The FEI2O: Actor (red box) itself *builds* knowledge (purple box), which may be divided into tacit or explicit knowledge (Figure 1). With the process of *socialization* among Actors, new knowledge is created and can be *internalized* and *externalized* to the group that the Actor belongs to. The group also *builds* new knowledge. The community (orange box), which *consists of* groups, *needs* community management (yellow box) from

other individuals to organize the knowledge sharing process. Therefore, it *builds on* group dynamic techniques.

The Actor has different roles when it comes to the knowledge creation process; it may act as a gatekeeper (light yellow box) of the information and articulator of the participants that interact in the environment where the knowledge sharing is performed. It may also act as a netnographer (dark grey box), which is an individual that performs netnography, and it may also act as a customer (blue box) that can have different roles and relations with other Actors and the environment where it operates.

The Actor faces different dynamics that allow or limit the knowledge to be shared; those dynamics are known as the knowledge sharing behaviors, which are *limited by* barriers to knowledge sharing.

Knowledge creation is a synthesizing process where an organization can interact with individuals and their surroundings to overcome barriers faced by an organization (Nonaka & Toyama, 2003). Organizational knowledge creation is the process of making knowledge available and amplifying it with individuals' contributions, as well as adapting and connecting it to the knowledge system of an organization (Nonaka & Krogh, 2009).

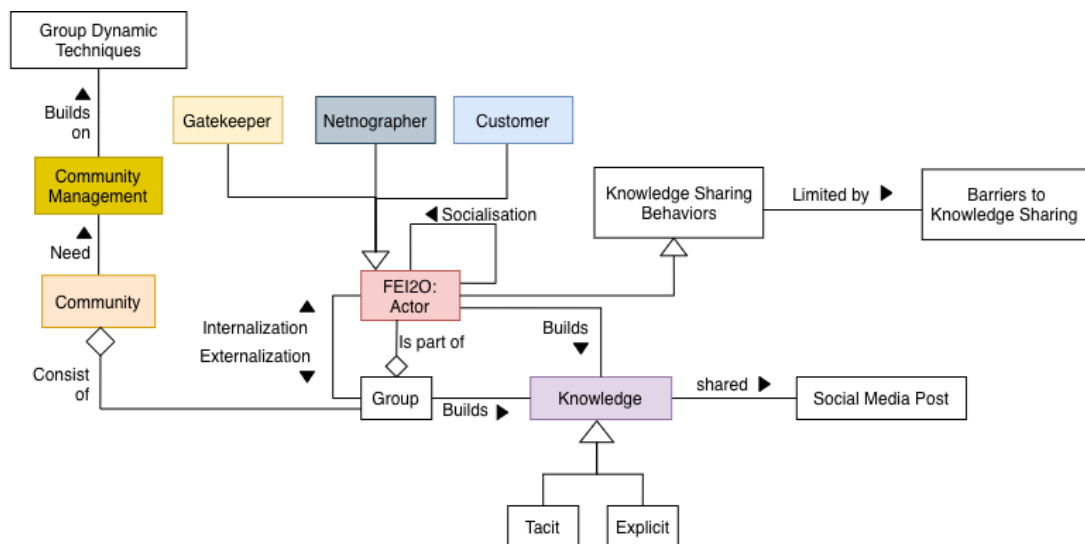


Figure 1 - Knowledge Creation Sub-ontology proposed by this study. Source: Own production.

The central element of this process is the Actor; it acts as an individual that performs actions in the FEI process. It may assume different roles according to the analyzed point of view, defined by Pereira et al. (2020). For its functions in society, it may perform actions and interactions with other individuals (actors) acting as an entrepreneur, an employee, a customer, a user that may assume the role of a lead user (Ernst & Brem, 2017; Brem & Bilgram, 2015). The government and a specific community can also act as a FEI2O Actor in the role of a stakeholder (Pereira et al., 2020).

The new knowledge creation builds on a mix of tacit knowledge, which is produced by practical actions, and the explicit knowledge, which is provided by discursive acts. The process starts with Socialization, the conversion of new tacit knowledge through an actor's shared experiences in daily social interaction. This knowledge is shared in explicit

knowledge, and then shared throughout an organization with the internalization process. The tacit knowledge is transformed in explicit knowledge through the externalization process; then, it is collected inside and outside the organization, combined, accomplished through the combination process that creates new explicit knowledge (Nonaka & Toyama, 2003).

The Actor can have different roles when sharing knowledge, it can act as a customer and as a gatekeeper, being responsible for creating criteria and making decisions concerning the future of the project (Pereira et al., 2020). The gatekeeper controls the information flow, connecting different actors (Aboal et al., 2018). This connection can be made in two ways, by protecting actors from unnecessary information, and by retaining important information (Andersen & Mørch, 2016). The actor can also perform a netnographer role; in this case, the actor connected to the enterprise plays an empathic qualitative analysis approach using publicly accessible data obtained from user conversations in social media. The netnographer collects customer opinions concerning the products or services offered by the company, or new needs yet to be considered to create new knowledge to be used by the enterprise (Brem & Bilgram, 2015; Kozinets, 2010).

The different forms of knowledge shared, among the different roles played by the actor, consist of the customer knowledge sharing behavior. Those are the essential elements that can promote or inhibit the sharing experience in social media, and that are a reflection of the customer sharing habits adopted in daily life. The knowledge sharing barriers can be functional or psychological barriers representing the resistance factors for this exchange to happen (Chen & Kuo, 2017).

Communities are formed by groups that are created by actors. Those are organized by managers that perform community management. This group has specific behaviors that can be understood as the group dynamics, and it consists of a set of norms, roles, and relations performed by its members (Pohjola & Puusa, 2016).

Therefore, the knowledge creation process has, as a central element, the actor, and it can be distinguished among other actors by their role in managing the information, in this case, shared in the social media network. The actor can create, inhibit, or bring more attention to certain types of information, according to the sharing behavior of the group it is inserted in. The different groups that form a community need external management from the company's side. It can generate specific dynamics that can be explored to increase or decrease the discussion and the knowledge creation, all depending on the stimulus given by the company and the types of actors active in the company's social media.

4.2.2. The customer roles and dynamics in social media

The company's main objective is to generate value to its customers, therefore, augmenting its relevance in the market and conquering more customers. Social media can be used as the communication channel for companies to explore their interactions with users and customers. The application of social media for knowledge co-creation between customers' feedbacks and employees' interactions is widely known but still needs to be

explored since the social media dynamics are improved according to the user's new demands (Papa et al., 2018).

Users share information from social media platforms; this action is known as a *post*. The information may be created according to external events that happened outside social media networks, for example, when the user shares a meal it had within its social media platform. It can also be information obtained from internal events that happened inside social media networks, for example, a discussion inside a social media community. Those discussions can be transformed into a social media *thread* when the intensity of interactions from actors is increased.

In this sub-ontology, we used the building blocks found in the literature to describe the interactions between the customer, the posts on social media, and the generation of threads (Figure 1). We presented the different roles of interactions that the user has inside the company's social media and what types of information or collaboration could be developed and extracted, in the format of data to be explored by the company (Pereira et al., 2020; Mourtzis et al., 2019; Ernst & Brem, 2017; Andersen & Morch, 2016; Barradas, 2015; Vollenbroek et al., 2014; Vollenbroek et al., 2013; Romero & Molina, 2009; Pattanaik & Chatterjee, 2009).

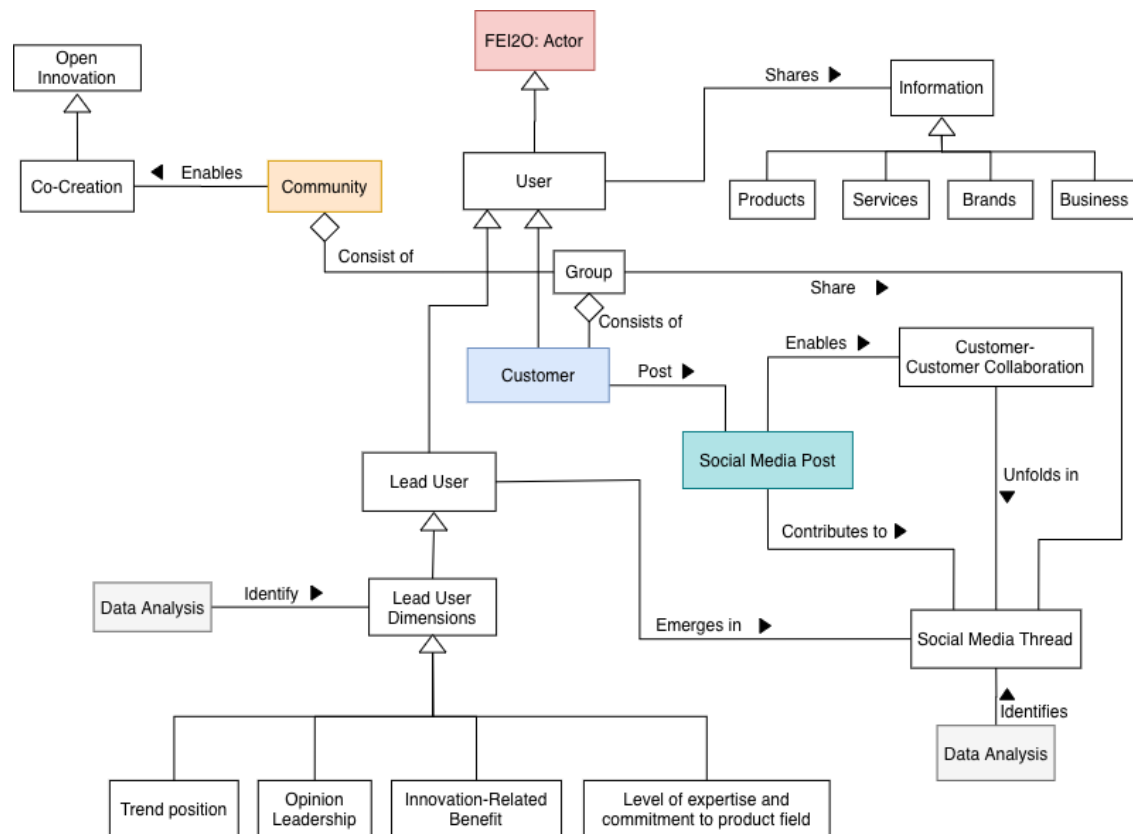
The customer (blue box) *is a* user that *is a* FEI2O: Actor (red box) (Figure 2). This user *shares* information that can be about a product, a service, a brand, or a business. The customer *posts* as a social media post (green sapphire box) that *enables* a customer-customer collaboration and can be *unfolded in* a social media thread. The social media post also *contributes to* the construction of the social media thread. As the data analysis (grey box) is performed, the social media threads are *identified*.

The group *consists of* customers, also *share* a social media thread. The lead user, which *is a* particular type of user, can be *identified* in the process of performing data analysis (white box). The lead user also *has* lead user dimensions. These dimensions can be the customer's trend position, the customer's opinion leadership, the innovation-related benefit perceived by the user, and the level of expertise and commitment to de product field the user has. The lead user can also *emerge in* the social media threads unfolding on the company's social media. The community (orange box), which *consists of* groups, *enables* the development of co-creation, which is a type of open innovation.

The Actor is an individual that acts in the front-end of innovation process. It can disseminate in social media networks, positive or negative information, and opinions regarding products, services, brands, or business (Vollenbroek et al., 2014). That information can directly impact on the reputation of the company and, therefore, influence other customers positively or negatively. Vollenbroek et al. (2013) highlight the "importance in listening to customer's voices," especially when shared on social media, due to their potential to influence directly the reputation of the product, service, brand, or business being commented by its users.

The customer's post on social media sharing information with other customers or the company itself represents new opportunities for knowledge creation and collaboration. As Andersen and Morch (2016) explain, the knowledge shared in social media is a reflection of human behaviors being expressed in the online platforms. The collaboration

experience expressed in social media can be understood as customer-customer collaboration. It can offer new knowledge concerning improvement or innovation that is



being co-created by the company's customers.

Figure 2 – Customer roles and dynamics in social media sub-ontology proposed by this study. Source: Own production.

For instance, if a customer posts a question or a problem on the company's social media and is helped by another customer that had the same difficulty or need for improvements, the company can incorporate this knowledge. The company itself can also reply to the customer and help address the problem. Other users that also have the same need can have access to this information and might decide to adopt that company's solution.

Those discussions on social media posts can become a thread according to the intensity of interactions given by users. Performing data analysis on a company's social media can help identify those threads and then explore the knowledge co-created on it (Vollenbroek et al., 2013). Those social media threads can be formed inside specific groups or communities that provide an open space for knowledge sharing and co-creation to happen (Pohjola & Puusa, 2016). The knowledge co-creation in that free space can drive to open innovation opportunity recognition by using customer-customer collaborations or even customer-company collaboration (Barradas, 2015; Vollenbroek et al., 2013).

The user can also be a *lead user*, that is a specific and particular type of user; they are consumer innovators. The *lead user* has specific dimensions; it must have a trend position

and knowledge in that specific market and expects high benefit from its contributions (Brem & Bilgram, 2015). It must also have opinion leadership, where it presents the capability of influencing other customer's opinions regarding specific subjects. The *lead user* must also offer an elevated level of expertise in that field of action or market; it must have a high commitment to the product field. Therefore, its contribution to future trends can be precious for the enterprise (Ernst & Brem, 2017).

The *lead user* concept and connection to innovation introduced by Urban and Von Hippel (1988) is used mainly by companies to understand future market trends. There are a variety of advantages for companies at identifying their *lead users*, and different methods can be used for this identification, from focus groups with customers to its performance on the company's social media, all possible through data analysis processes.

Therefore, the customer plays a central role in the discussion about the dynamics of a company's social media. It can act as an influencer, assuming the role of a *lead user*, or it can openly collaborate with other customers to create new knowledge. The openness provided by social media networks allows the collaboration between their users-and-enterprises or between users, to happen to develop new knowledge. The co-creation can drive to the identification of co-innovation opportunities and discussions among the related actors; therefore, the company's social media may become an open innovation space for knowledge sharing.

4.2.3. The company's social media knowledge extraction

The openness of social media and the intensive usage that it has, in the recent years, transformed these online platforms in the perfect channel for performing behavioral analysis of individuals and the different roles they play in society (Hjorth, Horst, Galloway & Bell, 2017, pp. 2-4). This behavioral analysis can be understood as the netnography method, that "applies ethnographic research principles to the online environment" (Brem & Bilgram, 2015, pp. 43). The *digital ethnography* understands digital media technologies as tools to be used for extending the ethnographic practice beyond geographical borders as well as allowing the exploration of the complex digital behavior in the everyday basis of the individual (Hjorth, Horst, Galloway & Bell, 2017, pp. 2-4).

After picturing the knowledge creation from the customer's interactions on the company's social media, the extraction of this knowledge is as fundamental as the motivation generated by the company to promote its social media. The Netnography method provides a qualitative analysis of the data generated in social media (Brem & Bilgram, 2015, pp. 43). It performs data analysis of the most exciting interactions for companies, for example, it can analyze the customer-customer interactions, the employee-customer interactions, and it can also help identify the *lead users* in the company's social media.

The netnographer has the central role of the netnography analysis; it represents the individual or group of actors that perform the ethnographic study of the company's social media. By performing qualitative and quantitative analysis of the data extracted from the social media, the company can understand its customers, their motivation and purposes,

as well as their ideas shared on the company's platform (Brem & Bilgram, 2015, pp. 43). This sub-ontology explores the actors involved in the analysis of the company's social media networks to generate customer's behavior analysis and to provide knowledge on innovation opportunities.

We presented the different interactions and the essential elements for the extraction of the knowledge generated from the customer-company relationship in the company's social media (Figure 3). With the concepts extracted from the literature, we visually present how the previous vital elements identified in this study are connected to identify innovation opportunities for the company (Pereira et al., 2020; Aromaa et al., 2020; Mourtzis et al., 2019; Simon & Tellier, 2019; Andersen & Mørch, 2016; Glogowska et al., 2016; Pohjola & Puusa, 2016; Lofty et al., 2016; Brem & Bilgram, 2015; Zhang et al., 2013; Li and Gao, 2012; Romero & Molina, 2009; Pattanaik & Chatterjee, 2009).

The user portraits engagement, which can be classified into three forms: the user may *act* as an influencer, as an engager, and also as a lurker (Figure 3). For the engagement to be effective, it *demands* the usage of commonly understood language and trust. The user posts on social media posts (green sapphire box) in *as* a statement post, a question post, a suggestion post, a comment post, or a miscellaneous post.

The social media post (green sapphire box) is *posted* on social media [platform]. There are two private types of social media, the industrial social networks, and the University co-authorship social media. Social media *can also be* of a mixed type that *allows* experiencing centric network performances. Social media also *can be* of public type.

The user that *posts* a social media post (green sapphire box) *has* a binary association, user relevance [in the network], *with* the perceived information quality. The social media post *has* also a perceived information quality that *impacts* on the social media thread selection criteria that *use* data analysis (white box). The social media post is *stored as* data (dark green box) that *may be* photographic data, audio-visual data, textual data, graphic data, or audio data.

The netnographer (dark grey box) *performs* data analysis (white box), *use* data (dark green box), by *doing* netnography. The netnographer (dark grey box) *does* community management that *produces* social media post (green sapphire box).

The netnography *does* (*qualitative*) social business intelligence analysis by *using* data analysis (white box). This analysis may also include *quantitative* data analysis in performing social business intelligence. The data analysis (white box) *uses* social listening and social monitoring tools that *can be* platform analytics tools, management tool analytics, and standalone analytics. The data analysis (white box) *has* two perspectives [of analysis], the sentiment analysis, and the corporate analysis. The sentiment analysis *can be* positive, neutral, or negative.

The gatekeeper (light yellow box) *accesses* social business intelligence reports that *include* social network insights (green box) and *is* a FEI2O Opportunity recognition. The gatekeeper (light yellow box) *helps disseminate* the social network insights that *are used* by Marketing, Research, and Development (R&D), Product Development, and Sales Teams. The gatekeeper (light yellow box) also *shares with* the Marketing, R&D, Product

Development, and Sales Teams the social business intelligence reports and insights. The gatekeeper is *an innovator role* (from the FEI2O ontology).

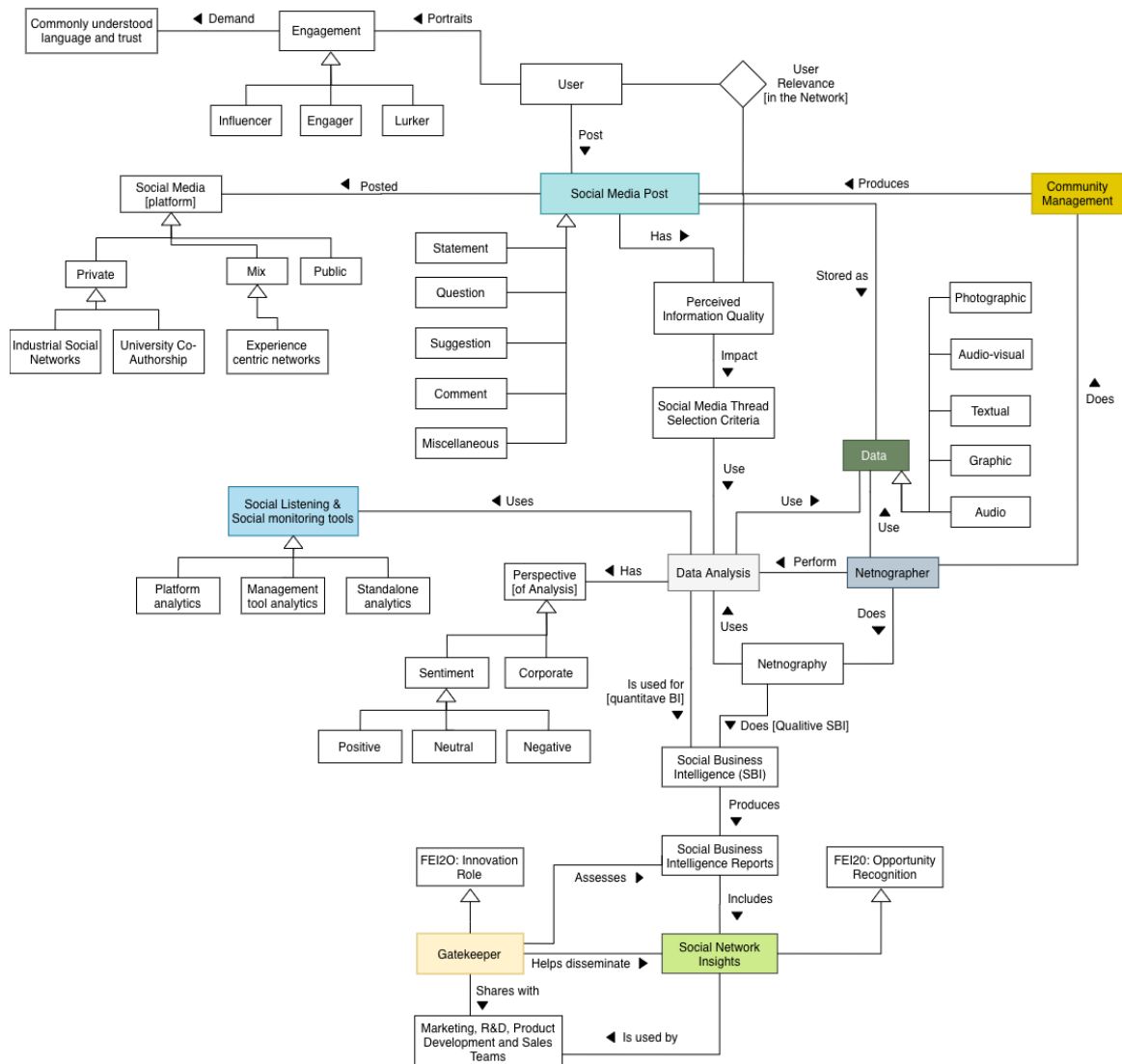


Figure 3 – The Sub-Ontology for enterprise social media knowledge extraction. Source: Own production.

The user's engagement is a measurement regarding the intensity of interactions in social media when sharing knowledge and expertise. Those interactions may happen in different forms, as much as comments, as the creation of discussions among other users', sharing behavior inside the networks, and various other types of action. That intensity of interaction, when measured, differentiate the users according to their contributions for that specific knowledge sharing situation (Mourtzis et al., 2019, pp. 1243).

The user may be classified as an influencer that represents "users that have access to a larger audience and have the potential of influencing it." The user may also be an engager, that represents "those who are more active in the community" and it may also be a lurker that is "people that monitor what you share but do not interact" (Mourtzis et al., 2019, pp. 1243; Sun & Jie, 2011; Crawford, 2009). For the engagement and its

knowledge sharing dynamic to happen among users in the social media network, this communication must use a commonly understood language and trust. With a growing conversation between users, the feeling of trust grows to make the knowledge shared among those individuals more accessible and more relevant (Pattanaik & Chatterjee, 2009, pp. 713).

The posts on social media networks can be in different forms and be stored as different types of data. Based on the approach explored by Zhang et al. (2013) that categorized the information shared on the social media Twitter using the Speech Act Theory, we expanded the encountered types of information sharing for all social media networks. Therefore, we assume that a social media post is information shared by users and it can be divided into five types: (1) a statement, (2) a question, (3) a suggestion, (4) a comment or (5) miscellaneous of the other types of information. (Zhang et al., 2013, pp. 650).

Social media networks can be categorized according to the permission of access. For general users, we have public networks that enable open access for all individuals allowing social networking. They can be private networks with limited access to a specific organization or entity. They can be a mixed type of social network, comprising features with open access and functions with limited access, allowing experience centric network performances (Aromaa et al., 2020; Mourtzis et al., 2019; Li and Gao, 2012; Romero & Molina, 2009).

The private social media networks can be an industrial social network to be used inside one specific organization “to provide useful information such as business value or how to improve knowledge creation and to share to make it more effective for employees” (Mourtzis et al., 2019, pp. 1243). The private social media networks are designed with similar functions and usability of the public social media networks, but with specific features designed according to the objectives of the organization. That organization may be an industrial company or education institution such as a university, for example, the case of University Co-Authorship Social Media (Aromaa et al., 2020; Li & Gao, 2012).

The objective of online social networks is to provide a channel for individuals to share their knowledge and expertise (Mourtzis et al., 2019, pp. 1243). The sharing capability is directly connected to the user’s perceived information quality, how this information is relevant or could be appropriate for other users or a community. The judgment of that information provides a criterion to classify how relevant that information can or could be, how valid it is, how other users could interpret it, and its integrity concerning its accuracy (Glogowska et al., 2016).

The perceived information quality of a post has a binary association with the user, the so-called user relevance in the network. The perceived information quality has an impact directly on the social media thread selection criteria to be used for analysis (Glogowska et al., 2019). A social media thread is the result of a social media post that generated intense interaction from the users of that social media; therefore, it has increased knowledge sharing behavior among the individuals participating in the discussion. The social media thread is most likely the place where companies will find user’s feedbacks and new knowledge co-created.

The user's social media thread selection criteria can be explored by companies using data analysis, using data stored with social media posts. That data can have different formats; it can be photographic data, audio-visual data, textual data, graphic data, or audio data (Brem & Bilgram, 2015). The data analysis can be performed using three types of social listening and social monitoring tools, the platform analytics tools provided by their own social media platform. Management tool analytics offers a form of collecting data for specialists and researches to perform analysis. It can also be performed using standalone analytics, that contains only social media analytics functionalities (Mourtzis et al., 2019; Lofty et al., 2016).

Data analysis has two perceptive of data to be analyzed, the sentiment data provided by users that "extracts knowledge/opinion from text represented by reviews/comments and/or statuses about a particular product of topic" (Lofty et al., 2016, pp. 1). The sentiment data can be used to analyze positive, negative, or neutral reactions, measuring the user's perception about that specific information (Mourtzis et al., 2019, pp. 1243). The data can be used for quantitative analysis of the information on social media, performing a quantitative business intelligence analysis.

The analysis of data is performed by the netnographer, the company's employee that performs the netnography, ethnographic analysis of data shared on social media (Brem & Bilgram, 2015). He also does the community management of the company's social media, producing specific posts with the objective of fostering knowledge sharing behavior among the company's customers (Pohjola & Puusa, 2016). Netnography involves a qualitative analysis using the information retrieved from the company's social media to perform Social Business Intelligence (SBI), that "incorporate social media monitoring and analytics with traditional business intelligence" (Lofty et al., 2016).

The SBI is performed using qualitative information retrieved from the company's social media posts and threads. It allows "an enhanced view of the people who like or unlike a product or service because social data can explain why product X sells so well in a specific place and not well in another" (Lofty et al., 2016). In other words, the SBI reports offer the company an overview of their customer's behavior trends when buying products or its problems that demand specific solutions not yet addressed by the market. Therefore, the SBI reports produce social network insights that are assessed by the gatekeeper, the company's employee responsible for the management of information discussed on the company's social media. The gatekeeper role involves deciding which information is relevant to the company in the user's knowledge sharing behavior (Simon & Tellier, 2019; Andersen & Mørch, 2016).

The gatekeeper is also responsible for sharing the extracted social network insights with the Marketing, Research and Development, Product Development, and Sales Teams. Therefore, the gatekeeper can be understood as an actor in the FEI2O Innovation Role described by Pereira et al. (2020), using the social network insights produced from the SBI reports extracted from the knowledge shared by customers in company's social media posts and threads. The social network insights are also a part of the FEI2O Opportunity recognition described by Pereira et al. (2020), that searches for innovation opportunities for companies and can be applied in the company's social media.

The sub-ontology created to describe the company social media knowledge extraction process highlights essential roles that should be addressed internally by the company as the gatekeeper role, the netnographer role, and the responsibility for performing social business intelligence analysis. By sending the social media posts with the right incentives, the company could make the best out of its customer's knowledge sharing behavior in the company's social media, and from that, extract innovation opportunities co-created from that interaction.

4.3. Exploratory Scenario and discussion

For the validation of the ontology, we adopted the approach suggested by Hevner et al. (2004) to use a descriptive design evaluation method as this method "should only be used for especially innovative artifacts for which other forms of evaluation may not be feasible" (Hevner et al., 2004, pp. 17). This design evaluation methodology was validated in two ways. The first was the use of *informed argument* building on the knowledge available in the literature to build arguments; this was done in the previous paragraph. The second was testing the application of the proposed model to the *scenario* in which the proposed model could be appraised and discussed.

The scenario describes the fictional interactions that could be possible to be seen in a social media post made by the company profile in social media similar to Facebook (

Figure 4). Our fictional post had the objective of motivating the customer's quality perception and maybe discover the lead users using a *question post*. The post was created and published by Ana, a representative of the company's employee that manages the enterprise social media.

The scenario validation was done with the help of experts to include the essential aspects critical in a company's social media. The use of netnography presents some limitations that were included in the scenario, namely: consider only social networks with an amount of posts manageable by one person; understand that the quality and the quantity of posts are not always together; and to have in mind that having one person to perform the analysis, providing a filter to exclude irrelevant information, may not be sufficient if the amount of information increases beyond a reasonable limit since the effort to manage the information would be overwhelming and impossible to be accomplished.

The scenario is limited to a couple of posts to explore an exciting situation. To this end, we needed a trigger to start the thread of comments. Therefore, we created the situation, using as inspiration, a real-live company, and its social media. We used a provocative image of a typical breakfast meal with coffee and one of the company's products, frozen croissants, to ask for customers to collaborate and share their best ideas to use the product. It is offered a prize to motivate interactions. Ana, that performs the role of the netnographer and moderator of the posts on the company's social media, creates the post. Three types of actors feel the motivation to interact with the company's question and among themselves. They decide to share their opinions and knowledge.

The figure describes the scenario using three columns; the first represents the social media post and its comments from the customers. The second describes the roles that

each individual play in the scenario and what steps they thought about following. The third describes the company's internal processes, employees, and the role they played when addressing the information of the thread post.

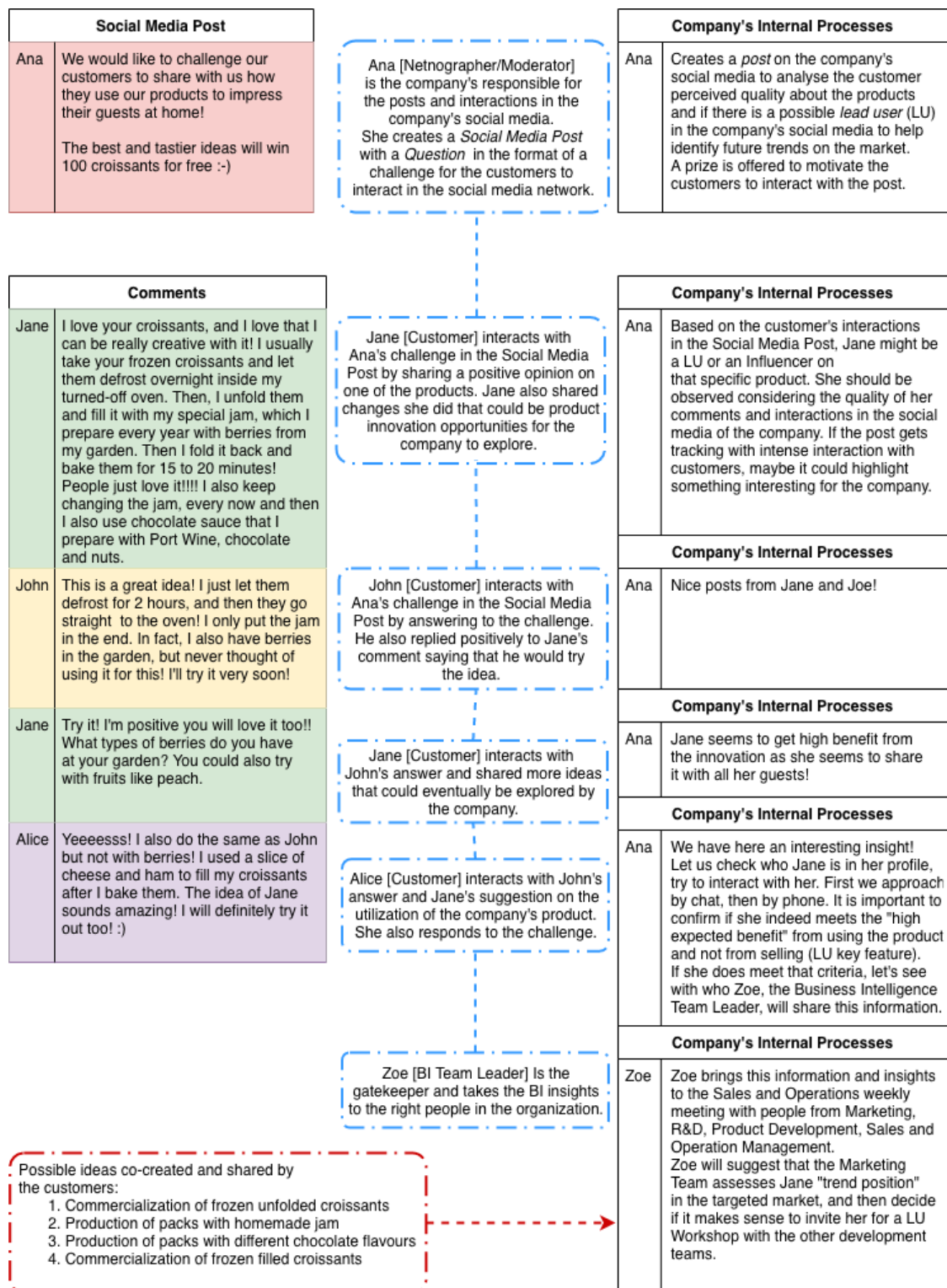


Figure 4 - Scenario Application. Source: Own production.

Figure 5 illustrated the instantiation of the described scenario in the designed ontology. Using boxes with dashed blue border, we identified the items in the scenario as instances of the classes in the ontology.

The user Jane, John, and Alice are customers that share information about the product *frozen croissants*. One of the users, Alice, presents a behavior that may be from a Lead User (LU) by displaying two LU dimensions, the innovation-related benefit and the trend position. If given more context, Jane might also reveal the other LU dimensions. The customers collaborate among themselves regarding the product, transforming the social media post in a thread.

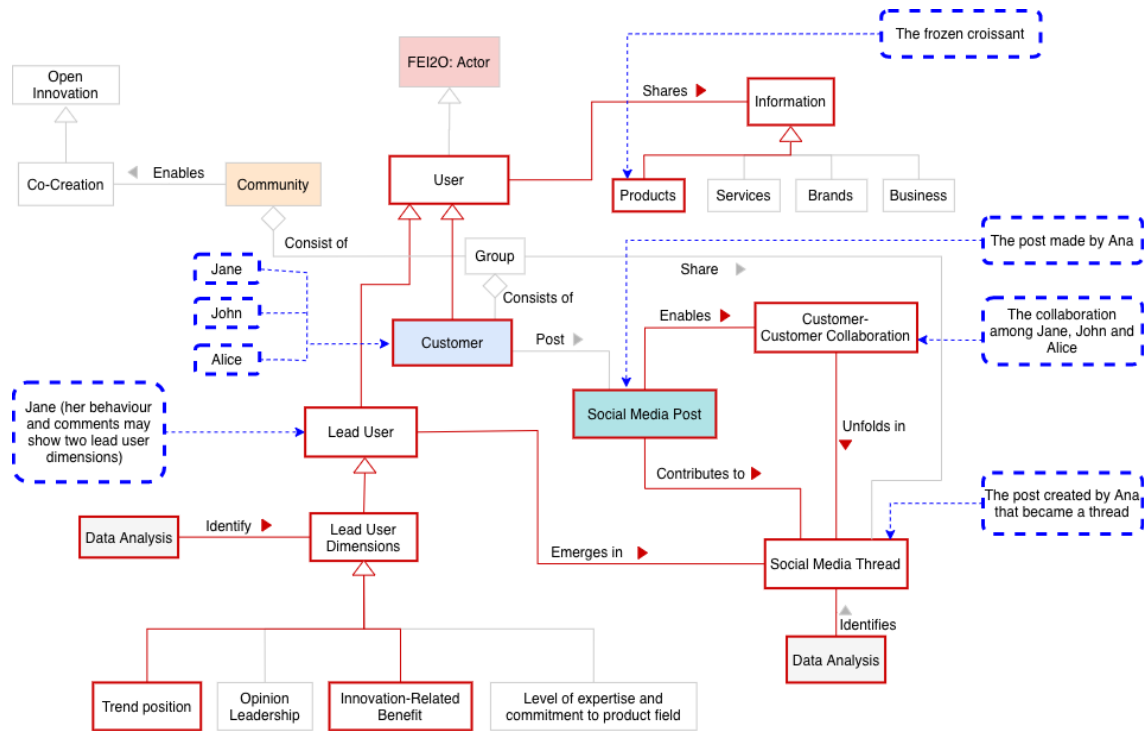


Figure 5 - The scenario in the sub-ontology of the customer roles and dynamics of social media. Source: Own production.

From the customers' comments, the moderator and netnographer Ana performs a qualitative analysis of the textual information shared on the thread (Figure 6). Those comments are positive opinions; therefore, sentiment data is used by Zoe, the company's responsible for using the Social Business Intelligence (SBI) reports and insights, as the gatekeeper.

The company's social media is of a public type. Jane, John, and Alice show interest in Ana's post, and later, in Jane's comment. From the interactions of the customers in the thread, Ana performs the netnographer role in assessing the perceived quality of the users. Ana passes the information for Zoe, who receives the information to receive the Social Business Intelligence reports and insights retrieved from the analyzed thread. The information is then also distributed by Zoe, when acting as a gatekeeper, in the meeting with other teams as Sales and Operation Teams. They will verify if the innovation opportunities retrieved from the comments of Jane, John, and Alice match the company's goals and objectives.

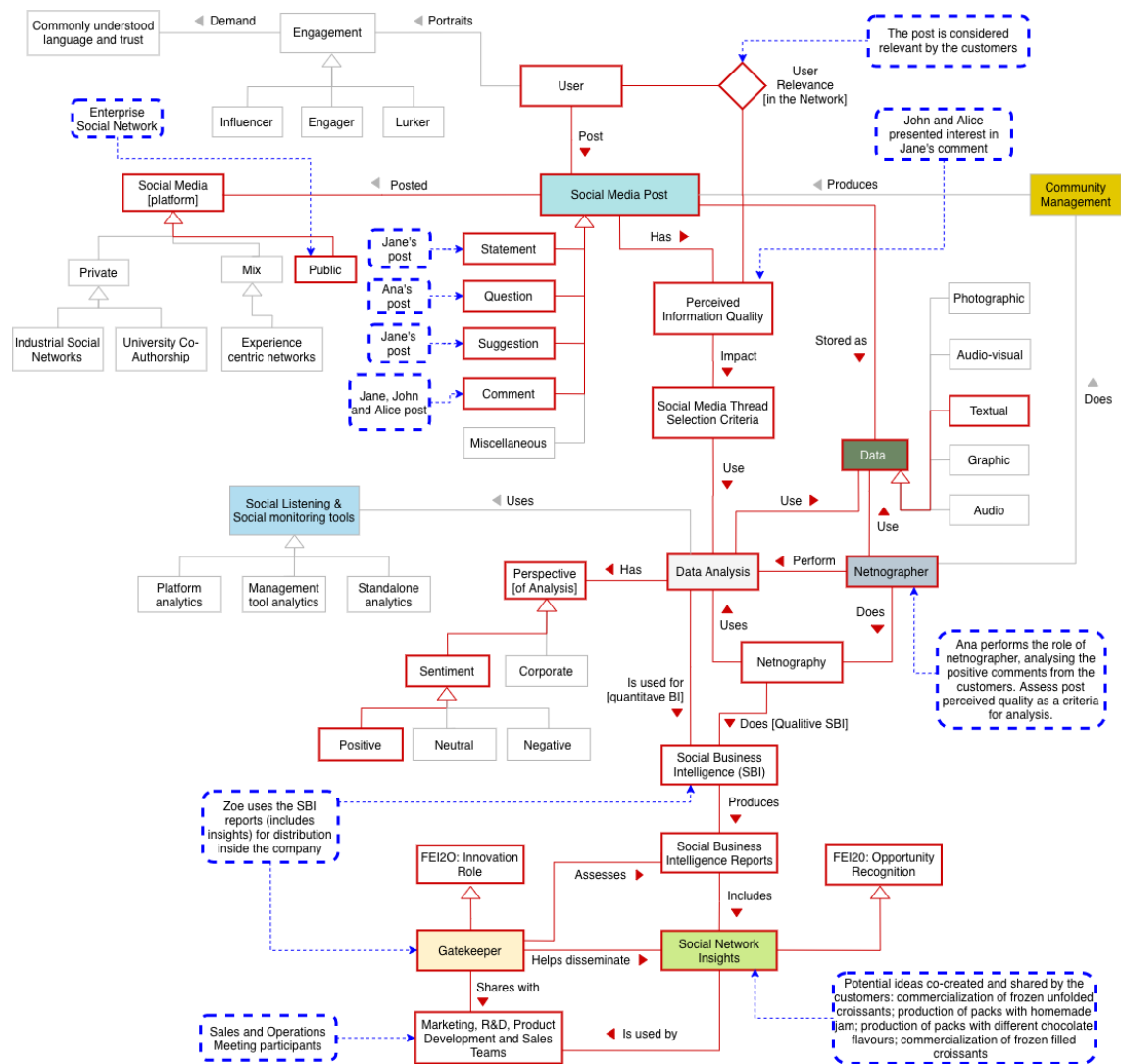


Figure 6 - The scenario in the sub-ontology of the company's social media knowledge extraction. Source: Own production.

In this scenario application, it is especially important to discuss how companies would understand and visualize the ontology. In this context, there are different perspectives that we could apply, namely:

Confidentiality: The explicit use of a cue to start the discussion. In this case, the first post was a provocation, and it could draw the attention of competing companies that could be looking at our company's social media. This means that this approach, if used, should be addressed carefully. However, it is likely that this scenario, or a similar one, may happen without the explicit provocation of the company, as it was used in this case.

Validation of the target audience: When gathering opinions in social media, as in this case, it could be raised the issue of how to extract and validate the profile of the involved users. Since this study was focused on a qualitative analysis, it would be interesting to understand the trustability of the user's profiles. Despite being difficult to retrieve such information, different approaches could be used for this purpose. For example, the use of

direct chat with the customer, followed by a phone call, and, eventually, if found adequate, an invitation for participation on a Focus Group or to a Lead User Workshop.

Confidence in the published information: This is a critical issue in social networks, mainly because influencers play an important role in the market. It is fundamental that the netnographer is aware of this reality and when searching for lead users or thread posts.

The role of emojis: It is essential to address the complexity of performing a correct interpretation of emojis usage. For example, the positive assessment of a "careless" post or statement may be misled as it may be interpreted both as acknowledging the carelessness or criticizing it. This will have to be considered upon the analysis of a thread.

4.4. Replying the research question

This study research question is:

How one can use the knowledge shared in a company's social media to identify innovation opportunities?

This question was detailed as the following sequence of competence questions, to which the developed ontology should be able to respond to:

Q1: Does the Ontology explain the dynamics of knowledge creation between individuals?

Q2: Is the Ontology describing how knowledge is created in social media networks?

Q3: Does the Ontology explain the role of the customer in social media networks?

Q4: Is the Ontology describing how knowledge can be extracted from social media networks?

Q5: Does the Ontology explain how the extracted knowledge can be used by enterprises for innovation?

By the end of the process, the interviewed experts and practitioners validated the ontology. It was further validated by its detailed description based on informed arguments. This was then complemented by the application of the ontology to a scenario later modeled as an instance of the actual ontology. Therefore, it is the author's perception that the research question was answered adequately, despite the limitations below.

4.5. Limitation of the research

The main contribution of this study is the proposal of the Social Media Innovation Ontology (SOMINO) that aims to describe and relate the concepts underlying this knowledge domain. The developing process was not easy since it was impossible to identify a company that performed all the identified steps. We also realized that companies often subcontract Social Business Intelligence reports externally. We consider this a limitation as we would have liked to use a company to test the proposed model.

The second limitation is inherently related to the first. As the option of the real company was excluded, we opted for using a scenario to validate the artifact. Despite the extreme care and detail, put into the scenario, we would have liked to go further.

In the scenario we do not explore the use of audio or video, despite their popularity. We could argue that the text content could be published as a video. However, watching a video usually takes longer than browsing through text information. These types of materials would hinder the netnographer speed of analysis.

4.6. Conclusion

In this study, we designed an ontology that described the process of knowledge creation in a company's social media. It is divided into three parts, the first part that consists of the knowledge creation process itself and its relationship with its actors, how they are connected, and what key aspects can influence that process. The second part explored the centerpiece of the company's social media, the customer, and its interactions with the social media actors and tools for knowledge creation and sharing. The third part explores the internal roles performed by the company to interact with its customers to share knowledge in the company's social media, as well as the types of information that can be extracted from the social network and its potential to recognize innovation opportunities and customer's insights.

The ontology presents the key actors and the central roles that are fundamental for knowledge creation and sharing in the company's social media networks. It offers an overview that a company could use to understand what functions it has and what roles could be missing inside the organization to uncover innovation opportunities within its social media. To validate and demonstrate the ontology, we created a scenario to demonstrate one possibility of analysis for a *post* made on social media. With examples of interactions from customers concerning the usage of a product, we also illustrated the scenario in the second and third sub-ontologies. We addressed how the research question was answered and presented the limitations of this study.

5. Conclusion

This study explored the usage of the company's social media networks that could offer the customer-company relationship and the recognition of innovation opportunities. We explored the key actors and the roles to be performed by the companies to build value from those relationships by recognizing innovation opportunities.

We performed extensive literature research but could not find a consistent model that described how knowledge is shared in social media, how this knowledge could generate innovation, and which actors and roles are involved in this process. From this gap, we formulated our research question: how can one use the knowledge shared in a company's social media to identify innovation opportunities? We used building blocks retrieved from 41 articles to design our artifact using the Design Science Process. Our artifact, the ontology, represents the domain model for knowledge creation and sharing using social media networks, as well as innovation opportunity recognition.

The ontology was divided into three sub-ontologies; the first explores the knowledge creation from the individual perspective, connecting actors and roles in sharing and creating new knowledge. The second explores the customer role in social media and the other functions related to it. The third studied the knowledge extraction from the company's social media and the interactions with different parts. The validation was performed using a descriptive scenario, created from inspirational real-life situations that companies face when using social media.

The demonstration of the ontology aimed providing an example of the utilization of our ontology in the internal analysis of the company's roles and usage of social media. From the feedback and opinions shared by specialists in different areas, we aimed to validate the efficiency and usefulness of the ontology when applied in real-life situations. Further studies must be performed to evaluate the ontology using real-life scenarios and with different conditions from the one we used.

Future research would explore different scenarios and applications of the actors and roles, as well as companies that perform the roles identified by our ontology or that want to play them in the future.

6. References

- Aboal, D., Rovira, F., & Veneri, F. (2018). Knowledge networks for innovation in the forestry sector: Multinational companies in Uruguay. *Forest Policy and Economics*, 97, 9–20.
- Ahmed, Y. A., Ahmad, M. N., Ahmad, N., & Zakaria, N. H. (2019). Social media for knowledge-sharing: A systematic literature review. *Telematics and Informatics*, 37, 72–112.
- Al-Abri, A., Jamoussi, Y., AlKhanjari, Z., & Kraiem, N. (2019). Aggregation and Mapping of Social Media Attribute Names Extracted from Chat Conversation for Personalized E-Learning. *2019 4th MEC International Conference on Big Data and Smart City (ICBDSC)*, 1–9.
- Andersen, R., & Mørch, A. I. (2016). Mutual development in mass collaboration: Identifying interaction patterns in customer-initiated software product development. *Computers in Human Behavior*, 65, 77–91.
- Alikilic, O. and Atabek, U. (2012). Social media adoption among Turkish public relations professionals: a survey of practitioners. *Public Relations Review*, 38, 56-63.
- Aromaa, S., Tsourma, M., Zikos, S., Kaasinen, E., Kreposna, M., Drosou, A., and Tzovaras, D. (2020). User experience of a social media based knowledge sharing system in industry work. *Ahram, T., Taiar, R., Colson, S., Choplin, A., (eds) Human Interaction and Emerging Technologies. IHIET 2019. Advances in Intelligent Systems and Computing, vol 1018.*
- Ashraf, N. and Javed, T. (2014). Impact of social networking on employee performance. *Business Management and Strategy*, 5, 139-150.
- Barradas, L. C. S. (2015, March). Information Technology and Enterprise Integration for the Fuzzy Front End of Innovation. Porto, Portugal: University of Porto.
- Berlanga, R., Aramburu, M. J., Llidó, D. M., & García-Moya, L. (2014). Towards a Semantic Data Infrastructure for Social Business Intelligence. *Advances in Intelligent Systems and Computing*, 319–327.
- Bhimani, H., Mention, A.-L., and Barlatier, P.-J. (2019). Social media and innovation: a systematic literature review and future research directions. *Technological Forecasting and Social Change*, 144, 251-269.

Binz, C., Truffer, B., & Coenen, L. (2014). Why space matters in technological innovation systems—Mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy*, 43(1), 138–155.

Björk, J., Di Vincenzo, F., Magnusson, M., & Mascia, D. (2011). The Impact of Social Capital on Ideation. *Industry & Innovation*, 18(6), 631–647.

Brem, A. and Bilgram, V. (2015). The search for innovative partners in co-creation: identifying lead users in social media through netnography and crowdsourcing. *Journal of engineering and technology management*, 37, 40-51.

Chan, H. K., Wang, X., Lacka, E., & Zhang, M. (2015). A Mixed-Method Approach to Extracting the Value of Social Media Data. *Production and Operations Management*, 25(3), 568–583.

Chen, P.-T., & Kuo, S.-C. (2017). Innovation resistance and strategic implications of enterprise social media websites in Taiwan through knowledge sharing perspective. *Technological Forecasting and Social Change*, 118, 55–69.

Cheung, C. & Lee, M.A. (2010). Theoretical model of intentional social action in online social networks. *Decision Support Systems*, 49, 24-30.

Chesbrough, H., & Bogers, M. (2014). Explicating open innovation: Clarifying an emerging paradigm for understanding innovation. *New Frontiers in Open Innovation. Oxford: Oxford University Press, Forthcoming*, 3-28.

Chu, Y. & Lin, S. (2011). Network ontology and dynamics analysis for collaborative innovation in digital services. *2011 Proceedings of PICMET '11: Technology Management in the Energy Smart World (PICMET)*, 1-4.

Churchill, J., Von Hippel, E., & Sonnack, M. (2009). *Lead user project handbook*. N/A, N/A: Eric Von Hippel.

Correa, T., Hinsley, A.W. and Zúñiga, H. (2010). Who interacts on the web? The intersection of users' personality and social media use. *Computational Human Behaviour*, 26, 247-253.

Crawford, K. Following you: Disciplines of listening in social media. *Continuum*, 2009, 525-535.

Culnan, M., McHugh, P., and Zubillaga, J. (2010). How large U.S. Companies can use Twitter and other social media to gain business value. *MIS Quarterly Executive*, Vol. 9, n^a 4.

Danciu E. and Grossek G. (2011). Social aspects of Web 2.0 technologies: teaching or teachers' challenges? *Procedia Social Behavioural Sciences* 15, 3768-3773.

DeAndrea, D.C., Ellison, N.B., LaRose, R., Steinfield, C. and Fiore, A. (2012). Serious social media: on the use of social media for improving students' adjustment to college. *Internet Higher Education*, 15, 15-23.

Dunn, B.J., (2010). Best buy's CEO on learning to love social media. *Harvard Business Review*, 32.

Dutta, S. (2010). What's your personal social media strategy? *Harvard Business Review*, 51.

Enders, A., Hungenberg, H., Denker, H. and Mauch, S. (2008). The long tail of social networking: revenue models of social networking sites. *European Management Journal*, 26, 199-211.

Ernst, M., and Brem, A. (2017). Social Media for identifying lead users? Insights into lead user's social media habits. *International Journal of Innovation and Technology Management* 14, n° 4 1750022.

Ernst, M., Brem, A., and Voigt, K. (2013). Innovation Management, lead users and social media – introduction of a conceptual framework for integrating social media tools in lead-user management. *Advanced Series in Management*, 11, 169-195.

Fischer, E. and Reuber, A.R. (2011). Social interaction via new social media: (How) can interactions on Twitter affect effectual thinking and behavior? *Journal of Business Venturing*, 26, 1-18.

Fuller, J., Jawecki, G., and Muhlbacher, H. (2007). Innovation creation by online basketball communities. *Journal of Business Research*, 60, 60-71.

Gioti, H., Ponis, S.T. and Panayiotou, N. (2018) Social business intelligence: Review and research directions. *Journal of Intelligence Studies in Business*. 8 (2) 23-42.

Glogowska, D., Feller, J., Csáki, C., and Gleasure, R. (2016). Reputation, User Feedback and perceived information quality in social internet media: an empirical study. *37th International Conference on Information Systems*.

Gourova, E., and Toteva, K. (2011). Raising creativity and participation in innovation and knowledge management activities. *17th International Conference on Concurrent Enterprising*.

Guetat, S. B. A., & Dakhli, S. B. D. (2013). A framework for integration of knowledge and innovation processes. *2013 World Congress on Computer and Information Technology (WCCIT)*, 1–11.

Hendriks, G. (1999). A model of knowledge management and the n-form corporation. *Strategy Management Journal*, 15, 73-90.

Hevner, March, Park, & Ram. (2004). Design Science in Information Systems Research. *MIS Quarterly*, 28(1), 75.

Hjorth, L., Horst, H., Galloway, A., & Bell, G. (2017). *The Routledge Companion to Digital Ethnography*. Abingdon, United Kingdom: Taylor & Francis.

Holsapple, C. W., & Joshi, K. D. (2002). A collaborative approach to ontology design. *Communications of the ACM*, 45(2), 42–47.

Holtzblatt, L., & Tierney, M. L. (2011). Measuring the effectiveness of social media on an innovation process. *Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '11*, 697–712.

James, T. L., Cook, D. F., Conlon, S., Keeling, K. B., Collignon, S., & White, T. (2015). A framework to explore innovation at SAP through bibliometric analysis of patent applications. *Expert Systems with Applications*, 42(24), 9389–9401.

Kane, G.C., Fishman, R.G., Gallaughier, J. and Glaser, J. (2009). Community relations 2.0. *Harvard Business Review*, 39.

Kaplan, A.M. and Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of social media. *Business Horizons*, 53, 59-68.

Kaplan, A.M. and Haenlein, M. (2012). The Britney Spears universe: social media and viral marketing at its best. *Business Horizons*, 55, 27-31.

Kärkkäinen, H., Jussila, J., & Janhonen, J. (2011). Managing customer information and knowledge with social media in business-to-business companies. *Proceedings of the 11th International Conference on Knowledge Management and Knowledge Technologies - i-KNOW '11*, 1–12.

Kayakutlu, G. and Laurent, E. M. (2012). From knowledge worker to knowledge cultivator-effective dynamics. *Federated Conference on Computer Science and Information Systems (FedCSIS)*, 1149-1153.

Khan, N.A. and Khan, A.N. (2019). What followers are saying about transformational leaders fostering employee innovation via organizational learning, knowledge sharing and social media use in public organizations? *Government Information Quarterly*, 36, 1-10.

Klen, E. R. (2009). Co-creation and Co-innovation in a Collaborative Networked Environment. *Leveraging Knowledge for Innovation in Collaborative Networks*, 33–40.

Kozinets, R. V. (2010). *Netnography: Doing ethnographic research online*. Sage publications.

Lee, C.S. and Ma, L. (2012). News sharing in social media: the effect of gratifications and prior experience. *Computers in Human Behaviour*, 28, 331-339.

Li, L., & Gao, X. (2012). Innovation performance of university co-authorship network. 2012 International Conference on Information Management, Innovation Management and Industrial Engineering, 410–413.

Liu, B.F. and Kim, S. (2011). How organizations framed the 2009 H1N1 pandemic via social and traditional media: implications for U.S. health communicators. *Public Relations Review*, 37, 233-244.

Lotfy, A., El Tazi, N., & ElGamal, N. (2016). SCI-F. Proceedings of the 20th International Database Engineering & Applications Symposium on - IDEAS '16, 1–6.

Mangold, W.G. and Faulds, D.J. (2009). Social media: the new hybrid element of the promotion mix. *Business Horizons*, 52, 357-365.

Mansfield-Devine, S. (2008). Anti-social networking: exploiting the trusting environment of Web 2.0. *Network Security*, 11, 4-7.

Michaelides, R., Morton, S. C., Michaelides, Z., Lyons, A. C., & Liu, W. (2013). Collaboration networks and collaboration tools: a match for SMEs? *International Journal of Production Research*, 51(7), 2034–2048.

Michaelidou, N., Siamagka, N.T. and Christodoulides, G. (2011). Usage, barriers and measurement of social media marketing: an exploratory investigation of small and medium B2B brands. *Industrial Marketing Management*, 40, 1153-1159.

Mors, M. L. (2010). Innovation in a global consulting firm: when the problem is too much diversity. *Strategic Management Journal*, n/a.

Mourtzis, D., Xanthi, F., Chariatidis, K., and Zogopoulos, V. (2019). Enabling knowledge transfer through analytics in industrial social networks. *52nd CIRP Conference on Manufacturing Systems*, 1242-1247.

Nieves, J., & Osorio, J. (2015). The Role of Social Networks in Knowledge Creation. *The Essentials of Knowledge Management*, 333–364.

Nonaka, I., and Takeuchi, H. (1995). The knowledge-creating company: how Japanese companies create the dynamics of innovation. *Oxford University Press*.

Nonaka, I., and Toyama, R. (2003). The knowledge-creating theory revisited: knowledge creation as a synthesized process. *Knowledge Research and Practice*, 1, 2-10.

Nonaka, I., & von Krogh, G. (2009). Perspective—Tacit Knowledge and Knowledge Conversion: Controversy and Advancement in Organizational Knowledge Creation Theory. *Organization Science*, 20(3), 635–652.

Noy, N., & McGuinness, D. (2001). Ontology development 101: A guide to creating your first ontology. *Development*, 32, 1–25.

Pajo, S., Verhaegen, P., Vandevenne, D., and Duflou, J. R. (2015). Fast Lead User Identification Framework. *World Conference TRIZ FUTURE, TF 2011-2014* 118.

Papa, A., Santoro, G., Tirabeni, L., & Monge, F. (2018). Social media as a tool for facilitating knowledge creation and innovation in small and medium enterprises. *Baltic Journal of Management*, 13(3), 329–344.

Parra-López, E., Bulchand-Gidumal, J., Gutiérrez-Taño, D. and Diaz-Armas, R. (2011). Intentions to use social media in organizing and taking vacation trips. *Computers in Human Behaviour*, 27, 640-654.

Pattanaik, D., & Chatterjee, J. (2009). Socio-technical innovation and the role of conversation in a digital ecosystem for agricultural extension services in India. *2009 3rd IEEE International Conference on Digital Ecosystems and Technologies*, 709–714.

Peffer, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V., & Bragge, J. (2006). The design science research process: a model for producing and presenting information systems research. In *First International Conference on Design Science Research in Information Systems and Technology*, 83-16.

Pereira, A. (2017). Shaping an Integrative Front End of Innovation (FEI) in a Design Science Approach. Porto, Portugal: University of Porto.

Pereira, A. R., Ferreira, J. J. P., & Lopes, A. (2020). A knowledge representation of the beginning of the innovation process: The Front End of Innovation Integrative Ontology (FEI2O). *Data & Knowledge Engineering*, 125, 101760.

Piskorski, M.J. (2011). Social strategies that work. *Harvard Business Review*, 63, 61-67.

Pohjola, I., & Puusa, A. (2016). Group dynamics and the role of ICT in the life cycle analysis of community of practice-based product development: a case study. *Journal of Knowledge Management*, 20(3), 465–483.

Ponomarev, A. (2016). Recommending tourist locations based on data from photo sharing service: method and algorithm. *18th Conference of FRUCT ASSOCIATION, ISSN 2305-7254*.

Post, C., Sarala, R., Gatrell, C., & Prescott, J. E. (2020). Advancing Theory with Review Articles. *Journal of Management Studies*, 57(2), 351–376.

Purdy, C.H. (2011). Using the internet and social media to promote condom use in Turkey. *Reproduction Health Matters*, 19, 157-165.

Romero, D., & Molina, A. (2009). Value co-creation and co-innovation: Linking networked organizations and customer communities. In *Working Conference on Virtual Enterprises*, 401-412.

Schutte, C. S. L., & du Preez, N. D. (2008). Knowledge networks for managing innovation projects. *PICMET '08 - 2008 Portland International Conference on Management of Engineering & Technology*, 529-545.

Shu, C., Page, A. L., Gao, S., & Jiang, X. (2011). Managerial Ties and Firm Innovation: Is Knowledge Creation a Missing Link? *Journal of Product Innovation Management*, 29(1), 125-143.

Silva, J. L. T. D., Ribeiro, A. M., Boff, E., Primo, T. T., & Viccari, R. M. (2012). A reference profile ontology for communities of practice. *International Journal of Metadata, Semantics and Ontologies*, 7(3), 185.

Simon, F., & Tellier, A. (2019). Creating and sharing knowledge during the unfolding of innovation streams: a social network perspective. *International Journal of Manufacturing Technology and Management*, 33(5), 303.

Smith, B.G., (2010). Socially distributing public relations: Twitter, Haiti and Interactivity in social media. *Public Relations Review*, 36, 329-335.

Suárez-Figueroa, M.C., Gómez-Pérez, A., and Villazón-Terrazas, B. (2009). How to Write and Use the Ontology Requirements Specification Document. *Lecture Notes in Computer Science*, vol 5871.

Sun, J. and Jie, T. A survey of models and algorithms for social influence analysis. *Social Network data analysis*, 23.4, 2011, 177-214.

Todaria, S. (2017, July). *Extending Business Model Ontology to Social Businesses*. Porto, Portugal: University of Porto.

Tseng, F. S. C., & Chou, A. Y. H. (2018). Generating Social Relationships from Relational Databases for Graph Database Creation and Social Business Intelligence Management. *Advances in Intelligent Systems and Computing*, 372-393.

Urban, G. L., & Von Hippel, E. (1988). Lead user analyses for the development of new industrial products. *Management Science*, 34(5), 569-582.

Vollenbroek, W., Constatinides, E., & de Vries, S. (2013). Co-creation in Social Media Platforms: End-users as Innovation Partners - Online Co-innovation within the Open Discovery Space. *Proceedings of the 9th International Conference on Web Information Systems and Technologies*, 1-6.

Vollenbroek, W., Vries, S. D., Constantinides, E., & Kommers, P. (2014). Identification of influence in social media communities. *International Journal of Web Based Communities*, 10(3), 280.

Wijnhoven, F., and Wang, T. (1998). Knowledge logistics in business context: analyzing and diagnosing knowledge sharing by logistics concepts. *Knowledge and Process Management*, 5, 1-16

Wongthongtham, P., & Abu-Salih, B. (2015). Ontology and trustbased data warehouse in new generation of business intelligence: State-of-the-art, challenges, and opportunities. *2015 IEEE 13th International Conference on Industrial Informatics (INDIN)*, 476-483.

Wright, T., Watson, S.K., & Castrataro, D. (2015). To tweet or not to tweet, that is the question – social media as a missed opportunity for knowledge management. *International Journal of Engineering*, 33-45.

Xiang, Z., and Gretzel, U. (2010). Role of social media in online travel information search. *Tourism Management*, 31, 179-188.

Zhang, R., Li, W., Gao, D., & You Ouyang. (2013). Automatic Twitter Topic Summarization With Speech Acts. *IEEE Transactions on Audio, Speech, and Language Processing*, 21(3), 649–658.

Zhou, L., and Wang, T. (2014). Social media: a new vehicle for city marketing in China. *Cities*, 37, 27-32.

Zhou, X., Wu, Z., Yin, A., Wu, L., Fan, W., & Zhang, R. (2004). Ontology development for unified traditional Chinese medical language system. *Artificial Intelligence in Medicine*, 32(1), 15–27.

Appendix A – FEI2O Ontology

The FEI is the initial phase of innovation, it is a multidisciplinary area and it can be used with different approaches. It represents a personalized strategy for companies to identify and implement the innovation process, therefore assuring their relevance and competitiveness in the society. By using a common language, the FEI2O developed by Pereira et al. (2020) “is a domain model as it explicitly describes a domain regarding concepts, properties, and relations of concepts.” The FEI aims to provide a possibility of a starting point for companies to implement changes in their processes.

By exploring different aspects of the customer-company relationship, the FEI2O identifies the entities that perform as an actor in the FEI process. Pereira et al. (2020) identified and described specific responsibilities of the FEI Actor, “perform, to won, to communicate, to borrow, to send and to receive objects in the FEI.” The actor is recognized as a stakeholder, and it can have different parts in the society as an entrepreneur, an employee, a customer, a user, a government agent, or part of a community (Figure 7).

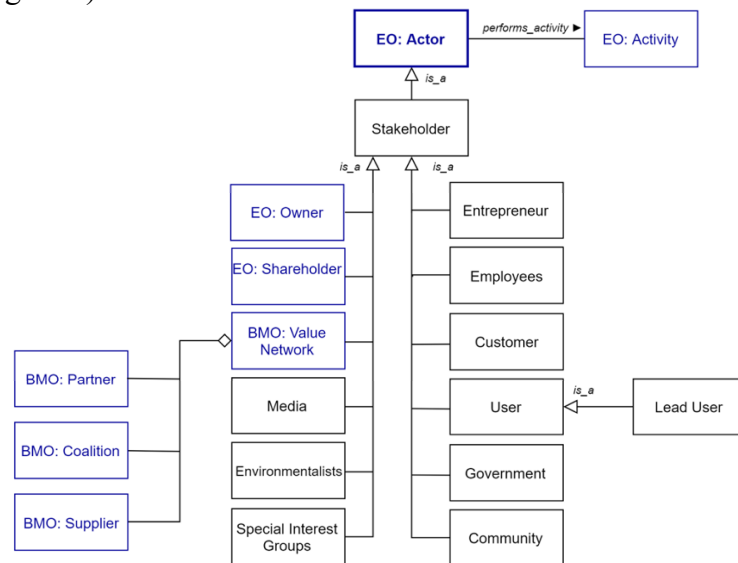


Figure 7 - FEI2O Actor sub-ontology extracted from Pereira et al., 2020, p.123.

The FEI2O also explores the organizational role performed by the FEI2O Actor as being a t-shaped specialist role, a leadership role, and an innovator role (Figure 8). The first refers to “someone who shares knowledge freely across the organization,” the second type refers to actors that have leadership behaviors and the third, the FEI2O Innovator Role, refers to “informal innovator roles frequently found in literature” (Pereira, 2019). We identified in our ontology, the presence of the FEI2O Innovator Role, where the actor

can perform different roles in the innovation process. It can be a facilitator, a gatekeeper, a sponsor, and a champion. In our ontology, we integrated the FEI2O Actor, and we identified specific roles performed by it, such as the facilitator role and the gatekeeper role.

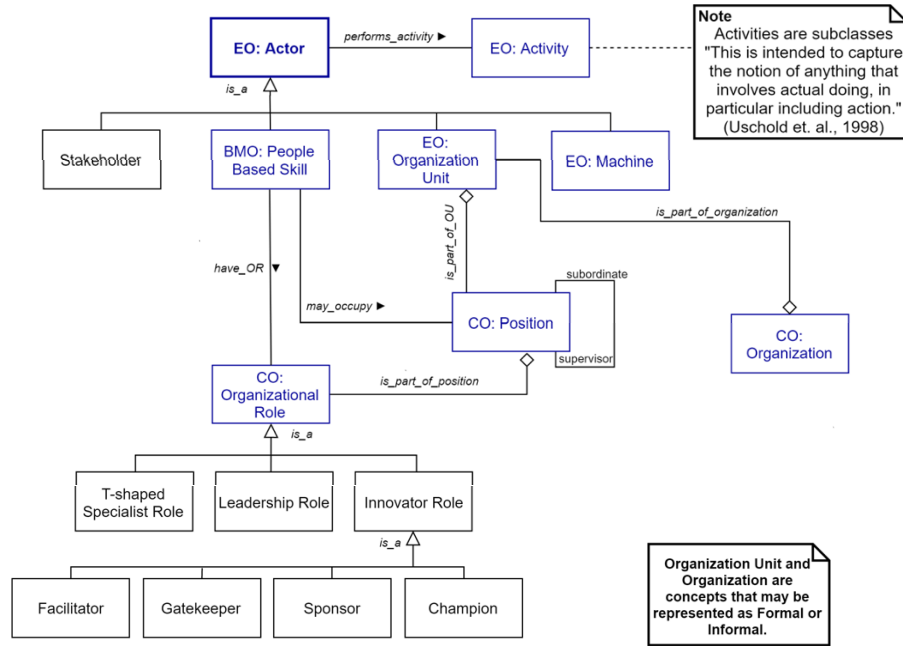


Figure 8 – FEI2O Actor sub-ontology extracted from Pereira et al., 2020, p.118.

Another relevant aspect of this study was FEI2O Opportunity Recognition, which considers the internal and external sources of opportunity (Figure 9). As described by Pereira et al. (2020), those are situations or actions that can answer different stimulus requirements, threats, strengths, weaknesses, and problems perceived by companies or individuals. The FEI2O Opportunity Recognition aspect was integrated into the ontology created in this study because its primary purpose was to find innovation opportunities.

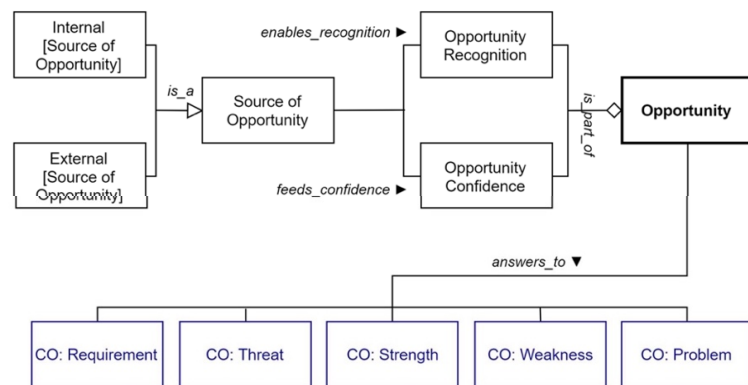


Figure 9 – FEI2O Purpose sub-ontology extracted from Pereira et al., 2020, p.98.

Appendix B – Building block glossary

Table 6 - Building blocks glossary

Concept	Definition	Author and Year
Barriers to knowledge sharing.	Psychological and function barriers that represent the sources of resistance of users when sharing knowledge in the company's social media.	(Chen & Kuo, 2017)
Co-Creation.	New knowledge created from the shared knowledge of individuals.	(Pohjola & Puusa, 2016)
Commonly understood language and trust.	The usage of common language and trust among users to enable knowledge to be shared.	(Pattanaik & Chatterjee, 2009)
Community.	A collective formed by different groups.	
Community management.	The act of management and monitoring a community.	
Corporate Data.	Data extracted from the company's performance in its market.	(Lofty et al., 2016)
Customer.	It is a user that is a FEI2O Actor.	
Customer-Customer Collaboration.	The necessity of users to create adaptations by themselves to fulfill a specific need.	(Andersen & Morch, 2016)
Data analysis.	The analysis of data.	
Engager.	Users that are active on the social media networks.	(Mourtzis et al., 2019)
Engagement.	The measure of interactions from an individual.	
Experience-centric networks.	Networks that have interactive and collaborative experience environments and multiple experience interfaces.	(Romero & Molina, 2009)
Explicit knowledge.	Knowledge provided by discursive acts.	(Nonaka & Toyama 2003)

Concept	Definition	Author and Year
FEI2O: Actor.	It is an actor that performs, communicates, borrows, sends, and receives objects of the Front End of Innovation (FEI).	(Pereira, 2017)
FEI2O: Innovation Role.	It is an actor that performs informal innovator roles commonly found in the literature.	(Pereira, 2017)
FEI2O: Opportunity Recognition.	Opportunity recognition that considers the internal and external sources of opportunity.	(Pereira, 2017)
Gatekeeper.	It is the actor that controls information by filtering or selecting what information to share with other users. It can do it by protecting or retaining information.	(Andersen & Morch, 2016)
Group Dynamic Techniques.	Techniques to assign the set of norms, roles, and relations that characterize a specific group in platforms on the internet.	(Pohjola & Puusa, 2016)
Industrial social media.	Usage of social media features in an organization's knowledge sharing platform.	(Aromaa et al., 2020)
Industrial Social Networks.	It is social networks applied in an organization to generate useful knowledge sharing and creation.	(Mourtzis et al., 2019)
Influencer.	Users that have access to a substantial audience of other users and can influence their thoughts and beliefs.	(Mourtzis et al., 2019)
Innovation-Related Benefit.	The lead user level of dissatisfaction with the existing products and new product needs.	(Ernst & Brem, 2017)
Lead User.	“Individuals, or firms, that are experiencing needs that are ahead of the targeted market” (pp. 3)	(Churchill et al., 2009)
Lead User Dimensions.	Dimensions of lead user characteristics, namely: trend position, opinion leadership, innovation-related benefit, and level of expertise and commitment to product field.	(Ernst & Brem, 2017)
Level of expertise and commitment to product field.	The lead user has a high level of expertise and is deeply committed to the product field.	(Ernst & Brem, 2017)

Concept	Definition	Author and Year
Lurkers.	Users that monitor the knowledge shared in social media platforms without interacting.	(Mourtzis et al., 2019)
Management tools analytics.	External analytics tools for collecting data from social media platforms.	(Mourtzis et al., 2019)
Netnographer.	The individual that performs netnography.	
Netnography.	It is understood as an emphatic approach to perform a qualitative analysis of data.	(Brem & Bilgram, 2015)
Open innovation.	“The use of purposive inflows and outflows of knowledge to accelerate internal innovations, and expand the markets for external use of innovation, respectively.”	(Chesbrough & Bogers, 2014)
Opinion Leadership.	The lead user influences the needs and requirements of other customers.	(Ernst & Brem, 2017)
Perceived information quality.	It is “the subjective judgments regarding the usefulness of the information in addressing the question posed” (pp. 3)	(Glogowska et al., 2016)
Platform analytics.	Social analytics tools provided by each social media platform.	(Mourtzis et al., 2019)
Sentiment Data.	Data extracted from the customer’s opinions about specific products, services, or companies, shared on social media.	(Lofty et al., 2016)
Social Business Intelligence.	The incorporation of social media monitoring and analytics with traditional business intelligence to track business performance.	(Lofty et al., 2016)
Social Business Intelligence Reports	Reports constructed from the insights retrieved from the performance of social business intelligence.	(Lofty et al., 2016)
Social listening and social monitoring tools.	Tools used to perform data mining on social media.	(Lofty et al., 2016)
Social Media.	It can be described as a platform driven by user-generated content based on internet usage.	(Zhou & Wang, 2014; Xiang & Gretzel, 2010)
Social Media Post.	Users’ shared information on social media platforms.	

Concept	Definition	Author and Year
Social Media Thread	A social media post with intense interaction from its actors.	
Social Media Thread Selection Criteria	Criteria for the selection of social media threads.	
Social Network Insights	Insights retrieved from social networks.	(Lofty et al., 2016)
Standalone analytics.	Social media measurement tools that only provide social media analytics functionalities.	(Mourtzis et al., 2019)
Trend Position.	The lead user is ahead of market trends.	(Brem & Bilgram, 2015)
University co-authorship network.	Universities and research institute its collaboration network to promote science and technology development.	(Li & Gao, 2012)
User	Individuals that use social media networks.	

Source: Own production.