UNIVERSIDADE FEDERAL DO ESTADO DO RIO DE JANEIRO
CENTRO DE CIÊNCIAS EXATAS E TECNOLOGIA – CCET
PROGRAMA DE PÓS-GRADUAÇÃO EM INFORMÁTICA – PPGI

SIDE: A FRAMEWORK FOR MANAGING SOCIAL INNOVATION DIGITAL ECOSYSTEMS

Luciana de Oliveira Vilanova Chueri

Orientadores

Até 15 de Agosto de 2018: Renata Mendes de Araújo

De 15 de Agosto de 2018 até a Defesa: Rodrigo Pereira dos Santos

Co-orientadora

De 15 de Agosto de 2018 até a Defesa: Aline Pires Vieira de Vasconcelos

RIO DE JANEIRO, RJ – BRASIL

JULHO DE 2021

SIDE: A FRAMEWORK FOR MANAGING
SOCIAL INNOVATION DIGITAL ECOSYSTEMS

LUCIANA DE OLIVEIRA VILANOVA CHUERI

TESE DE DOUTORADO APRESENTADA COMO REQUISITO PARCIAL PARA OBTENÇÃO DO TÍTULO DE DOUTOR PELO PROGRAMA DE PÓS-GRADUAÇÃO EM INFORMÁTICA DA UNIVERSIDADE FEDERAL DO ESTADO DO RIO DE JANEIRO (UNIRIO). APROVADA PELA COMISSÃO EXAMINADORA ABAIXO ASSINADA.

Aprovado por:

RODRIGO PEREIRA DOS SANTOS, D.Sc. (UNIRIO)

ALINE PIRES VIEIRA DE VASCONCELOS, D.Sc. (IFF)

GLEISON DOS SANTOS SOUZA, D.Sc. (UNIRIO)

SEAN WOLFGAND MATSUI SIQUEIRA, D.Sc. (UNIRIO)

CLAUDIA MARIA LIMA WERNER, D.Sc. (UFRJ)

CARLA MARTINS CIPOLLA, D. Sc. (UFRJ)

RIO DE JANEIRO, RJ – BRASIL
JULHO DE 2021

Catalogação informatizada pelo(a) autor(a)

C559 Chueri, Luciana de Oliveira
SIDE: A framework for managing Social Innovation Digital Ecosystems / Luciana de Oliveira Chueri. -- Rio de Janeiro, 2021.
208

Orientador: Rodrigo Pereira dos Santos.
Coorientadora: Aline Pires Vieira de Vasconcelos.
Tese (Doutorado) - Universidade Federal do Estado do Rio de Janeiro, Programa de Pós-Graduação em Informática, 2021.

1. Social Innovation. 2. Digital Ecosystems. 3. Social Innovation Ecosystems. 4. Management. 5. Social Innovation Digital Ecosystems. I. Santos, Rodrigo Pereira dos, orient. II. Vasconcelos, Aline Pires Vieira de, coorient. III. Título.

Acknowledgements

Thanks to Rodrigo Pereira dos Santos for being welcomed into his research group. Thanks to Professor Rodrigo and Professor Aline Pires Vieira de Vasconcelos for guiding me on this journey and for the opportunity to learn throughout this process. I thank the evaluation board: Gleison dos Santos Souza, Sean Wolfgand Matsui Siqueira, Claudia Maria Lima Werner and Carla Martins Cipolla for accepting to evaluate this thesis research.

Thanks to my husband Bruno for the companionship, for understanding my studies on weekends and the years without vacations. Thanks to my daughter Belinha for being so understanding, caring, and teaching me the importance of family moments.

Thanks to my parents, Francisco and Eulina, for the support and encouragement they always gave me, for understanding my lack of availability, even in difficult times. I am very grateful to my sister Angela de Oliveira Vilanova (in memoriam) for everything.

Thanks to my friends Daniela Amaral, Rodrigo Cotrim, Eduardo Medeiros, Fabricio Dantas, Lourdes Rangel, Juliana Fernandes for encouraging me and giving all the support.

Thanks to Anderson Tavares and Mariana Pinheiro for everything they allowed me to teach, learn and share in this journey. For all the partnerships built over these 30 months. Every conversation, laughter, support, encouragement was vital in this process.

Thanks to João Brandão for his dedication to the front-end and back-end of the eSIDE tool. The result was excellent.

Thanks to all members of the Complex Systems Engineering Laboratory for the essential exchanges and discussions throughout the entire process. In particular, Juliana and Felipe supported me so much in the final stretch.

Thanks to Renata Mendes de Araujo for guiding this thesis research until August 15, 2018.

Thanks to the support of the secretariat, in particular, Ives, Leandro, and Douglas.

I would like to thank the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES) - Finance Code 001 for financial support to my research.

Finally, I thank everyone who was part of my doctoral career.

CHUERI, Luciana de O. V. **SIDE: Um Framework para o Gerenciamento de Ecossistemas Digitais de Inovação Social**. UNIRIO, 2021. 208 páginas. Tese de Doutorado. Programa de Pós-Graduação em Informática, UNIRIO.

RESUMO

Atualmente, pesquisadores e profissionais reconhecem globalmente a importância das inovações sociais para enfrentar com sucesso os desafios sociais, econômicos, políticos e ambientais. Com o crescimento destas inovações, começaram a emergir ecossistemas de inovações sociais, que englobam um conjunto de atores de diferentes setores da sociedade atuando de forma colaborativa para desenvolver estas inovações e atender às necessidades sociais. Nesta pesquisa, foi identificado que os desafios reportados pelos atores apontam para a necessidade de um suporte tecnológico relacionado a colaboração, compartilhamento de conhecimento, bem como apoio ao gerenciamento do ecossistema. A fim de preencher estas lacunas, foi proposta uma nova categoria de ecossistema para apoiar atores de inovação social, particularmente os orquestradores, usando conceitos de ecossistema digital, o Ecossistema Digital de Inovação Social (*Social Innovation Digital Ecosystem* ou SIDE). No SIDE, os atores interagem e colaboram por meio do suporte de uma plataforma tecnológica comum e de um processo colaborativo, inclusivo e aberto à geração de inovações sociais para atender aos desafios da sociedade. Objetivando caracterizar o SIDE, foi desenvolvido um modelo conceitual, com elementos extraídos de mapeamentos sistemáticos da literatura nas áreas de ecossistemas digitais e ecossistemas de inovação social e avaliado por 21 especialistas em inovação social. Para identificar qual a melhor abordagem para apoiar o gerenciamento de SIDE, foram realizados estudos em ecossistemas maduros e consultados profissionais e pesquisadores no domínio de ecossistemas de inovação social. Como resultado, foi desenvolvido um *framework*, considerando três dimensões para apoiar os atores dos ecossistemas (técnico, negócio e social) e uma adicional para apoiar o orquestrador (gerenciamento). Com os artefatos gerados, foi desenvolvida a eSIDE, que é uma plataforma tecnológica comum e central, de apoio aos atores do SIDE. A eSIDE foi avaliada por meio de uma etapa de análise da ferramenta e de um grupo focal, nos quais os participantes destacaram a relevância das funcionalidades do painel de gerenciamento para apoio aos orquestradores.

Palavras-chave: Inovação Social; Ecossistemas Digitais; Ecossistemas de Inovação Social; Gerenciamento; Framework; Ecossistemas Digitais de Inovação Social.

CHUERI, Luciana de O. V. **SIDE: A framework for managing Social Innovation Digital Ecosystems**. UNIRIO, 2021. 208 pages. D.Sc. Thesis. Graduate Program of Informatics, UNIRIO.

ABSTRACT

Currently, researchers and practitioners globally recognize the importance of social innovations to successfully address social, economic, political, and environmental challenges. With the growth of social innovations, ecosystems of social innovations began to emerge, comprising a set of actors from different sectors of society working collaboratively to develop these innovations and meet social needs. As a result of the studies carried out in this research, it was identified that the challenges reported by actors in this domain point to the need for technological support concerning aspects such as collaboration, knowledge sharing, and support for ecosystem management. To fill these gaps, we proposed a new ecosystem category to support social innovation actors, particularly orchestrators, using digital ecosystem concepts, the Social Innovation Digital Ecosystem (SIDE). SIDE is an ecosystem where actors interact and collaborate through the support of a common technological platform and a collaborative, inclusive, and open process to generate social innovations to meet society's challenges. Aiming to characterize this ecosystem, a conceptual model was developed, with elements extracted from systematic mapping studies concerning digital ecosystems and social innovation ecosystems and evaluated by 21 experts in social innovation. Next, we performed studies on mature ecosystems as well as surveys and semi-structured interviews involving professionals and researchers in social innovation ecosystems. These studies aimed to identify elements to build an approach to support SIDE management. As a result of these studies and the conceptual model, a framework was developed, considering three dimensions to support the ecosystem actors (technical, business, and social) and one dimension to help the orchestrator (management). With the generated artifacts, eSIDE was developed, which is a common and central technological platform to support ecosystem actors. The eSIDE features were evaluated through a tool analysis stage and a focus group, in which participants highlighted the relevance of the management dashboard functionalities to support the orchestrators.

Keywords: Social Innovation; Digital Ecosystems; Social Innovation Ecosystems; Management; Framework; Social Innovation Digital Ecosystems.

Contents

List of Figures

List of Tables

Abbreviations

BPM - Business Process Management

DE - Digital Ecosystem

DIT - Technological, Cultural and Social Innovation of Federal University of the State of Rio de Janeiro's Graduate, Research, and Innovation Department

GQM – Goal Question Metric

IT - Information Technology

LASIN - Latin American Social Innovation Network

NCSI - Nucleus of Cultural and Social Innovation

NGO - Non-Government Organizations

OECD - Organization for Economic Co-Operation and Development

REQBD - REQuirements from Business Dimension

REQCME - REQuirements from Conceptual Model Evaluation

REQMD - REQuirements from Management Dimension

REQSD - REQuirements from Social Dimension

REQTD - REQuirements from Technical Dimension

RQ - Research Question

R&D - Research and Development

SDG - Sustainable Development Goals

SECO - Software Ecosystems

SI - Social Innovation

SIDE - Social Innovation Digital Ecosystem

SIE - Social Innovation Ecosystems

SISU - Social Innovation Support Unit

SMS - Systematic Mapping Study

TAM – Technology Acceptance Model

UML - Unified Modeling Language

UFRJ - Federal University of Rio de Janeiro

UNIRIO - Federal University of the State of Rio de Janeiro

Chapter 1. Introduction

This chapter presents the context and motivation for conducting this research, the characterization of the problem, the objective and research questions that guide the work, and the scientific methodology used to achieve the objective. Finally, the organization of the thesis is described.

1.1. Context

Innovation has driven advances in productivity and economic growth. While it is true that the contributions from innovation have not only been economic - innovations in the industry have released workers from difficult and dangerous tasks through automation - it is also true that much of the thrust and focus of efforts to mobilize innovation has focused on economic objectives (OECD, 2011). However, there is a growing consensus among practitioners, policymakers, and research communities that the results of only technological innovations appear to be ineffective as compared to social innovation in addressing complex social, economic, political, and environmental challenges (ALTUNA et al., 2015; HOWALDT et al., 2016; DOMANSKI et al., 2019; TERSTRIEP et al., 2020).

Technological innovations are defined as "the implementation of technologically new products and processes and the achievement of significant technological improvements in products and processes". It is implemented if introduced on the market (product innovation) or used in a production process (OECD, 2011). Social innovations consist of new solutions (products, services, processes) that simultaneously meet social needs (more efficiently than existing solutions), bringing new or improved capacities and relationships, making them possible for better use of resources, and improving current societies' performance capacity (CAULIER-GRICE et al., 2012). They differ from exclusive technological innovation in the process they demand (cooperative and collaborative versus competitive), in purpose (meeting social needs, creating new relationships, and empowering participants versus commercial sense and profit) (ANDRE & ABREU, 2006; HOWALDT et al., 2016). Social innovation is not only concerning

developing innovative products or processes, and authors such as Cajaiba-Santana (2013) point out its relevance in the generation of social change through the reconfiguration of how objectives are realized, proposing new alternatives and practices for social groups.

We can mention two examples of innovations for visiting museums: the first is a technological innovation, represented by a device that allows visitors in a museum to hear explanations about works of art[1] (Figure 1). The second is an innovative application that allows deaf people to access museum exhibition content, without the need for an interpreter at their side. It incorporates augmented reality techniques and language in pounds that support people with hearing impairments[2] (Figure 2). The project results from the Master's dissertation of the web designer Priscyla Barbosa from the Graduate Program in Informatics at the University Federal of the State of Rio de Janeiro (UNIRIO) in 2018 (BARBOSA, 2018).

Figure 1. Technological innovation.

Figure 2. Social innovation.

Currently, there is a large contingent of social innovation initiatives developed in isolation (HOWALDT et al., 2016), where each initiative follows its path and each manager makes his/her interpretation of concepts and processes. In this isolated path, an initiative may even result in a concrete social innovation. However, it may happen in a more challenging way and without connection or collaboration with other actors. In this scenario, actors need to develop networks and increase the participation of intermediary actors to boost the development and dissemination of social innovations (HOWALDT et al., 2016; DOMANSKI & KALETKA, 2018). It requires building a new environment based on the convergence and interactions between several actors: citizens, government, companies, non-governmental organizations, and universities.

The term *ecosystem* comes from ecological thinking, where "an ecosystem consists of the biological community that occurs in a particular location, and the physical and

[1] https://www.istockphoto.com/br/vetor/guia-de-%C3%A1udio-do-museu-com-fones-de-ouvido-audioguia-digital-para-turista-fones-de-gm1223678324-359537172
[2] https://www.coppe.ufrj.br/pt-br/planeta-coppe-noticias/noticias/funcionaria-da-coppe-desenvolveu-aplicativo-para-apoiar-deficientes

chemical components and processes that make up its abiotic environment" (LINDEMAN, 1942). However, the use of this concept as a metaphor in the social innovation domain has been observed recently in some studies found in the literature (SGARAGLI, 2014; HOWALDT et al., 2016; TERSTRIEP et al., 2020). A social innovation ecosystem describes the enabling environment that supports initiatives developed and coordinated with the participation of various entities belonging to different sectors of society, aiming to achieve social needs (HOWALDT et al., 2016; BRAITHWAITE, 2018; DOMANSKI & KALETKA, 2018; ANDION et al., 2020; TERSTRIEP et al., 2020).

Ecosystems have also been explored in technological contexts such as, for example, as Digital Ecosystems (DE), that consist of a self-organizing digital infrastructure to create a digital environment for organizations (or agents) connected in a network, providing support for cooperation, knowledge sharing, and the development of adaptive and open technologies (MAGDALENO & ARAUJO, 2015). Another ecosystem mentioned in the context of this research is the Software Ecosystem (SECO). SECO is considered as a sub-category of the DE and considers the relationships between companies and software communities from a technical, social, and business point of view (BOSCH, 2009; SANTOS & WERNER, 2012b).

1.2. Motivation

With the advent of social innovation ecosystems, the role of the orchestrator emerges, responsible for activities that encompass diverse sub-activities such as: i) the coordination of resources, information, and artifacts of the ecosystem; ii) the definition of policies that support communication and cooperation between actors, iii) and the definition of the degree of openness of the ecosystem, among others (CHUERI et al., 2019). This role can be played by representatives of universities (ANDERSON et al., 2018; NUNES, 2018; CHUERI et al., 2019; ANDION et al., 2020), social organizations (SLIMANE & LAMINE, 2017) or any other economic sector.

The orchestrator is responsible for managing an ecosystem formed by actors who are people and organizations with their own norms, policies and infrastructure (HOWALDT et al, 2016a, DOMANSKI & KALETKA, 2018). Moreover, in these ecosystems many actors are volunteers, increasing the complexity and need to maintain engagement in the ecosystem. In this environment, these actors can play different roles simultaneously and act in the ecosystem as developers of social innovations, collaborators, and beneficiaries (CHUERI et al., 2019).

As the main requirements of this ecosystem, social needs need to be met by projects carried out by the developers of social innovations, who are responsible for a social innovation idea and its execution until its use by the beneficiaries (BUTZIN & TERSTRIEP, 2018). In addition, developers have the fundamental support of other ecosystem actors through mentoring, sponsorships, dissemination, and other types of collaboration (BUTZIN & TERSTRIEP, 2018). In turn, beneficiaries can support the ecosystem by evaluating solution ideas, approving solution requirements of social innovation, and testing developed solutions, for example (HOWALDT et al., 2016a).

According to Manzini (2015), social innovation ecosystems are crucial for: i) promoting, supporting, and developing successful social innovation initiatives; ii) creating the networks that allow actors to get involved; and iii) sharing ideas and innovation. Given the complexity of these ecosystems and the relationship between their actors and roles, we identified the need for developing studies to support the orchestrator. Moreover, these studies should provide elements to improve the understanding and management of ecosystems as well as to meet the requirements of the social innovation ecosystem.

1.3. Problem

In social innovation ecosystems, the exchange of experiences, contacts, and collaborations is often carried out in person through meetings and events, as perceived in the observational study reported by Chueri et al. (2019) and on studies by Nunes et al. (2018) and Andion et al. (2020). Moreover, some studies reported the relevance on technology to support social innovation ecosystem actors (MANZINI, 2015; ANDION et al., 2020; CIPOLLA, 2020), but none of these studies proposed a solution to help collaboration or management issues.

Within the scope of developers, the lack of resources to support interaction and collaboration with other actors, the decrease of actor's participation, and knowledge sharing was aggravated, which undermines the experience of developers and the completion of their projects. Aspects such as engagement, lack of skills, and difficulties in co-creation were listed as some of the biggest challenges for collaboration in social innovation environments (PINHEIRO et al., 2020) and for the development of social innovations (CHUERI & ARAUJO, 2018). Once developers become isolated, the ecosystem begins to weaken, threatening the survival of social innovation ecosystems for a long time.

In this multisectoral environment, the actors must interact and collaborate without violating collaboration rules or taking advantage of others, threatening the ecosystem's future. The application of management mechanisms is essential to support the orchestrator in maintaining this balance and fostering the actions of articulation and the engagement of the actors, positively impacting the ecosystem. However, the orchestrator needs the means follow-up the collaboration, interaction and knowledge sharing between developers and collaborators.

The literature on social innovation ecosystems does not present mechanisms to support the role of orchestrator. Some authors even point out that the field of study of these ecosystems is incipient (DOMANSKI et al., 2019; TERSTRIEP et al., 2020). Furthermore, even in more studied ecosystems, such as software ecosystems, the lack of studies concerning management in open ecosystems and how to support real ecosystem orchestrators was identified (ALVES et al., 2017).

In this context, some needs are reported in ecosystems where social innovations are developed, as follows: i) combining different types of information, knowledge, resources, and competencies; ii) providing access to existing innovation; iii) providing infrastructure and support to the development and scalability of social innovations; iv) providing methods, processes, and tools to support actors' activities from different sectors of the economy; v) providing an infrastructure to support and connect the actors of different projects; vi) dealing with the complexity of social innovation processes; and vii) providing ways to managing and monitoring the ecosystem (SGARAGLI, 2014; MANZINI, 2015; CHUERI & ARAUJO, 2018).

It is possible to identify the need of technological solutions for supporting the social innovation ecosystem orchestrator by analyzing these items. These solutions would help actors interact and collaborate remotely through a common technological platform. Moreover, they will support the ecosystem orchestrator in coordinating all the ecosystem's activities.

Moreover, at a time when agglomerations, seminars and events are avoided due to the COVID-19 pandemic, the processes, and techniques used need to be revised so that social innovation ecosystems can be adapted to a digital environment. In this scenario, it becomes more urgent to use new processes, techniques, and technological solutions to support these ecosystems. Coordination became even more complex due to the transition between the live and digital worlds in the ambit of orchestrators. It challenged mediation activities and the coordination of open networks formed by social innovation actors who work in different domains and sectors of the economy.

1.4. Objectives

The objective of this research is to investigate a solution to support orchestrators in the management of social innovation ecosystems based on a novel approach called Social Innovation Digital Ecosystem (SIDE), which is structured from elements of digital ecosystems and concepts from the area of social innovation. SIDE is an ecosystem that provides the interaction of a community formed by actors whose objective is to develop social innovations to meet society's challenges through a common technological platform and a collaborative, inclusive, and open process (CHUERI, 2018).

The solution proposed in this research comprises a framework (SIDE) that supports the orchestrator in the ecosystem management. The SIDE framework presents activities concerning the planning and monitoring of: i) internal ecosystem processes and processes concerning the life cycle of social innovations (business dimension of the framework); ii) a platform for actors (technical dimension of the ecosystem); and iii) actors, considering their interactions, collaborations and participation (social dimension of the framework). Finally, the framework has a management dimension that integrates the three dimensions of the ecosystem.

The common technological platform goes beyond a place for meeting and interaction between the actors, having features to support interaction, communication, collaboration and engagement made available with the support of technology. The solution should support the orchestrator and its management team in decision-making by using indicators concerning communication, cooperation, and coordination actions in the ecosystem. From these indicators, the SIDE platform generates a set of indications to support the orchestrator's decision-making process.

As specific objectives, this research aims to: i) identify elements and relationships that characterize a social innovation digital ecosystem; ii) design a conceptual model that supports the representation of a SIDE based on digital ecosystems and elements of social innovation; iii) evaluate the understanding of the conceptual model; iv) develop a support framework for SIDE management; and v) specify, develop and make available a common technological platform to support orchestrators in the management of a SIDE.

1.5. Methodology

Some research questions were defined to guide this research. The main research question of the thesis (RQ) is: *What are the main components that support the orchestrator in the management of a social innovation digital ecosystem?*

From this RQ, the thesis sub-questions were defined:

- RQ1: What are the main elements and relationships that characterize a social innovation digital ecosystem?
- RQ2: Which is the most appropriate approach for the management of a social innovation digital ecosystem?

To answer these questions, the research methodology, presented in Figure 3 was structured in three main phases: i) the conception phase, ii) the implementation phase, and iii) the evaluation phase. For each activity in each phase, the publication vehicles in which its results were published are mentioned.

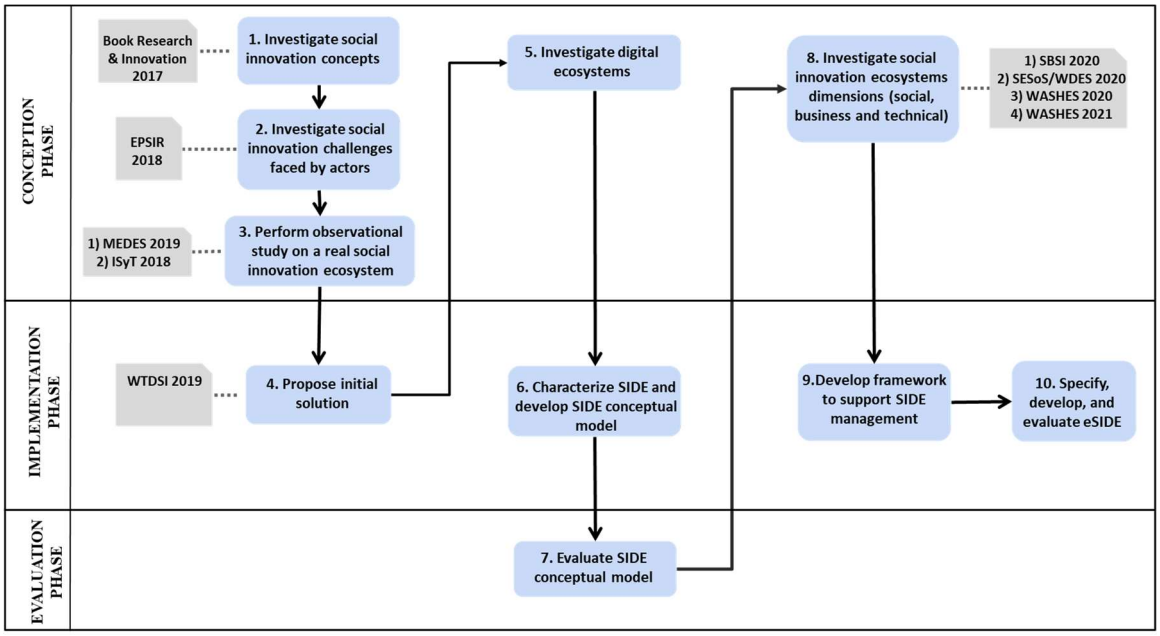


Figure 3. Research methodology.

In phase 1, we conducted a **literature review** to identify what has been discussed about social innovation related to: i) research gaps; ii) characteristics; iii) differences from technological innovations; iv) the process for their development; and v) existing related concepts. In other words, we sought to obtain a greater understanding of the research domain. This study was published as a chapter in the book entitled "Research and Innovation" (CHUERI, 2017).

Then, a **systematic mapping study** (SMS) (phase 2), was carried out to identify challenges faced by the actors who participate in the development of social innovations. The mapping also sought to identify which techniques and tools the actors used, and the processes followed in the development. This SMS followed the guidelines for performing secondary studies proposed by Kitchenham & Charters (2007). This activity resulted in

an article published in the *European Public Social Innovation Review* - EPSIR (CHUERI & ARAUJO, 2018).

The next phase (phase 3) involved investigating a real scenario of a real social innovation ecosystem by conducting an **observational study**. The ecosystem was formed by actors involved in developing social innovations, by volunteer mentors to support these projects, by an orchestrator, and by volunteer collaborators. This investigation sought to confirm the challenges identified in the SMS carried out previously, in addition to identifying: i) characteristics of this environment; ii) positive points, and iii) the most critical factors faced by such actors. The study followed the guidelines for observational studies proposed by Seaman (1999). The study conducted at this phase resulted in a paper published in the *International Conference on Management of Emergent Digital EcoSystems* (MEDES'19) (CHUERI et al., 2019) and another published in the *VI International Symposium on Social and Technological Innovation* (ISyT'18) (NUNES et al., 2018).

Based on the findings made in the previous phases, a **proposal for a research solution** (phase 4) was elaborated, which was approved in a doctoral qualifying exam (CHUERI 2018). Furthermore, based on the refinement of the solution proposal, it was published in the *XI Workshop on Theses and Dissertations in Information Systems* (WTDSI'19) (CHUERI & SANTOS, 2019). The proposal presented the use of digital ecosystems as a technological basis for SIDE.

Phase 5 included an **SMS** to investigate digital ecosystems in aspects concerning characteristics and properties and their constituent elements and the relationships between these elements. This SMS also followed the guidelines proposed by Kitchenham & Charters (2007).

Based on the studies carried out, four research gaps were identified: i) the lack of a formal characterization of what components makes up a social innovation ecosystem; ii) the need to verify in industry how collaboration in social innovation ecosystems occurs; iii) the need to consult the industry on the processes that occur in social innovation ecosystems; and iv) the need to consult the industry on technological solutions to support social innovation ecosystems.

In phase 6, a study was developed to characterize a SIDE, involving the **specification of a conceptual model** containing elements that need to be considered by the ecosystem's orchestrators. This study covered the definition of the actors that make up SIDE and their profiles. The model covered both the definitions and characteristics of

social innovation ecosystems and elements of digital ecosystems found in the studies of the previous phases.

Subsequently, the SIDE conceptual model (phase 7) was evaluated through **semi-structured interviews** with industry experts who have experience in social innovation ecosystems. After the evaluation, a qualitative analysis of the responses was carried out, followed by the refinement of the model. This study also identified in the model elements concerning the following dimensions: i) technical (e.g., focus on technical characteristics for a support platform); ii) transactional: focusing on processes concerning SIDE (e.g., concerning knowledge sharing); and iii) social: focusing on the actors of the ecosystem (e.g., their collaborations and the contributions they provide to the ecosystem). The evaluation process uses an adaptation of the methodologies presented by Kitchenham & Pfleeger (2008), Chazin & Freitas (2017), Wouters et al. (2019), and Oliveira et al. (2020).

In parallel, in phase 8, we investigated these dimensions in real social innovation ecosystems considering the research gaps identified. Regarding the need to verify in industry how collaboration in social innovation ecosystems occurs, concerning the social dimension, the following studies were carried out: i) an **SMS** to understand how collaboration occurs in four categories of ecosystems, namely: digital, software, business and innovation, and ii) an online **survey** with 39 experts in social innovation, aiming at understanding the main collaboration challenges they face in the ecosystems in which they operate. The first study was published in the 6th *Workshop on Social, Human and Economic Aspects of Software* (WASHES'21) (PINHEIRO et al., 2021). The second study was published in the *XVI Brazilian Symposium on Information Systems* (SBSI'20) (PINHEIRO et al., 2020). This study contributed to ratifying the importance of collaboration and its influence on social innovation ecosystem. The SMS followed the guidelines proposed by Kitchenham & Charters (2007) and the survey followed the guidelines presented by Kitchenham & Pfleeger (2008).

Two studies were carried out to consult the industry on the processes that occur in social innovation ecosystems. The first study was an SMS, whose objective was to understand how business process management is carried out in two categories of ecosystems, namely: digital and software. We investigated two mature technological-based ecosystems as there were no studies on processes in social innovation ecosystems. Moreover, it was intended to offer digital support to ecosystem actors. The study was published in the *IEEE/ACM Joint 9th International Workshop on Software Engineering for Systems-of-Systems and 15th Workshop on Distributed Software Development, Software Ecosystems and Systems-of-Systems* (SESoS/WDES'20) (AFONSO et al., 2020).

The second study involved modeling business processes in a domain of social innovation ecosystems and subsequent evaluation through **semi-structured interviews** with specialists in the domain. The qualitative analysis resulting from this evaluation showed that several requirements are necessary to develop solutions to support ecosystem processes, such as collaboration, knowledge sharing, standardization of information, and the presence of forms with utility and usability. The SMS followed the guidelines proposed by Kitchenham & Charters (2007) and the semi-structured interviews followed the guidelines presented by Chazin & Freitas (2017).

Regarding the need to consult the industry on technological solutions to support social innovation ecosystems, an **exploratory study** was conducted on digital platforms concerning this category of ecosystems in Brazil. This study was published in the *5th Workshop on Social, Human, and Economic Aspects of Software* (WASHES'20) (CHUERI et al., 2020). The study made it possible to identify the technical perspective of social innovation ecosystems in Brazil, presented in two ways: i) without a digital support platform (CHUERI et al., 2019); and ii) with support platforms still in their initial stages, compared to platforms from other ecosystems.

Based on the dimensions identified in the SIDE conceptual model and with the results of phases 7 and 8, phase 9 contemplates the **elaboration of a framework to support SIDE management**. The framework contains four dimensions, namely: transactional, social, technical, and management. The first three dimensions are concerning the research carried out in social innovation ecosystems and presented above. In order to serve the SIDE orchestrator, a management dimension was proposed, which received inputs from the studies on the dimensions and the evaluation phase of the SIDE conceptual model. The steps and activities of the *ReuseECOS '3+1'* framework (SANTOS & WERNER, 2012b), which includes the four dimensions, served as the basis for the framework generated in this phase. For each dimension, requirements and desirable indicators are presented to facilitate monitoring by the orchestrator.

Phase 10 of the research refers to the **specification, development, and evaluation** of eSIDE, a common technological platform to support SIDE actors. This solution was implemented using the requirements defined in the previous phases and has two modules: i) a module to be used by actors who develop innovations and by actors who collaborate with them, and ii) a manager panel devoted to the orchestrator. The objective of eSIDE is to support the orchestrator and allow him/her to follow, for example, indicators concerning collaboration between actors, knowledge sharing, the interaction of actors with each other, and the ecosystem. We evaluated the eSIDE functionalities based on two studies: a **tool**

analysis to verify ease of use and usefulness of the eSIDE Management Panel and a **focus group** with representatives from a real social innovation ecosystem. The tool analysis was performed using part of the Technology Acceptance Model (TAM) proposed by Davis (1993). In addition, the focus group followed some guidelines presented by Stewart & Williams (2005), Freeman (2006), and Klein et al. (2007).

1.6. Outline

This Ph.D. thesis is organized into eight chapters. This chapter presented the context, problem, and motivation concerning this research. The objectives and research questions were also defined, and the methodology used to conduct this study was detailed.

Chapter 2 presents a discussion on this research's main topics: social innovation, social innovation ecosystems, and digital ecosystems.

Chapter 3 describes an observational study conducted in a real social innovation ecosystem. Results were significant to help us develop our approach and include indicators and requirements definition for SIDE management.

Chapter 4 presents the design process of the SIDE conceptual model, which includes the method of construction and tracking of the concepts, elements, and relationships.

Chapter 5 presents the evaluation of the SIDE conceptual model, including the refining activity based on the qualitative analysis carried out after the evaluation.

Chapter 6 describes the SIDE framework as an approach to support the orchestrator in managing a SIDE, considering the technological platform. The studies carried out that provided inputs for each dimension of the SIDE framework are also briefly presented.

Chapter 7 presents eSIDE as a tool for managing SIDE to support orchestrator activities, specifically communication, cooperation, and coordination analysis. Details of the architecture, tool support, and evaluation are provided in this chapter. Strengths and weaknesses are summarized, as well as opportunities and threats to validity.

Chapter 8 concludes the research with the final considerations, a summary of the contributions of this research, the limitations, and future work.

Finally, the references used to support the research, the glossary of terms used in this thesis, and the other appendices of the study are listed.

Chapter 2. Background

2.1. Introduction

This chapter provides an overview of the concepts concerning the research context, cited in the rationale on the area of social innovation (Section 2.2) and social innovation ecosystems (Section 2.3). Then, the rationale concerning digital ecosystems is presented (Section 2.4), which represents the basis of the technological solution of the research. Section 2.5 presents the *ReuseECOS '3 + 1' framework* as a related work for the framework proposed in this research. Finally, we conclude the chapter in Section 2.6 with the final remarks.

2.2. Social Innovation

Social innovations are literally everywhere. They happen across and in-between sectors (public, private, civil) and span an extremely large variety of areas (economy, environment, social inclusion, integrated development, and others) (ANGELIDOU & PSALTOGLOU, 2017).

2.2.1. Main Concepts

Currently, no definite consensus exists on the term 'social innovation'. A critical literature review conducted by Howaldt et al. (2014) reveals that social innovation has many different (and sometimes conflicting) meanings, spanning a variety of areas such as: i) innovation studies; ii) management and organizational research; iii) workplace and quality of working life research; iv) as part of the social economy; v) in sustainable development; vi) as an aspect of local competitiveness; and vii) territorial development (HOWALDT et al., 2014).

For the purpose of this research, it was adopted the definition provided by Caulier-Grice et al. (2012). This definition is widely adopted by a large number of academic and policy documents and states that: '**social innovations are new solutions (products, services, models, markets, processes etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society's capacity to act**'.

According to Chueri (2017), a social innovation must match the following criteria: it must 1) be new with regard to the user, context or application, although not necessarily original; 2) generate an improvement which could be translated both into a satisfactory result that would demonstrate efficiency, as well as into an achievable alternative to the already existing solutions; 3) should be able to generate value to the community or to a specific group; 4) results of a process that is divided into multiple stages (beginning as an idea until implementation); and 5) enhances society's capacity to act.

In addition to looking at social innovation to generate a solution, this research also relates to other definitions in the literature, such as the one mentioned by Cajaiba-Santana (2013), where: "social innovations are new social practices created from collective, intentional and result-oriented actions, intending to activate social change through the reconfiguration of how objectives are realized, proposing new alternatives and new practices for social groups" (CIPOLLA, 2017). This research aims not only to offer solutions to support the environment where social innovations are developed, but also to create conditions that allow changes to occur in the way social agents act and interact with each other (and changes in the social context in which these actions occur through creating new institutions and new social systems).

2.2.2. Differences Between Social Innovation and Technological Innovation

Although the term **innovation** is often associated with purely technological innovations, there are differences between these and social innovations. The main differences between social innovation and technological innovation, pointed out by OECD (2011), Caulier-Grice et al. (2012), Silva & Bignetti (2012), Cajaiba-Santana (2013), Howaldt et al. (2016a), and Butzin & Terstriep (2018), are described below:

1. *Value*: deviating from the Schumpeterian view, the question of value appears as essential in this distinction. While technological innovation deals with the appropriation of value, social innovation aims at value-creation;
2. *Stakeholder interest*: technological innovation is often concerning obtaining competitive advantage by companies, while social innovation is concerned with the interests of social groups and the community and being concerned with self-empowerment and the empowerment of the beneficiaries involved;
3. *Strategy*: technological innovation seeks competitive advantages, focusing primarily on economic success and profit. Social innovative projects and initiatives address social needs and societal challenges;

4. *Objective*: social innovative projects and initiatives address social needs and societal challenges instead of focusing primarily on economic success and profit. Social innovation deals with improving the welfare of individuals and community through employment, consumption or participation;

5. *Locus of innovation*: technological innovation is centered on the company, while social innovation focuses on community actions. By making high investments in Research & Development, a company counts on generating innovations to meet its market differentiation strategies. The development of social innovations often starts with small, local efforts, as leverage resources are scarce;

6. *Development process*: Technological innovation relates to a process that develops through sequential steps defined and controlled by specific management tools. The innovation process is managed from the inside out, that is, by introducing a new production process, a new product or service aimed at the market. On the other hand, a social innovation results from the participation of beneficiaries and community actors throughout the process. In other words, it is concerning social construction, of generating solutions dependent on the trajectory;

7. *Dissemination of knowledge*: in the case of technological innovation, intellectual protection mechanisms seek to prevent an idea or technology developed and applied by a company from being copied and used by competitors. Social innovations, however, follow diffusion mechanisms that favor the replication and expansion of results to other communities. Thus, the transposition of experiences from one community to another, or between organizations, is a common practice and fed by social innovation centers, organizational networks, and different forums for discussing ideas and presenting cases.

According to the differences presented, social innovation management differs from that carried out in technological innovation, and its management requires different models from traditional models. Likewise, for the study of this type of management, it is necessary to adopt specific methodologies to address the particularities of the social innovation process (BIGNETTI, 2011).

Even with all the listed differences, it is important to note that technological innovation and social innovation do not represent two mutually exclusive sets. Several technological innovations have a social character, and social innovations can use

technology to assist in developing or disseminating social innovations (ANDRÉ & ABREU, 2006).

2.2.3. Actors

In social innovation research, it is common to use the term "actors" to designate the stakeholders who take part in the social innovation development process. These actors may be represented by individuals or companies that take part in social innovation development as (BENNEWORTH & CUNHA, 2015; HOWALDT et al. 2016; CHUERI, 2017):

- *Social Entrepreneurs*: individuals can be agents of change in the social sector by developing innovative solutions to society's problems. According to ASHOKA (2010), these individuals are social entrepreneurs who, instead of waiting for the actions of governments and private sectors to solve the needs of society, find what is not working and solve the problem by persuading entire societies to move in different directions;
- *Government*: leadership divided into three spheres: Federal, State, and Municipal is responsible for public policies concerning innovation and can also encourage its development and the articulation between the actors;
- *Profit-oriented companies*: organizations that aim to provide products and services. They generate jobs, taxes and they may be the supplier of the ecosystem platform, leading or providing management support for the development of social innovation. They can offer partnerships and financing to social innovation projects that are also in line with their business strategy;
- *Universities and Research Centers*: they can support social innovations in the following ways: i) providing existing knowledge or creating new knowledge for the development of a solution; ii) working with a social partner to co-create new knowledge that contributes to social innovation; iii) investing in activities that contribute to testing and escalating a social innovation; iv) making their spaces available (library, laboratories, offices) during the social innovation process; v) advising social partners on the best way to access external sources of knowledge; and vi) assisting social actors regarding the value of social innovation so that others can adopt and invest in it;
- *Social Organizations:* they can be a source of experiences in the social innovation process, being responsible for bridging the gap between the actors that want to

develop a social innovation and the ones who will benefit from its process or product. A social organization may bring the beneficiary to participate in the collaborative process of social innovation development.

Despite the different approaches proposed by Murray et al. (2010), Caulier-Grice et al. (2012), Avelino & Wittmayer (2016), and Howaldt et al. (2016), the five actors mentioned can generate social innovation, especially when they collaborate. Social innovations are characterized by a wide range of actors involved, who may have various roles which fluctuate across different innovations and the development process of a single innovation (BUTZIN & TERSTRIEP, 2018).

Moreover, innovations that start in one sector can be assumed by others, and, often, the most exciting innovations occur at the borders between economic sectors (MURRAY et al., 2010). It is common for innovations to be driven by different actors while advancing in the development stage. For example, some non-profit-oriented organizations devised many distance learning models and were subsequently implemented and adopted by government or private organizations.

2.2.4. Process

Social innovation typically is a result of a process with several stages, as mentioned in several studies on models of processes of development of social innovations (MULGAN, 2006; MURRAY et al., 2010; NEUMEIER, 2012; BENNEWORTH & CUNHA, 2015). In this research, the model selected as a reference is the six-staged model conceived by Mulgan (2006), illustrated by Caulier-Grice et al. (2012) and presented in Figure 4. This model is more detailed than the others found in the literature (WESTLEY & ANTADZE, 2014), as well as the most cited (1,379 citations) according to Google Scholar. Next, we present a brief description on each development stage.

- *Prompts*: the first stage highlights the need for innovation. Sometimes, it comes in the form of unexpected changes in the immediate external environment; for example, a sudden environmental or political crisis;
- *Proposal*: involves generating a new idea that provides a solution to the identified need. In some cases, this stage will follow on naturally from identifying need – for example, working with the same group and research techniques to identify potential solutions. At other times, it might involve a new practice or technique;

- *Prototyping*: testing the idea in practice. Usually, ideas are introduced and adjusted considering experience. It involves a constant interaction between the need and solution;
- *Sustaining*: relates to taking an idea that has shown promise as a pilot or prototype and turns it into a sustainable initiative over time. It means developing an economic model that will secure the venture's financial future;
- *Scaling and diffusion*: relate to the way to disseminate a social innovation. It may involve much more organic processes of diffusion, with ideas spreading and adapting rather than growing through a single organization;
- *Systemic change*: social innovations are inherently about changing how to do things and conceptualizing social needs. Systemic change is the goal of some social innovations because some aim to remain local or regional.

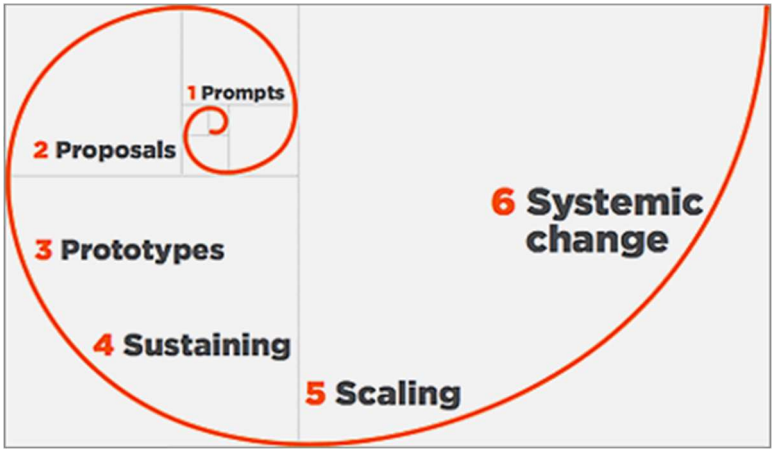


Figure 4. The process of social innovation (CAULIER-GRICE et al., 2012).

Social innovations do not necessarily go through all six stages. In some cases, social innovations remain small in scale and are locally based, rather than attempting growth and scale, and very few social innovations reach the stage of systemic change (CAULIER-GRICE et al., 2012). This may not be a great problem because some social innovations are designed to solve local or regional problems. While this six-stage process does not capture the often messy nature of developing and growing social innovations, it does provide a proper methodological basis to understand the range of different activities that take place and the support and resources required at each stage.

2.2.5. Challenges

The development of a social innovation involves actors from different domains, economic sectors, and organizations. Moreover, they may represent different interests and

antagonistic points of view (BOUCHARD, 1997), impacting the social innovation process. Although social innovations have been one alternative to modern societies' challenges, little evidence is found on how this process occurs and the main challenges faced by actors.

In this scenario, we decided to investigate how actors develop social innovations. A systematic mapping study (SMS) was carried out to achieve this objective regarding the challenges and use of techniques, methods, models, and tools concerning social innovation development (CHUERI & ARAUJO, 2018). This SMS was performed from June 2017 to September 2017 and is presented in Appendix 1.

The most mentioned challenges are concerning the actors: lack of competencies, capabilities, and skills to successfully develop social innovation projects and lack of engagement/commitment/involvement of the actors (locals, sponsors, social entrepreneurs and others). These results are in line with the Social Innovation Index Report (THE ECONOMIST INTELLIGENCE UNIT, 2016), where the biggest barriers for social innovation are lack of time and talent to reach the best work done. It is clear that the social innovation process requires attention to the individual persons; more specifically, to what they think, to what they value, to how they behave, and to how interrelations between actors and social systems take place. The lack of competencies, capabilities, and skills to successfully develop social innovation projects demonstrates a closed view of development, where the need for these skills falls on the developer. In an open environment, this challenge could be mitigated by collaborating actors who have the necessary skills.

Another challenge mentioned by several actors is the lack of incentives and support in municipal, state and local policies. Since social innovation bears, as a main goal, causing positive impacts on society which sometimes involves a change in legislation, it is expected that this kind of innovation may, in some cases, depend on government support. The SMS also raised a number of important additional challenges, namely:

- **Lack of consensus in the conceptualization of social innovations:** wide multiplicity of social innovation definitions was observed according to its concepts and process. There is no shared understanding of the meaning of social innovation, including clear differentiation from other concepts such as social entrepreneurship or technology innovation;
- **Reports on the development of social innovation projects:** a scarcity of reports about the development of social innovation projects (only eleven studies from 576 initially selected) was ascertained. Although significant effort has been expended

in approaching a definition for the term ‘social innovation’, little attention has yet been paid to the mechanisms that made it happen;

- **Focus on proposal stage:** most of the studies mentioned processes and methods concerning the proposal stage demonstrating that this stage may display higher level of maturity compared to the others. It may also portray projects emphasis on generating innovative ideas and not yet attention to their implementation and sustainability;
- **Lack of development details:** considering that “Prototype” stage comprises development and prototyping activities, it was observed that, from the six studies which mention activities concerning this stage, only a few presented more information on prototype construction;
- **Lack of project management practices:** most of the studies analyzed did not mention how the social innovation project was managed according to scope, cost, or time. Moreover, the monitoring aspect of these projects, both concerning a process or tool, was not clear;
- **Support provided by technological tools:** tools and techniques for engaging actors in analysis and design was considered a challenge, impacting the engagement. Information related on what tools are used to maintain actors involved, after the first project meetings and how they relate and communicate along the project was also missing.

2.2.6. Discussion

The most effective social innovation initiatives occur when collaboration between different sectors involves actors and beneficiaries (MURRAY et al. 2010; HOWALDT et al., 2016a). This represents an even greater challenge if we think that the management of social innovation involves managing the participation of the different actors who assume several roles in different stages of developing and disseminating social innovation.

The SMS achieved as a conclusion that, to take into account the complexity of social innovation, further research is needed for proposing development methodologies considering an environment formed by multiple actors, the local context needs, the relationships between actors, where cross-sector collaboration is crucial to overcome social demands and societal challenges, actively involving public, economic and civil society partners. Probably these solutions call for significant collaboration methodological and technological solutions based on participatory design and a human-centered approach.

2.3. Social Innovation Ecosystems

As social innovation research progressed, we have seen the identification of an increasing number of actors, suggesting that social innovation emerges and develops within a complex and dynamic ecosystem (BUTZIN & TERSTRIEP, 2018). Therefore, social innovation researchers and professionals began to move the attention from supporting isolated initiatives to investigating ways of supporting environments with multiple and interconnected innovations (BRAITHWAITE, 2018). Thus, the next step of the research was to carry out an SMS on social innovation ecosystems, to better understand this topic and identify opportunities for improvement in this domain.

2.3.1. Concepts

The term *ecosystem* is drawn from ecological thinking and has been applied to social innovation in recent years to describe the enabling environment that needs to be put in place to support social innovation (BRAITHWAITE, 2018). According to Andion et al. (2020) and Terstriep et al. (2020), studies that focus on social innovation ecosystems (SIE) are still scarce and the concept is still confusing. After carrying out the SMS related to the challenges actors face in managing social innovation projects, the next step was to carry out another SMS to investigate the environment in which these innovations are developed. Thus, an SMS to get a better understanding of such ecosystem category was planned, executed, and described next.

2.3.2. Planning

The SMS performed follows the guidelines for performing secondary studies proposed by Kitchenham & Charters (2007). We prepared a review protocol for this SMS and its details are presented in the following paragraphs.

Research Question

We defined the goal of this study based on the Goal-Question-Metric approach (BASILI, 1992): to **analyze** existing studies on social innovation ecosystems **in order to** get a comprehensive understanding **with respect to** the definition of social innovation ecosystems, their characteristics, their actors, and the challenges they face, **from the point of view of** researchers and practitioners **in the context of** social innovation ecosystem studies. Thus, the following research question was defined (RQ): "*What is the state of the*

art of social innovation ecosystems?". Furthermore, in order to answer this question, the following sub-questions (Sub-Q) were specified:

(**Sub-Q1)**: What are the characteristics that define a social innovation ecosystem?

(**Sub-Q2)**: Who are the actors that take part of a social innovation ecosystem and what are their roles?

(**Sub-Q3)**: What challenges were mentioned in the studies?

Search Strategy and Data Source

The electronic search was applied on the following Search Engines: IEEE Xplore Digital Library, ACM Digital Library, EI Compendex, and Scopus[3]. During the execution on the search engines, two filters were applied to set "English" as the language. There was no restriction concerning the study publication date.

In preliminary tests of the string, we observed the low return of studies referencing the ecosystems of social innovation, converging with the speech of Terstriep et al. (2020) about the presence of few studies in the area. Therefore, we decided to use only the terms concerning "social innovation ecosystem" and do not use the terms derived from the research questions. In order to obtain relevant SMS results, some iterations were made to test the string execution on the digital databases. The search string used in this SMS is:

("social innovation ecosystem*" OR "social innovations ecosystem" OR "ecosystem of social innovation*" OR "ecosystems of social innovation*")

Inclusion and Exclusion Criteria

We adopted the following inclusion criteria to select studies: i) studies written in English; ii) studies must present evidence based on scientific empirical methods (e.g., interviews, surveys, case studies etc.); and iii) studies that answer at least one sub-question.

The exclusion criteria adopted in this study were: i) secondary studies (e.g., systematic mapping studies and systematic reviews); ii) the full version of the study is not available through the authors' institution; iii) repeated studies found in different search engines (in this case, just one study was considered); and iv) the study is a poster, editorial, summary, note, tutorial, workshop, review or article in press.

[3] Digital libraries:
- •ACM Digital Library (http://portal.acm.org)
- •El Compendex (http://www.engineeringvillage.com)
- •IEEE Digital Library (http://ieeexplore.ieee.org)
- •Scopus (http://www.scopus.com)

Study Selection Process

The selection process comprised six stages: 1) execute automatic search; 2) duplicates removal; 3) 1st filter: title, abstract and keywords screening; 4) 2nd filter: introduction and conclusion screening; 5) snowballing search; and 6) 3rd filter: complete screening. At the beginning, it was planned to use quality criteria assessment as an additional stage. However, the return of few occurrences after applying the third filter made us decide not to apply this stage.

2.3.3. Execution and Results

At the first step, we conducted the automatic search in December 2019, resulting in 13 studies retrieved from the digital libraries. After removing the duplicate studies, only 11 remained. Next, we applied the backward snowballing technique (WÖHLIN, 2014) to the studies returned in the searches and identified seven more articles. In the end, we selected eight primary studies for data extraction. The quantitative results of each stage are presented in Figure 5. Table 1 shows the studies retrieved from the SMS, ordered by year and title name. For each study, we defined an identifier (ID) that was used to reference the mapping in the text. As such, the studies were enumerated from S1 to S9.

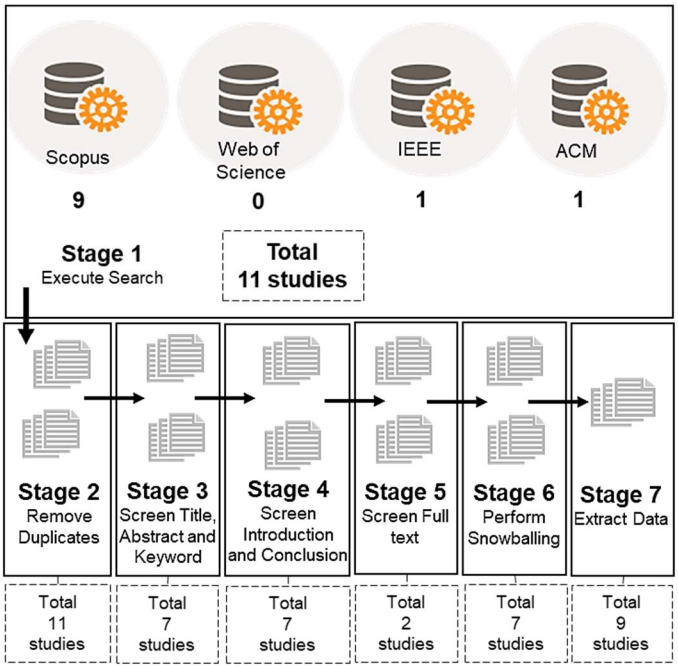


Figure 5. SMS results.

(**Sub-Q1**): What are the characteristics that define a social innovation ecosystem (SIE)?

S1 mentions that SIE brings a paradigm shift where grassroots movements and communities of change are shaping new ecosystems and replacing the existing governance

models. The new governance models are more open, inclusive and participatory. Moreover, this kind of ecosystem is forming around a clear set of values: shared intent, common purpose, collaboration, transparency, and openness.

According to S2, SIE is crucial for: i) promoting, supporting, and developing successful social innovation initiatives; ii) creating the networks that allow actors to get involved; and iii) sharing ideas and innovation. For S7, SIE depends on the specific contextualized social demand or challenge confronted.

Table 1. Studies retrieved from the SMS on SIE.

ID	Title	Authors	Source	Year
S1	Enabling Social Innovation Ecosystems for Community-led Territorial Development	F. Sgaragli	Fondazione Giacomo Brodolini	2014
S2	Design, When Everybody Designs: An Introduction to Design for Social Innovation	E. Manzini	MIT Press	2015
S3	Social Entrepreneurs: Important Actors within an Ecosystem of Social Innovation	J. Howaldt, C. Kaletka, A. Schroder	European Public Social & Social Innovation Review	2016
S4	A transaction-based approach to social innovation	K. B. Slimane, W. Lamine	The International Journal of Entrepreneurship and Innovation	2017
S5	Actor and roles in social innovation	A. Butzin, J. Terstriep	Atlas of Social Innovation	2018
S6	Social Innovation Ecosystems	D. Domanski, C. Kaletka	Atlas of Social Innovation	2018
S7	Social Innovation Ecosystems: What the concept means, How it has been applied elsewhere and a proposal for Northern Ireland	P. Braithwaite	Building Change Trust	2018
S8	An observational study on the challenges faced by actors in a social innovation ecosystem	L.O.V. Chueri, A.P.V. Vasconcelos, R.P. Santos	11th International Conference on Management of Digital EcoSystems (MEDES'19)	2019
S9	Understanding the effects of social capital on social innovation ecosystems in Latin America through the lens of Social Network Approach	V.A. Lozano, L.A. Molinerc, D. Murillod, H. Bucklandc	International Review of Sociology	2019

S3 mentions that new constructive partnerships between the sectors are developed on SIE, guaranteeing cross-sector fertilization, emphasizing that they are key factors to reap the full potential of social innovation. According to S3, social innovations are diffused on SIE, but it points out that other dimensions are critical and must be considered, such as actors and governance or drivers and barriers. S5 also demonstrates that SIE may include barriers, quoting that this ecosystem is a set of actors and space, whether physical or virtual, that defines the conditions of the environment necessary to support or block

social innovations. For these actors, an ecosystem can stimulate development or offer conditions that prevent social innovation growth.

S8 cites the SIE definition presented by S6. In addition, S3 and S6 mention that the SIE perspective goes beyond actor-centered concepts and must include governance models.

S4 cites that SIE is formed by networks where social innovations are conducted and based on continuous, repeated interaction between social actors that know each other. SIE is also a space for coordinating social innovation. S6 defines that SIE enables or inhibits the development of social innovation and adds that they consist of actors from different societal sectors and their environments with legal and cultural norms, potentially supportive infrastructures, and many other elements. S2 also mentions the need for a supporting infrastructure for SIE.

(**Sub-Q2)**: Who are the actors that take part of a social innovation ecosystem and what are their roles?

For S5, social innovation initiatives engage a wide variety of actors and networks in a diversity of roles and functions, which is part of what allows the initiatives to respond to social problems. For S1, S3, S4, S5, S6, S7, S8 and S9, a SIE is composed of a group of social actors that may include social entrepreneurs, government (including public sector companies), profit-oriented companies, universities and research centers, social organizations, and civil society, just to mention the most typical ones. These actors are explained in Section 2.2.3, concerning actors involved in the development of a social innovation. S3 presents the importance of social entrepreneurs in social innovation ecosystems but indicates that they are not in the center of SIE. Finally, S3, S6 and S9 also mention the participation of local communities.

S5 conceptualize different roles for actors within SIE. **Developers** are the inner core of social innovation initiatives, initiating and operating the solution. These actors are seen as being able to translate knowledge about unsatisfactory circumstances into an innovative idea in order to improve the situation. Furthermore, these actors have the ability to not only invent but also to develop and implement the idea in order to make it a social innovation. **Promoters** of social innovations are involved in social innovation processes as partners that provide infrastructural equipment, funding, and connect initiatives to superior policy programs. In addition, **supporters** refer to actors facilitating the spread and diffusion of social innovations through, for example, dissemination or lobbying activities. Accounting for the importance of knowledge as key resource in social

innovation processes, **knowledge providers** refers to actors that provide special knowledge relevant to spur and enrich the development process. S3 also cites these roles.

Another role mentioned in the literature is that of **beneficiaries** (S3) or **users** (S5), that refers to the actors who benefit from the implementation of social innovations. They are involved in the development or improvement of the solution or acting as knowledge providers. More precisely, beneficiaries provide knowledge throughout the social innovation process in the form of dialogues, feedback, testing and experimentation, suggestions for further improvement, and tutoring. These findings correspond to the observation that they have a substantial role in social innovation processes beyond the mere utilization of the solution provided by others. Moreover, it suggests that social innovation initiatives rely on their specific knowledge and feedback to meet their needs appropriately.

S8 indicates other roles in an SIE during the planning and execution of a mentoring cycle: i) *Ecosystem orchestrator*: being responsible for the managing and monitoring ecosystem's activities; ii) *Mentor*: an expert who gives advice, suggesting strategies, and presenting new ideas for the project team to run the social innovation project's necessary actions; iii) *Mentee*: representative of a social innovation project that receives advice from the mentor; and iv) *Collaborator*: assist the orchestrator in the planning and monitoring of activities associated or collaborates with the mentee.

S1 emphasizes the importance of the government, which may act as an enabler and as a facilitator. It includes fostering coordination between actors, ensuring the provision of information and evidence on needs and demands, and creating opportunities and facilitating cross-sectoral coordination to stimulate social innovation and processes of scaling.

(**Sub-Q3)**: What challenges were mentioned in the studies?

S3 cites the importance to focus on the cross-sector dynamics of social innovation and the diversity of actors and their roles and functions within the social innovation process (including their interaction in networks). S3 mentions that a SIE needs further theoretical and empirical elaboration, e.g., regarding which governance structures support collaborative action for social innovation and which roles the state and research can play. The relevance of governance was also mentioned by S6, pointing that a challenge for both research and practice has to do with the development of new governance models for SIE.

Regarding the social aspect, concerning ecosystem's actors, S6 cites those traditional patterns and mechanisms concerning empowerment, co-creation and citizen involvement seem obsolete. It adds that a SIE can only develop their full potential if there

are people who have the necessary skills to work in this area. Moreover, it points out that universities could play an important role and that developing capabilities for SIE is a key task for actors from all societal sectors. S4 indicates that the factors that allow social actors to enter and belong to an ecosystem are critical, and the relations between the actors are more than simply partnerships, due to a strong interdependence and mutual trust.

S3, S4, S5, S6, S7 and S9 call for more theoretical and empirical investigation of SIE. S3 cites that an important task for future research is not only to better understand social innovation ecosystems themselves, but also to explore connections between ecosystems which would facilitate diffusion of social innovations.

S8 identified the following challenges in an observational study performed in a real SIE: i) relevance of the qualification of actors; ii) need for a dedicated infrastructure to held physical meetings; iii) need of a common vocabulary concerning methodology; and iv) lack of a common technological infrastructure.

S4 indicates the relevance to research the aspects: i) how social links are created and developed; ii) how the structure of the SIE evolves over time; iii) how actors interact with each other; and iv) how value is shared and captured among ecosystem members.

S7 raises several questions for further investigations: i) to be effective supporters of social innovation, to what extent must governments relinquish some control?; ii) do we need to rely on random connections between SIE actors, or can we design encounters?; iii) to what extent should we focus on creating and communicating an enabling environment for innovation?; iv) how can governments help create ecosystems which allow for experimentation?; and v) what can we learn from other sectors, such as business, or from ecological metaphors about ecosystems?.

2.3.4. Discussion

This SMS results show that social innovation ecosystem is still an emergent field. Besides, this topic is recent given the publications' dates. It is possible to notice that all the studies were published in the last decade, and the oldest study was published in 2014 (S1). The other eight studies have been published from 2014-2019.

The authors of the studies emphasized that SIE research is new and that further investigations are needed. However, by analyzing SIE definitions, it is possible to identify similarities. From all the research questions, we identified a set of characteristics that make up a SIE: i) as well as social innovation, SIE is formed by actors from different sectors of the economy, who can act in the ecosystem as representing people or organizations (S1-

S9); ii) it is formed by actors who may have more than one role in the ecosystem, which is subject to change over time (S3, S5, S6, S8); iii) it enables or inhibits the development of social innovation (S3, S5-S7); iv) it is a space for coordinating social innovation (S4); v) it involves a clear set of values: shared intent, common purpose, collaboration, transparency, and openness; vi) it involves activities to support the development and diffusion of social innovation (S1, S4, S6, S8); vii) it is concerning new governance models and structures (S1, S3, S8); viii) it is heavily dependent on the skills actors bring to the ecosystem (S2, S3, S6, S8); and ix) it involves the networks that allow actors to get involved (S2, S3).

In this context, some needs are reported to support a SIE, as follows: i) combining different types of information, knowledge, resources, and skills; ii) providing infrastructure and support to the development and diffusion of social innovations; iii) providing methods, processes, and tools to support actors' activities from different sectors of the economy; iv) providing methods and tools to support collaboration between SIE actors; v) providing ways to managing and monitoring the ecosystem through supporting tools, governance models and processes; and vi) providing a common vocabulary to improve social actor's communication and understanding. This research intends to meet the needs concerning topics i, ii, iii, iv, and vi. For item v, concerning managing and monitoring the ecosystem through supporting tools, governance models, and processes, it is intended to focus only on management support.

By analyzing these items, it is possible to identify that technological solutions would help the management of SIE. These solutions would help actors to interact and collaborate remotely through a common technological platform and the ecosystem orchestrator (who is responsible for its management), to coordinate all the ecosystem's activities.

2.4. Digital Ecosystems

After carrying out the SMS on social innovation ecosystems, it was decided to investigate digital ecosystems in order to verify the possibility of using them as a basis for technological support for the solution of this research. Then, we sought to formalize a protocol to conduct a systematic mapping of the literature. The purpose of this third SMS was to investigate digital ecosystems, how they are understood, in which domains they are used, and their characteristics and elements that compose them. Three steps were performed: (1) planning, (2) conducting, and (3) analyzing the results. The study was conducted according to the guidelines of Kitchenham & Charters (2007).

2.4.1. Concepts

Chang & West (2006) define a digital ecosystem (DE) as an "open, loosely coupled, domain clustered, demand-driven, self-organizing agents' environment, where each specie is proactive and responsive for its own benefit or profit". This definition suggests that each species within a digital ecosystem participate with the aim of achieving something. Table 2 presents an explanation of terms presented in this definition.

Table 2. Digital ecosystem - terms and meanings (CHANG & WEST, 2006).

Term	Meaning...
Open	a transparent environment
Loosely coupled	freely bounded, open relationship between species or entities within a virtual Community
Species	entities that join an environment or a community based on its own interest
Domain clustered	colony where species have something in common or share the same interests
Demand driven	driving force to join a Community
Self-organizing	agents being capable of acting autonomously, making decisions and fulfilling responsibilities
Agents environment	environment which contains human individuals, information technologies and tools that facilitate interaction along with resources that sustain the synergy among human beings or organizations
Proactive	entity being full of enthusiasm to participate in team work or in the community
Responsive	agent that demonstrates willingness, is cooperative and takes responsibility for its action
Benefit	advantage that an agent can take without any risks
Profit	social and economic gain

2.4.2. Planning

The goal of this study was defined based on the Goal-Question-Metric approach (BASILI, 1992): to **analyze** existing studies on DE **in order to** get a comprehensive understanding with respect to the definition of DE and its elements, **from the point of view of** researchers and practitioners **in the context of** DE studies. Thus, the following research question was reached (**RQ**): "*What is the state of the art on Digital Ecosystem?*". To help answering this question, the following sub-questions (Sub-Q) were specified:

- (**Sub-Q1**): How is a DE defined?
- (**Sub-Q2**): What are the main characteristics of a DE?
- (**Sub-Q3**): What are the main domains studied from the context of DE?
- (**Sub-Q4**): What are the research groups studying DE?
- (**Sub-Q5**): What are the elements studied from the perspective of DE and how these elements are related?
- (**Sub-Q6**): What are the main benefits and challenges obtained by the adoption of DE?

The electronic search was conducted using the following search engines: IEEE Xplore Digital Library, ACM Digital Library, Elsevier ScienceDirect, EI Compendex[4], Scopus, Web of Science, and Wiley Interscience[5]. During the execution on the search engines, two filters were applied to set "English" as the language. There was no restriction concerning the study publication date.

After the selection of the electronic databases, the search strategy was defined. This mapping focused on computing solutions, excluding other domains. Thus, a filter was applied by selecting the Computing sub-area. The search string was adjusted to include more studies because some authors use the term "digital business ecosystem" as an alternative term for "digital ecosystem". This helps to maximize the number of the returned relevant studies, as it places as few restrictions as possible on the search string. The basic search string formulated was:

"digital ecosystem*" OR "digital business ecosystem*" OR "DBE"

The steps in the data selection and extraction process are summarized and shown in Figure 6. During the execution of the selection steps, inclusion criteria (CI) and exclusion criteria (CE) were applied. The following list shows the inclusion criteria adopted: i) studies presenting a DE definition; ii) studies presenting DE characteristics; iii) studies presenting challenges and benefits concerning the application of DE; and iv) studies presenting elements and relationships that may represent a DE component.

The exclusion criteria were: i) the study is not written in English; ii) the full version of the study is not available through the authors' institution; iii) if the same study has been published more than once, only the most relevant version (e.g., the one explaining the study in greatest detail) should be used; iv) repeated studies found in different search engines (in this case, just one study was considered); v) the study is a preface, book, poster, editorial, summary, note, tutorial, workshop, review and article in press (exclusively commercial studies); and vi) the study used DE as an example, a reference to explain other concepts, or listed them as a keyword without further discussion in the main text.

2.4.3. Execution

String execution in search bases occurred in April 2019. After removing the duplicate studies analysis took place in three stages (Figure 7):

[4] http://engineeringvillage.com
[5] https://onlinelibrary.wiley.com/

- in the first filter (stage 3.2), the studies returned in the searches were analyzed by screening, for each study, its title, abstract and keywords, based on the inclusion and exclusion criteria, to filter studies that are relevant for the SMS. In case of any doubt about the study's relevance with to the SMS, it is included for the next step;
- in the second filter (stage 3.3), the introduction and conclusion texts of the studies selected in the previous stage were read, analyzing them again based on the same criteria used previously;
- in stage 3.4, we performed the complete reading of the studies that were approved in the second filter, analyzing them again based on the same criteria used previously. In this case, each analyzed study is selected if all the inclusion criteria were applied.

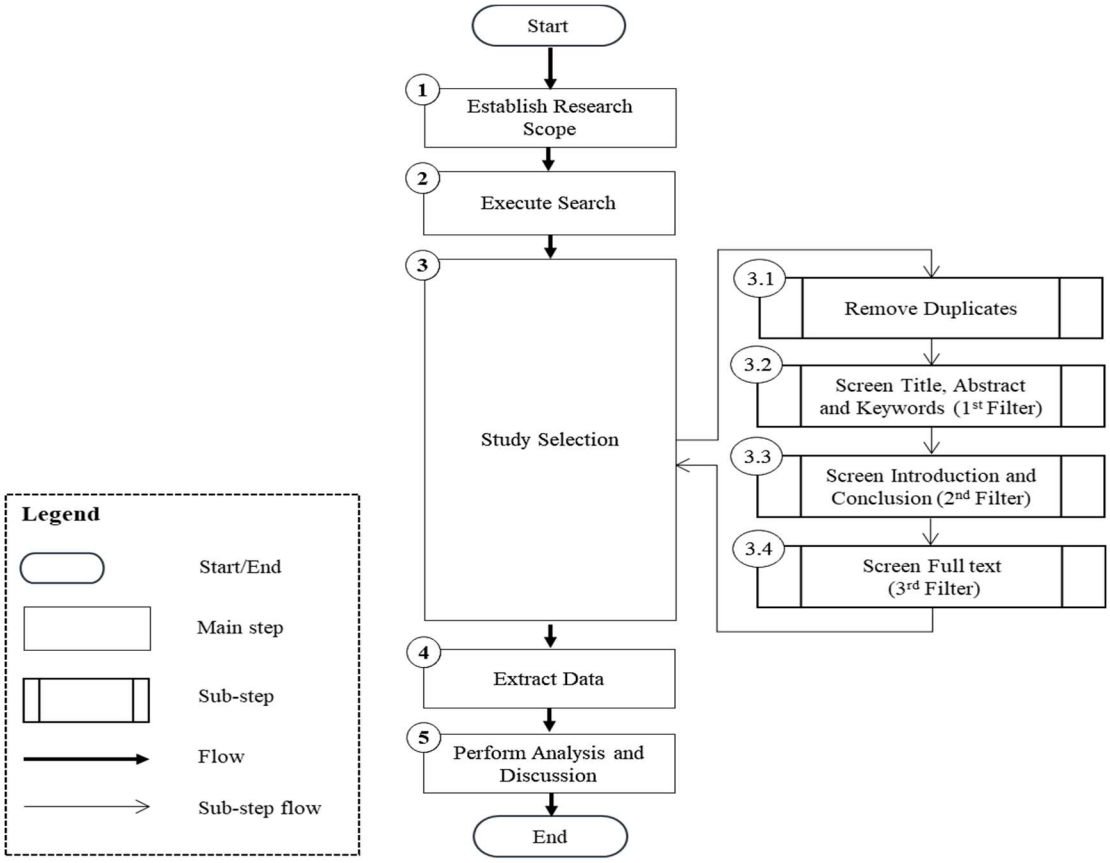


Figure 6. Procedure for SMS on DE. Adapted from LI et al. (2012).

The data extraction process took place through a form for recording data concerning the reading of each work. The extraction form recorded the data needed to respond to the Sub-Qs. From each selected study, it was extracted some key information into several forms, aiming to characterize a DE: (1) ID - study identifier; (2) Title – the title of work;

(3) Author(s) - the author(s) of work; (4) Definition - DE definition used by authors; (5) Characteristics - DE characteristics presented by authors; (6) Source - Conference/journal where the study was published; (7) Year - year of work publication; (8) Institution - institution where authors are located; (9) Benefits - advantages obtained by DE; (10) Domain - area to which DE is applied; (11) Elements - concepts identified by the authors as part of an DE; and (12) Relationships - interactions identified between DE elements.

In order to answer the research sub-question (**Sub-Q5)**, a sequence of steps was defined and applied for the identification of elements. These steps, presented in Figure 7 were applied to identify, and extract the elements from the SMS studies. It was considered that the possible DE elements are composed only by nouns. For example, if the quote concerning a DE is "generating an artifact" in the study, the element to be studied will be "artifact". These nouns are searched inside the sections of the study that explains a DE.

For each study presented on the SMS results table (step 1), the nouns that seems to be an element that composes a DE are analyzed (step 2), it is verified if it belongs to the Elements table (step 3). If the element did not belong to the Elements table, then the acceptance criteria are verified (step 4).

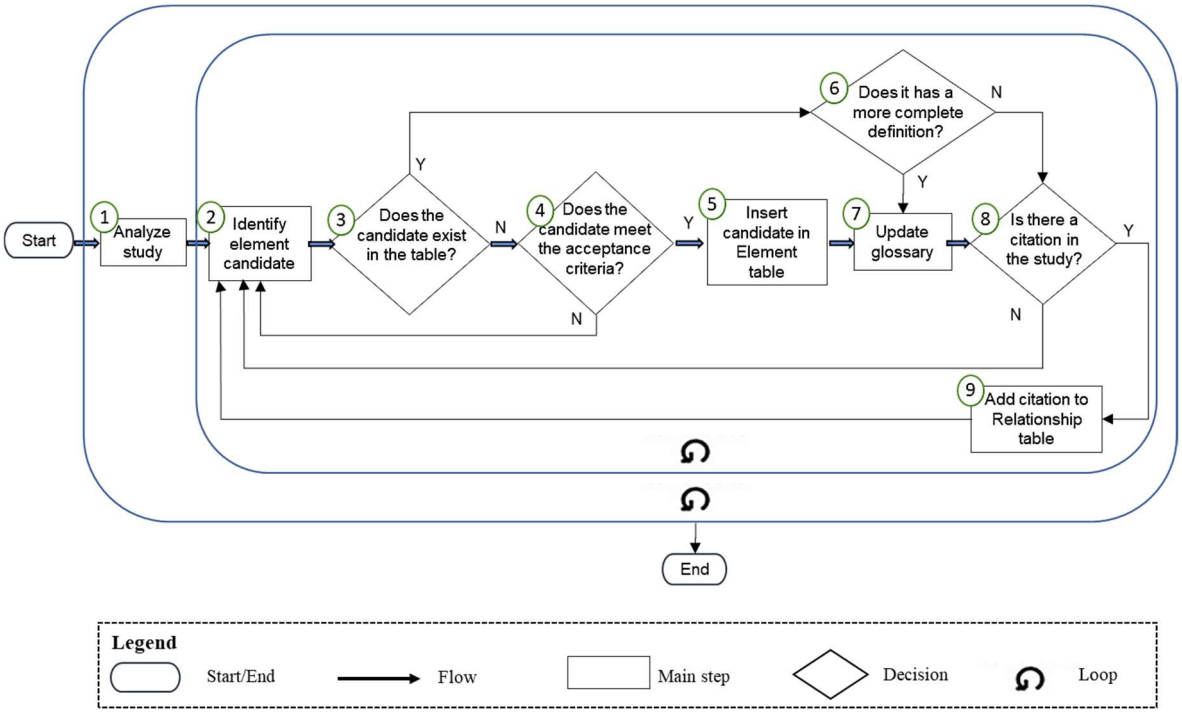


Figure 7. Element and relationship process identification.

The acceptance criteria applied for each element are: C1) it should be unique (so no synonym), unambiguous and clear, and should not be included in another definition or definitions; C2) it should be applicable to all DE; C3) it is defined and described in academic literature; and C4) it must be relevant to describe a DE. Criteria C1 to C4 were

adopted from another research, specific for the development of a software ecosystems meta-model (WOUTERS et al., 2019). Acceptance requirement C2 is oriented to prevent the inclusion of elements that are concerning a specific domain. For example, an element named “Pedagogical Theories” is specific to learning or education domains, so it is not included into Elements table. If the element meets the criteria, then it is inserted into Elements table (step 5), together with the study’s identification, for traceability proposes. At the end of this process, each element has an associated list of the studies from it was observed.

If the element belongs to Elements table the Study ID column is updated, by adding the additional Study Id. Then, if the study presents a definition for the element and the Elements table already has a definition for it, we verify the most complete definition (step 6) and the most recent one is updated (step 7). These definitions will compound a glossary. For every identified element, it is verified if it presents a citation containing a relationship with another noun (step 8). In this case, the entire sentence is recorded into Relationship table (step 9), together with the Study ID.

In the case that the element has no definition into the SMS study from where it was extracted, works from the general literature which described the element were considered. The search for general works that are outside the list of primary studies was necessary for two reasons: i) the articles included in the mapping carried out do not provide definitions for all the elements identified; and/or ii) there are elements that are characteristic not only of the domain of digital ecosystems, but of several areas concerning business (for example: collaboration, politics etc.).

2.4.4. Results

The SMS includes all publications that were indexed at the time of extraction (May 2019). We searched for relevant studies in seven main publication databases and, after applying the search string, they provided 3,016 studies. After removing the duplicate studies, only 1,378 left. At the end, there were selected 22 primary studies for data extraction. The quantitative results of each stage are presented in Figure 8.

The studies were ordered by year and title name and presented in Table 3. For each study, we defined an identifier (ID) that was used to reference the mapping in the text. As such, the studies were enumerated from S1 to S22. Then the primary studies were classified from two perspectives: contribution type and research type.

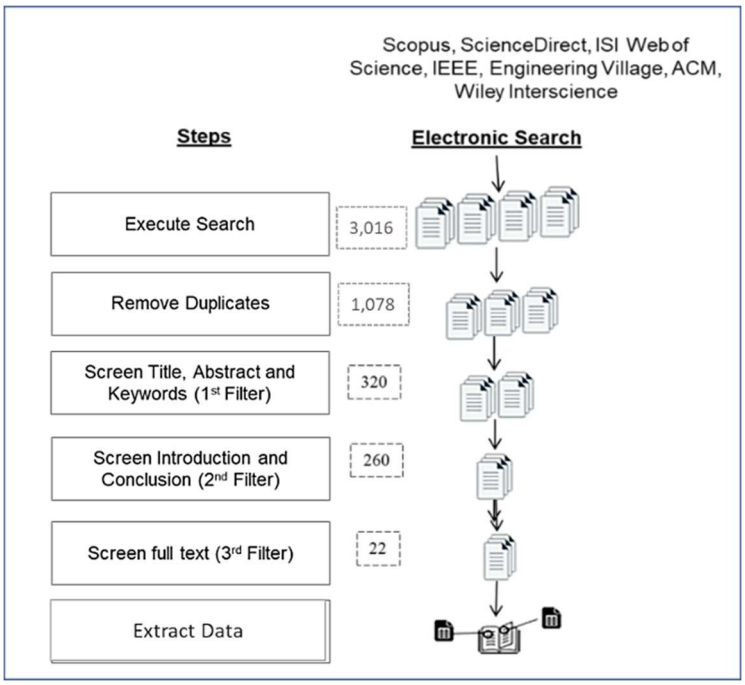


Figure 8. Results obtained in each SMS stage.

In order to classify the studies according to the contribution type, it was adopted the classification scheme suggested by Abdelmaboud et al. (2015). The types were split into five classes, which are described as follows: i) **Tool**: refers to research presenting a software tool; ii) **Method**: refers to research that presents a model, algorithm or approach; iii) **Process**: refers to research that describes the actions or activities and the associated workflows; iv) **Model**: refers to research that discusses concepts, makes comparisons, explores relationships, identifies challenges, or makes classifications; and v) **Metric**: refers to research that proposes measurements and metrics.

The research type classification proposed by Wieringa et al. (2006) was applied to characterize research and its degree of novelty. We followed this classification in our SMS and categorized the primary studies into six research types as follows: i) **Evaluation research**: investigates a problem in practice, or implementation of a technique in practice; ii) **Experience paper:** emphasizes experience about one project or more, reflects the author's personal experience, and contains a list of lessons learned by the author; iii) **Opinion paper:** discusses a theme theoretically, or contains an opinion about what is wrong or good about something, how we should do something etc.; iv) **Philosophical paper:** sketches a new way of looking at things, a new conceptual framework etc.; v) **Solution proposal:** presents a solution for a problem and can be either novel or a significant extension of an existing technique; and vi) **Validation research:** investigates the properties of a solution proposal that has not yet been implemented in practice.

Table 3. Studies analyzed in the SMS on digital ecosystems.

Study	Title	Reference	Source
S1	A digital ecosystem for co-creating business with people	(KARHU et al., 2011)	Journal of Emerging Technologies in Web Intelligence
S2	A Holistic Approach for Creating a Digital Ecosystem Enabling Personalized Assistive Care for Elderly	(BAJENARU et al., 2018)	2018 IEEE 16th International Conference on Embedded and Ubiquitous Computing
S3	A Multimedia-Oriented Digital Ecosystem: A new collaborative environment	(KIDANU et al., 2015)	2015 International Conference on Information Systems (ICIS)
S4	An ecosystemic environment for knowledge and services sharing on creative enterprises	(FERRI et al., 2014)	MEDES'14 - International Conference on Management of Emergent Digital EcoSystems
S5	An Integrative view of the concept of Digital Ecosystem	(DONG et al., 2007a)	Third International Conference on Networking and Services (ICNS'07)
S6	An internationally distributed ubiquitous Living Lab innovation platform for digital ecosystem research	(TANG et al., 2010)	MEDES'10 - International Conference on Management of Emergent Digital EcoSystems
S7	An ontology supporting planning, analysis, and simulation of evolving Digital Ecosystems	(BIERMAN et al., 2016)	MEDES'16 - International Conference on Management of Emergent Digital EcoSystems
S8	Analyzing requirements with the digital learning ecosystem approach	(FICHEMAN & LOPES, 2009)	2009 3rd IEEE International Conference on Digital Ecosystems and Technologies
S9	Capabilities for digital platform survival: Insights from a business-to-business digital platform	(BLASCHKE et al., 2018)	Thirty Ninth International Conference on Information Systems
S10	Complex Adaptive Digital Ecosystems	(BRISCOE, 2009)	MEDES'10 - International Conference on Management of Emergent Digital EcoSystems
S11	Conceptual foundations for understanding smart tourism ecosystems	(GRETZEL et al., 2015)	Computers in Human Behavior
S12	Digital ecosystems: Challenges and prospects	(LI et al., 2012)	MEDES'12 - International Conference on Management of Emergent Digital EcoSystems
S13	Digital ecosystems: Principles and semantics	(BOLEY & CHANG, 2007)	2007 Inaugural IEEE International Conference on Digital Ecosystems and Technologies
S14	Digital teaching and learning ecosystem (DTLE): A theoretical approach for online learning environments	(REYNA, 2011)	Proceedings of the 2011 Australasian Society for Computers in Learning in Tertiary Education's (ASCILITE)
S15	Ecological system meets 'digital ecosystem': Can ICT benefit from understanding biology?	(WHELAN, 2010)	4th IEEE International Conference on Digital Ecosystems and Technologies (IEEE DEST 2010)
S16	Exploring a digital ecosystem conceptual model and its simulation prototype	(WU & CHANG, 2007)	2007 IEEE International Symposium on Industrial Electronics
S17	Exploring the conceptual model of digital ecosystem	(DONG et al., 2007b)	Second International Conference on Digital Telecommunications (ICDT'07)
S18	Foundation of a new digital ecosystem for u-Content: Needs, definition, and design	(OH et al., 2011)	2011 International Conference on Virtual and Mixed Reality: Systems and Applications
S19	MAS2DES-onto: Ontology for MAS-based digital ecosystems	(KIDANU et al., 2015)	2017 XLIII Latin American Computer Conference (CLEI)
S20	MMDES: Multimedia Digital Ecosystem: New Platform for Collaboration and Sharing	(KIDANU et al., 2016)	2016 IEEE International Conference on Computational Science and Engineering
S21	Synchronous remote collaboration using multi-touch devices	(MOULIN et al., 2013)	2013 Eighth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing
S22	Towards an agent-oriented architecture of the digital healthcare ecosystem	(VASILĂŢEANU & ŞERBĂNAŢI, 2012)	Scientific Bulletin-University Politehnica of Bucharest

Demographics

As a result of these classifications, it was observed that contributions were related to methods (S1, S2, S3, S5, S7, S8, S10, S14, S16, S17, S19, and S22) since several studies proposed models for DE on several domains. Next, there were eight studies which discussed concepts, made comparisons, explored relationships, or identified challenges (S9, S11, S12, S13, S15, S18, S20, and S21). Only four studies proposed some software tool (S4, S6, S16, and S20). Regarding the research type, fourteen studies were concerning philosophical studies (S1, S3, S5, S8, S10-S15, S17, S18, S20, and S22), eight were concerning solution proposal (S4, S6, S7, S8, S16, S19, S20, and S22), and only one to an experience paper (S21).

Most of the studies selected were philosophical studies because they were presenting models, frameworks or were concerning the presentation of new concepts. In this case, it was observed that several studies were presenting new ecosystem categories, including the introduction of new definitions, models or frameworks. Some studies were categorized as philosophical paper and solution paper because they addressed both categories.

Answers to sub-questions

- (**Sub-Q1)**: How a DE is defined?

The term "Digital Ecosystem" has been used to describe a variety of concepts in Information Technology (IT) and this assumption was proved in this systematic study due to the number of definitions obtained. Table 4 lists the DE definitions identified in the selected studies. Some studies made use of more than one definition, mostly because they (S5 and S17) recognize that the digital ecosystem has a business objective and at the same time, inherit properties from natural ecosystems. Most studies (7 studies) reference the definition presented by Chang & West (2006) in the study "Digital Ecosystems: A Next Generation of the Collaborative Environment". The table also shows that there is no consensus for digital ecosystems conceptual foundations.

- (**Sub-Q2**): What are the main characteristics of a DE?

Table 5 lists the main characteristics of DE identified in the studies. As there are several distinct definitions, the same happens with DE characteristics. Even so, some characteristics were mentioned in several studies, emphasizing the relevance of collaboration, openness, self-organization, scalability, sustainability, dynamism, interaction, promotion of knowledge and the presence of a digital infrastructure. Other results state that DE are linked to natural/biological ecosystems and business ecosystems.

Table 4. DE definitions.

Study	Definition
S5, S6, S12, S13, S16, S15, S17, S22	"an open, loosely coupled, domain clustered, demand-driven, self organizing, and agent-based environment in which each species is proactive and responsive for its own benefit and profit"
S5, S17	"an open-source network environment for business mainly including small and medium enterprises to interact with others in an effective and efficient way"
S8, S12	"a self-organizing digital infrastructure aimed at creating a digital environment for networked organizations that supports the cooperation, the knowledge sharing, the development of open and adaptive technologies and evolutionary business models"
S18, S22	"dynamic and synergetic complex of digital communities consisting of interconnected, interrelated, and interdependent digital species situated in a digital environment that interact as a functional unit and are linked together through actions, information, and transaction flows"
S1	"the partial digital representation of Digital Business Ecosystem"
S3	"digital environment for interested participants that supports in-between cooperation and promote collective knowledge sharing in order to provide mutual benefits, as a new way to handle collaboration in a distributed and heterogeneous environment"
S4	"a virtual environment that supports mash-up, involving services and knowledge sharing and management among the multiple and independent entities that are part of this environment"
S7	"consists of people that use digital technology for communication which has finally an influence on the knowledge and economics"
S9	"a complex network of actor-to-actor interactions, which is mediated by a digital platform (offered by digital platform's owner) and becomes increasingly accessible to a wide range of end users through complementary resources offered digital platform's partners"
S11	"complex of a community of digital devices and their environment functioning as a whole"
S14	"an ecological model of learning and teaching, understanding e-learning infrastructure and implementation, and an aid when designing new learning tools"
S16	"new networked architecture and collaborative environment that addresses the weakness of client-server, peer-to-peer and web services environments"
S19	"ecosystems formed by computing resources (e.g., devices, services, data), in order to acquire news on information systems"
S20	"a collaborative environment which has the characteristics: promoting interaction and collaboration, individual resource management, equilibrium and shared knowledge"
S21	"combination of digital entry points, people who use them to communicate, the business processes and technology environment that support both"

- (**Sub-Q3)**: What are the main domains studied from the context of DE?

Given that DE is an approach which characteristics may help to solve several issues in many fields, different research and industry communities have been investigating the area independently. Some studies did not show the investigation of such ecosystems associated with a specific domain, as it was the case with S4, S5, S6, S7, S10, S12, S13, S15, S17, and S21. The studies that investigated or proposed new DE categories are presented on Table 6.

- (**Sub-Q4)**: What are the research groups studying DE?

The findings indicate a strong significance of academic institutions involved in the DE field with 90 percent (20 studies) of studies. The most active academic institutions were: Curtin University of Technology, in Australia (S5, S13, S16, and S17), University of Pau and Adour Countries, in France (S3, S19, and S20) and Universidad Simon Bolıvar

in Venezuela (S3, S19, and S20). Table 7 presents the academic institutions sorted by the number of studies returned in the SMS. In case the groups have the same number of studies, they are sorted alphabetically.

Table 5. DE characteristics.

Study	Characteristic
S3, S4, S5, S6, S8, S10, S11, S12, S13, S16, S18, S20, S21	Promotes interaction and collaboration
S1, S2, S6, S11, S12, S16, S18, S22	Has a digital infrastructure
S3, S5, S10, S11, S12, S15, S16, S22	Has the properties: self-organization, scalability, sustainability and dynamism
S10, S11, S12, S13, S15, S16, S22	Is related to the openness of the environment
S4, S8, S16, S18, S20, S22	Promotes knowledge sharing
S11, S12, S16, S17, S22	Is linked to business ecosystem perspective
S8, S11, S12, S20	Are composed of multiple and independent entities such as individuals, organizations, services, software and applications.
S3, S10, S13, S16	Contains characteristics as interaction and engagement, balance, domain clustered and loosely coupled, self-organization.
S4, S11, S13, S16	Contains a networked architecture
S1, S6, S12, S22	Is concerning innovation processes
S6, S18, S21	Is supported by a platform
S6, S8, S10	Inherits characteristics of natural ecosystems like mutualism, commensalism, amensalism, symbiosis etc.
S7, S8, S15	Include digital components that interact with each other and with the digital environment
S19, S20	Is formed by agents that act autonomously, making decisions, and fulfilling responsibilities
S3, S20	Guarantee the mutual benefits among all participants, achieving equilibrium
S5, S22	Consists of two basic parts or components – species and an ecosystem environment. Each species can be viewed as an individual or an organization and has its own role to play.
S8	Are dynamic and complex systems
S13	May contain a leadership structure that may be formed (and dissolved) in response to the dynamic needs of the environment
S5	Is formed by species form a hierarchical organization, of flexible structures

Table 6. Domains identified for DE.

Study	Domain	Digital Ecosystem Type
S9, S16	Business	Digital Business Ecosystem
S2, S22	Health	Digital Health Ecosystem
S8, S14	Learning	Digital Learning Ecosystem
S3, S20	Multimedia	MultiMedia Digital Ecosystem
S19	Multi-agent	Multi-agent-based digital ecosystems
S11	Tourism	Tourism Ecosystem
S18	U-Content	Digital Ecosystem for u-Content
S1	Web 2.0	Web 2.0 Digital Ecosystem

Table 7. Institutions identified from the SMS studies.

Study	Institution	Country
S5, S13, S16, S17	Curtin University of Technology	Australia
S3, S19, S20	University of Pau and Adour Countries	France
S3, S19, S20	Universidad Simon Bolıvar	Venezuela
S1, S6	Aalto University	Finland
S6	Beijing University of Posts and Telecommunications	China
S21	Chiba Institute of Technology	Japan
S7	Georg-August-Universität	Germany
S10	Heriot Watt University	United Kingdom
S7	King's College London	United Kingdom
S11	Kyung Hee University	Korea
S2	National Institute for Research and Development in Informatics	Romania
S4	National Research Council	Italy
S13	National Research Council of Canada	Canada
S11	Parque Tecnológico de San Sebastián	Spain
S8	Universidade de São Paulo	Brazil
S20	Universidade Peruana de Ciencias Aplicadas	Peru
S21	Université de Technologie de Compiègne	France
S12	Université de Lyon	France
S11	University of Queensland	Australia
S9	University of St. Gallen	Switzerland
S15	University of Wollongong in Dubai	United Arab Emirates
S22	University Politehnica of Bucharest	Romania
S11	Vienna University of Technology	Austria

The diversity of universities from eighteen countries demonstrates the coverage of digital ecosystem research worldwide. In addition, industrial institutions published two studies (S14 and S18). This result suggests that the field is also investigated from the industrial standpoint.

- (**Sub-Q5)**: What are the elements studied from the perspective of DE and how these elements are related?

At the end of this process, two distinct tables were generated: i) *Elements table*: contains the element's name, the definition mentioned in one of the studies (it is chosen the best definition), an associated list of SMS studies from it was observed and is presented in Table 8 and Table 9; and ii) *Relationship table*: contains the citation that mentions the relationship between the element and other elements, an associated list of SMS studies from which it was observed and is presented in Table 10.

Table 8. DE elements – part 1.

Class	Description	Studies
Actor	an atomic autonomous entity that is capable of performing functions and represents a participant in the ecosystem. specie (S1), agent (S2, S20), player (S6), biotic component (S14), peer (S3), stakeholder (22).	S3, S4, S6, S8, S10, S11, S14, S19, S20, S22
Artifact	service (S5) /product/information/data/content (S11) that an actor requests/user/consumes or provides/develop.	S1, S3, S5, S6, S7, S8, S9, S11, S16, S17, S18, S20
Benefit	a social or economical advantage that an actor gains by digital ecosystem. Benefit refers to an advantage that an agent can take without any risks. Profit refers to personal gain.	S5, S11, S16
Collaboration	the recursive process in which two or more people or organizations work together towards an intersection of common goals	S4
Common Vocabulary	common terms used by actors to communicate with each other.	S17, S13
Communication	any act by which one person gives to or receives from another person information about that person's needs, desires, perceptions, knowledge, or affective states.	S4
Content	is any kind of digital content from text, images, sounds and videos to browsers, authoring tools, simulators and software.	S8, S14, S19
Digital ecosystem	an open, loosely coupled, domain clustered, demand-driven, self-organizing agent environment, where each agent of each actors is proactive and responsive regarding its own benefit/profit but is also responsible to its system. Also considered as a system that supports cooperation, knowledge sharing, the development of open and adaptative technologies and the evolution of knowledge rich environments.	S5, S2, S11, S13, S15
Domain	field in digital ecosystem where a actors has common interest with other actors.	S5, S3, S8, S10, S11, S20
Follower	someone who follows a leader in a specific situation in a DE.	S5, S3, S17
Interoperability	ability of two or more systems or system components to exchange information and use information that has been exchanged.	S3, S11, S19
Knowledge Services	knowledge management processes necessary to organize, maintain and distribute knowledge to all the actors.	S4
Leader	a person who leads a group of people.	S5, S3, S17
Lessons Learned	knowledge or understanding gained by experience that has a significant impact for an organization. The experience may be either positive or negative.	S3, S4, S8
Orchestrator	someone who coordinates activities in the ecosystem.	S20
Organization	company and institution that participate in the digital ecosystem. Also considered an economic species.	S5, S11, S17, S22
Ontology	a conceptualization of knowledge in a special domain.	S13, S17, S22
Person	a human as an individual (Oxford Dictionary).	S5
Platform	a building block, providing an essential function to a technological system—which acts as a foundation upon which other firms can develop complementary products, technologies or services. It supports the description, compositions, evolution, integration, sharing and distribution of its components.	S4, S9, S11, S21
Policy	a guideline that defines the desired state inside a DE, expressed with constraints. It covers mandatory, legal, aspirational and not implementable policies.	S7, S11, S22
Privacy/ Security	the state of being free from danger or threat.	S2, S3, S6, S19, S20, S22
Privilege	a special right or advantage that a particular person or group of people has (Oxford Dictionary).	S3

Table 9. DE elements – part 2.

Class	Description	Studies
Product	a good that most closely meets the requirements of a particular market and yields enough profit to justify continued existence (Business Dictionary).	S9
Profile	a profile is a set of information describing an agent with its preferences. A profile defines: i) localization, interests, preferences in terms of domains, contents, applications, etc.; ii) resources in terms of multimedia contents and processing; and iii) processing and storage capacities.	S20, S3, S22
Role	the part played by an actor in the interaction with other actors (S20).	S5, S1, S3, S6, S7, S8, S11, S13, S14, S17, S20, S21
Rule	common or special regulation set by a specific agent that others should follow while interacting. They are defined by the resource owner and should be followed by the rest of the community as long as they have interest to access and consume those resources.	S2, S3, S5, S13, S17, S20, S22
Service	a business whose work involves doing something for customers but not producing goods (Oxford Dictionary).	S4, S5, S22
Social Networks	web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system.	S4, S11
Task	mission that an actor is executing, to survive and achieve its goals in the environment of digital ecosystem. Activity, Action (represents the set of actions that a peer can provide).	S5, S11, S17, S20, S3, S21, S22
Trust	a directional relationship between two parties that can be called trustor and trustee," where a trustor is said to trust, or not to trust, a trustee, in a particular context. Trust can be used as a form of 'soft security' or, by reflecting the real-world social relations, as an enabler of "trade, competition, collaboration and so on".	S3, S11, S19
Web Services	a specific type of service that is identified by a Uniform Resource Identifier (URI), whose service description and transport utilize open Internet standards.	S4, S6

At the end of this process, 31 elements and 33 relationships were identified. In order to clearly identify the elements (classes) and their relationships, the definitions were presented in a glossary using a tabular format.

- (**Sub-Q6)**: What are the main benefits and challenges obtained by the adoption of DE?

S4 describes the benefits brought by the use of DE concerning knowledge in two aspects: i) sharing: it becomes easier, more immediate, and less expensive, increasing its effectiveness; and ii) improvement in the quality of the community's knowledge base, due to the growing number of skills, competencies and "knowledge profiles" of each member involved in the community.

Regarding communication, S4 points out that the development of multi-channel communication and interaction makes it possible to interact independently from people's location. Moreover, it may extend the community's network by accessing other communities interested in joint activities. S5 and S17 also point out the efficiency of

communication between ecosystem actors. Finally, S5 and S17 also indicate the use of DE to formally structure existing business ecosystems.

Table 10. DE relationships.

#Id	Relationship	Study
R1	Platform offers different services, including network communication, interoperability, communication, collaboration, knowledge management, and Web Services	S1, S2, S3, S4, S6, S8, S13, S14
R2	Actor is proactive for or is responsive for own Benefit or Profit	S5, S13, S15, S16
R3	Each Actor has its own role to play and can be associated with several roles in the ecosystem.	S3, S5, S13, S20
R4	Actor provides an Artifact through Task	S5, S7, S11
R5	Leader guides all Followers	S3, S5, S13
R6	Actor carries out Tasks	S5, S16
R7	Actor consumes Artifact through Task	S5, S11
R8	Actor follows Policy (norms or regulations)	S5, S16
R9	Actor manages Tasks	S5, S16
R10	An Actor interacts with at least another actor	S3, S13
R11	Digital ecosystem consists of Actors and a Platform	S5, S13
R12	Each Actor can be viewed as a Person or an Organization	S5, S17
R13	Platform is provided by an organization	S5, S13
R14	Rules bring Trust among actors	S3, S11
R15	Tasks relates to Profit or Benefit	S5, S13
R16	Actor communicates through Commonly Vocabulary	S17
R17	Actor shares Lessons Learned	S4
R18	Actor uses Service	S5
R19	Actor(s) comes(come) from a certain Domain.	S5
R20	Actors comply with usage rules (Rule) of Artifact owners	S3
R21	Artifact has associated Rules	S3
R22	Artifact may be a Product or Content	S3
R23	Artifacts can be stored in the platform	S21
R24	Digital Ecosystem has a Policy	S7
R25	Ontology generates Common Vocabulary	S17
R26	Ontology supports Knowledge Management Services	S4
R27	Platform makes use of Social Networks	S4
R28	Platform provides services to the constituent Actor	S5
R29	Policy brings Trust	S7
R30	Profile is a set of information describing an Actor with its preferences	S20
R31	Role has a set of associated privileges.	S3
R32	Rules obey Ecosystems' Policy	S7
R33	Tasks contribute to Lessons Learned (generate Knowledge)	S4

About supporting heterogeneity within the ecosystem, S11 indicates that consumers, businesses, and various collectives of different players interact with information and technologies in new ways. S12 points out that DE can provide adaptable infrastructure to design heterogeneous systems. Finally, S4 indicates that DE creates a virtual environment

that involves services, knowledge sharing, and management among the multiple and independent entities that are part of this environment.

S12 and S15 show benefits arising from the association with the characteristics of biological ecosystems, indicating that, for being robust, self-organizing, and scalable, the development of Digital Ecosystems may help to manage a large amount of information in a large-scale environment.

The interaction between actors is mentioned by S4, S11, and S19, where S19 indicates that the DE provides the basis for an open environment where agents interact with each other to reach their individual or shared goals in an evolving environment. S4 and S11 emphasize this aspect of DE in supporting interaction and cooperation among individuals and organizations from different sectors.

Regarding the challenges mentioned in the studies, S3 points out that a crucial challenge in contemporary computing is to develop systems that address multifaceted, dynamic problems in a scalable and efficient way. S4 indicates the availability of the web resources and integration of web services, information and data.

S11 presents challenges concerning social aspects concerning digital ecosystems, such as: privacy concerns, the effects of technology-mediated life, information overload/the value of information, trust in smart technology and enjoyment of technology-enriched experiences. S18 points out low considerations for human factors (e.g., restrictions for kids, adaptations for novices, rewards to motivate end-user participation).

Regarding the terminology of DE, S12 mentions that these ecosystems, due to their multidisciplinary aspect, are challenging to define. Therefore, several definitions are identified, depending upon the ecosystem's domain (e.g., ecology, economics, and technology), making the concept difficult to understand. S15 and S17 also reported some issues concerning digital ecosystems terminologies.

S18 presents challenges in using traditional DE in the use of e-content, such as: i) lack standardized formats and (high capacity, quality) infrastructures to share contents; ii) lack in the provision of alternatives to find, combine (e.g., subtitles, translations), transform (e.g., format, version), and use contents; iii) do not particularly facilitate contents removal; and iv) lack of features that regulate what to share, how to share, who gets the right/ownership and granting accessibility of who can view, edit and publish. S19 indicates that there is still a need for more general conceptual models to represent the specific characteristics of DE in terms of win-win interaction, engagement, equilibrium, and self-organization.

2.4.5. Discussion

SMS results show that the final literature base is comprised of studies from different perspectives such as information technology, education, e-health systems, and business. The oldest studies were published in 2007 (S5, S13, S16, and S17), and the other eighteen studies have been published in journals (3 studies) and conferences (19 studies) between 2007 and 2018. That status of this topic is also reinforced by the research type analysis, which pointed that most of the primary studies were philosophical studies (14 studies), and proposal studies (8 studies) (solution proposal, conceptual proposal, and opinion paper), followed by one experience paper. It was not identified any study conducting practical evaluations of the proposed tools. Regarding the contribution type analysis of the selected studies, it was identified that most of them were concerning the method category (12 studies), followed by the model (8 studies) and tool (4 studies). It can indicate a gap in the evaluation research and also the lack of studies on 'metrics' and 'process'.

It was observed that much research (S1, S6, S8, and S20) investigated existing scenarios that might be real ecosystems, applications, or projects as sources for their research. S1 investigated real ecosystems by making use of two cases from two different domains: i) the smartphone applications market and the case is the ecosystem that has emerged around Apple's application store, App Store; and ii) the second domain chosen is bioinformatics, and the case is the ecosystem around the life science Web service registry, BioCatalogue. S6 proposed a DE architecture for a ubiquitous campus Living Lab innovation platform based on the international exchange and collaboration between two long-term Living Lab research projects in Finland and China.

In order to verify the applicability of the Gaia Model presented in the study S8, the researchers applied its artifacts on two previously developed study cases: A Space Simulator and a Music Education Portal. Another study, S20, made use of the framework proposed to implement a java-based mobile application to access multimedia content provided by the Archivo Nacional de Arte Rupestre, which is a non-profit organization responsible for collecting information on the rock manifestation in Venezuela. S2 proposes an ecosystem focused on an integrated, personalized, and elderly-centered assistive care provided by multidisciplinary healthcare specialists, supported by digital technology able to provide customized, in real-time assistance that is also focused on prevention and well-being of the elderly, and its project is funded by the Romanian Core Program of the Ministry of Research and Innovation. Manikas & Hansen (2013) already identified the importance of using existing real ecosystems in a research study to improve

empirical evidence on the topic. Besides, another study (S7) planned to apply the proposed model in real applications.

From the DE elements' perspective, it was identified a lack of standard concerning the terminology concerning the entity that can perform functions and represents a participant in the ecosystem. In this research we decided to adopt the term ‘actor’, that was mentioned in eight studies (S1, S3, S4, S6, S8, S9, S11, and S20). However, other terms mentioned by researchers were: i) agent (S5, S12, S13, S15, S16, S17, and S18); ii) stakeholder (S2 and S22); iii) participant (S2, S3, S20, and S22); iv) player (S6); v) peer (S3 and S20); vi) biotic component (S14); and vii) member (S21). The term ‘actor’ was selected because it was considered as an overlapping term for all entities in a DE who are taking part in the ecosystem in some form.

Regarding the role categories assumed by the actors presented in the SMS studies, the same lack of standard terminology was identified. Some roles mentioned were derived from the ecosystem domain, as it may be observed on studies related to: i) health: roles patient, doctor, researcher (S22); ii) e-learning: roles teacher, learner, tutor, lecturer, student, e-learning officer (S8 and S14); and iii) tourism: roles touristic consumer; resident consumer; tourism supplier; industry supplier; destination marketing organization (S11). In addition, it may be observed that roles concerning orchestration activities (orchestrator, coordinator) were mentioned in studies (S19 and S20) starting in 2016.

The most frequent role identified was user/end-user (S1, S4, S7, S8, S9, and S18), and derived roles were also identified as: primary end-user, secondary end-user, and tertiary end-user (S2). In addition, a group of roles mentioned concern similar business relations as: client x server (S17), consumer x producer (S19), provider x consumer (S6, S20), and supplier x requester (S5). Other roles mentioned were researcher (S6), developer (S6), keystone (S15), and mediator (S22).

Some studies made use of ontologies to describe a DE. Kidanu et al. (2016) described an ontology used to model Multi-Agent Systems-based Digital Ecosystems. They categorized the key concepts in the approach into five modules: structural, species, reasoning, interaction, and the core concept is the agent. The concepts were based on a previous work concerning Kidanu et al. (2015). Dong et al. (2007a) proposed a conceptual model that is built by using ontological notations. It presents the concepts of DE and its subclass concepts: species and environment. Species are individuals or organizations that participate in the ecosystem. They come from a specific domain, play roles, and follow the rules. The concepts are based on the DE definition from Soluta.net, which proposes a description from a structural and functional perspective, which sees DE as an open-source

network environment for business, mainly small and medium enterprises. We observed that the DE domain lacks a conceptual model that describes its elements and relations as a whole since the models presented faced specific DE characteristics or specific disciplines.

2.4.6. Threats to Validity

As in every empirical study, there are several threats that might negatively affect the validity of this SMS. This section analyzes the threats to validity for this study, considering the descriptive validity, theoretical validity, generalizability validity, interpretative validity e repeatability, according to Petersen et al. (2015):

Descriptive validity is related to how accurately and objectively the observations are described (PETERSEN et al., 2015). The researcher designed a data collection form to support the execution of the protocol, the recording of decisions made, and the data extraction process to reduce threats related to this threat.

Theoretical validity refers to the ability to capture what one wants to capture (PETERSEN et al., 2015). Two researchers were involved in the SMS protocol's elaboration, execution, and reporting to mitigate possible biases in the extraction and classification of information. Moreover, all extraction and consolidation of results were reviewed by another researcher to avoid researcher bias in answering the research questions. The researcher followed generally accepted practices for conducting SMS (KITCHENHAM & CHARTERS, 2007; PETERSEN et al., 2015) to mitigate the bias in selecting publications.

Regarding the degree of *generalization* of the findings, a threat concerns the limitation of using the six search engines considered. However, previous experiences (KITCHENHAM & CHARTERS, 2007; OLIVEIRA et al., 2017) show that the machines used have good coverage in software and information systems research. Furthermore, the researcher did not apply a filter concerning the publication years of the studies and

Interpretative validity is achieved when the conclusions obtained are derived from the data (PETERSEN et al., 2015). This threat is related to researcher bias. To reduce the bias, we seek to elaborate a set of clear inclusion and exclusion criteria for study selection. Moreover, the researcher discussed the study protocol with two senior researchers to ensure a common understanding of study selection and mitigate the bias on study selection results. Furthermore, the researcher discussed all findings, results, and conclusions resulting from this SMS with another researcher.

Repeatability requires detailed reporting of the research process (PETERSEN et al., 2015). The researcher applied a defined search string, used deterministic databases, used a free and online tool to support the SMS process (Parsifal[6]) and followed a step-by-step procedure that can be easily replicated. Moreover, the entire protocol for conducting the mapping is documented in this thesis to address this threat.

2.5. *ReuseECOS '3+1'* Framework

The work directly concerning the elaboration of the framework of this PhD thesis represents a consolidated framework in the area of software ecosystems (SECO): the *ReuseECOS '3+1'* framework. It provides a step-by-step process to serve as an instrument to help researchers to characterize and analyze organizational platforms considering the SECO context in the management teams' point of view (SANTOS & WERNER, 2011ab, 2012).

In this approach the elements that comprise an ecosystem are divided into three dimensions (Figure 9): i) architecture dimension, which focuses on the ecosystem platform; ii) business dimension, which focuses on the knowledge (e.g., set of artifacts, resources and information that flows from/to the organization, subject to self-regulation mechanisms); and iii) social dimension, which focuses on the ecosystem stakeholders (defined as the actors who interact within an ecosystem).

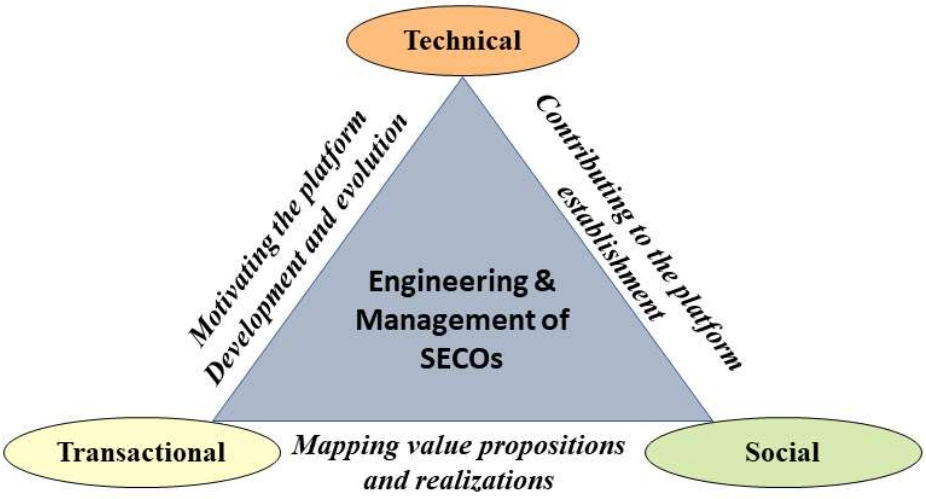


Figure 9. Overview of ReuseECOS '3+1' framework (SANTOS, 2016).

These dimensions are integrated through a fourth dimension, engineering and management (E&M), according to a SECO "3+1" view. This dimension aims to combine

[6] https://parsif.al/

the three dimensions presented through their relationships. Relation #1 is in between the technical and transactional dimensions and focuses on understanding the impacts of the SECO external view over ecosystem sustainability. Relation #2 is in between the technical and social dimensions and focuses on understanding the impacts of the SECO socio-technical network (community) over platform stability. Finally, Relation #3 is in between the transactional and social dimensions and focuses on understanding the impacts of the SECO internal view (community) over ecosystems performance. *ReuseECOS '3+1'* framework has served as an initial body of knowledge to support empirical studies to properly investigate a specific SECO concept and/or relation each time.

2.6. Final Remarks

This chapter presented the theoretical foundation concerning this research, which involved an SMS on the context (social innovation), on the domain (social innovation ecosystems) and on the rationale of the technological base for the solution (digital ecosystem). According to André & Abreu (2006), Bignetti (2011) and Silva & Bignetti (2012), social innovation management differs from technological innovation in aspects concerning value, strategy, process, knowledge diffusion and actors involved. Moreover, according to these authors, due to these differences, the conduct of social innovation processes requires models, methods, processes and methodologies different from those traditionally used for the management of technological innovations. This finding leads us to reflect on the need for research that specifically address the promotion in new ways (environments, governance, and processes) to support the management, development and diffusion of new social innovations.

Studies concerning the development of social innovations indicated the need for tools and an environment to support the development and engagement of actors. By analyzing studies concerning SIE, it was possible to identify its main characteristics and greatest challenges, which indicated the need for technological support solutions for ecosystem actors. Studies concerning DE and SIE pointed out the elements and relationships necessary for the design of these ecosystems.

Chapter 3. Social Innovation Ecosystem's Observational Study

This chapter reports an investigation of an emerging Brazilian social innovation ecosystem formed by actors involved in developing social innovation projects. It presents an observational study performed to investigate the characteristics and components of a real social innovation ecosystem and the challenges faced by its actors, including those concerning its management and monitoring. Moreover, the study also aimed to identify opportunities that a common technological platform could offer in attending to the reported challenges. After this observational study and the analysis of its results, it was possible to build a preliminary conceptual model concerning the scenario investigated.

Firstly, we explain the method we used to conduct an observational study in one Brazilian scenario where a social innovation ecosystem held a mentoring cycle (Section 3.1). In Sections 3.2 and 3.3, we characterize the studied scenario, analyze and discuss the challenges and elements identified. Finally, Section 3.4 brings threats to validity and Section 3.5. presents the final remarks.

3.1. Method

An observational study refers to research that involves social interaction between the researcher (observer or investigator) and the participants involved in a particular scenario, during which data are systematically and unobtrusively collected (TAYLOR & BOGDAN, 1984). In this method, the researcher conducts analysis to build the observational study and performs activities while other participants were observed, although this rule is not mandatory for observational studies (SEAMAN, 1999).

Some reasons to conduct a qualitative research in our context are suggested by Hancock et al. (2009), as follows: i) it allows studying behavior in natural settings, usually without manipulation of variables; ii) it focuses on reporting experiences or data which cannot be adequately expressed numerically; iii) it focuses on how informants can have different ways of observing a reality; iv) it focuses on description and interpretation,

leading to an evaluation of an organizational process; v) it considers complexity by incorporating real-world context; and vi) it uses a flexible methodology. In the social innovation field, researchers have adopted qualitative research to observe real situations (KLEVERBECK & TERSTRIEP, 2017; PURTIK & ARENAS, 2017). Edmondson & Mcmanus (2007) suggest that qualitative research approaches are more appropriate than emerging theories; in other words, theories that answer to "why" and "how" questions. Kleverbeck & Terstriep (2017) point out that social innovation-related theories are at an early stage, which is reinforced and can be observed in the research by Purtik & Arenas (2017).

The study was performed according to recommendations adapted from SEAMAN (1999), presented in Table 11. The planning of this study was inspired by the observational study described in (SANTOS, 2016). The researcher used questions from an existing systematic literature mapping study on the field as the basis (CHUERI & ARAUJO, 2018), which was concerning the challenges faced by actors in developing social innovation projects to the target (management ecosystem).

3.2. Case Observed

The real case observed was the social innovation ecosystem provided by the Nucleus of Cultural and Social Innovation (NCSI). NCSI is an integral part of the Board of Technological, Cultural and Social Innovation of Federal University of the State of Rio de Janeiro's Graduate, Research, and Innovation Department (DIT). NCSI aims to promote and monitor the implementation of social and cultural innovation projects at the university, and gives support to external initiatives (NUNES et al., 2018).

Table 11. Recommendations for observational studies. Adapted from SEAMAN (1999).

Situation	Recommendation
Many of the development activities are implicit and some key participants keep important information in their mind.	Communication is the best resource for a researcher to observe the environment's activities, taking part of project meetings and requesting short meetings when necessary.
Informants can think they are being observed throughout the study activities.	Notes are the best resources for a researcher to register participants' behavior, and project meetings should be as unobtrusive as possible.
Notes are often visible to some informants throughout the study activities.	Attention is the best advice for a researcher to keep his/her notes confidential and to have freedom to write opinions and thoughts.
Different meetings and sessions happen throughout the study activities	Emails are the best resources for a researcher to gather information on meetings dates and times, and participants.
Different issues are usually discussed in a project meeting beyond the initial outline	Text marks are the best resources for a researcher to highlight relevant information, since he/she should write down observations as much as he/she can.

3.2.1. Characterization

NCSI started as a SISU (Social Innovation Support Unit) representing the university at LASIN (Latin America Social Innovation Network). LASIN (Latin American Social Innovation Network) project has developed a new model for University - Socioeconomic engagement, based on a combination of curricular and extra-curricular activities, learning materials and tools, practical training, mentoring, and the development of specific support units that are dedicated to strengthening the universities' links with the wider social environment (ANDERSON et al., 2018). LASIN is a network of universities that aims to effectively support and promote social innovation in the universities to achieve sustainable and inclusive social and economic growth, social cohesion and equality in Latin America through intercultural, academic and extracurricular activities (NUNES et al., 2018).

This real case was chosen for three reasons:

- the ecosystem provided by NCSI focused on social innovation actors and their projects;
- NCSI was about to start a mentoring cycle, and we were interested in understanding the relationship between actors in this context;
- this social innovation ecosystem of social innovation was in its initial phase and growing. In this way, we identified an opportunity to monitor: i) which roles are manifested; ii) what activities are carried out; and iii) what challenges are observed in this phase of the ecosystem.

3.2.2. Description

The activities of the NCSI mentoring cycle were followed from June to December of 2017, and data was analyzed between January-June 2018. One researcher worked on two fronts: as a collaborator providing lectures and as a social innovation project mentor, focusing on activities concerning the mentoring cycle for social projects. The start of the mentoring cycle activities matched with the beginning of the ecosystem design phase. This phase is marked by the arrival of new actors to the ecosystem (mentors, developers, and collaborators). The ecosystem design phase happened from April to July 2017.

At the beginning of every semester, NCSI, the DIT Board, and the collaborators plan the next mentoring cycle. It was planned and implemented in 2017, including the following phases: 1) publication of the call for project developers and mentors; 2) matching between mentors and project developers; 3) selection of mentors and mentees to be part of the cycle, according to the nucleus' capacity; 4) training workshops and

lectures; and 5) assessment and closure of the mentoring cycle. In this scenario, four roles were identified:

- *Ecosystem manager*: role performed by the NCSI coordinator, being responsible for the activities: i) inviting organizations, professionals and researchers to join the mentoring cycle; ii) setting the mentoring cycle duration; iii) formalizing the invitation to the project developers; iv) authorizing the access to physical spaces; v) defining the number of mentee that the mentoring cycle will assist; and vi) defining how the ecosystems activities are monitored by the collaborators;
- *Mentor:* this role is performed by a professor, student, technician at the university, or a developer from outside UNIRIO. A mentor is an expert professional who: i) gives advice; ii) suggests strategies; and iii) presents new ideas for the developer and the project team. As such, he/she guides the developer to perform the social innovation project's necessary actions, considering a specific knowledge area. In the context of NCSI, internal mentors are involved through their research, teaching, and extension projects associated with social innovation. External mentors are volunteers interested in participating in the mentoring cycle to gain experience as well as to collaborate and apply their knowledge in social innovation projects;
- *Mentee:* this role is performed by the developer of a university's internal or external project. He/she may be a student, public worker, professor, or people external to the university. He/she is responsible for the social innovation project. In this case, a social innovation project aims to develop a new solution for a non-satisfactory social situation, with the main purpose of fostering the well-being of individuals, social groups, and society;
- *Collaborator:* is performed by a university's professor, student or technician, entrepreneur, or representative from external institutions or companies. His/her work is to assist the NCSI in planning and monitoring activities associated with the mentoring cycle. He/she may also give lectures or take part in other networking and qualification events concerning the cycle.

After the NCSI releases the public call for projects and mentors, the future mentees register their projects by filling in the data required. For example, the project representative must inform the project description, objectives, justification (so as to be considered an innovative project), the estimated number of beneficiaries, and the areas of knowledge most needed by the project. On the other hand, mentors answer the public call

by informing what knowledge areas (for example, project management, fundraising) they may provide mentoring. Then, NCSI coordinates an event with all the future mentors and mentees to establish a match between the areas of expertise offered by mentors and project-related needs. From that moment, the mentoring relationship between mentors and mentees begins through face-to-face meetings and workshops.

The first mentoring cycle comprised 11 mentors and 11 projects, and the researcher worked as a mentor in three projects and as a collaborator. During the study, the researcher participated in several events and meetings attended by different actors in every session. For instance, meetings were attended by professors, researchers, consultants, social entrepreneurs, and social project developers. In every session, observed data were recorded on a notebook for further analysis to support the idea's creation, recommendations, and improvement opportunities. It is essential to highlight that all events and meetings were face-to-face. Table 12 presents a summary of the most relevant meetings in which the researcher participated.

Table 12. Most relevant meetings of the observational study.

Date	Participants	Project	Discussion
09-JUN-2017	NCSI Coordination and Collaborators	Meeting for action planning of NCSI/LASIN	Structure of 2017 mentoring cycle, identification of possible partners. Definition of team and workgroups. Resource mapping for the project. Discussion and referrals for NICS actions concerning public notices for inviting mentors and mentees.
24-AUG-2017	NCSI Coordination and Collaborators	Meeting for the planning of the first mentoring cycle	Setting up of the cycle duration, key events, mentoring process, digital presence (Twitter, website, Facebook), and communication.
28-SEP-2017	NCSI Coordination and Collaborators	Meeting for the planning of public calls for projects	Setting up of criteria for the selection of mentors and projects, establishment of communication channels, media dissemination.
03-OCT-2017	NCSI Coordination and Collaborators	Selection for mentors and projects	Meeting for the analysis of mentor and project registrations.
07-OCT-2017	NCSI Coordination, Mentors, Mentees	Match between Mentors and Mentees	Meeting for the presentation of mentors and developers, with the purpose of defining those mentors responsible for specific projects.
13-OCT-2017	NCSI Coordination and Collaborators	Meeting for the monitoring of the mentoring cycle	Setting up of the reports for the follow-up and closure of the cycle.
24-NOV-2017	NCSI Coordination and Collaborators	Meeting for the monitoring of the mentoring cycle	Analysis of issues related to strengths and opportunities for improvement.
16-DEC-2017	NCSI Coordination, Mentors, Mentees	Meeting for the closure of the first mentoring cycle	Identification of improvement opportunities and strong points of the mentoring cycle.

3.2.3. Analysis

An analysis of the study's data was performed from January to June 2018. The findings observed during the observational study were:

- *Qualification of actors*: a strong need to qualify project developers was observed in terms of management methodology, fundraising, mapping of resources, actions on social media, among others. In the first cycle, an imbalance was found between mentors' expertise and mentees' expectations, since there were many projects and few mentors to fulfill the demand, producing an overload to some mentors;
- *Participation of beneficiaries*: the cycle was not attended by developers of the communities that would benefit from social innovation;
- *Mentoring cycle duration*: a challenge reported by the developers was concerning the short period of mentoring cycles (3 months) since many of them needed a more extended period of follow-up to develop competencies and to apply the orientations provided by the mentors;
- *Infrastructure*: all communication events between mentors and mentees, in addition to the training workshops, were held in person. NCSI and the mentors used meeting rooms, classrooms, and laboratories at the university to hold seminars and meetings. However, when none of these spaces was available, meetings were postponed due to the absence of a dedicated space. No events or meetings were held online;
- *Lack of knowledge concerning social innovation development process*: it was found that developers were unaware of some of the stages and activities required to turn their ideas into social innovations. For example, before developing a solution for such projects, it is very important to learn about the beneficiaries, which means involving them in the development process. Another important aspect is to make feasibility studies before requesting funds from sponsors. It was observed the need to use models in the process of contact between mentors and mentees;
- *Relationships between social actors*: regarding project developers, it was observed the potential to share experiences and resources between developers of different projects, but with no specific methods for that purpose. Anyhow, one partnership proposal between two projects of the cycle was reported. Regarding the communication tools used for that purpose, a *Facebook* group was created so that

actors could share their doubts and experiences. However, a low level of interaction was observed;

- *Governance*: considering that the first cycle of that environment was conducted in the second semester of 2017, many aspects associated with building partnerships, the scope of the initiative, environment monitoring, and results from measurement were still embryonic at that time. It is also important to consider the fact that social innovation projects integrating the mentoring cycle were in the stages of diagnosis or proposal, without a clear definition of aspects concerning the implementation or results measurement;
- *Financial support*: as the initiative did not include any financial support to projects, some developers worked as volunteers in their projects and had formal jobs, which affected the development pace and availability to attend mentoring meetings;
- *Sustainability*: issues concerning actors' engagement, lack of financial support (making some projects dependent on volunteer's involvement), lack of required competencies to fulfill projects' demands, lack of a supporting platform for the development of projects, and the relationship between actors can bring risks to the analyzed environment's sustainability;
- *Lack of a common technological platform*: the actors involved in this ecosystem (e.g., developers, mentors, and collaborators) work, study and live in different geographic locations. Hence, carrying out activities without a central and common platform to support communication activities between the actors and to exchange experience and mentoring became challenging. An example is that supporting documentation to be made available for the projects during the meetings was scattered across several bases, such as mailboxes, *WhatsApp*, and *Google Drive*. It was created a group in a social network (*Facebook*) to support the mentoring cycle. This group was supposed to facilitate the exchange of experiences, the sharing of doubts, and the dissemination of information. However, it was possible to observe a low level of adherence in its use.

By conducting this observational study, it was possible to observe the following positive aspects: i) the mentoring cycle involved several face-to-face meetings in order to encourage collaboration between the cycle participants; ii) from face-to-face meetings, it was possible to observe behavioral aspects; iii) workshops gave to the project developers the opportunity to see possible partnerships; iv) the mentoring cycle promote an

environment that can be the groundwork for studies and researches at the university; and v) the actors demonstrated a high level of trust in the mentoring relations by sharing all the project information requested by the mentors.

Based on the observational study results, we identified the following main ecosystem components: i) *actors*, who may have different roles as a mentor, mentee, collaborator, or ecosystem manager; ii) *infrastructure* (physical and digital), which is used during the mentoring cycle; iii) *social innovations* that are currently being developed by the mentees; and iv) *mentoring cycle events*.

Some relationships were identified considering that i) the mentor supervise one or more mentees on a specific area concerning the development of social innovation projects; ii) the mentor makes use of his/her expertise to meet mentee' needs during the mentoring meetings; iii) the mentee develops a social innovation that is structured as a project; and iv) collaborators support the ecosystem manager and are responsible for coordinating the digital and physical infrastructure).

3.3. Discussion

As a result of the observational study, some challenges faced by actors (developers, collaborators, mentors, and orchestrators) were observed in a specific social innovation ecosystem (CHUERI et al., 2019). These challenges could be reduced with the use of a common technological platform to support social innovation actors towards fostering collaboration, co-creation, and knowledge and competencies sharing. Such support aims to improve the development of social innovation projects, disseminate, and generate more effective social innovations, and use existing knowledge.

Some characteristics were observed in this ecosystem: i) there were representatives from different economic sectors since it included the work of university's professors and students, civil organizations' representatives, social entrepreneurs, and private companies' representatives; ii) actors working at different locations (geographically dispersed); iii) external actors playing as consultants involved in some ecosystem activities; iv) actors making use of synchronous and asynchronous communication through ecosystem interactions; v) actors working collaboratively for a common goal (development of social innovation); vi) actors willing to collaborate with other project representatives; vii) absence of organizational frontiers; and viii) no formal regulation or control concerning the actors. Characteristics ii, iii, iv, v, and vi could be supported using a common technological platform.

Some additional services could be offered to the ecosystem actors by the supporting technological platform, such as: i) *information services*, providing advice on what to do and how, as well as creating experience repositories; ii) *collaboration services,* making co-creation and collaboration activities possible; iii) *communication services,* clarifying and sharing the motivations behind collaborative organizations, their reference scenarios, and the outcomes they aspire to or have already achieved; iv) *assessment services,* allowing the monitoring of activities; and v) *infrastructure services,* allowing the conception, development, and systematization of all the previously indicated services.

The observational study results reinforce those from the existing SMS on social innovation development and from the SMS on social innovations ecosystem (Chapter 2). They expose the need for technological solutions to support social innovation actors. These solutions could leverage some ecosystem aspects, such as collaboration, co-creation, information, and knowledge exchange and sharing.

By conducting this observational study, it was possible to observe the following positive aspects: i) the mentoring cycle involved several face-to-face meetings in order to encourage collaboration between the cycle participants; ii) from face-to-face meetings, it was possible to observe behavioral aspects, which helped to identify the benefits of the integration between different projects produced to their developers; iii) workshops gave to the project developers the opportunity to see possible partnerships; iv) the mentoring cycle promote an environment that can be the groundwork for studies and researches at the university; and v) the actors demonstrated a high level of trust in the mentoring relations by sharing all the project information requested by the mentors.

As an additional result of this observational study, it was possible to identify the main elements of the investigated ecosystem as well as their relationships, allowing the design of a specific conceptual model. This model, presented and described in Appendix 2, allowed us to represent the scenario investigated during the observational study. However, it is not intended to claim it as a generic model applicable to other social innovation ecosystems.

In the social innovation ecosystem observed by the researcher, social innovations are developed through projects, according to the stages explained by Caulier-Grice et al. (2012). However, some authors do not consider the approach through projects in the social innovation process, such as Castro-Arce & Vanclay (2020). For these authors, social innovation can be defined as the creation, renewal, or transformation of social relations in developing ways of working together to achieve social goals and bring systemic change.

3.4. Threats to Validity

This section analyzes the threats to validity for this study. It considers the construct, reliability, internal and external validities, according to Wöhlin et al. (2012), and the threats reported by Santos (2016) in an observational study.

- *Construct validity*: i) impressions, opinions and thoughts were reported in a subjective manner in the observational study (this is a particularity of qualitative studies, as explained in Section 3.1, and we reduce it with the participation of two senior researchers revising the study's data); and ii) only one researcher attended the meetings and events reported (in order to mitigate such impact, the researcher participated in all the meetings, besides the project mentoring meetings, and attended a meeting between another mentor and their mentored projects, working only as an observer);
- *Reliability validity* refers to the potential repeatability of the study by other researchers. The observational study applied a known method (SEAMAN, 1999), was based on two other similar studies described in Santos (2016) and followed a step-by-step procedure that can be easily replicated;
- *Internal validity* threats refer to problems in the analysis of the data. Although only one researcher attended the mentoring cycle meetings and analyzed the data generated, we reduce this threat with the participation of two senior researchers revising the study's data;
- *External validity* concerns the ability to generalize from one study. However, generalization is not an aim of this observational study as we were interested in the characterization and identification of challenges in a particular scenario.

3.5. Final Remarks

This chapter presented an observational study carried out in a Brazilian real scenario. In this context, some insights from the presented study are: i) lack of methodology, techniques, and tools regarding project development; ii) relevance of actors' engagement; iii) relevance of a technological solution to support the development environment; iv) need to qualify the actors (lack of some competencies and skills to manage projects); v) relevance of supporting infrastructure; vi) lack of methodology, techniques, and tools regarding ecosystems management; and vii) relevance of the relationship between actors.

The challenges and positive aspects observed reinforce the relevance of studies in the environment where social innovations are developed. During the study, it was possible to observe that several challenges faced by the actors are similar to the challenges found in an existing SMS on social innovation development (CHUERI & ARAUJO, 2018). In this context, this study contributes to the first step of exploring digital ecosystem concepts regarding the construction of a solution to support social innovation ecosystem where social innovation actors interact and collaborate through the support of a common technological platform. Moreover, it was possible to draw a specific conceptual model of the social innovation ecosystem concerning the scenario observed, and we addressed some motivations concerning the demand for digital support.

Chapter 4. A Social Innovation Digital Ecosystem Conceptual Model

This chapter introduces a new ecosystem category to serve social innovation ecosystem actors. A Social Innovation Digital Ecosystem (SIDE) adds the advantages of social innovation ecosystems (SIE) with the functionalities found in digital ecosystems (DE). We use a conceptual model to characterize this integration joining elements of the two ecosystems that serves as a theoretical framework. Moreover, we also describe SIDE by presenting its main pillars and the roles performed by ecosystem actors.

Firstly, we explain the reasoning that leads to the Social Innovation Digital Ecosystem (Section 4.1). In Section 4.2, we present the development process of the SIDE conceptual model. Based on this process, the SIDE conceptual model is delivered in Section 4.3. Section 4.4 presents the final remarks.

4.1. Social Innovation Digital Ecosystem

When a SIE does not have any digital support structure, including processes referencing the use of techniques and tools in a digital way, it is an example of an ecosystem that cannot operate remotely. In this scenario, the use of elements of the DE can enable the ecosystem's remote functioning, allowing the actors to collaborate virtually.

According to Domanski et al. (2019), actors' perspectives, functions in the social innovation process, and their ability and willingness to cooperate are sufficiently complex. It should be considered when describing actors and constellations of actors on social innovation ecosystems.

From the gaps presented in studies concerning the development of social innovation (CHUERI & ARAUJO, 2018) and the ecosystems in which they are developed (Section 2.3), the demand to structure a technological solution to support the SIE was identified (CHUERI et al., 2019). Furthermore, the objective is for the solution to be integrated with

the ecosystem's actors and processes and mostly support the orchestrator in their management activities.

Considering the need of technological support, some categories of ecosystems that made use of information and communication technologies (ICT) were investigated. In more mature domains, such as software (JANSEN et al., 2013), health (IYAWAA et al., 2016) and business (LENKENHOFF et al., 2018), these needs have been addressed through the use of a common technological platform, bringing together actors and artifacts, called the digital ecosystem (DE). DE is a self-organizing digital infrastructure aimed at creating a digital environment for networked organizations or agents that support cooperation, knowledge sharing, and the development of open and adaptive technologies (BOLEY & CHANG, 2007).

After realizing that no proposal in the literature addressed the concepts and characteristics of DE with the elements of SIE, the possibility of defining a new type of an ecosystem that filled the identified gaps was identified. A Social Innovation Digital Ecosystem (SIDE) is defined as an ecosystem where social innovation actors interact and collaborate through the support provided by a common technological platform and a collaborative, inclusive, and open process towards the generation of social innovations (e.g., products, processes, or services) to fulfill societies challenges. The ecosystem involves three main pillars as described next:

1st Pillar – Actors: social innovations are characterized by a wide range of actors involved, who may have several roles that vary between different innovations and develop a single innovation (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018). Social innovation actors may fill a number of these roles, which are subject to change over time. In this ecosystem, everyone works collaboratively, and actors obtain non-monetary returns (for example, knowledge, ideology etc.). In this ecosystem, we consider five categories of actors involved in social innovation:

- *Developers*: the innovators who have the capacity to translate knowledge about unsatisfactory situations, into innovative ideas and projects that strive to improve such situations, thus they are at the core of social innovation activities;
- *Collaborators*: the actors who work in a social innovation ecosystem in collaborative activities, assisting developers of social innovations. In this research, we consider Knowledge Providers, Promoters, and Mentors, described in Section 2.2.3 as a specialization of *Collaborators*;
- *Beneficiary*: an individual to whom the conception of social innovation is directed and who benefits when it is implemented;

- *Ecosystem Orchestrator*: responsible for managing and monitoring the ecosystem. This role is described in Section 3.2.1;
- *Platform Administrator*: actor responsible for managing the platform's design and operation throughout the ecosystem's lifecycle.

2nd Pillar – Processes and knowledge: it guides how the actors relate to the ecosystem and to other actors, guiding the development of social innovations. It is necessary for the process that guides the development of social innovations to be open since social innovation ecosystems are not limited by an organizational frontier. Although developers have detailed knowledge about unsolved social problems and unmet needs, they often lack sufficient business knowledge and managerial skills (KLEVERBECK et al., 2017). Thus, there is a need to open up the ecosystem and involve actors with different skills. Other characteristics concerning the process are co-creation and mutual learning in social innovation. They require an open and interactive flow of knowledge, which is very different from protecting intellectual property inherent in traditional economic thinking (TERSTRIEP et al., 2020);

3rd Pillar – Platform: it enables communication, collaboration, and knowledge sharing among the actors. As the orchestrator is considered the main client of this research, the platform must provide services to support it in defining indicators and goals for planning the activities of the ecosystem. In addition, it must also keep his/her communication with the actors and allow the monitoring of indicators, ecosystem actors, and shared artifacts.

A conceptual model is the representation of a set of entities and relationships between these entities, which are part of a given domain of knowledge and help in understanding the domain in question (OLIVEIRA et al., 2020). The proposed conceptual model represents a holistic view of the elements to be observed and governed in SIDE ecosystems and their relationships. Its purpose is to summarize in a single picture the key aspects that comprise a SIDE and how these entities (actor, role, platform etc.) interact with each other.

4.2. SIDE Conceptual Model Development Process

To obtain the SIDE conceptual model, a three-steps process was performed: (1) Analysis of the elements derived from the two SMS described in Chapter 2 and from the observational study described in Chapter 3; (2) Construction of the conceptual model; and

(3) Evaluation. The evaluation step is described in Chapter 5. Figure 10 illustrates the methodological process carried out in this research.

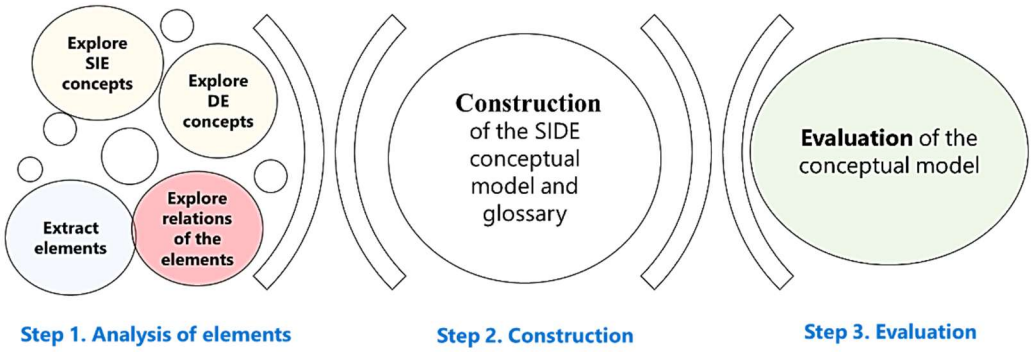


Figure 10. Method for designing and evaluating the SIDE conceptual model.

Step 1 – **Analysis of elements**: in this step, the following activities were carried out: i) searching the literature for studies on DE for social innovation; ii) analyzing the results obtained in the SMS on SIE and the SMS on DE (Chapter 2), as well as the results and discussion from the observational study (Chapter 3); and iii) extracting elements, concepts and their relationships from the results of the mapping so that the model could be built from appropriate definitions and characteristics.

Step 2 – **Construction**: concepts and/or characteristics relevant to the context of DE that would be maintained were identified. Then, the concepts, elements and characteristics that are part of the SIE domain were added. The construction process is detailed together with the presentation of the model in Section 4.3.

Step 3 – **Evaluation**: it encompasses planning, execution, analysis of results, and refinement of the model based on feedback from participants. The evaluation was planned and carried out with the participation of 21 experts in the area of social innovation ecosystems. Details of all evaluation stages are presented in Chapter 5.

4.3. Proposed Conceptual Model

This section presents the version of the conceptual model prior to the evaluation step. The evaluation step and the final version of the conceptual model are presented in Chapter 5. The research uses an adaptation of the methodologies presented by Wouters et al. (2019) and Oliveira et al. (2020) to develop conceptual models. The following requirements are considered for the conceptual model: i) the entities included in the conceptual model have to be derived from scientific sources; ii) the conceptual model should be easy to use and understand; and iii) the conceptual model should provide an

extensive list of universally used terms to make it easier for researchers and practitioners to discuss SIDE.

The following paragraphs describe the components of the SIDE conceptual model: i) the elements that make up such ecosystem; ii) the propositions elaborated from the relations between the ecosystem's elements; and iii) the design of the conceptual model for SIDE. The main benefits of the proposed model are: i) understanding the context of SIDE; ii) facilitating the communication and understanding of researchers on the area of social innovation and digital ecosystems; and iii) acting as a reference for professionals to build their own models according to its context and specific needs.

4.3.1. Elements

To identify the elements involved in a SIDE, several inputs were adopted as described in Section 4.2. It was possible to identify 42 elements that compose the SIDE ecosystem, which are presented in Table 13. A glossary containing its definitions is presented on Appendix 3.

We subsequently extracted a set of citations from studies to describe the context of each element. The same process was adopted concerning elements and citations from social innovation ecosystems. Based on the outputs from these studies and the results from the observational study (Chapter 3), we proposed a list of elements and a set of propositions for the composition of a SIDE.

Table 13. SIDE elements.

Elements identified for the SIDE Conceptual Model			
• Actor	• Interoperability	• Privilege	• Social Cause
• Artifact	• Knowledge Item	• Process	• Social Innovation
• Beneficiary	• Knowledge Provider	• Product	• Social Innovation Digital Ecosystem
• Benefit	• Knowledge Service	• Profile	• Social Need
• Collaboration	• Mentor	• Project	• Social Network
• Collaboration Technique	• Ontology	• Promoter	• Sustainable Development Goals
• Collaborator	• Orchestrator	• Quality Requirement	• Target Audience
• Common Vocabulary	• Platform	• Requirement	• Task
• Communication	• Platform Administrator	• Role	• Web Service
• Communication Event	• Policy	• Service	
• Developer	• Privacy	• Skill	

4.3.2. Propositions of the Conceptual Model

We used propositions to explain the relationships between SIDE conceptual model elements. The set of resulting propositions represents the relations that may exist in SIDE. They were constructed based on evidence from 1) the primary studies of the SMS based on ‘digital ecosystems’ (Section 2.4); and 2) the primary studies of the SMS based on

‘social innovation ecosystems’ as described in Section 2.3. Each proposition is presented in the following paragraphs.

Proposition 1 **(P1) - A Social Innovation Digital Ecosystem (SIDE) is formed by actors, social innovations, and a platform.**

Evidence - A SIDE is an ecosystem in which social innovation actors interact and collaborate through the support provided by a common technological platform for the development of social innovations (e.g., products, processes or services) to face the challenges of society (CHUERI et al., 2019).

Proposition 2 **(P2) - The actors of a SIDE have skills and competencies, are described by a profile, and are motivated by benefits that they can obtain from their participation in the ecosystem.**

Evidence - An actor is an individual or organization capable of performing functions and representing a participant in the ecosystem (KIDANU et al., 2015). An actor interacts with at least one other actor (KIDANU et al., 2016). A profile is a set of information that describes an actor with his/her preferences (KIDANU et al., 2016) and is owned by one or more actors. The benefit represents a social or economic advantage that the actor receives from participating in the digital ecosystem (DONG et al., 2007).

Proposition 3 **(P3) - Each actor can play one or more roles in his/her relationship with the ecosystem.**

Evidence - A role is an actor's way of interacting with other actors (KIDANU et al., 2015) in the ecosystem. Actors in a digital ecosystem can act through more than one role at the same time (KIDANU et al., 2015). Social innovations are characterized by a wide range of actors involved, who may have several roles that vary between different innovations and in the process of developing a single innovation (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018). Each role has a set of associated privileges (KIDANU et al., 2015) and needs skills to be performed.

Proposition 4 **(P4) - Actors can assume the role of developer, collaborator, beneficiary, platform administrator, and ecosystem orchestrator (manager). Developers and beneficiaries can identify social needs that will serve as inspiration for the development of social innovations.**

Evidence - In a social innovation ecosystem, actors can assume the role of developers and collaborators, such as promoters, supporters and knowledge

providers (BUTZIN & TERSTRIEP, 2018). A Beneficiary is an individual to whom social innovation is directed (HOWALDT et al., 2016). A Developer is responsible for transforming an innovative idea and developing the solution associated with social innovation (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018). An Ecosystem Orchestrator is responsible for defining internal processes such as the insertion of new actors in the ecosystem, planning and carrying out actions for monitoring the ecosystem, among others (CHUERI et al., 2019). A Platform Administrator is responsible for managing and configuring the platform services. Beneficiaries or Developers identify social needs, which can inspire social innovation projects (CHUERI et al., 2019).

Proposition 5 **(P5) - Actors can contribute to social innovations by acting as a mentor, knowledge provider or promoter.**

Evidence - A knowledge provider provides special relevant knowledge to stimulate and enrich the process of developing social innovation (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018). A promoter is an actor who acts as a partner, providing infrastructure equipment, financing and connecting initiatives to public policy programs. A mentor is an expert who advises, suggests strategies and presents new ideas for the developer to carry out the necessary actions of the social innovation project (CHUERI et al., 2019).

Proposition 6 **(P6) - Actors perform tasks that are derived from the role they assume. These tasks are part of the processes that can implement the ecosystem policy.**

Evidence - An actor performs a task to achieve his/her digital ecosystem goals (DONG et al., 2007). An actor follows the policies (rules or regulations) of the ecosystem. A policy is a guideline or a goal that defines the desired state within the ecosystem, expressed with restrictions, and involves mandatory, legal, and aspirational policies. One or more processes carry out a policy that can restrict the behavior and evolution of any element in the digital ecosystem. The objective of the ecosystem is achieved by the execution of processes which are composed of tasks (VASILĂŢEANU & ŞERBĂNAŢI, 2011; BIERMANN et al., 2016).

Proposition 7 **(P7) - Each task, when performed by an actor, can provide or use an ecosystem artifact.**

Evidence - An actor provides or consumes an artifact through a task that he/she performs (DONG et al., 2007a; VASILĂŢEANU & ŞERBĂNAŢI, 2011; BIERMANN et al., 2016). The actor performs the tasks (DONG et al., 2007a; WU & CHANG, 2007). Tasks contribute to the generation of knowledge items (FERRI

et al., 2014; BIERMANN et al., 2016) which can be lessons learned or suggestions for improvements (BUTZIN & TERSTRIEP, 2018). An artifact can be a product (GRETZEL et al., 2015) or a knowledge item.

Proposition 8 **(P8) - A social innovation aims to serve a social cause, is concerning a sustainable development goal, and benefits a target audience. Social innovations are achieved by the execution of projects.**

Evidence - Social innovations are new solutions that simultaneously address a social cause more efficiently than existing solutions, bring new or improved capabilities (and relationships), and enable better use of resources, improving society's capacity to act (CAULIER-GRICE et al., 2012). Social innovation is developed through projects, which are made up of requirements (PMI, 2017; CHUERI & ARAUJO, 2018). The target audience to which social innovation is directed represents the category of beneficiaries (TERSTRIEP et al., 2015). In the development of social innovation, several communication events are held (CHUERI et al., 2019). Social innovations are concerning one or more Sustainable Development Goals (SDG) (KULMAN & RIP, 2018; UN, 2020).

Proposition 9 **(P9) - A social innovation project uses communication events and collaboration techniques to promote greater interaction between the actors.**

Evidence - Collaboration techniques foster collaboration between actors in a social innovation environment (NICOLOPOULOU et al., 2015). Communication events promote communication, knowledge sharing, and collaboration between actors (CHUERI et al., 2019).

Proposition 10 **(P10) - SIDE has a platform responsible for supporting the actors of the ecosystem.**

Evidence - The platform provides services to ecosystem actors (DONG et al., 2007b). The platform makes use of social networks to support actors (FERRI et al., 2014). A platform can provide the following functionalities to the actors: i) information services: advice on what to do and how, in addition to creating repositories of experiences; ii) collaboration services: support co-creation and collaboration activities; iii) communication services: support communication between actors; iv) assessment services: monitor activities and results; and v) infrastructure services: support the design, development and systematization of services (CHUERI et al., 2019). A platform helps to understand social networks, actors' behavior in the ecosystem, and the interaction between different cultures and contexts (TANG et al., 2010).

Proposition 11 **(P11) - Web services and knowledge management services are made available to actors through the platform.**

Evidence - The actor communicates through a common vocabulary based on an ontology (DONG et al., 2007). The ontology supports knowledge management services and makes sharing multidisciplinary knowledge between actors from different sectors easier (FERRI et al., 2014; KIDANU et al., 2015). The platform offers different services, including knowledge management and web services (FERRI et al., 2014).

Proposition 12 **(P12) - The services offered to the actors have interoperability, privacy, collaboration, and communication as quality requirements.**

Evidence - The platform provides actors with services that involve communication, collaboration, and interoperability (TANG et al., 2010; FERRI et al., 2014; GRETZEL et al., 2015; BAJENARU et al., 2018). In the context of social innovation, collaboration is a key factor (NICOLOPOULOU et al., 2015). Privacy guarantees users the protection of their data in the ecosystem (KIDANU et al., 2015). One of the digital ecosystem's objectives is to improve the efficiency of communication between the actors (VASILĂŢEANU & ŞERBĂNAŢI, 2011). The composition of services results from the dynamic environment created by the ecosystem, increasing the skills and competencies of the actors in the ecosystems (DONG et al., 2007b).

4.3.3. Design

SIDE conceptual model summarizes in a single picture the key aspects that comprise this ecosystem and how its entities (actor, role, platform etc.) interact with each other. It uses Unified Modeling Language (UML) notational language to provide a clear representation of a set of elements and their relationships. The model was developed using Astah tool[7].

Figure 11 shows the conceptual model for SIDE, which elements and relations were based on the literature (Chapter 2) and the observational study (Chapter 3). The elements are represented as rectangular boxes, while the propositions are represented as verbs on the relations between elements. An element may have types and sub-types, and it is represented by the concept of inheritance in UML.

[7] https://astah.net/

The propositions are important to explain the relations among the elements. SIDE conceptual model has 42 elements and 12 propositions distributed in 39 relationships. As we built the SIDE conceptual model by inserting elements of SIE and elements from DE, the models' description presents references from the literature of the two areas.

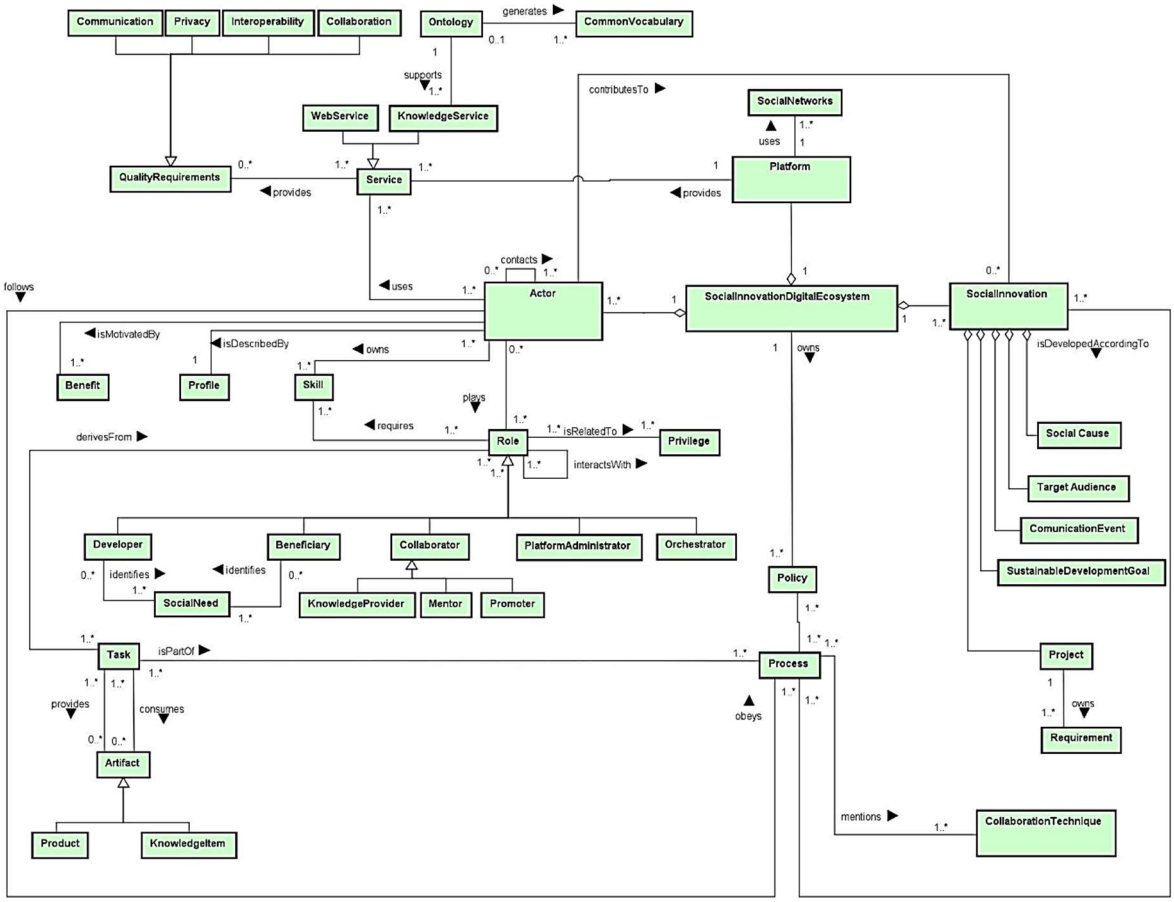


Figure 11. SIDE conceptual model.

The SIDE conceptual model comprises three main elements: *Actor* (who are the ecosystem's stakeholders), *Platform* (representing a digital infrastructure that supports the services provided in the ecosystem), and *SocialInnovation* (representing at the same time the domain and the final ecosystem deliverable). When analyzing the conceptual model's design in terms of relationships, we can say that the central element of the ecosystem is an *Actor*, given the number of relationships between this element and other entities. An *Actor* is also responsible for the administration and specification of the services provided on a *Platform* and for the development of *SocialInnovations*.

According to a DE property (**Interaction**), any participant (*Actor*) that joins the ecosystem must interact with at least another participant (*Actor*) (KIDANU et al., 2015). Each *Actor* can be viewed as a *Person* or an *Organization*. For example, a *Person* can develop one social innovation and have the ability not only to invent but also to develop

and implement the idea to make it a social innovation. An *Organization* is a company and institution that participate in the DE. It may provide infrastructural equipment or funding in a SIE.

An *Actor* is motivated by *Benefit*, which is a social or economic advantage that an *Actor* achieves by its participation in a DE (DONG et al., 2007b). Moreover, an *Actor* is proactive for or is responsive for its own *Benefit*. A *Benefit* is also concerning a DE characteristic named Equilibrium based on the assumption that this ecosystem must guarantee the mutual benefits among all participants (KIDANU et al., 2016).

An *Actor* is described by a *Profile*, which is a set of information describing an actor with its preferences. According to Ficheman & Lopes (2008), a profile is defined by digital literacy, motivation, learning style and preferences. In a DE, individual services are conceived to manage personal information and to address specific functionalities according to the user profile information (FERRI et al., 2014). In SIDE, an actor's profile has information about his/her preferences concerning the target audience, social causes, and sustainable development goals. This information serves to bring together actors with social innovations that have a profile aligned to their preferences.

An *Actor* communicates with another *Actor* through *CommonlyAgreedVocabulary*, which refers to the common terms used by actors to communicate with each other (BOLEY & CHANG, 2007; DONG et al., 2007a). It supports *KnowledgeManagementServices* because it enables a high precision of information retrieval, acting as the agreed upon vocabulary of a DE (BOLEY & CHANG, 2007).

An *Actor* uses *Services*, which are provided by a *Platform* (FERRI et al., 2014). A platform is a building block, providing an essential function to a DE, which acts as a foundation upon which the actors can develop complementary products, technologies, or services (GAWER, 2011). Generally, it is provided by an organization and it may store *Artifacts* developed by SIDE actors. For example, resources developed by ecosystem actors during work sessions can be stored in the platform (MOULIN et al., 2013). A *Platform* offers a composition of different *Services*, including communication, collaboration, privacy, knowledge management, interoperability, and web services. A *Platform* makes use of *SocialNetworks* (FERRI et al., 2014; GRETZEL et al., 2015). Tang et al. (2010) present an example of such integration where actors can keep the same accounts and their social relationships among all actor services.

An *Actor* owns *Skills* (e.g., project management, regional knowledge, and design thinking) (DOMANSKI & KALETKA, 2018), required by *Roles*. Social innovations are characterized by a wide range of actors involved, who may have several roles

(TERSTRIEP et al., 2015). Therefore, in SIDE, an *Actor* may play one or more *Roles*, which are i) *Developer*, *Beneficiary*, *Collaborator*, *Platform Administrator*, and *Orchestrator* according to Proposition 4; and ii) *KnowledgeProvider*, *Mentor*, and *Promoter*, according to Proposition 5. Although the ecosystems literature also uses the term 'Ecosystem Manager', we chose to use the term 'Orchestrator', as explained in Chapter 3, as we consider it more applicable to the context of this research.

Each *Role* has a set of associated *Privileges*, which is a special right or advantage that a particular person or group of people has (KIDANU et al., 2016). In SIDE, there can be different types of privileges. For example, only the platform administrator has the right to add new functionality to the platform. Another example concerns the developer, which is the only one that may change information on its social innovation.

An *Actor* carries out a *Task*, which refers to a mission that an *Actor* is executing to survive and achieve its goals in the environment of a DE (DONG et al., 2007a). A task is an activity concerning the development of social innovation, and it may be, for example, a mentoring that a mentor can provide to a social innovation developer.

In this ecosystem, the term *Artifact* is used to identify the elements provided or consumed by *Actors* through *Tasks* that they carried out. An *Artifact* may be a *Product* (information, data, spreadsheet, template, or other digital content) or *KnowledgeItem*. An *Artifact* may also be an item that an actor requests/user/consumes or provides/develops into an ecosystem (OH et al., 2011; KIDANU et al., 2015). A *KnowledgeItem* may be a lesson learned, which is knowledge or understanding gained by experience, which may be positive, as in a successful test or mission, or negative, as in a failure (SECCHI, 1999).

In SIDE, a *Product* is a type of artifact ready to be used by an actor. Simultaneously, a *Knowledge Item* represents a learning experience that may not be ready to be used (e.g., it may be an experience report with an indication of techniques). All *Tasks* are part of one or more *Process* and once they are concerning the artifacts that are concerning the ecosystem, the must obey Ecosystem's *Policy*. A *Policy* is a guideline that defines the desired state inside a DE, expressed with constraints. It covers mandatory, legal, aspirational and not implementable policies (VASILĂŢEANU & ŞERBĂNAŢI, 2011).

A *SocialInnovation* is developed according to a *Process* and structured by a *Project* divided into *Stages* (MULGAN, 2006; CAULIER-GRICE et al., 2012). A *Process* mentions *CollaborationTechniques*, and these are concerning *CommunicationEvents* (project meetings, validation meetings). The importance of collaboration in social innovation has been reported in several studies, such as (NICOLOPOULOU et al., 2015) and (DRAKE, 2018), which reinforces the relevance of the elements concerning

collaboration in the model. Each *SocialInnovation* is concerning one or more *SustainableDevelopmentGoals*, is directed to one or more *Target* and is dedicated to one or more *SocialCauses*. A *SocialInnovation* is measured by *Metrics* which help to build a knowledge base by assessing and evaluating what works, and shape public policy (BATURINA & BEŽOVAN, 2015).

4.4. Final Remarks

This chapter presented a new category of ecosystem called SIDE, whose conceptual model considers actors' participation from different sectors of the economy, acting in different roles, aiming at social innovations development. In this chapter, we defined a set of elements (Section 4.3.1) from two SMS on the concepts explored by studies about DE and SIE. Then, we formulated 12 evidence-based propositions from the studies included in the SMS (Section 4.3.2). They were designed through UML notation (4.3.3) and they represent elements and relationships between them to explain SIDE domain.

The glossary, developed in this chapter, provides a unified and comprehensive description of all elements that are considered relevant in a SIDE. The conceptual model provides a reference for researchers to understand the elements involved in SIDE. Our model helps academics and practitioners in the social innovation domain to understand how DE elements and properties may benefit their context. Since the proposed version of the SIDE conceptual model was prepared based on studies from two SMS, the next step of the research is to carry out its evaluation. The evaluation planning and execution as well as the adjustments necessary to generate the final conceptual model are presented in Chapter 5.

Chapter 5. Evaluation of SIDE Conceptual Model

This chapter describes the planning (Section 5.1), execution (Section 5.2), and results (Section 5.3) of the qualitative survey conducted with 21 social innovation experts to assess the SIDE conceptual model. Section 5.4 presents the discussion concerning the study and the model evaluated. Moreover, we discuss threats to the validity of this study in Section 5.5. Then, the final remarks are discussed (Section 5.6).

5.1. Planning

Once the SIDE conceptual model was designed, it was decided to evaluate it with social innovation specialists who work in real ecosystems. Figure 12 illustrates the methodological process carried out for SIDE conceptual model evaluation.

Survey research is performed with the objective of obtaining knowledge from people, seeking to understand a certain aspect of a population (WÖHLIN et al., 2012). The methodological aspects used in this research make use of the guidelines present in Kitchenham & Pfleeger (2008) and the planning of open questions on guidelines present in Chazin & Freitas (2017).

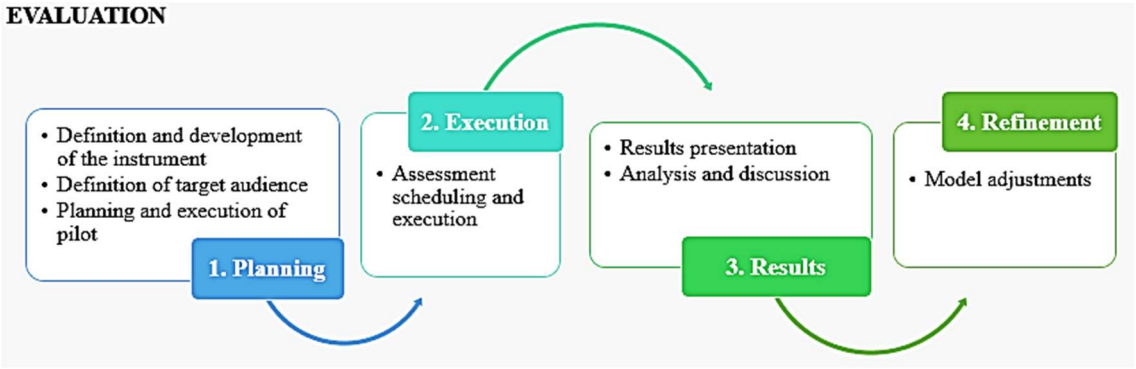


Figure 12. SIDE conceptual model evaluation process.

According to Manzini (2003), the semi-structured interview focus on a subject on which a script is made with main questions, complemented by other issues inherent to the

momentary circumstances of the interview. We conducted the open questions of the research as a semi-structured interview. Therefore, it was possible to make information emerge more freely since the answers are not conditioned to the standardization of alternatives.

The protocol involved the following activities: i) definition of the objective; ii) research project; iii) development of the instrument (questionnaire); iv) evaluation of the instrument (pilot); v) data collection; and vi) analysis of the results. The study's objective was formalized based on the GQM (Goal-Question-Metric) method (BASILI, 1992) and is presented in Table 14.

Table 14. GQM method.

Analyze	SIDE propositions and conceptual model design
With the objective of	evaluating
With respects to	SIDE conceptual model propositions and design
From the point of view of	practitioners
In the context of	social innovation ecosystems

The evaluation process uses an adaptation of the methodologies presented by Kitchenham & Pfleeger (2008), Chazin & Freitas (2017), Wouters et al. (2019) and Oliveira et al. (2020). After the researcher elaborated a preliminary set of evaluation questions and developed an initial version of the research questions and screens, two researchers with a large conceptual modeling experience analyzed them. Afterward, adjustments were made and a new set of questions was generated. Additionally, three specialists took part in a pilot study to evaluate and calibrate the survey instrument (e.g., to detect misleading questions and/or poor instructions). Next, the instrument was adjusted and its final version is presented in Appendix 4. The adjusted questions are presented in Table 15 and 16.

Experts in social innovation ecosystems evaluated SIDE's conceptual model through a survey. The evaluation process is composed of three parts, each composed of closed questions (CQ) and open questions (OQ).

- **Part I – *Demographic questions*:** composed of 7 closed questions (CQ) used to standardize responses, facilitate reading, and synthesize the required information more simply. The CQ supported the characterization of the participants and their context (Table 15). This information allowed us to explore differences in responses according to participant's characteristics;
- **Part II – *Evaluation of propositions*:** composed of 24 questions aiming to evaluate the SIDE conceptual model's propositions, as presented in Section 4.3.2. The expert

should analyze its description, its evidence, and the piece of the conceptual model associated with each proposition. Then, the proposition was evaluated through one closed question and one open question. The closed question had 3 possible answers: i) “I agree”; ii) “I do not agree”; and iii) “I do not know”. This question assesses the participant's approval concerning the model piece presented concerning the proposition.

When defining the scale of responses, we chose to use only three possibilities for the following reasons: i) the survey instrument has more than 30 questions (20 closed questions, plus 18 discursive questions about comments); ii) the participant must evaluate 13 figures (twelve pieces of the conceptual model, plus the complete model); and iii) the participant must not take time to read and answer the scale. Another category of scale, such as the Likert scale, has as one of their disadvantages the need for a respondent to first analyze the content and then the degree of intensity of the statement (SILVA JÚNIOR & COSTA, 2014).

The open question was “Comment on your answer and, if you wish, record suggestions and/or examples”. The open questions allowed participants to describe their responses more completely. Additionally, there was a question entitled “In your opinion, what is the social innovation ecosystem?”. This question aimed to collect the expert's perception concerning the “social innovation ecosystem” concept;

• **Part III – *Evaluation of the complete model*:** composed of 12 questions (6 closed questions and 6 open questions), where the closed questions aimed at assessing the complete conceptual model according to the following criteria (SJØBERG et al., 2008): i) *Testability*: the degree to which a theory is constructed so that empirical refutation is possible; ii) *Empirical support*: the degree to which a theory is supported by empirical studies that confirm its validity; iii) *Explanatory power*: the degree to which a theory is simple, with few ad hoc assumptions and relates to what is already well understood; iv) *Parsimony*: the degree to which a theory is economically constructed with a minimum of concepts and propositions; v) *Generality*: the breadth of the scope of a theory and the degree to which the theory is independent of specific settings; and vi) *Utility*: the degree to which a theory supports the relevant areas of the software industry. Based on the definition presented for each criterion, the closed questions presented in Table 16 were formulated. Each question had three possible answers “Yes”, “No”, and “I do not know”. The open question was “Comment on your answer and, if you wish, record suggestions and/or examples” and it allowed the participants to describe responses more completely.

Table 15. Demographic questions.

CQ	Closed Question
CQ1	What is your highest academic degree?
CQ2	In which sector do you work?
CQ3	How many years have you been working with social innovation?
CQ4	Check the types of social innovation environments in which you worked.
CQ5	Indicate your experience in using the following categories of information technology tools.
CQ6	Do you work with information systems and software development?
CQ7	Do you know or have heard of the term "digital ecosystems"?

Table 16. Closed questions - complete model.

Criterion	Closed Question
C1	*Testability*: Are the elements and relationships of the model unambiguous?
C2	*Experimental support*: Are there studies that you know of that confirm the elements and relationships of the model?
C3	*Explanatory power*: Are the elements of the model understandable by the social innovation community?
C4	*Parsimony*: In your opinion, were the minimum of elements and relationships used to build the model?
C5	*Generality*: In your opinion, does the model presented include different scenarios of social innovation environments?
C6	*Utility*: Do you consider the model to be useful for theory and practice or just for one perspective?

The semi-structured interview used two tools: i) *Google Forms*: to support the evaluation process, containing questions, possible answers, space for suggestions; and ii) *Google Meet*: to support the interview execution. In addition, files containing the conceptual model, a glossary of elements, and a brief explanation of the UML notation were created to support the interview sessions. The evaluation instrument was developed in Portuguese.

In order to obtain a sample of participants from different locations and guarantee that they worked on different social innovation ecosystems, we selected the experts through LinkedIn[8] professional network. The expert needed to own a LinkedIn profile mentioning knowledge on social innovation environments to participate in the evaluation. After this activity, the experts were invited to take part in the evaluation.

[8] https://www.linkedin.com/

5.2. Execution

The interviews were carried out from June 26 to July 23, 2020. We invited 61 Brazilian researchers and professionals working in social innovation environments to evaluate the SIDE conceptual model. Twenty-one experts accepted taking part in the evaluation, and we obtained a response rate of 34.4%. This response rate is considered positive for studies such as online surveys (NULTY, 2008). Moreover, as we conducted the semi-structured interviews online and the questions concerning the SIDE propositions were structured as a questionnaire, we consider this result satisfactory.

Each participant has real experience in different social innovation ecosystems. The average interview time was 1h20min. According to their profiles on the LinkedIn[9] network, the interviewees had job positions as program managers, project managers, project directors, Non-Governmental Organizations (NGO) founders, social innovation developers etc.

The first part of the evaluation contains the demographic questions aiming to obtain the profile of the experts. Regarding the academic background of the participants, it was observed that 9 participants hold a Master of Business Administration degree; 6 hold a Bachelor's degree; 2 hold a PhD degree; 3 hold a Master's degree; and 3 have high school.

Regarding the sector of activity of the participants (CQ2), it was identified that the majority (14) works in the private sector. The question allowed the participant to choose more than one option since it is common for a person in social innovation environments to have experience in more than one sector. Moreover, the results showed that 12 participants work in the third sector, composed of Non-Government Organizations, associations, foundations, among other several civil society organizations. A total of 10 participants selected more than one sector of activity. Only 4 participants work in the public sector. The answers to question CQ3 are presented in Figure 13 and the results showed that most participants (14) have worked in the area for less than 5 years.

Regarding the type of environment where the participant worked (CQ4), most indicated participating or having already participated in Ecosystems (11), followed by Collectives (9) and Hubs (9). Other answers were concerning Laboratories (6), Research Group (4), and NGO (2). The answers to question CQ6, concerning the length of experience in information systems or software development, indicated that most

[9] https://www.linkedin.com/

participants (16) did not have experience in this area. The remaining results are shown in Figure 14.

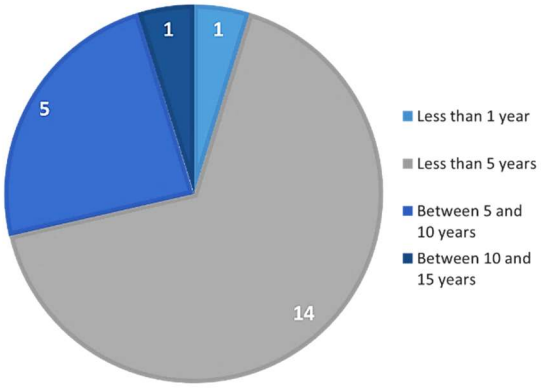


Figure 13. Experience in social innovation.

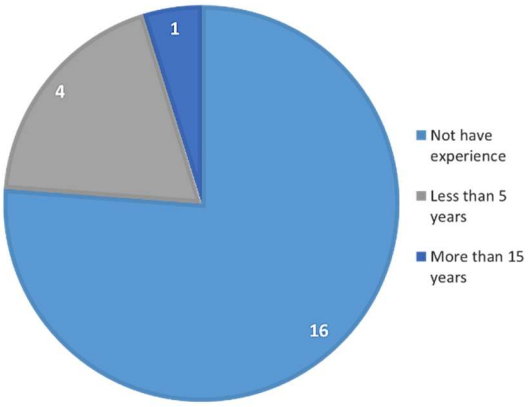


Figure 14. Experience in information systems or software development.

However, it does not mean that they have no experience with digital tools. Concerning their experience with some digital tools (CQ5), all participants identified experience with tools to support their meetings. Most of them reported experience on digital tools associated with information sharing (20), collaboration tools (20), task management (19), social networks (19), and project management (18). However, most of the participants (14) answered that they have never heard about the concept of "digital ecosystem" (CQ7), and 7 reported that they have heard about the concept.

5.3. Results

The second part of the evaluation contains the propositions that must be analyzed by the experts, and the results obtained were synthesized and presented in Figure 15. For each proposition, it is presented the total of experts that selected the answers "I agree", "I

disagree" or "I do not know". It is possible to notice that all the propositions were accepted by at least 18 experts.

The third part of the evaluation contains the questions concerning criteria by SJØBERG et al. (2008) and the results obtained were synthesized and presented in Figure 16. For each criterion, it is presented the total of experts that selected the answers "I agree", "I disagree" or "I do not know". Below it is described the result of each criterion, together with the comments filled in by the experts. Each expert is identified as *Ex* where *x* is his/her ID.

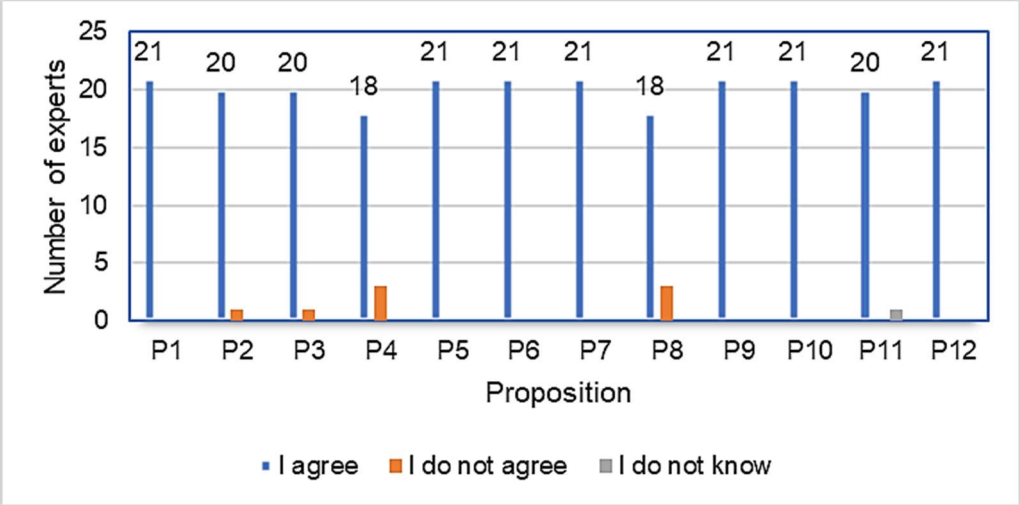


Figure 15. Evaluation of propositions by experts.

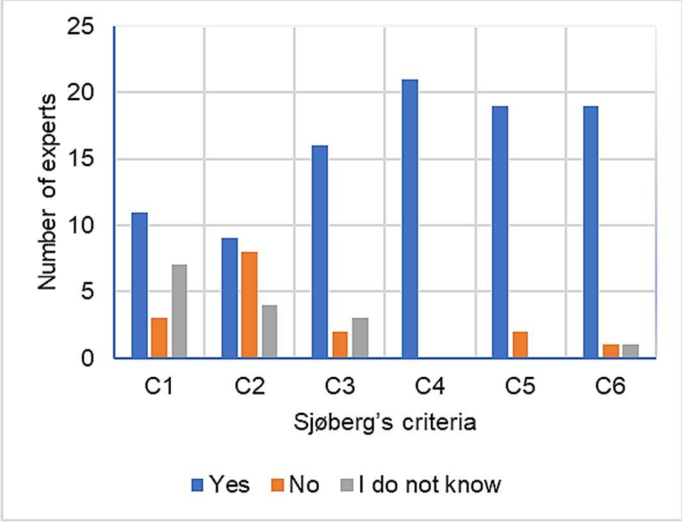


Figure 16. Evaluation of the SIDE conceptual model according to criteria by Sjøberg et al. (2008).

Testability: the experts answered the question: "Are the elements and relationships of the model unambiguous?". Their answers were: "Yes" (11), "No" (3), and "I do not know" (7). Despite the definition of testability being presented at the beginning of the

questionnaire, experts had some difficulty to evaluate this criterion. E3 mentioned that "*I don't know of systems to evaluate this*" and E16 pointed that "*I don't have a good view of graphics to say, for sure, whether there is ambiguity or not*". It is important to remember that criteria by SJØBERG et al. (2008) are common in the software engineering area and most of the experts answered that they have no experience in this area. Perhaps this is the reason for the strangeness of this criterion on the part of the interviewees. E9 mentioned that "*the only thing that was not very clear was the knowledge part in relation to ontology*". From the 12 propositions, none were refuted. Therefore, if we analyze the answers based on those who did not experience difficulty in assessing ambiguity in the model, the model testability is considered high.

Empirical support: the experts answered the question: "Are there studies that you know of that confirm the elements and relationships of the model?". Their answers were: "Yes" (9), "No" (8), and "I do not know" (4). Although they have large experience in social innovation ecosystems, some experts (8) answered that they have no knowledge of studies in the field concerning digital ecosystems and social innovation. E3 affirmed that "*my practical experience in managing a social innovation ecosystem for about 2 years corroborates the validity of the elements, relationships, and the proposed model*" and E13 answered that "*Despite not knowing any studies, I have practical experience in social project management, and I see the application of the model's elements and relationships in practice*". Similar comments were written by E4, E12 and E15. Therefore, despite not knowing formal studies and answering "No" to the question, 5 experts considered that their experiences confirm elements and relationships of the model.

Explanatory power: the experts answered the question: "Are the elements of the model understandable by the social innovation community?". Their answers were: "Yes" (16), "No" (2), and "I do not know" (3). E13 argued that "*the terms are complex for the beneficiaries of the projects, especially if they are people of greater social vulnerability*" and E14 argued that "*the terms are quite technical and may not be understood by everyone, especially beneficiaries*". However, 76% of respondents considered that the conceptual model had explanatory power.

*Parsimony***:** the experts answered the question "In your opinion, were the minimum of elements and relationships used to build the model?". Their answers were: "Yes" (21), "No" (0), and "I do not know" (0). Therefore, it was considered by the experts that the model presented a high level of parsimony.

Generality: the experts answered the question "In your opinion, does the model presented include different scenarios of social innovation environments?". Their answers

were: “Yes” (19), “No” (2), and “I do not know” (0). E12 pointed that “*I believe that the model is generic and can be adapted to different scenarios*”. E19 argued that “*the model was not applied to beneficiaries who do not have access to the internet*”. According to the majority of the expert’s responses (90,4%), the conceptual model presents a high level of generality.

Utility: the experts answered the question: “Do you consider the model to be useful for theory and practice or just for one perspective?”. Their answers were: “Useful for theory and practice” (19), “Useful for practice” (1), and “Useful for theory” (1). This result points out that the experts believe that the model has theoretical utility because it contributes to increasing the body of knowledge of social innovation ecosystems.

At the end of the second part of the evaluation, there was a question entitled “In your opinion, what is the social innovation ecosystem?”. All the experts (21) answered their opinion on the meaning of “social innovation ecosystem” and the results are presented in Table 17 and Table 18.

Although most experts report that they do not know about studies in social innovation ecosystems, it was observed that several responses are in line with definitions present in the literature on social innovation and SIE. The definition presented by E15, in which the platform is seen as an integrating element of ecosystem actors, is aligned with studies performed by MANZINI (2015), who emphasized the “*importance of creating an infrastructure to support these actors, represented by a well structured to support and connect the different initiatives*”. The element platform is also mentioned in definitions provided by E16 and E20.

E4, E15, E16, E18, E19, and E20 mentioned in their definitions the use of collaboration and knowledge exchange. Their understanding is aligned with HOWALDT et al. (2016), in which “*social innovation focuses on the interfaces and collaborations of the societal sectors of the state, business, civil society and academia*…” and the citation by SGARAGLI (2014), in which “*these new ecosystems are forming around a clear set of values: shared intent, common purpose, collaboration, openness*”.

Some responses from experts indicated that one of the objectives of social innovation ecosystems is to generate benefits to society to some degree, whether through i) meeting the social development goals and 2030 Agenda[10] (E3 and E21); ii) meeting the needs of a group of beneficiaries (E21); iii) building a just society (E18); iv) well-being

[10] 2030 Agenda: a plan of action for people, planet and prosperity defined by United Nations Sustainable Development Summit on 25 September 2015. It comprises 17 Sustainable Development Goals and 169 targets that must be full implemented by 2030 (https://sdgs.un.org › 2030agenda).

of society (E1, E3, and E6); and v) generation of positive socio-environmental impact (E2, E5, E9, E12, E13, and E14).

Table 17. Social innovation ecosystem definition provided by experts – part 1.

Social innovation ecosystem definition
"*a space (whether physical or remote) that promotes access to information, people (actors in the sector), solutions and problems / challenges. A space that exists collaboration, learning, prototyping / experimentation to bring alternatives (products / services) that improve the well-being of society.*" [E1]
"*the results of actions and projects that aim at positive social impact and interfere or modify the environment in a medium to long term period, establishing significant and high impact changes in communities, cities, and society as a whole.*" [E2]
"*an integration of actors, innovations, and services that aim to support the development of social innovation projects that meet the SDGs and improve the quality of life of vulnerable populations.*" [E3]
"*a living system of people who think and act empathically on behalf of other people, adding their knowledge and skills, and passions.*" [E4]
"*an ecosystem that allows interaction between different actors from different sectors (public, private and social), encouraging interaction between them in order to generate a positive socio-environmental impact.*" [E5]
"*social innovation is the radical idea of using good ideas, services and products to benefit the community. A social innovation ecosystem is an environment where it is lived, stimulated and celebrated.*" [E6]
"*a set of actors who create solutions to real problems.*" [E7]
"a*n environment that provides meetings and social commitments.*" [E8]
"a *set of actors open to collaborating in favor of local development based on innovation to generate social impact.*" [E9]
"*every initiative that proposes to contribute in a structured way with the ideas and solutions proposed by the projects.*" [E10]
"a *social innovation ecosystem occurs when the actors work to solve one or more problems with complementary activities using resources in an innovative way and with property of effectiveness.*"[E11]
"a *social innovation ecosystem is* a*n environment where it allows the exchange of knowledge, services, skills and mutual help between different actors to generate social impact actions.*" [E12]
"*a connection space between different agents that have the common objective of addressing or alleviating some social or environmental problem.*" [E13]
"*it involves several organizations that operate both nationally and globally to ensure the creation of solutions to the world's biggest socio-environmental problems and to support the implementation of these projects and measure results, ensuring the sustainability of activities.*" [E14]
"*a platform that integrates the plurality of actors for social innovation, enabling connections for the development of projects and knowledge to expand the universe of actors.*" [E15]
"a *group (physical, digital, platform, application) formed by actors with multiple knowledge, interested in adding or gaining knowledge, networking and exchanging information about the tools and the use of these tools, in order to create and develop innovative projects in a collaborative.*" [E16]

Table 18. Social innovation ecosystem definition provided by experts – part 2.

Social innovation ecosystem definition
"a self-organized living organism that nourishes actors linked to social innovation." [E17]
"*a system in which interactions, collaborative or not, occur between different actors, who can perform (or accumulate) different functions and roles in relation to others and in the evolution around a common theme - social innovation, in this case.*" [E18]
"*a space where several different actors share social norms and ideas to build a more just society and work together, in collaboration for this.*" [E19]
"*a network of information, knowledge, people, tools and platforms whose ultimate goal is to create social innovation for a specific demand from a beneficiary group.*" [E20]
"*a system of cooperation for social development initiatives led by different actors, all with the same objective in the 2030 agenda.*" [E21]

These responses are in line with the definition of social innovation by CAULIER-GRICE et al. (2012), where "*social innovations consist of new solutions (products, services etc.) that simultaneously meet social needs (more efficiently than existing solutions)* ...". Besides, according to DOMANSKI & KALETKA (2018), actors of social innovation projects increasingly try to address social needs and societal challenges instead of focusing primarily on economic success and profit.

Some experts mentioned that an ecosystem is a set of actors (E5, E15, E16, E18, E19, and E21). It is aligned with the definition given by DOMANSKI & KALETKA (2018) "*the social innovation ecosystem refers to a set of actors from different societal sectors and their environments with legal and cultural norms, supportive infrastructures, and many other elements; that enable or inhibit the development of social innovations*".

The definitions of social innovation ecosystems presented by the experts, in general, cited the word *actor* as a subject of action in the ecosystem, which can be evidenced in the word cloud presented in Figure 17. Other words most cited by the experts were i) *social*: corresponds to the end objective of social innovations developed in ecosystems; ii) *knowledge*: demonstrates the importance recognized by experts concerning knowledge sharing among ecosystem players; and iii) *project*: indicates the way of structuring social innovations in ecosystems.

5.4. Discussion

This section presents the discussion regarding the evaluation of SIDE propositions, including the most relevant comments mentioned by the interviewed experts. Moreover,

based on these evaluations, the final version of the SIDE conceptual model is presented, along with the minor adjustments that were necessary from the experts' suggestions.

Figure 17. Social innovation ecosystem word cloud.

5.4.1. Evaluation of SIDE Propositions

In the following paragraphs, we discuss the results obtained during the evaluation and its implications for the proposed model. In the topic concerning evaluating the experts' conceptual model propositions, it was not necessary to exclude any proposition, because there was a high agreement by the experts. Propositions P2, P3, P4, P8 and P11 had a response rate of “I agree” below 100%. Therefore, it was necessary to analyze if the expert's arguments were solid based on the experts' feedback. When analyzing each expert suggestion, before modifying the proposition or the conceptual model, the following criteria were observed: i) the suggestion does not hurt the scope of SIDE; ii) the suggestion applies to a conceptual model (e.g., observations about the platform architecture are not applicable); and iii) the suggestion does not contradict any proposition already evaluated by other experts.

Therefore, the experts' feedback presented previously guided the modification and improvement of the conceptual model's propositions as well as its refinement. The researcher conducted several discussions with two senior researchers with extensive experience in conceptual modeling to analyze and interpret each feedback. The following paragraphs present each proposition that had to be analyzed. In addition, in the case of an

approved adjustment, we used an identifier (CHx) to reference it. The approved changes and their impacts on the model are presented in more detail in Section 5.4.2.

Proposition 2 (P2) - The actors of a SIDE have skills and competencies, are described by a profile, and are motivated by benefits that they can obtain from their participation in the ecosystem. 95.2% of experts agreed and 4.7% did not agree with this proposition. As an example of disagreement, E14 mentioned that "*I think the element corporate actor is missing in the model. It is the case of the Organization that supports the project*". As the organization element is mentioned in the social innovation ecosystem context, and it does not harm any other element or relationship inside the model, it was decided to include the elements *Organization* and *Person* (CH1) in the conceptual model.

Proposition 3 (P3) - Each actor can play one or more roles in his/her relationship with the ecosystem. 95.2% of experts agreed and 4.7% did not agree with this proposition. As an example of disagreement, E15 pointed out that "*The meaning of the term 'privilege' and its applicability was not well understood*". However, the term "privilege" comes from articles on DE (KIDANU et al., 2015). Privilege is concerning the special access that a role may own into the ecosystem. For example, all the information concerning a social innovation project may only be updated by a user responsible for its development. In this case, only this user has the privilege to change the information. As only one expert did not understand the term, despite the explanation, we improved the privilege definition inside the glossary with examples, and the proposition was not changed.

Proposition 4 (P4) - Actors can assume the role of developer, collaborator, beneficiary, platform administrator and ecosystem orchestrator (manager). Developers and beneficiaries can identify social needs that will serve as inspiration for the development of social innovations: 85.71% of experts agreed and 14.28% did not agree with this proposition. As an example of disagreement, E20 mentioned that "*All roles can identify social needs, not just the beneficiary and the developer*". The model only indicates developers and beneficiaries identifying social needs, but any actor can assume these roles inside the ecosystem. E12 pointed out that "*I believe that some responsibilities can be fulfilled by other actors, not exclusively by one*". However, the conceptual model proposed indicates that more than one actor may fulfill all the ecosystem's roles. Probably these suggestions are due to the fact that some experts are not used to evaluate conceptual models concerning digital ecosystems. In the expert characterization, these experts answered that they have never heard about digital ecosystems.

Proposition 8 (P8) - A social innovation aims to serve a social cause, is concerning a sustainable development goal and benefits a target audience. Social innovations are achieved by the execution of projects. 85.71% of experts agreed and 14.29% did not agree with this proposition. As an example of disagreement, E9 pointed out that "*In my opinion, social innovation is developed through projects, but not only*". In the academic literature, there are several definitions of the term 'social innovation' (EDWARDS-SCHACHTER & WALLACE, 2017). This research follows the definition proposed by Caulier-Grice et al. (2012) and the concept of a social innovation process presented by Mulgan (2006), where social innovation is divided into development stages. Therefore, on the SIDE, social innovation may be a product according to a project divided into stages with tasks requiring support from the other ecosystem actors. An actor complained about the lack of information related to the stage of social innovation. So, it was decided to include the element *Stage* (CH2) to shown that the social innovation projects are divided into stages.

Proposition 11 (P11) - Web services and knowledge management services are made available to actors through the platform: 95.2% of experts agreed, and 4.7% did not know how to respond to this proposition. As an example of disagreement, E9 pointed out that "*the only thing that was not very clear was the knowledge part about ontology*". Other experts also reported this difficulty. As ontology is not common in social innovation domain, so we decided to keep the proposition, but we adjusted the conceptual model, removing the element *Ontology* from the model (CH3). Finally, experts asked to include the *Tool* element (CH4) concerning how the services will be available on the platform.

Although no model proposition addresses the use **of metrics and forms of assessment** in the ecosystem, some respondents addressed this topic. E11 included a comment concerning the evaluation of the progress of a project, highlighting: "*services that support the monitoring and evaluation of initiatives are important. For example, a record of social innovation could have information concerning the project goals.*". E1 pointed that "*it is important to think about ways of measuring the impact of social innovations*", emphasizing another category of metrics, this time concerning the impact on society of the innovations developed.

Although the use of indicators was not mentioned in the literature consulted on social innovation ecosystems, we identified some works mentioning the importance of indicators in the social innovation literature. According to Preskill & Beer (2012), Bund et al. (2015) and Cunha & Benneworth (2019), the use of indicators on some comparative basis to assess impact remains important because: i) it helps to build a knowledge base on

social innovation initiatives; ii) they can assist public decision-makers in formulating better public policies in the promotion of social innovation initiatives; and iii) they can support the efforts of social organizations. As a result of the relevance of metrics, emphasized in some studies related to social innovations, we decided to include the elements *Metric*, *ImpactIndex* (for the measurement of social innovations impact), and *ProcessIndex* (as an indicator for the ecosystem's processes) (CH5) into the conceptual model. Moreover, to manage the metrics (generation and analysis), the element *Evaluation* was included into the model (CH6).

Some experts reinforced the relevance of specific actor*'s* roles. E14 mentioned that "*the manager's role is one of the most important, as it does not help everything online and does not have a human eye on the ecosystem*". Moreover, E6 claimed that "*mentorship is essential in social innovation processes*". Other experts emphasized the concepts presented in the model and glossary. E3 pointed out that "*this possibility of switching roles, for example, mentor and mentored, makes the social innovation experience richer because it allows a greater degree of empathy among those involved*" and E4 mentioned that "*the roles are very consistent with what we have accomplished*".

The relevance of **collaboration** was mentioned by some experts (E3, E11, E13, and E17) regarding the techniques, tools, and new collaboration approaches. E3 states that "*the system should suggest the best collaboration techniques for each case*". E13 pointed out that "*it is interesting to include collaboration tools*". E17 mentioned that "*actors are, in fact, multi-roles and multi-tasking. The keyword for the ecosystem is radical collaboration*". The importance of collaboration in social innovation ecosystems had already been recognized by Nicolopoulou et al. (2015), that pointed out that collaboration is a key factor in social innovation and can be expanded by relationship networks created to respond to social challenges.

As the conceptual model presented in the evaluation, detailed in Chapter 4, has a level of abstraction that some experts were not familiar with, there was an indication of including information that is not considered elements but attributes of elements. The model submitted for evaluation included only the elements and their relationships. As an example, E14 pointed out that "*a box is missing indicating the differential of this solution, with the reason it is an innovation*". This differential, which represents the justification for which a registered social innovation is innovative, is present as an attribute of the element "Social Innovation" and is written in the model's glossary.

Another topic mentioned by the experts was concerning **integration between the platform with other tools**. These comments are relevant for future versions of the SIDE

conceptual model, but in some cases, they bring different aspects to the model that are outside the proposed scope. For example, E21 proposed "*enabling integration with crowdfunding platforms and services*". However, this integration would bring financial aspects that are outside the scope of this research. E6 proposed to "*use all Digital Marketing tools*". Some comments reinforced the approval of the proposal, as was the quote from E16: "*I liked the proposal to create a tool for networking and exchanging information in social innovation, bringing people and their knowledge together with other people*".

Some experts have stressed the importance of **ecosystem policy**. For example, E10 mentioned that "*it is important to adapt to the General Law on Protection of Personal Data, if applicable*". E1 pointed out that "*to ensure that the ecosystem is inclusive, it is important to have agreements, such as codes of ethics and conduct*".

The topic that received the most comments was concerning the **actors' roles** in the ecosystem, mainly concerning their nomenclature and the tasks performed. E4 pointed out that "*...the person who links projects and companies, acting as a mediator is missing*" and E5 indicated that "*perhaps the Knowledge Provider can be called a Speaker and perhaps a Partner instead of a Promoter*". Some interviewees suggested names different from those proposed in the model. This difference in terminology observed in the responses relates to the following aspects: i) the experts work in different ecosystems; ii) the studies in social innovation ecosystems are incipient (ANDION et al., 2020); and iii) there is still no standard for social innovation terms. However, the conceptual model presents role names cited in three studies in the area (TERSTRIEP et al., 2015; HOWALDT et al., 2016; BUTZIN & TERSTRIEP, 2018). In these cases, complementary adjustments were made to the glossary associated with the model to facilitate the understanding of these roles.

5.4.2. Final Version of SIDE Conceptual Model

After analyzing the experts' comments, we made adjustments in the conceptual model. Eight elements were included in the conceptual model and one element was excluded. The changes made to the conceptual model are described below, based on change indicators CH1 to CH6 (referred in Section 5.4.1) and are presented in Figure 18:

- CH1: to include the elements *Organization* and *Person* in the conceptual model. These elements were inserted as a specialization of the *Actor* element since, in a SIDE, the actor can be a natural or legal person;

- CH2: to include the element *Stage* to shown that the social innovation projects are divided into stages. Therefore, the *Stage* element and a relationship between it and the *Project* element were included in the model;
- CH3: to remove the element *Ontology* from the model. *Ontology*, which had an association with the elements *CommonVocabulary* and *KnowledgeService*, was excluded. Next, we designed an association between these two elements representing that the element *CommonVocabulary* supports *KnowledgeService* since the vocabulary used by ecosystem actors is essential in the specification of knowledge support services;

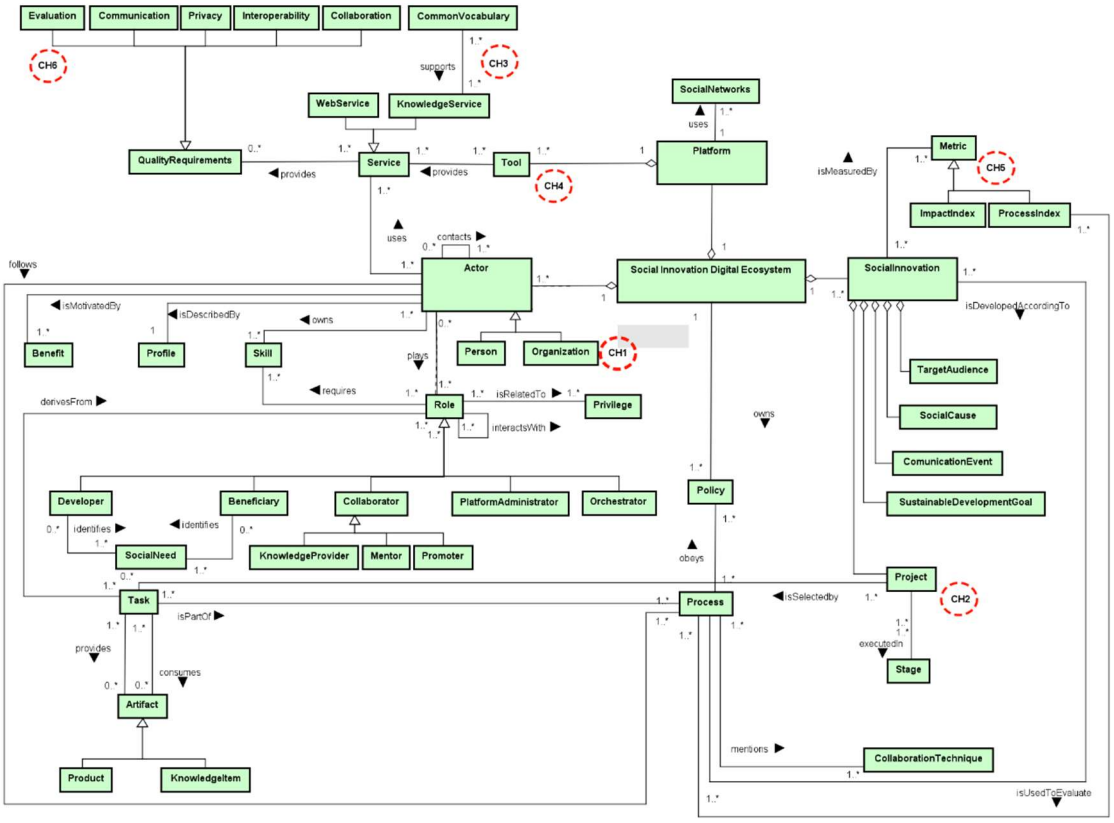


Figure 18. SIDE conceptual model after expert's evaluation.

- CH4: to include the *Tool* element to clarify how the services will be available on the platform. We removed the aggregation between *Service* and *Platform* and replaced it by adding the *Tool* element and two relationships. The first relationship is an association between *Tool* and *Service* (indicating that the SIDE services are provided through a tool). The second relationship is an aggregation between *Tool* and *Platform* (representing that the platform has several tools available to users);

- CH5: to include the elements *Metric*, *ImpactIndex* (for the measurement of social innovations impact), and *ProcessIndex* (as an indicator for the ecosystem's processes) into the conceptual model. A new element, *Metric*, was inserted into the model to represent the metrics associated with one social innovation. Besides, an association between *Metric* and the *SocialInnovation* element was included in the model. Moreover, we included two elements to specify which metrics are represented in SIDE: *ImpactIndex* and *ProcessIndex*. At last, we designed an aggregation between *Metric* and these two elements;
- CH6: Moreover, to manage the metrics (generation and analysis), the element *Evaluation* was included into the model. Since performing evaluations represents a quality requirement in the SIDE, we have included an element named "*Evaluation*" and designed an aggregation relationship between *QualityRequirements* and *Evaluation*.

SIDE conceptual model allows academics and practitioners to obtain a common vision of the social innovation and digital elements and understand the relationships among them. The model refined describes 49 elements, in which three of these elements – e.g., 'actor,' 'platform' and 'social innovation' – have many relationships with other elements. The experts' comments and suggestions were analyzed and, in some cases, provided a change into the conceptual model. When adjusting the model, attention was taken not to have a conflict with the approved propositions.

5.5. Limitations and Threats to Validity

The objective of the survey consisted of evaluating the SIDE conceptual model from the perspective of the experts. There are some limitations to this study. First, to attenuate the low number of participants, the experts were selected from a professional network, according to the following criteria: i) their profile should indicate their experience in social innovation ecosystems; and ii) the experts did not work in the same ecosystem. Moreover, we selected participants who act in these ecosystems, performing different functions. This criterion aimed to obtain distinct perceptions based on the roles they perform. Therefore, the amount of the data collected through the experts' perception was mitigated by their experience in different ecosystems.

Another limitation of this study is the inherent bias in interpreting the extracted evidence to compose the propositions. However, this bias was mitigated by executing

several cycles of revision of the propositions and the conceptual model. The revision was carried out by two experts with extensive experience in ecosystem conceptual modeling.

Finally, an additional limitation consists of the difficulty of accessing data on social innovation ecosystems that would help to understand the phenomenon better. Studies concerning social innovation ecosystems are recent and scarce (BRAITHWAITE, 2018; DOMANSKI et al., 2019). However, the studies performed by authors of the primary studies used to build the propositions and the examples given by experts in the survey to explain their arguments mitigated this problem. Below, we discuss the threats to validity of this study according to Wöhlin et al. (2012) and in the study carried by Oliveira et al. (2020):

- **Construct validity:** refers to the connection between a theory behind an investigation and its observations. It is also concerning the capacity of measuring correctly the concepts studied. The main concept investigated in this research is the social innovation digital ecosystem. As this is a concept proposed in this study, we conducted two distinct SMS for the terms "digital ecosystem" and "social innovation ecosystem" to provide a wide understanding of the theme and ensure that the conceptual model was built based on definitions established by literature. In the evaluation of our conceptual model, we guaranteed confidentiality and offered anonymity of the responses to mitigate potential problems of evaluation inhibition. The threat of giving incomplete responses was mitigated by providing in the questionnaire an additional question to mention additional comments, suggestions, and examples when appropriate. Moreover, as the survey was conducted synchronously, the researcher could suggest that the expert included comments on the reasons behind his/her disagreement with a proposition or model design. Obtaining feedback regarding the SIDE conceptual model from experts with different levels of knowledge and experiences also helped to address the construct validity;
- **Internal validity:** consists of establishing a causal relationship between variables. It involves the degree to which the study minimizes bias. We addressed internal validity mitigating instrumentation threats by running a pilot. The use of a simple scale of the responses ("I agree", "I do not agree", "I do not know") in the survey minimized threats regarding to expert responses ambiguity;
- **External validity:** refers to the capacity of generalization for another context. According to 90.47% of the experts, the conceptual model presented includes different social innovation environments, which indicates a high level of

generalization. It is also important to point out that all experts work at different ecosystems, and they live in 9 different cities;

- **Conclusion validity:** refers to the connection between a treatment and its outcome. To ensure the expert's familiarity with the context of our research and its goal, we provided a site containing the glossary and references about digital ecosystems and social innovation ecosystem and detailed instructions on how to answer the questionnaire. Additionally, we mitigate misinterpretation threats by providing the experts with a glossary of terms present in the conceptual model. The glossary adopted terminologies from literature studies in the digital ecosystem and social innovation ecosystem literature;
- **Reliability:** refers to the potential repeatability of the study by other researchers. Individual interpretations of research that would harm the reliability of outcomes were attenuated through two types of triangulations: data triangulation and theory triangulation. Data triangulation refers to using different distinct sources of evidence to investigate or confirm phenomena (FLICK, 2009). In this research, studies from the digital ecosystem area, studies from the social innovation area, and experts' responses were used to obtain the data for the SIDE conceptual model development and evaluation. According to Flick (2009), theory triangulation refers to creating multiple hypotheses to test their utility and power regarding the investigated context.

5.6. Final Remarks

This chapter described the evaluation process and execution of SIDE conceptual model. From this work, we hope to help practitioners on the digital ecosystem, and social innovation ecosystems have a comprehensive view of the opportunities provided by SIDE conceptual model. Moreover, the model contains elements and relations that may compose requirements for future technological solutions to support these ecosystems. The generated conceptual model, the list of propositions, and a glossary describe the elements that are useful for the management of a SIDE.

Both SIDE conceptual model development and evaluation processes involved researchers and specialists in social innovation, combining research and practice. This interdisciplinary aspect's relevance is aligned with the studies of Brown et al. (2019) that emphasized the importance of roles and networks' diversity for developing the solutions for social innovation.

From the insights obtained from the SMS on the characteristics and demands of social innovation ecosystems (obtained from the SMS on social innovation ecosystems), the characteristics reported in the SMS on digital ecosystems and the challenges reported in the observational study (CHUERI et al., 2019), a preliminary set of requirements from the conceptual model (REQCM) for a solution to support social innovation digital ecosystems was elaborated, as listed next:

- **REQCM1**: The proposed solution must be characterized through a set of concepts and their relationships;
- **REQCM2**: The proposed solution must contain a knowledge base composed of a glossary of basic terms (concepts and respective meanings) and all documentation regarding the actors and their relationships;
- **REQCM3:** The proposed solution should contain a tool to enable archiving, search, and retrieval of artifacts for knowledge sharing among actors;
- **REQCM4**: The proposed solution must have a tool to facilitate collaboration and co-creation between the actors;
- **REQCM5**: The proposed solution must contain a mechanism to support the ecosystem orchestrator to identify project skill gaps;
- **REQCM6**: The proposed solution should contain a tool to enable archiving, search, and retrieval of social innovation.

In the process of supporting the SIDE orchestrator in managing the ecosystem, the characterization of the model was the first step. Since the conceptual model and glossary are elaborated and refined, the next step is to provide mechanisms to support the orchestrator in managing a SIDE. The results presented in this chapter helped in answering the research question RQ1 (*What are the main elements and relationships that characterize a social innovation digital ecosystem*?), because several experts could evaluate elements and relationships concerning social innovation digital ecosystems. As such, the SIDE conceptual model is the answer to RQ1.

Chapter 6. A Three-dimensional Framework for Social Innovation Digital Ecosystem

This chapter describes a three-dimensional framework to support SIDE orchestrators. Section 6.1 presents the theoretical foundation of SIDE framework and its connection with SIDE conceptual model. Section 6.2 discusses the studies carried out on the business dimension, describes the stages and activities, and lists requirements identified in this process. Sections 6.3 and 6.4 present the same structure concerning the social and technical dimensions, respectively. Section 6.5 describes the design of the management dimension, and Section 6.6 concludes this chapter with the final remarks.

6.1. Theoretical Foundation

After perfoming the SIDE evaluation as detailed in Chapter 5, this chapter presents the SIDE framework, inspired by the *ReuseECOS '3+1'* framework (SANTOS & WERNER, 2011ab; 2012ab) in the proposal of activities concerning the business, technical and social dimensions and uses the 3C (Communication, Cooperation, and Coordination) Collaboration model to support the management dimension. The SIDE framework helps to answer RQ2: '*Which is the most appropriate approach for the management of a social innovation digital ecosystem?*', by presenting activities to support the SIDE orchestrator. However, the SIDE framework is the first part of the answer to RQ2. The second part of the answer is the platform to support the orchestrator and other SIDE actors, which is described in Chapter 7. Finally, this section briefly presents these references and the motivation concerning their use in building the SIDE framework.

ReuseECOS '3+1' is a framework that aims to support the management and monitoring of a software ecosystem (SANTOS & WERNER, 2011ab; 2012ab), described in Section 2.5. In this approach, the elements that comprise an ecosystem are divided into three dimensions: i) technical dimension, which focuses on the ecosystem platform; ii)

business dimension, which focuses on the knowledge (e.g., a set of artifacts, resources, and information that flows from/to the organization, subject to self-regulation mechanisms) and involves the processes and transactions performed between actors; and iii) social dimension, which focuses on the ecosystem stakeholders (defined as the actors who interact within an ecosystem).

Although it applies to a context different from this research, the choice of *ReuseECOS '3+1'* framework as a theoretical basis for the foundation of the SIDE framework occurred for the following reasons: i) the purpose of supporting the management of an orchestrator of an ecosystem is the same; ii) the four dimensions presented in the framework were also identified in the SIDE conceptual model; iii) we considered the form of presentation and description of steps to be didactic; and iv) we carried out an analysis and found it possible to adapt some activities to SIDE context.

Concerning the management dimension, we decided to use the 3C Collaboration Model integrated with *ReuseECOS '3+1'*, since it supports the investigation and understanding on how people work in groups. As noticed in the SIDE conceptual model, an actor is a central element of the ecosystem. Social innovation ecosystems fundamentally depend on cooperation, communication, knowledge exchange, and interaction between actors. These activities are fundamental for the development of social innovation and for actors to perceive added value by belonging to the ecosystem. So, we consider essential that the management dimension emphasize these activities.

To investigate and understand how people work in groups, Fuks et al. (2007) define the 3C Collaboration Model according to the scheme presented in Figure 19. According to this model, members of a group need support for i) communication, ii) cooperation, and iii) coordination so that the collaboration takes place effectively. The support aspects cannot be considered in isolation, as they are intimately dependent and related (FUKS et al., 2007). Communication involves exchanging messages and negotiating commitments. Based on coordination, people, activities, and resources are managed to deal with conflicts and avoid losing communication and cooperation efforts. Cooperation is the joint production of group members in a shared space, generating and manipulating cooperation objects in carrying out tasks.

Despite the separation of these three activities to carrying out analysis or studies, they are not isolated or independent. Instead, they are performed continuously and iteratively during group work (FUKS et al., 2007). The tasks originate from commitments negotiated during communication, are managed by coordination, and are carried out

during cooperation. From perception mechanisms, the individual obtains feedback on his/her actions and feed through on the actions of his/her colleagues.

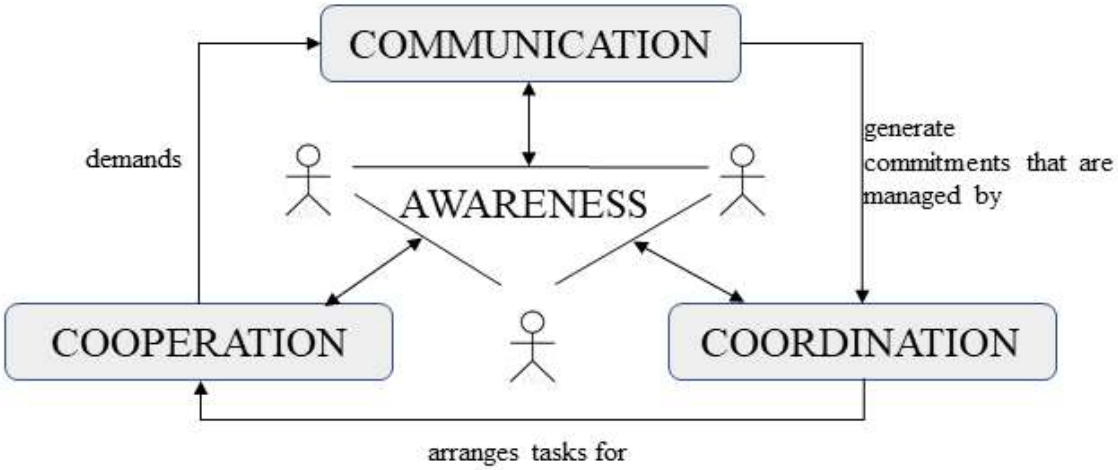


Figure 19. 3C Collaboration model. Source: (FUKS et al., 2007).

After evaluating and refining the SIDE conceptual model, described in Chapter 5, we end up with 49 elements to be managed by the SIDE orchestrator. Then, we decided to facilitate SIDE management through the grouping of elements. They were grouped around the main elements of the model, identified by those having the greatest number of relationships. The main elements identified were 'Social Innovation', 'Actor' and 'Platform'. Therefore, by analyzing each of these elements and their relations, we observed that they belong to different views or dimensions:

i) **Business dimension**: group of elements of SIDE conceptual model concerning 'Social Innovation'. It represents the business vision of the ecosystem, considering the knowledge that circulates in the ecosystem, whether in the form of a generated product, a shared artifact, a lesson learned etc.;

ii) **Social dimension**: group of elements of SIDE conceptual model concerning 'Actor'. It represents the ones whose relationship enables the process of developing social innovation, through their social interaction and roles performed;

iii) **Technical dimension**: group of elements of SIDE conceptual model concerning 'Platform': represents the technological support structure and its services.

Next, it was possible to rearrange the SIDE conceptual model by grouping the elements according to the three dimensions, resulting in a representation. This strategy

makes it clear and more manageable for researchers and practitioners to understand the dimensions. Figure 20 presents SIDE elements regarding the three dimensions.

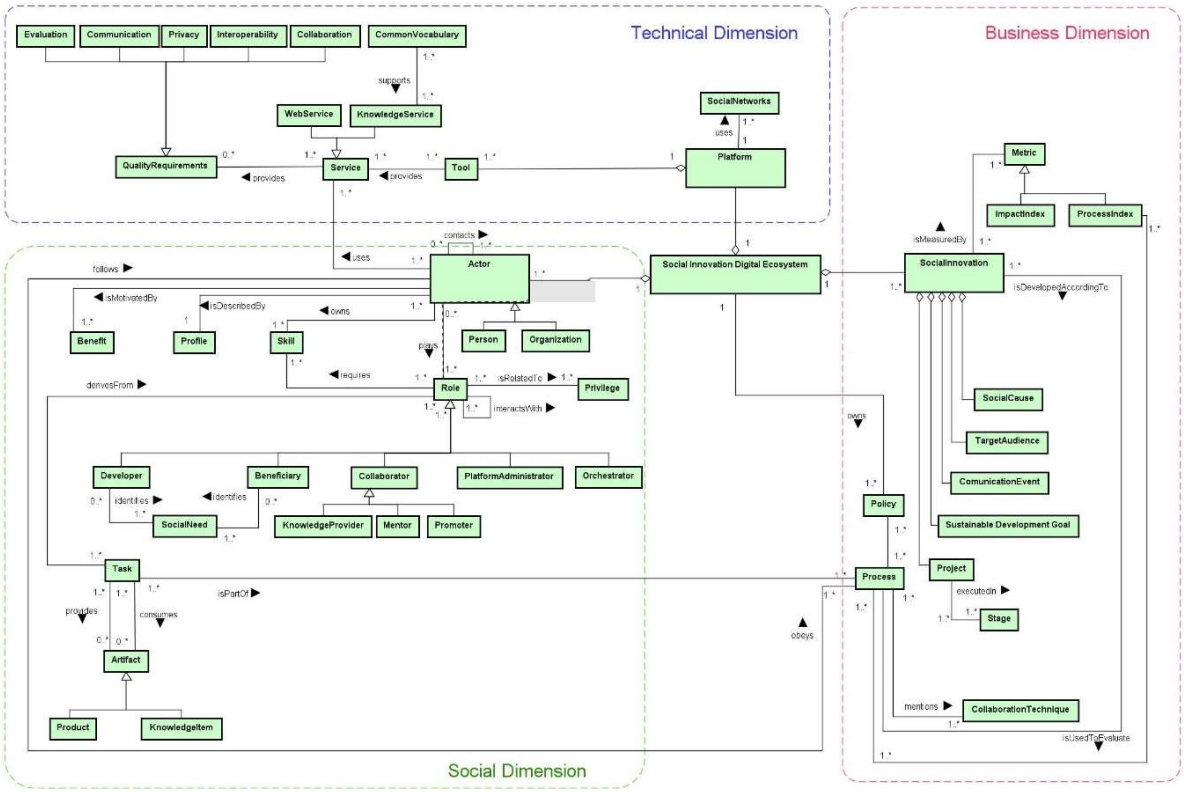


Figure 20. SIDE elements grouped by business, social and technical dimensions.

Based on this representation by dimensions, the next step is to build a framework that supports the orchestrators in managing the SIDE activities. The framework is divided into the three dimensions and has an additional dimension to support SIDE management.

For each dimension, preliminary studies were carried out by the researcher and the members of the UNIRIO extension project entitled "Development of a Social Innovation Digital Ecosystem Platform"[11]. The main objective of this project is to foster collaboration, co-creation, knowledge sharing, and engagement based on the development and availability of a platform for supporting social innovators.

The preliminary studies in the business and social dimensions of SIDE resulted in Bachelor's final projects (AFONSO, 2021[12]; PINHEIRO, 2021[13]), which were co-supervised by the author of this thesis.

[11] "Desenvolvimento da plataforma de um Ecossistema Digital de Inovação Social" – PROExC nº X0002/2019). http://sistemas.unirio.br/extensao/detalhes/index?ID_PROJETO=8629
[12] https://bsi.uniriotec.br/wp-content/uploads/sites/31/2021/05/202104AndersonTavares.pdf
[13] https://bsi.uniriotec.br/wp-content/uploads/sites/31/2021/05/202104MarianaPinheiro.pdf

6.2. Business Dimension

The first dimension of the SIDE framework is based on the elements from the business dimension of the SIDE conceptual model and inspired on the transactional dimension of the *ReuseECOS '3+1'* Framework (SANTOS & WERNER, 2011b). It focuses on the knowledge and refers to the ecosystem internal and external view. In this context, knowledge is a set of artifacts, resources and information that flows from/to the actors of the ecosystem. Instead, the term business in this research is associated with knowledge and processes supporting SIDE actors (not only the commercial side).

To support the identification of steps and activities necessary to meet the business dimension of SIDE, we carried out two studies: one concerning the area of business process management in ecosystems and the other to investigate business processes in social innovation ecosystems.

6.2.1. Preliminary Studies

Our first objective was to understand how business process management occurs in social innovation ecosystems. As we did not find any study answering this question, we decided to investigate two mature technological-based ecosystems: digital (DE) and software (SECO). Moreover, it was intended to offer digital support to ecosystem actors. Precisely the study aimed to identify which elements of business process management (BPM) are available to contribute and add value to a DE or SECO. These elements could stimulate the participation of actors in these ecosystems, besides providing support to ecosystem orchestrators.

To achieve this objective, we carried out an SMS regarding the use of techniques, methods, models, and tools concerning business process management in DE or SECO (AFONSO et al., 2020). This study followed the guidelines for performing secondary studies proposed by Kitchenham & Charters (2007). As a result, a total of 106 studies were identified in the main digital libraries. Figure 21 presents the stages performed and the quantitative results. The planning, execution and discussion stages of this SMS is described in (AFONSO et al., 2020).

SMS results show that the use of business process management techniques or methods for supporting DE or SECO managers is still an emergent field and is relatively recent in publications. The oldest study was published in 2008 and the other seven studies have been published in conferences from 2008-2019 (AFONSO et al., 2020).

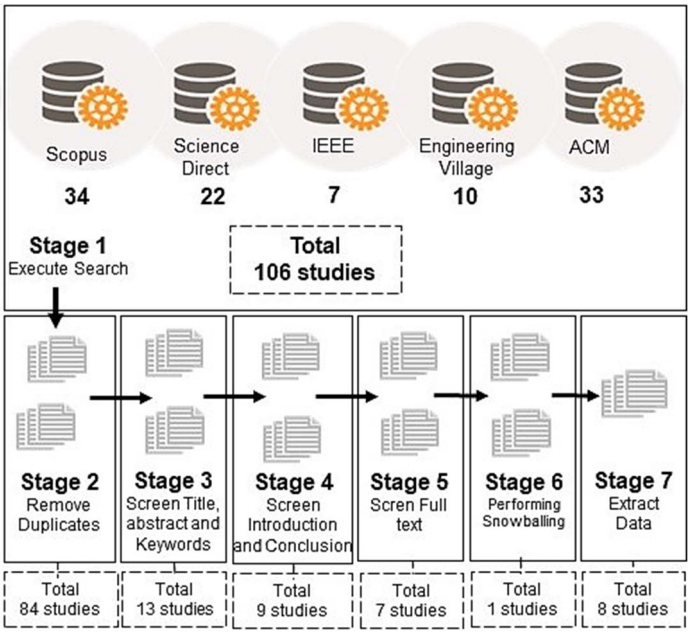


Figure 21. Quantitative SMS results – BPM in DE and SECO.
Source: (AFONSO et al., 2020).

According to the business process management lifecycle presented by Dumas et al. (2013), it was observed that most studies focused on the "Process Identification" phase, indicating that the studies are still at the beginning of covering the lifecycle. After analysis and discussion, we concluded that there are approaches to support the modeling ecosystems in mobile and health domains, but there is a need to apply and analyze these elements in other scenarios. These results were aligned with the perception by Holgado et al. (2019) that considering the business structure during the design and development of technological ecosystems conception is not an easy task. There is also a need for approaches considering methods and tools concerning the application of BPM phases concerning implementation, monitoring, and discovery processes. The application of such processes was not identified in this SMS to support actors and their relationships during ecosystem analysis and monitoring.

The second study involved modeling business processes in social innovation ecosystems and subsequent evaluation through semi-structured interviews with specialists in the domain (AFONSO, 2021). This study was essential to understand how the processes within social innovation ecosystems work, to define the steps and activities for designing the framework supporting SIDE. It involves identifying which actors interact, the activities carried out, and the products generated. In this context, we consider these processes of the domain "social innovation ecosystem" as the business processes between the actors within the ecosystem.

In carrying out the SMS on social innovation ecosystems (Section 2.3), the resulting studies did not present how the relationships between actors occur and the internal processes performed in these environments. However, these studies were relevant to identifying actors/roles, activities, and products. As an example of the first approach, studies such as Nunes et al. (2018) and Chueri et al. (2019) presented helpful information to build the mentoring cycle process. We also used elements from Mulgan (2006) and Caulier-Grice et al. (2012) to design the social innovation process. Finally, the studies by Chueri et al. (2019) and Andion et al. (2020) were used as examples to understand how actors become part of a social innovation ecosystem.

The preliminary processes were developed using the BPMN (Business Process Management Notation) notation and the *Draw.io*[14] tool. We chose the BPMN notation given its wide adoption in process mapping and ease of use and interpretation (HARMON, 2007). Draw.io is an online graphics editor in which one can develop processes and graphics without the need to use expensive and cumbersome software.

An example of a preliminary process refers to the collaboration between social innovation actors, shown in Figure 22. This process is essential because, in social innovation ecosystems, mentoring cycles are applied to support social innovation developers in learning new skills and receiving strategy guidance from more experienced actors (NUNES et al., 2018; CHUERI et al., 2019). For each process modeled, we defined questions to support its evaluation, totalizing eight processes and 43 questions. All the preliminary processes and the questions are described in (AFONSO, 2021).

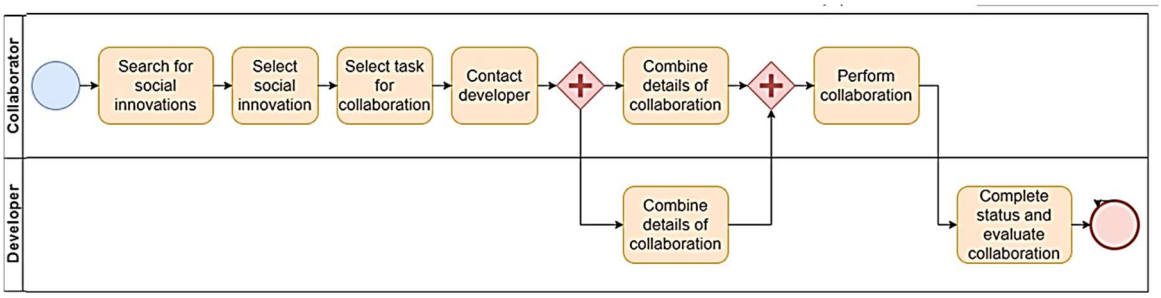


Figure 22. Collaboration process. Adapted from AFONSO (2021).

Then, a semi-structured interview was carried out with experts who work in real social innovation ecosystems to evaluate the designed processes. The methodological aspects employed in this activity followed the guidelines provided by Kitchenham & Pfleeger (2007) and Chazin & Freitas (2017). A summary of this study's planning,

[14] https://www.draw.io

execution, and discussion stages, besides the processes refined after evaluation by social innovation experts are presented in (AFONSO, 2021). The selection of participants was made based on their profiles on the professional network LinkedIn[15], according to the following criteria: i) experience in social innovation ecosystems; ii) respondents did not work in the same ecosystem; and iii) experience in many functions in the ecosystem.

The qualitative analysis resulting from the evaluation brought new inputs for the refinement of processes, and it was possible to adapt them to the SIDE context. The interviewees mentioned important observations which allowed extracting a set of desirable requirements concerning to the business dimension for a technological solution to support SIDE actors. These requirements are named REQBD (REQuirements from Business Dimension) and they are described as follows:

- **REQBD1**: The solution should have a mechanism that allows the registration, search, and storage of social innovations in a knowledge base;
- **REQBD2**: The solution should have a mechanism to allow the registration, search, and storage of lessons learned;
- **REQBD3**: The solution should offer collaboration techniques and tools to encourage engagement in the ecosystem;
- **REQBD4**: The solution should enable a mechanism to allow the editing, storage, and recovery of information regarding the actors and their relationships;
- **REQBD5**: The solution should contain a glossary to facilitate the understanding of the processes by the actors;
- **REQBD6**: The solution should be integrated with social networks and communication tools to allow disseminating events such as the call of mentors;
- **REQBD7**: The solution should be integrated to mechanisms to provide accessibility and usability for actors;
- **REQBD8**: The solution should have mechanisms that allow actors to make suggestions to the ecosystem orchestrator to contribute to the ecosystem evolution.

In addition, we investigated the degree of impact perceived by the actors in case of problems in the execution of the processes. Results revealed that the most critical situations in the ecosystem were the “low diversity of profiles in the ecosystem” and “low participation of the actors in the definition of ecosystem processes”.

[15] https://www.linkedin.com/

6.2.2. Steps and Activities

We intend that these steps and activities will help support the orchestrator in managing the business dimension of SIDE, whose elements are part of SIDE's conceptual model. Steps and activities of this dimension are shown in Figure 23 and described next.

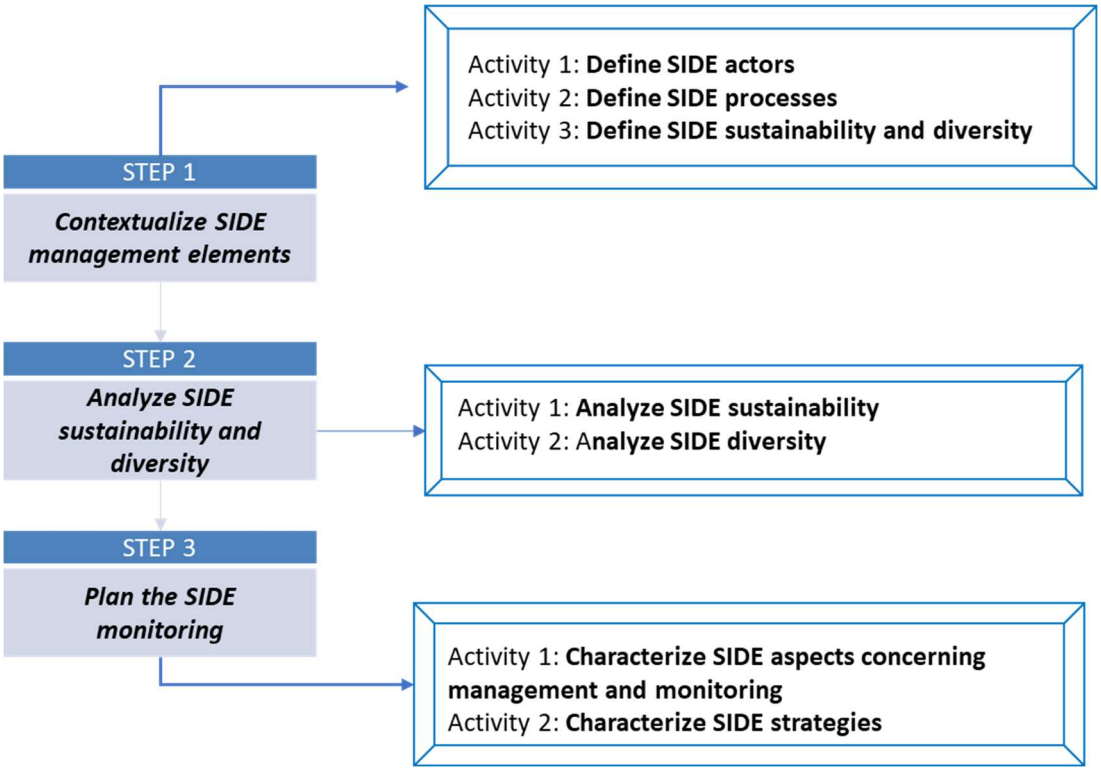


Figure 23. Business dimension of SIDE framework.

- **Step 1**: *contextualize SIDE management elements* helps the orchestrator to identify element's behaviors and characteristics in the SIDE context. These elements are aligned with the SIDE conceptual model (Chapter 4) and the definitions in SIDE glossary (Appendix 3). It can make the understanding of a SIDE lifecycle easier:
    - ***Activity 1***: *define SIDE actors* - in SIDE, as in other social innovation ecosystems, all actors can act as developers or collaborators. At the same time, they may act as the ecosystem orchestrator or benefit from a social innovation development. Furthermore, an actor can have more than one role and perform his/her activities in different situations. For example, in the observational study (Chapter 3), an actor was developing a social innovation, and, at the same time, he/she was mentoring other developers. All actors can produce knowledge for the ecosystem.
    - ***Activity 2***: *define SIDE processes* - while defining the processes, the orchestrator must consider that SIDE is an open ecosystem due to the inherited

characteristic of social innovation ecosystems, which are open and formed by different actors, from several organizations, which may have distinct norms and regulations. In this activity, the orchestrator may consult and adapt the SIDE processes. The orchestrator must create the ecosystem policy, which should provide information on aspects such as the code of ethics, ecosystem data privacy, platform usage rights, among others. The policy must be followed by all actors in the ecosystem, and it is interesting that it is conceived with their participation. Some processes that must be defined are: i) entry of actors into the ecosystem; ii) knowledge sharing; iii) stakeholder engagement; iv) communication between actors; v) collaboration between actors; vi) stakeholder participation in making adjustments to the ecosystem policy; vii) communication between the actors and the orchestrator by sending suggestions for new features, doubts, or process changes must also be created; and viii) evolution of the ecosystem, in which the orchestrator will meet with the actors to assess the performance of the ecosystem in general and may discuss opportunities for improvement concerning processes and the common technological platform functionalities.

  - ***Activity 3***: *define SIDE sustainability and diversity* - aims to identify the knowledge flow from SIDE artifacts, resources, information, and actors. For example, SIDE may present the following flow: i) a new developer receives mentoring; ii) this actor develops a pilot project to develop a product that will benefit people in his/her community; iii) he/she exchanges experiences with other developers to establish his/her goal and an action plan (e.g., developing a new template); iv) this new document represents a knowledge that is shared within the SIDE; and v) he/she externalizes knowledge by presenting it to other actors in a communication event or by uploading this document into the ecosystem.

- **Step 2.1**: *analyze SIDE sustainability* helps SIDE orchestrator to check if the ecosystem can increase or maintain its platform and community over longer periods of time to survive when inherent changes affect the population, e.g., new ecosystems cause migrations of developers, collaborators etc. The critical SIDE element is the orchestrator's actions. Dhungana et al. (2010) proposed the following parameters to perform this step:

1. How are the finite resources or reservoirs treated? It characterizes resources, actors etc. For example, define the number of collaborators that must be acting in the ecosystem to provide the skills needed to support the developers.

2. How does population control happen? It characterizes the incentives offered to a new actor entering into the ecosystem or an existent actor to remain. For example, how can we keep contributors and developers engaged and active in the ecosystem to prevent them from leaving the ecosystem?

3. What are the types of interaction among stakeholders? It characterizes collaboration and competition within the SIDE. What types of collaboration exist between actors? For example, an actor might offer to mentor, execute some task concerning a social innovation development, or provide supporting infrastructure or equipment. If a mentor has skills needed by five developers, but he/she only has the availability to offer mentoring to one of them, competition might occur.

4. What is the process of energy transfer? It characterizes knowledge exchange within the SIDE. What are the ways of exchanging knowledge within SIDE? For example, it could be through analyzing a lesson learned archived in the SIDE or through a communication event.

5. What is the basis for defining processes? It characterizes the context where SIDE belongs. For example, if the orchestrator is an organization connected to the government, some actions need to be formalized, and others need to be in line with the federal/state interests.

Step 2.2: *analyze SIDE diversity* helps SIDE orchestrator to check if the ecosystem has opportunities to compensate the eventual loss of actors after catastrophes that affect the SIDE, e.g., actions plans and situated actions. An advantage of a SIDE is the fact that when an actor leaves the social network, part of the knowledge remains in the SIDE, differently from nutrients in natural ecosystems. We use some of the parameters proposed by Dhungana et al. (2010) to perform this step:

1. What is diversity to the SIDE? It characterizes the diversity of actors. For SIDE, diversity is characterized by an assortment of skills, target groups, roles, economic sectors, and organizations.

2. Why is diversity important to the SIDE? For SIDE, diversity is fundamental because social innovation is recognized for having the best results precisely in initiatives where actors from different economic sectors and with different profiles and skills are involved.

3. How can diversity be ensured in the SIDE? Diversity must be guaranteed in SIDE in several ways, such as i) by monitoring the profiles of actors in the ecosystem, ii) balancing the skills offered and demanded by ecosystem actors, and iii) providing technological needs demanded by the actors.

Step 3: *Plan the SIDE monitoring* helps the orchestrator to characterize aspects and strategies to monitor SIDE platform and community.

- ***Activity 1:*** *Characterize SIDE aspects concerning management and monitoring* - i) SIDE actors: define processes and indicators concerning SIDE actors' management, such as the entry/exit of actors in the ecosystem and the collaboration between actors. The orchestrator may monitor some indicators as: the number of actors collaborating, the number of collaboration tasks completed, and the number of collaboration tasks ongoing; ii) SIDE resources: defines processes for managing ecosystem resources, such as artifacts and lessons learned that actors share.
- ***Activity 2***: *Characterize SIDE strategies* - SIDE actors: aims to perform three tasks: i) technical questions: define the platform functionalities to monitor the indicators in the processes defined in Activity 1; ii) business considerations: the orchestrator must monitor SIDE ecosystem productivity, for example, the number of communication events, the number of collaboration tasks completed which helps to reduce the social innovation development process; and iii) social: monitor the actors' engagement in SIDE's activities.

6.3. Social Dimension

The second dimension of the SIDE framework is based on the elements from the social dimension of the SIDE conceptual model and inspired on the social dimension of the *ReuseECOS '3+1'* Framework (SANTOS & WERNER, 2012a). It focuses on the 'Actor' (SIDE element) and refers to the ecosystem internal and external view. The actors are the ones who interact within a SIDE, e.g., orchestrators, developers, collaborators, beneficiaries etc.

To support the identification of steps and activities necessary to meet the social dimension of SIDE, we carried out two studies: the first one concerning the area of collaboration in ecosystems and the other to investigate collaboration in social innovation ecosystems.

6.3.1. Preliminary Studies

Our second objective was to understand how collaboration occurs in social innovation ecosystems. Collaboration is an essential element in social innovation processes and has its benefits recognized within organizations. However, studies that investigate this concept in social innovation ecosystems were not found. Therefore, we decided to investigate collaboration in digital, software, business, and innovation ecosystems.

To achieve this objective, an SMS was carried out regarding collaboration to identify which characteristics, methods, models, techniques, tools, challenges, benefits, and actors involved in the context of the ecosystems mentioned (PINHEIRO et al., 2021). This study followed the guidelines for performing secondary studies proposed by Kitchenham & Charters (2007). As a result, a total of 598 studies were identified in the main digital libraries. Figure 24 illustrates the stages performed and the quantitative results achieved. The planning, execution and discussion stages of this SMS is described in (PINHEIRO, 2021).

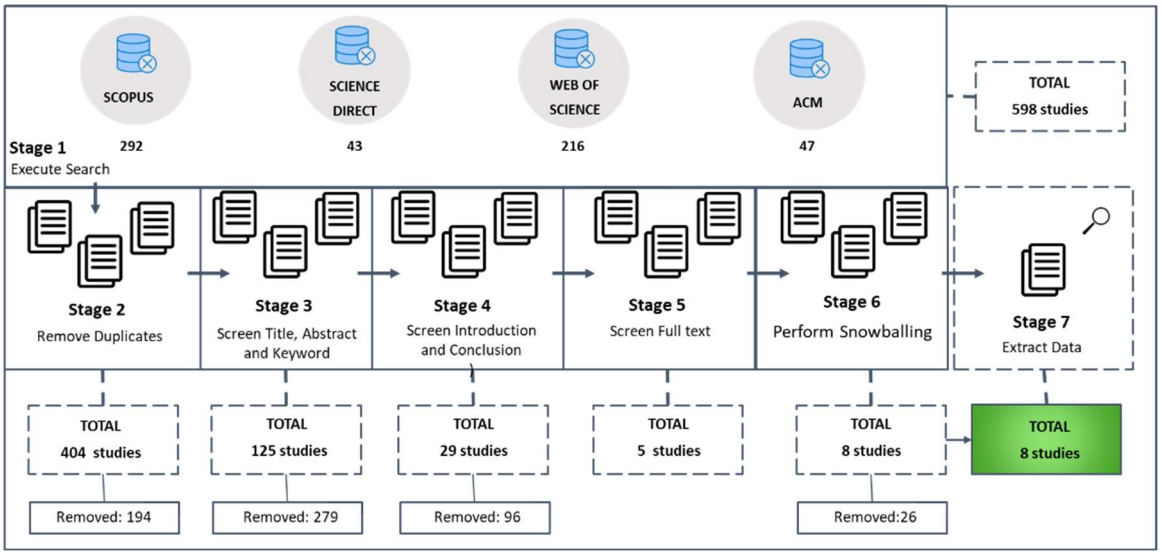


Figure 24. SMS stages and quantitative results – collaboration in ecosystems.

The SMS indicated that most primary studies were evaluation surveys, emphasizing the idea that, initially, research focuses on observing collaboration in real scenarios before proposing solutions. Each study presented different categories of benefited actors, and this fact may be concerning the research context, which covered ecosystems from several domains.

Several studies investigated collaboration in real ecosystems as sources for their research. These investigations carried out observational studies, surveys, case studies, and

semi-structured interviews. For example, in one study, interviews were carried out with actors from two real innovation ecosystems in Germany, one from the microelectronics industry and the other from the photonics industry, in which collaboration represents a key element. These investigations are in line with Manikas (2016), which identified the importance of using real existing ecosystems in research to improve the experimental evidence on the subject.

The challenges faced by the actors had several categorizations: i) technological when there is a need for a technological solution; ii) procedural when there is a need to adapt processes to support collaboration; or iii) social, characterized by the importance of trust and leadership in teams. These categories were mentioned by other studies on collaboration (CAMARINHA-MATOS et al., 2015). It was possible to identify only one mechanism to support collaboration in this context, demonstrating the alignment with some identified challenges that mentioned the absence of technological support. Regarding the benefits of collaboration, sharing knowledge and experiences among ecosystem actors, completing tasks in less time and using partner infrastructure were the most cited ones.

In the second study, an online survey on how collaboration occurs in social innovation ecosystems was carried out with 39 researchers and professionals in the field of social innovation in Brazil (PINHEIRO et al., 2020). The research involved closed questions to characterize the participants and open questions that investigated aspects concerning collaboration in these ecosystems.

The results obtained in this research allowed us to identify: 30 designations of collaboration process/method/technique and 41 designations of tools used by the participants to support collaboration in social innovation environments. *Design Thinking* was the most used method in social innovation environments. The result was quite diverse about tools, but when it comes to file sharing, the most recognized was *Google Docs*, followed by *Skype*, *Google Forms,* and *Trello*. Although topics such as engagement, training and co-creation are listed as difficulties in applying collaboration in social innovation environments, the most cited tools in the survey are for general use and do not have functionality concerning any of them. These data corroborate other studies in the literature that indicate that the study of collaboration networks in the field of social innovation is still poorly evidenced (DRAKE, 2018). Moreover, no tool mentioned by the participants supports a collaboration method.

Regarding the perception of the importance of collaboration in social innovation environments, all participants were unanimous in emphasizing how its use is fundamental

and essential in social innovation. The survey revealed that the understanding of collaboration perceived by the research participants was quite different. Finally, most participants agreed that the use of collaboration mechanisms influences the individual to act better in a group.

In addition, we used the answers from this survey and the SMS studies to build a conceptual map in support of social innovation ecosystems orchestrators. the conceptual map was built around the core element of collaboration and used as main categories the aspects investigated in the studies carried out, namely: success factors, mechanisms to influence teamwork, methods/techniques, tools, and challenges. Within each branch, we created subcategories to facilitate understanding and navigation through the map. The Whimsical tool was used to support the conceptual map. Whimsical[16] is a web tool that allows a visual elaboration of mind maps, flows, taxonomies etc.

Figure 25 presents the conceptual map partially, in which it is possible to notice the use of 3C Collaboration model dimensions to categorize methods and techniques. We investigated each technique/method identified in the studies, including its name plus a short description in a glossary. This glossary aims to support the orchestrator in the selection of the technique, method, or tool. A summary of the planning, execution and discussion stages of this survey, besides the complete conceptual map is presented in (PINHEIRO, 2021).

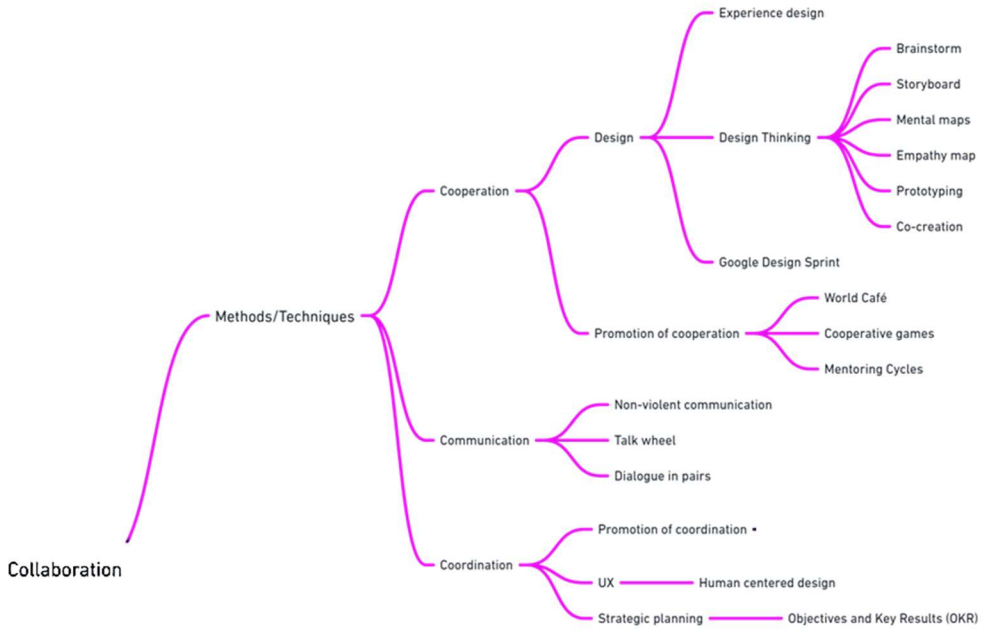


Figure 25. Conceptual map on collaboration methods and techniques for social innovation ecosystems. Source: (PINHEIRO, 2021).

[16] https://whimsical.com/

Based on the SMS carried out and the qualitative analysis resulting from the survey, it was possible to identify the following requirements, based on the reported challenges and the perception of the importance of collaboration, using the participants' responses and the SMS studies. These requirements are named REQSD (REQuirements from Social Dimension), and they are described as follows:

- **REQSD1:** The solution should offer collaboration techniques and tools to encourage engagement in social innovation ecosystems;
- **REQSD2:** The solution should present processes for creating and validating ideas adopted in the ecosystem;
- **REQSD3:** The solution should contain a glossary with common concepts to be used;
- **REQSD4:** The solution should offer processes and tools to support the prioritization and monitoring of activities;
- **REQSD5:** The solution should have a collaboration agreement that ensures the commitment of those involved;
- **REQSD6:** The solution should have a knowledge base containing information regarding the actors and their relationships;
- **REQSD7:** The solution should contain mechanisms and tools for sharing knowledge;
- **REQSD8:** The solution should contain mechanisms to allow and encourage multidisciplinarity;
- **REQSD9:** The solution should make information and data available online;
- **REQSD10:** The solution should contain mechanisms to make it possible to recognize individual collaborations;
- **REQSD11:** The solution should use mechanisms to support decision-making.

6.3.2. Steps and Activities

This dimension aims to understand how the actor-artifact network affects the SIDE over time, also known as socio-technical network. First of all, we consider artifacts the social innovations, the tasks performed by collaborators, the SIDE artifacts (templates, presentations, spreadsheets) and knowledge items (lessons learned). SIDE's network elements are modeled based on the types of relationships among actors and artifacts. Next, an environment to support such a network should be characterized through social resources. We intend that these steps and activities will help support the orchestrator in

managing the social dimension of SIDE, whose elements are part of SIDE's conceptual model. Steps and activities of this dimension are shown in Figure 26 and described next.

- **Step 1**: *model SIDE network elements* requests the orchestrator to identify some SIDE social information: i) *relationships types*: map the main existing relationships within a SIDE, e.g., between actors, among actors and artifacts and among actors and social innovations; and ii) *socio-technical network*: map SIDE actors and social innovation as 'nodes' and their relationships as 'edges'. At this moment, the orchestrator may use the conceptual model presented in Chapter 4.

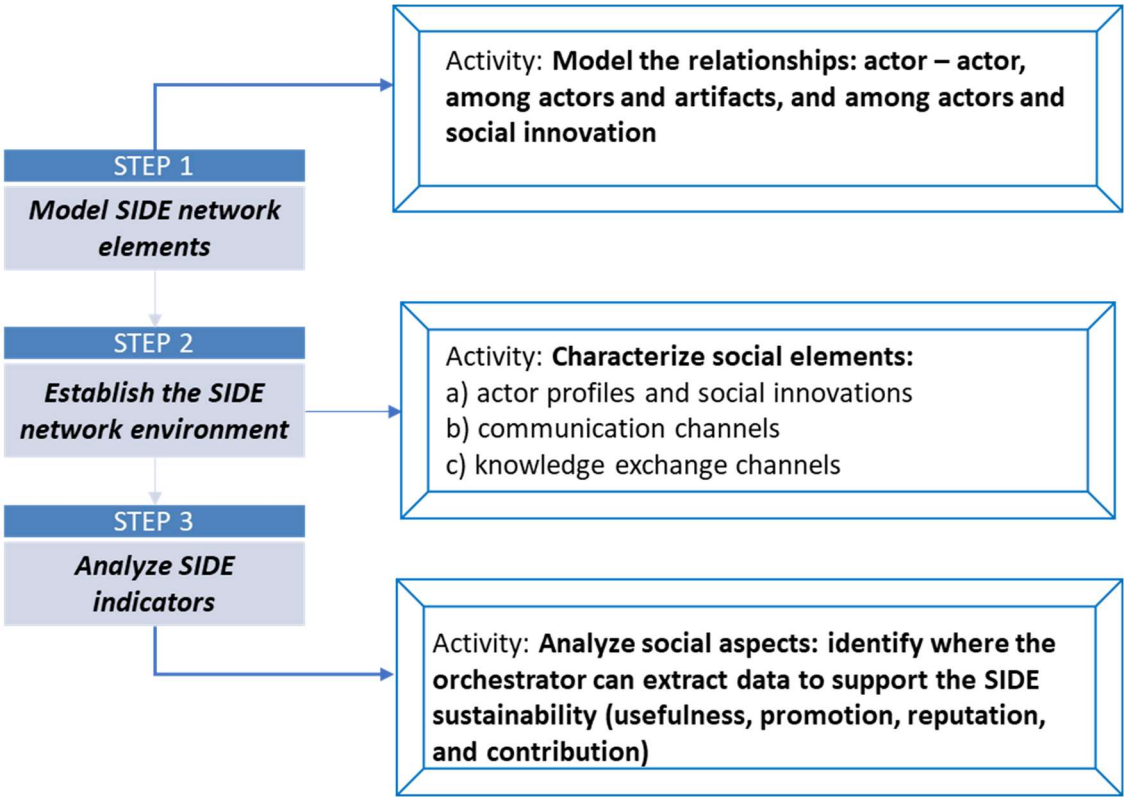


Figure 26. Social dimension of SIDE framework.

- **Step 2**: *establish the SIDE network environment* requests from the orchestrator and the platform administrator to characterize an environment (infrastructure) to support the SIDE's network, considering the following social elements that leverage different types of interaction: i) *actors profiles and social innovations*: relevant information about SIDE actors and social innovations, e.g., ID, role, skills etc.; ii) *communication channels*: social resources that help actors to interact, e.g., messaging between collaborators and developers, as well as suggestions of social innovation tasks for an actor engage in collaborations based on his/her skills; and iii) *knowledge exchange channels*: management resources that aid actors and artifacts to drive SIDE results,

e.g., activities concerning managing knowledge as well as searching for finding actors, social innovation and artifacts in the SIDE.

- **Step 3**: *Analyze SIDE indicators* requests from orchestrators to identify where he/she can extract data to support SIDE sustainability. Therefore, the socio-technical network allows capturing the interactions among actors and social innovation tasks to answer some questions as “who are the actors that may collaborate to a social innovation?” or “what is the skill that is more required by social innovation developers?”. Qualitative and quantitative data can support other social indicators, commonly used in ecosystem studies, such as reputation, utility, promotion, and contribution degrees (JANSEN, 2014; SANTOS, 2016; FONTAO et al., 2017). It can be useful to infer relationships or affinities (proximities) among actors and social innovation.

6.4. Technical Dimension

The third dimension of the SIDE framework is based on the elements from the technical dimension of the SIDE conceptual model and is inspired on the technical dimension of the *ReuseECOS ‘3+1’* Framework (SANTOS & WERNER, 2011b). It focuses on the 'Platform' (SIDE element) and refers to the ecosystem internal view. In this context, a *platform* is a software product.

To support the identification of steps and activities necessary to meet the technical dimension of SIDE, we carried out one study to investigate digital platforms in social innovation ecosystems. It is presented next.

6.4.1. Preliminary Study

Regarding the need to consult the industry on technological solutions to support social innovation ecosystems, an exploratory study was conducted on digital platforms concerning this category of ecosystems in Brazil (CHUERI et al., 2020). Challenges in the design and management of these platforms are combined with economic and social issues since the actors from social innovation ecosystems work on different organizations and economic sectors (BUTZIN & TERSTRIEP, 2018). In this context, investigating the technical, human, and organizational factors of these platforms becomes necessary to improve the design, management, and evolution of solutions to support the social innovation ecosystem.

Because the field of social innovation ecosystems has few studies in this area (DOMANSKI et al., 2019), ways to investigate support platforms for social innovation

actors were sought in other domains through dimensions that encompass technical aspects (e.g., types of digital infrastructures), organizational (e.g., process improvement and transparency), and human (e.g., people-to-people relationships and engagement). Thus, we used the SECO factors identified by Santos et al. (2016) and applied by Luz et al. (2020), presented in Table 19, in an exploratory study on real platforms of social innovation existing in Brazil. The exploratory study carried out followed the sequence of activities illustrated in Figure 27 and was conducted by four experts with experience in the subject, working in academia and industry.

First, we adapted the SECO factors to scenarios of social innovation ecosystems, more specifically concerning support platforms. This activity was necessary so that they could be investigated in social innovation ecosystems since some factors are specific to software development environments. In this case, some factors such as F6, F8, and F10 were excluded from the analysis.

Table 19. Technical, human and organizational factors affecting a SECO. Source: (SANTOS et al., 2016; LUZ et al., 2020).

Factor	Description
F1	Deal with diversity of organizations and relationships within a SECO
F2	Encourage external developers to use a common technological platform
F3	Share content, knowledge, problems, experiences, and abilities
F4	Improve software reuse in the scenario of global software engineering
F5	Reposition organizations to act as network actors and reduce internal workforce
F6	Consider diversity of new functionalities offered to clients
F7	Invest in transparency
F8	Support modular system design
F9	Support organization openness
F10	Define internal characteristics concerning SECO health and stability
F11	Define well-established SECO scope/boundaries
F12	Identify capacities and relationships between actors within a SECO
F13	Have a clear definition of the processes
F14	Strengthen a communicative character inherent for programming activities
F15	Ensure compliance based on the characteristics of different application domains

At first, we adapted the SECO factors to the context of social innovation and the results are presented in Table 20. Next, websites concerning social innovation platforms were identified, generating a list of 12 candidates for analysis. From this list, only three were identified as supporting social innovation ecosystems. We can explain these results by the understanding and using the term “platform”, which may be an information portal, as a website for the sale of services.

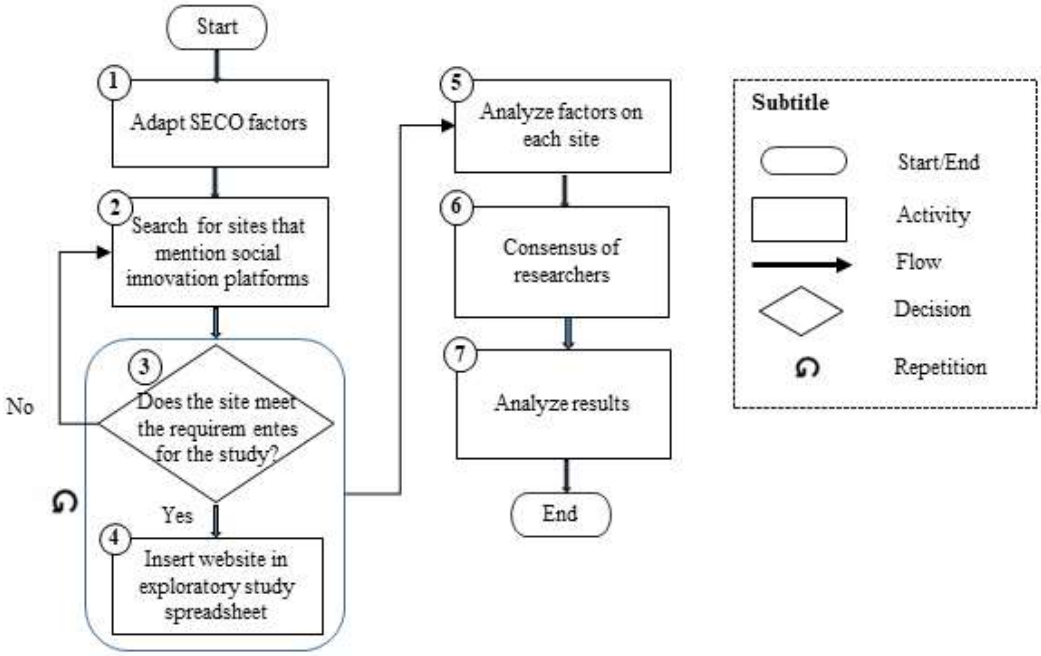


Figure 27. Steps - Exploratory study on digital platforms for social innovation ecosystems (CHUERI et al., 2020).

Table 20. Adaptation of SECO factors to the context of social innovation.

Factor	Original Factors (SANTOS et al., 2016; LUZ et al., 2020)	Adapted Factor	Adapted Factors
F1	Deal with diversity of organizations and relationships within a SECO	F1'	Deal with diversity of actors and their relationships
F2	Encourage external developers to use a common technological platform	F2'	Encourage actors to engage on a common platform
F3	Share content, knowledge, problems, experiences, and abilities	F3'	Share content, knowledge, issues, experiences and skills
F4	Improve software reuse in the scenario of global software engineering	F4'	Improve reuse of social innovations in others that are in the development stage
F5	Reposition organizations to act as network actors and reduce internal workforce	F5'	Engage actors want to act in a network
F7	Invest in transparency	F7'	Provide transparency
F9	Support organization openness	F9'	Supoort the ecosystem openness
F11	Define internal characteristics concerning SECO health and stability	F11'	Define characteristics concercing the ecosystem health
F12	Identify capacities and relationships between actors within a SECO	F12'	Identify capacities and relationships between actors
F13	Have a clear definition of the processes	F13'	Have adaptable processes
F14	Strengthen a communicative character inherent for programming activities	F14'	Engage new external actors to join traditional actors involved in the development of social innovations
F15	Ensure compliance based on the characteristics of different application domains	F15'	Ensure means to the community to maintain the environment by providing demands and solutions for the ecosystem

Next, four experts in the field performed the factor analysis. The general analysis of technical, human, and organizational factors in the context of the investigated platforms allowed us to verify that four were observed (F1', F3', F9', and F14'), two were partially observed (F2' and F5'), and four were not observed (F7', F11', F12', and F13').

This result, in line with the small number of platforms identified, reflects the novelty of the theme concerning support platforms for social innovations in Brazil. This fact is in line with the reality of studying social innovation ecosystems, which is recent and needs further studies (DOMANSKI et al., 2019).

Based on the exploratory study carried out, it was possible to identify requirements that could serve as an input to specify a technological solution to support SIDE. These requirements are named REQTD (REQuirements from Technical Dimension) and they are described as follows:

- **REQTD1:** The solution should contain mechanisms that allow understanding each actor's roles in the ecosystem (factor F1');
- **REQTD2:** The solution should offer mechanisms to encourage engagement to use the common technological platform (factor F2');
- **REQTD3:** The solution should contain mechanisms for sharing knowledge, experience and abilities (factor F3');
- **REQTD4:** The solution should contain mechanisms to support collaboration between actors (factor F5');
- **REQTD5:** The solution should contain links to external tools or integrations to promote a diversity in new functionalities provided to customers (factor F6');
- **REQTD6:** The solution should offer information concerning the platform development process (factor F7');
- **REQTD7:** The solution should have mechanisms to support the selection and analysis of indicators concerning health and stability (factor F10');
- **REQTD8:** The solution should have a knowledge base containing information regarding the actors and their relationships (factor F12').

6.4.2. Steps and Activities

This dimension aims to support the orchestrator to plan and monitor activities concerning the technical dimension. First of all, an orchestrator needs to select a target platform and contextualize its project/acquisition based on identifying actors' roles and health indicators.

We intend that these steps and activities will help support an orchestrator in managing the technical dimension of SIDE, whose elements are part of SIDE's conceptual model. Steps and activities of this dimension are shown in Figure 28 and described next.

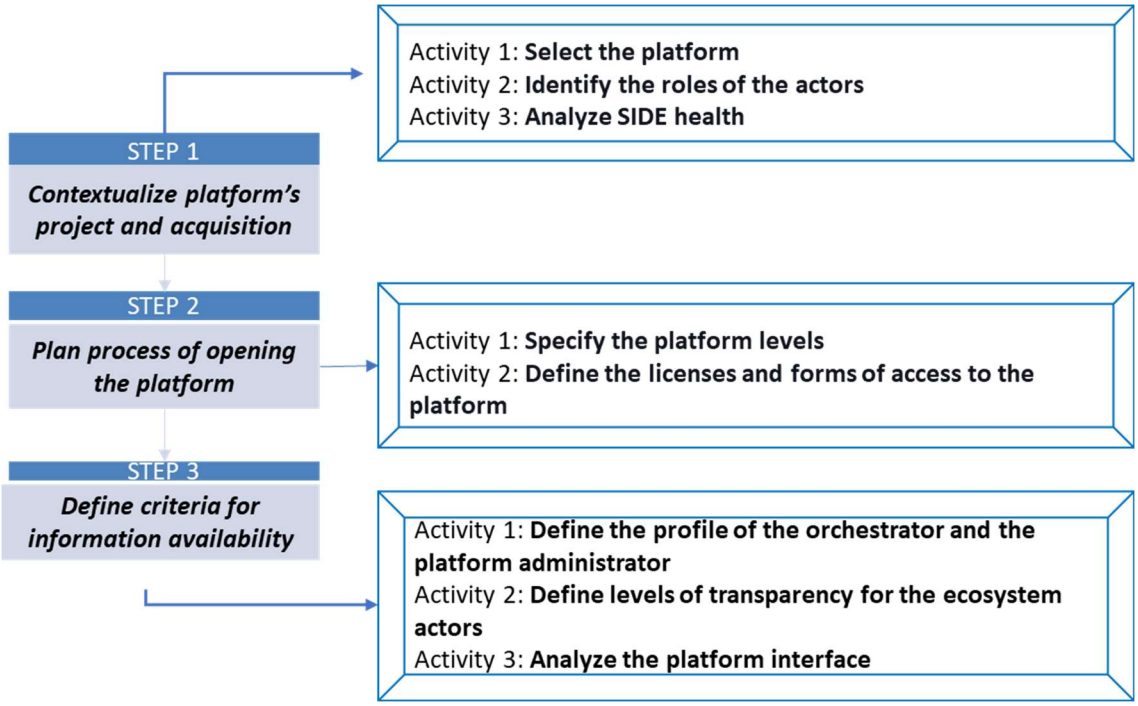


Figure 28. Technical dimension of SIDE framework.

- **Step 1:** *Contextualize platform's project and acquisition* helps orchestrators with elements to characterize a SIDE.
    - **Activity 1**: *Select the platform* represents a decision point where the orchestrator chooses a platform of interest, depending on the SIDE context and on the requirements from social/business/technical dimensions.
    - **Activity 2**: *Identify the roles of the actors* aims to define what the actors' roles are part of this SIDE. As presented in Section 4.1, SIDE roles are classified into: developers, collaborators (mentor, knowledge provider and promoter), beneficiary, orchestrator, and platform administrator. At this point, the orchestrator defines whether the support of another actor is needed to manage/configure the platform and plan/monitor/test the development of new features.
    - **Activity 3**: *Analyze SIDE health* consists in quantifying and qualifying some health measures. The concept of **health** is defined as the ability to provide durable growth opportunities for its members and those who depend on this ecosystem (MANIKAS & HANSEN, 2013). To measure how much a business ecosystem is healthy, Iansiti & Richards (2006) define the following indicators (SANTOS et al., 2020):

- **Productivity**: is the ability to create energy. It might be measured through the total productivity factor, improvement of productivity through time and delivery of innovations (ability of the ecosystem to adapt and deliver new technologies, processes, and even ideas to its actors);
- **Robustness**: is the ecosystem's ability to sustain disturbances and disconnections. It is measured through the persistence of the ecosystem structure (the ability to maintain relationships), predictability (the core capacity of an ecosystem remain solid even if there is noise between the relationship of those involved), limited obsolescence (the ability to control the usefulness of components and technology), continuity of use experience and use cases (the ability of products to evolve in response to change in technologies);
- **Creation of niche or innovation**: it is the ability of the ecosystem significantly increase the diversity of those involved during the time. It is measured by growth in variety of the company and growth in technical and product variety (value creation), which measures the increase in value that growth brings.

The suggestion of health indicators to be analyzed by the orchestrator was elaborated based on: i) analysis of the related concepts previously presented; and ii) examples of indicators extracted from the studies by Dhungana et al. (2010), Santos (2016), Amorim et al. (2017), and Iuri et al. (2017). The result of this specification is presented in Table 21. From the analysis, the indicators were adapted to the SIDE context, using the conceptual model and the activities defined in the other dimensions of the framework. For example, in the case of the productivity category, the indicator named "knowledge creation" represented in one of the studies was adapted to "stored lessons learned". Another example of this category is the case of "New Projects" being adapted to "New social innovations". In the case of the robustness category, the indicator "Customer satisfaction" can be adapted to "Actor satisfied with the collaboration performed".

- **Step 2***: Plan process of opening the platform* helps the orchestrator and platform manager to characterize the platform's architecture of the selected SIDE.

- **Activity 1:** *Specify the platform levels:* aims to identify the platform's modules to support different roles with a particular abstraction level. For example, the SIDE platform may have an interface for the orchestrator role and another for developers or collaborators.

Table 21. SIDE health indicators.

Indicator: Diversity
How many categories of actors per target audience are there on the platform?
How many categories of social cause actors are there on the platform?
How many categories of actors per sustainable development objective are there on the platform?
How many actor skills are there on the platform?
Does the ecosystem have actors with roles of registered developers, collaborators, and beneficiaries?
How many actors are there registered in each role?
Indicator: Productivity
How many social innovations changed the development stage in the last 30 days?
How many collaboration tasks were completed in the last 30 days?
How many communication events took place in the ecosystem in the last 30 days?
How many lessons learned were added to the repository in the last 30 days?
How many artifacts were added to the repository in the last 30 days?
How many messages were transmitted in the ecosystem's communication channels?
How many social innovations have reached the final stage in the last 30 days?
What is the average time to fix bugs on the platform?
What is the average response time to messages from actors on the platform?
How many collaborating actors have been added to the ecosystem in the last 30 days
How many users used the platform in the last 30 days?
How long on average do users use the platform?
Indicator: Robustness
Feature: Interrelation
How many actors does the platform have?
Feature: Information Consistency
Does the platform have a glossary of terms?
Feature: Grouping
How many categories of social innovations per target audience are there on the platform?
How many categories of social innovations by social cause are there on the platform?
How many categories of social innovations by sustainable development objective are there on the platform?
Indicator: Niche Creation
Does the platform have documentation?
How many beneficiaries per target audience category are registered on the platform?

- **Activity 2**: *Define the licenses and forms of access to the platform*: restricts the actors' participation in the platform development based on rights and obligations that rules the process of SIDE. Concerning access, the orchestrator defines the conditions under which an actor may have access to the solution: i) through direct access to the platform via the website, registration made by the

author, and immediate creation of the register; ii) by invitation from the orchestrator and sending the actor's account and password; iii) by provisional registration made by the author and approval by the orchestrator for access to the platform. If the platform is open for any actor to register, it is necessary to verify if the software licenses that integrates the technological solution contemplate this situation. The orchestrator defines whether the platform will be open and free or if there will be a subscription fee, which is not usually common in social innovation ecosystems.

- **Step 3***: Define criteria for information availability* helps the orchestrator and platform manager to characterize which kind of information is available for each actors' profile.
    - **Activity 1:** *Define the profile of the orchestrator and the platform administrator*: aims to define what functionalities will be executed for each role. For example, only the platform administrator has access to documents concerning platform planning and development and source code. Depending on the context in which they find themselves, two different SIDE can serve different target audiences for social innovations. Audience is one of the examples of categories that are set up by the orchestrator.
    - **Activity 2:** *Define levels of transparency for the ecosystem actors*: not all information will be available for viewing or editing all actor's roles. For example, an actor's contact details should not be available to all roles. The orchestrator needs this information to be able to contact the actor in case of an issue of non-compliance with the ecosystem's code of ethics, for example.
    - **Activity 3:** *Analyze the platform interface: a*ccess to information types and functionality differs between the orchestrator/administrator and the other actor roles in SIDE. Thus, it is recommended to use different interfaces between these groups of actors. For example, the SIDE platform may have a specific functional panel for the orchestrator/platform administrator pair.

6.5. Management Dimension

Although they are distinct, the business, social and technical dimensions are interrelated. For this reason, we could observe the identification of requirements concerning collaboration, which is an aspect associated with the social dimension, resulting from studies carried out in the business and technical dimensions.

The management dimension received inputs from the studies on the other dimensions (Sections 6.2, 6.3 and 6.4) and from the evaluation phase of the SIDE conceptual model. The steps and activities of the *ReuseECOS '3 + 1'* framework (SANTOS & WERNER, 2012b) and the 3C Collaboration Model (FUKS et al., 2011) served as a foundation for this dimension. This integration is presented in Figure 29.

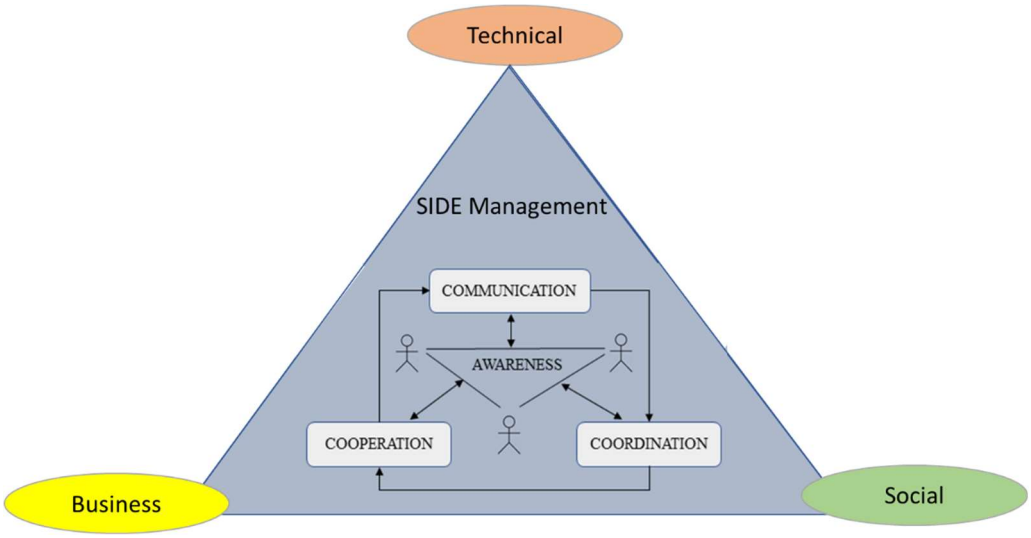


Figure 29. SIDE Framework.

In this framework, we divided the management needs into steps categorized by the dimensions of the 3C Collaboration Model: coordination, cooperation, and communication. We made this decision to facilitate the SIDE management and follow-up by the orchestrator. Steps and activities of this dimension are shown in Figure 30 and described next.

- **Step 1:** *Identify and perform follow-up coordination indicators* - requests an orchestrator to identify indicators concerning to coordination in a SIDE and prioritize the most appropriate indicators for performing the SIDE follow-up. The orchestrator may use the SIDE indicators presented in Table 22 and add others, if necessary. For example, an orchestrator may choose to monitor the indicator of contributors present in the ecosystem. Based on this information, he/she can decide to carry out actions to publicize the ecosystem to attract new actors.
- **Step 2:** *Identify and follow-up communication indicators* - requests an orchestrator to identify indicators concerning to communication in SIDE and prioritize the most appropriate indicators for performing the SIDE follow-up. The orchestrator may use the SIDE indicators presented in Table 22 and add others, if necessary. For example, an orchestrator may choose to monitor the indicator of messages sent from

collaborators to developers in the ecosystem. Based on this information, he/she can decide to carry out actions to foster collaborators' engagement in the ecosystem's social innovations.

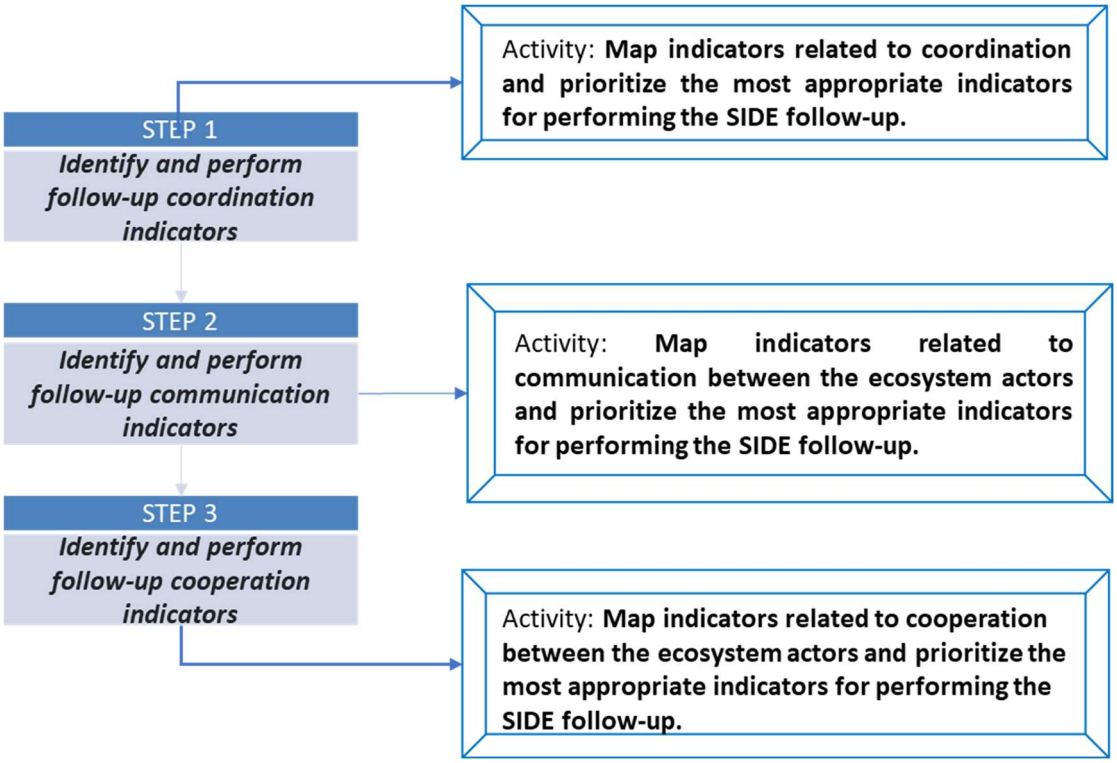


Figure 30. Management dimension of SIDE framework.

- **Step 3:** *Identify and perform follow-up cooperation indicators* - requests an orchestrator to identify indicators concerning to cooperation in SIDE and prioritize the most appropriate indicators for performing the SIDE follow-up. The orchestrator may use the SIDE indicators presented in Table 22 and add others, if necessary. For example, an orchestrator may choose to follow-up the indicator of collaboration tasks available for collaborators. If the indicator is too low, it is an indication that collaborators are not selecting collaboration tasks. Based on this information, he/she can decide to carry out actions to foster collaborators' engagement in the ecosystem's social innovations.

Table 22 was prepared based on the elements of the SIDE conceptual model and some processes mentioned in the business dimension of the SIDE framework (Section 6.2.2) and the health indicators defined in Section 6.4.2. However, it is not exhaustive and can be increased as the orchestrator considers necessary. Moreover, the use of all indicators is not mandatory and should be concerning the elements and processes that the orchestrator decides to give higher priority to in each phase of the ecosystem.

Table 22. SIDE management indicators.

Code	Indicator	3C Dimension	SIDE Dimension
I1	Messages sent from collaborator to developer	Communication	Social
I2	Communication events created	Communication	Business/Social
I3	Suggestion of a new feature for the ecosystem	Communication	Business/Social
I4	Messages sent from the internal actors to the orchestrator	Communication	Social
I5	Suggestion of a new collaboration task for the ecosystem	Communication	Business/Social
I6	Suggestion of a new skill	Communication	Business/Social
I7	Invitations sent to friends to participate in the ecosystem	Communication	Social
I8	Messages suggesting a social innovation to an external actor	Communication	Social
I9	Collaboration tasks created	Cooperation	Business
I10	Collaboration tasks in progress	Cooperation	Business
I11	Collaboration tasks completed	Cooperation	Business
I12	Tasks needing a collaborator	Cooperation	Business
I13	Tasks needing a collaborator, with the skills in the ecosystem	Cooperation	Business
I14	Lessons learned considered useful for one actor	Cooperation	Business
I15	Positive returns on completed collaborations	Cooperation	Social
I16	Shared artifacts	Cooperation	Business
I17	Shared lessons learned	Cooperation	Business
I18	Social innovations that have moved to a new stage	Coordination	Social
I19	Registered actors	Coordination	Social
I20	Registered developers	Coordination	Social
I21	Registered collaborators	Coordination	Social
I22	Registered beneficiaries	Coordination	Social
I23	Skills needed for innovations	Coordination	Business
I24	Actors who entered the ecosystem	Coordination	Business
I25	Social innovations registered	Coordination	Business
I26	Social innovations by stage - Opportunities and Challenges	Coordination	Business
I27	Social innovations by stage - Idea Generation	Coordination	Business
I28	Social innovations by stage - Development and Testing	Coordination	Business
I29	Social innovations by stage - Sustainability	Coordination	Business

Based on the management dimension, it was possible to identify requirements that could serve as an input to specify a technological solution to support SIDE orchestrator. These requirements are named REQMD (REQuirements from Management Dimension) and they are described as follows:

- **REQMD1:** The solution should contain a mechanism to support the ecosystem orchestrator to manage coordination indicators;
- **REQMD2:** The solution should contain a mechanism to support the ecosystem orchestrator to manage communication indicators;

- **REQMD3:** The solution should contain a mechanism to support the ecosystem orchestrator to manage cooperation indicators.

6.6. Final Remarks

This chapter introduced the SIDE framework, composed of the dimensions: business, social and technical, and the dimension that supports management. Initially, we describe the 3C Collaboration Model, which together with the *ReuseECOS "3+1"* make up the theoretical foundation of the SIDE framework.

For each dimension, we present the preliminary studies that contributed to understanding their particularities in social innovation ecosystems. Then, we proposed the steps and activities to support the orchestrator in each dimension and a set of desirable requirements for a technological solution to SIDE. Next, we present the management dimension with the design of the solution concerning the framework.

The framework presented in this chapter helped answer the research question RQ2 (*Which is the most appropriate approach for the management of a social innovation digital ecosystem?*) by providing steps and activities to support the SIDE orchestrator. However, the SIDE framework is the first part of the answer to RQ2. The second part of the answer refers to a technological solution to support the orchestrator and other SIDE actors. Therefore, the next step refers to developing and evaluating a supporting technological solution based on the set of requirements identified during the evaluation of the model and the investigations reported in this chapter. Finally, chapter 7 presents the technological solution and its evaluation by experts.

Chapter 7. eSIDE – A Platform for Social Innovation Digital Ecosystem

This chapter proposes a technological solution for managing and monitoring SIDE to support the orchestrator in management activities, called eSIDE. Firstly, we present an overview of our platform in Section 7.1, including details on the requirements and strategy. We discuss the eSIDE design and development in Sections 7.2. and 7.3. The Management Panel is presented in Section 7.4. eSIDE evaluation is presented in Section 7.5 and Section 7.6 concludes with some final remarks.

7.1. Requirements

In response to RQ2: "*Which is the most appropriate approach for the management of a social innovation digital ecosystem?*", we started with the proposition of the SIDE framework (Chapter 6). This chapter presents the complementation of the answer by presenting a technological solution to support the management of SIDE represented by a digital platform.

According to the SIDE definition (CHUERI, 2018), the platform must support actors, relationships, and social innovations. Specifically, it must support two types of profiles: social innovation actors, represented by developers, collaborators, beneficiaries, and those responsible for its management, described by the ecosystem *orchestrator* and the platform *administration*.

In order to help orchestrators to apply the SIDE perspective in managing activities, we propose a technological solution for SIDE management named eSIDE. eSIDE is a common technological platform and represents the digital support to SIDE. Moreover, eSIDE has an additional module to support other ecosystem actors, such as developers, collaborators, and beneficiaries.

We developed eSIDE based on i) elements of the SIDE conceptual model (Chapter 5); ii) requirements identified during the SIDE evaluation process; iii) requirements

identified in studies concerning SIDE framework (Sections 6.2.1, 6.3.1 and 6.4.1); and iv) activities described for SIDE framework presented in Chapter 6. Table 23 presents a relationship between the eSIDE requirements and the requirements presented on previous studies.

Table 23. eSIDE requirements.

ID	Description	Source				
		Business dimension	**Social dimension**	**Technical dimension**	**Management dimension**	**SIDE Conceptual Model Evaluation**
REQ1	eSIDE should contain a glossary with common concepts and mechanisms to allow the update of its terms by the orchestrator.	REQBD5	REQSD3	REQTD1		REQCM2 REQCM1
REQ2	eSIDE should offer collaboration mechanisms to encourage engagement in the ecosystem.	REQBD3	REQSD1	REQTD2		
REQ3	eSIDE should have a mechanism to allow the registration, search, and storage of lessons learned.	REQBD2	REQSD6	REQTD3		REQCM3
REQ4	eSIDE should contain a tool to enable archiving, search, and retrieval of artifacts for knowledge sharing among actors.					REQCM3
REQ5	eSIDE should contain mechanisms to support collaboration between actors.			REQTD4		REQCM4
REQ6	eSIDE should offer information related to the platform development process.			REQTD6		
REQ7	eSIDE should have mechanisms to support the selection and analysis of indicators related to health and stability.		REQSD11	REQTD7	REQMD1, REQMD2, REQMD3	
REQ8	eSIDE should use mechanisms to support decision-making.		REQSD4	REQTD7		
REQ9	eSIDE should enable a mechanism to allow the editing, storage, and recovery of information concerning actors and their relationships.	REQBD4	REQSD5	REQTD8		
REQ10	eSIDE should allow data available online.		REQSD8			
REQ11	eSIDE should contain mechanisms to make it possible to recognize individual collaborations.		REQSD9			
REQ12	eSIDE should contain mechanisms to allow and encourage multidisciplinarity.		REQSD7			
REQ13	eSIDE should have a mechanism that allows the registration, search, and storage of social innovations in a knowledge base.	REQBD1				REQCM6
REQ14	eSIDE should be integrated into mechanisms to provide accessibility and usability for actors.	REQBD7				
REQ15	eSIDE should have mechanisms that allow actors to make suggestions to the orchestrator to contribute to the ecosystem evolution of the ecosystem.	REQBD8				
REQ16	eSIDE should be integrated with social networks and communication tools to allow disseminating events such as the call of mentors.	REQBD6				
REQ17	eSIDE must contain means to support the orchestrator to identify skills gaps in the ecosystem and search for actors with these skills					REQCM5
REQ18	eSIDE should contain links to external tools or integrations to allow new functionalities.			REQTD5		
REQ19	eSIDE should contain a mechanism to support the orchestrator to manage coordination indicators.				REQMD1	
REQ20	eSIDE should contain a mechanism to support the ecosystem to manage communication indicators.				REQMD2	
REQ21	eSIDE should contain a mechanism to support the orchestrator to manage cooperation indicators.				REQMD2	

7.2. Design

Figure 31 presents a conceptual view concerning eSIDE. The platform is made available to a community of SIDE actors, who may have one or more roles: orchestrator, collaborator, developer, beneficiary, and platform administrator. These actors belong to the ecosystem community and access the platform through a website and carry out activities registered in the repository.

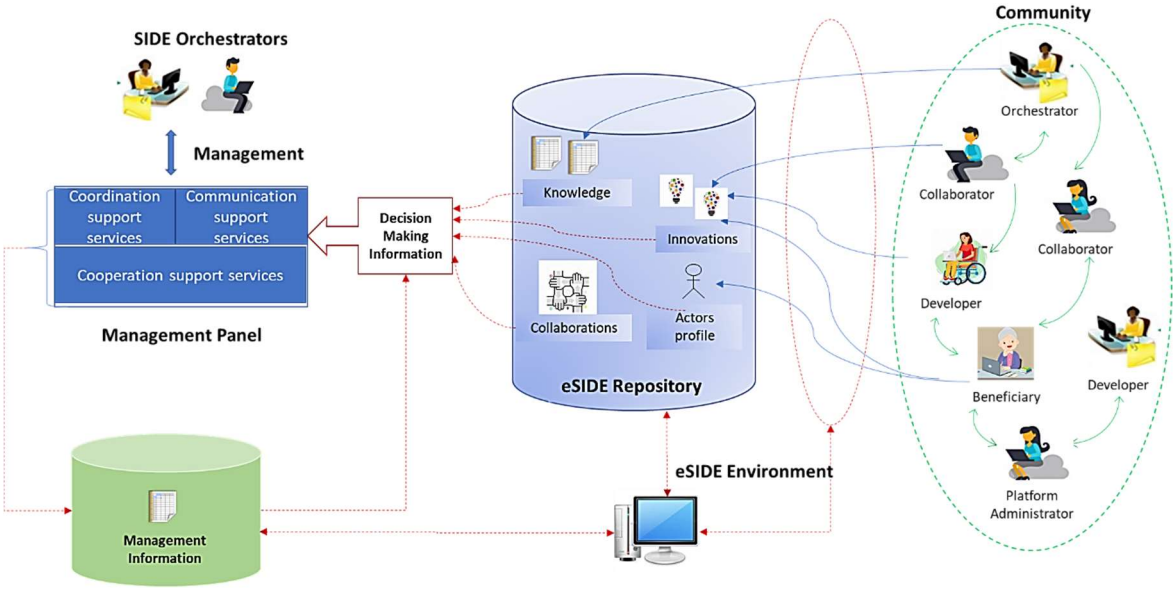


Figure 31. SIDE management. Inspired by SANTOS & WERNER (2012b).

The repository stores the profiles of the actors, the social innovations, the items of knowledge (which can be artifacts or lessons learned), and information about the collaborations carried out between the actors. Based on the activities performed and on support tables stored on the repository, the platform generates information that supports the orchestrator's decision-making process. This information is consolidated into indicators in the following categories: coordination, communication, and cooperation. These indicators are selected by the orchestrator and monitored individually or by category.

In addition, based on all indicator selections made by the orchestrator, a perception report is made available by the platform, providing guidelines from the selected (or not selected) indicators and containing consolidated ecosystem information. For example, suppose an orchestrator selects only indicators from the communication category. In that case, the generated report presents an analysis of this category and a possible impact on the ecosystem due to the non-monitoring of the cooperation dimension. Despite the 3C model categories, the orchestrator can also consult other management information, such

as graphics on input/output of actors in the ecosystem, configure the glossary, configure the basic tables and consult records of actors and social innovations.

Although the conceptual model of SIDE contains different categories of collaborating actors, such as mentors, promoters and knowledge providers, eSIDE has only the *collaborator* profile. This decision occurred because during the evaluation of the model some interviewees recognized these roles, but in the region of Brazil in which they operate, these roles received different names. The tool is intended to be used by different contexts of social innovation ecosystems, it was decided to keep only the collaboration profile.

The cooperation between developers and collaborators takes place through collaboration tasks. From a set of generic tasks, a developer selects, which ones are essential for developing his/her social innovation and for which he/she needs the help of collaborators. Actors choose tasks according to their interest in participating in social innovations. However, when an actor wants to collaborate on a social innovation, he/she can choose between performing tasks concerning these three sub-roles. This is possible because tasks concerning the three types are present in the ecosystem Task table. An example of tasks available for selection by eSIDE actors is presented in Table 24.

Table 24. Examples of tasks concerning collaborator roles.

Task Id	Task name
1	Mentoring for project structuring
2	Fundraising mentoring
3	Project management mentoring
4	Mentoring for idea generation meetings
11	Provide space for project meeting
12	Provide space for a communication event
15	Support fundraising for the social innovation development
16	Mentoring for project structuring
17	Fundraising mentoring

Although the main objective of this research is to support SIDE orchestrators, there was no prior technological support structure to support the data generation concerning actors and social innovations. So, we decided that the solution should also support data entry from social actors, their innovations and support collaboration between them. Therefore, the eSIDE tool has two modules:

- *Development and Collaboration*: it is accessed by actors who are developers, collaborators, and beneficiaries of social innovations. All operations that can be performed in eSIDE by these actors are shown in Figure 32. The sign (*) indicates operations that only the *Developer* may execute;

- *Management Panel*: only actors who have the role of orchestrator or platform administrator have access to this panel. Figure 33 shows all operations that can be performed in eSIDE by this set of actors.

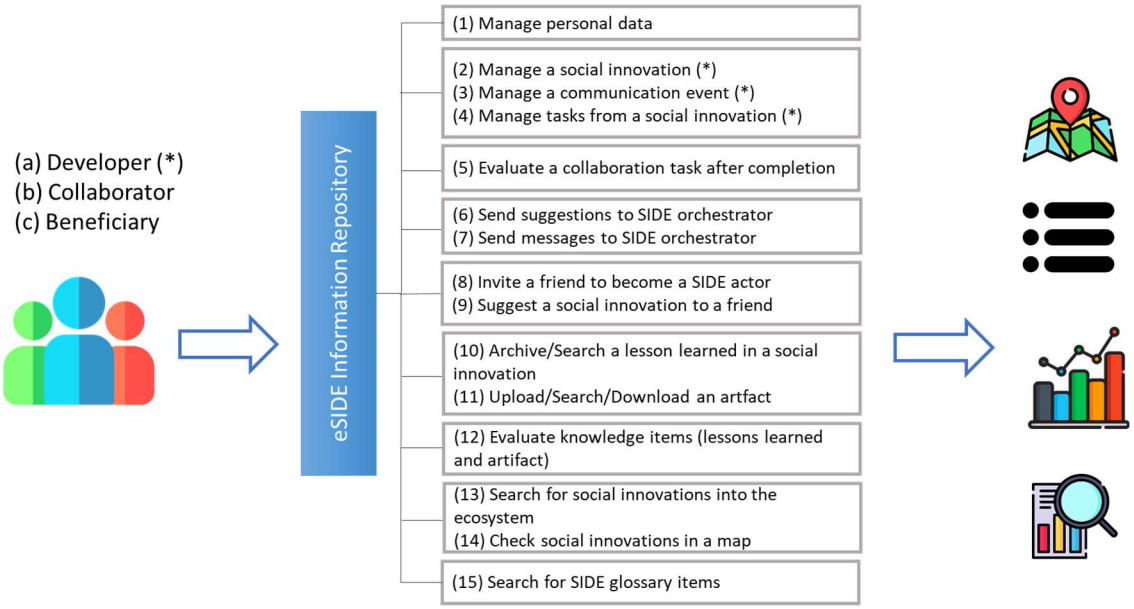


Figure 32. Operations performed by developers, collaborators and beneficiaries. Inspired by SANTOS (2016).

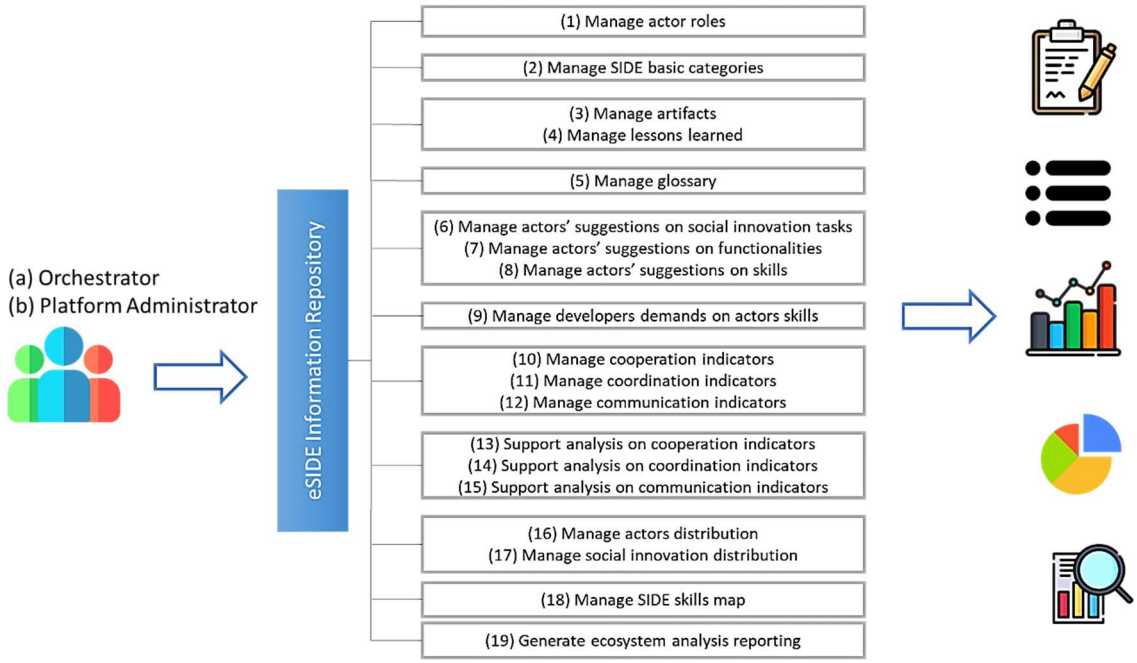


Figure 33. Operations performed by orchestrators and platform administrators. Inspired by SANTOS (2016).

After defining the necessary requirements for the Management Panel, we defined a total of 60 use cases, based on which the eSIDE interface and functionalities were developed. Figure 32 presents the diagram of use cases concerning the Management Panel.

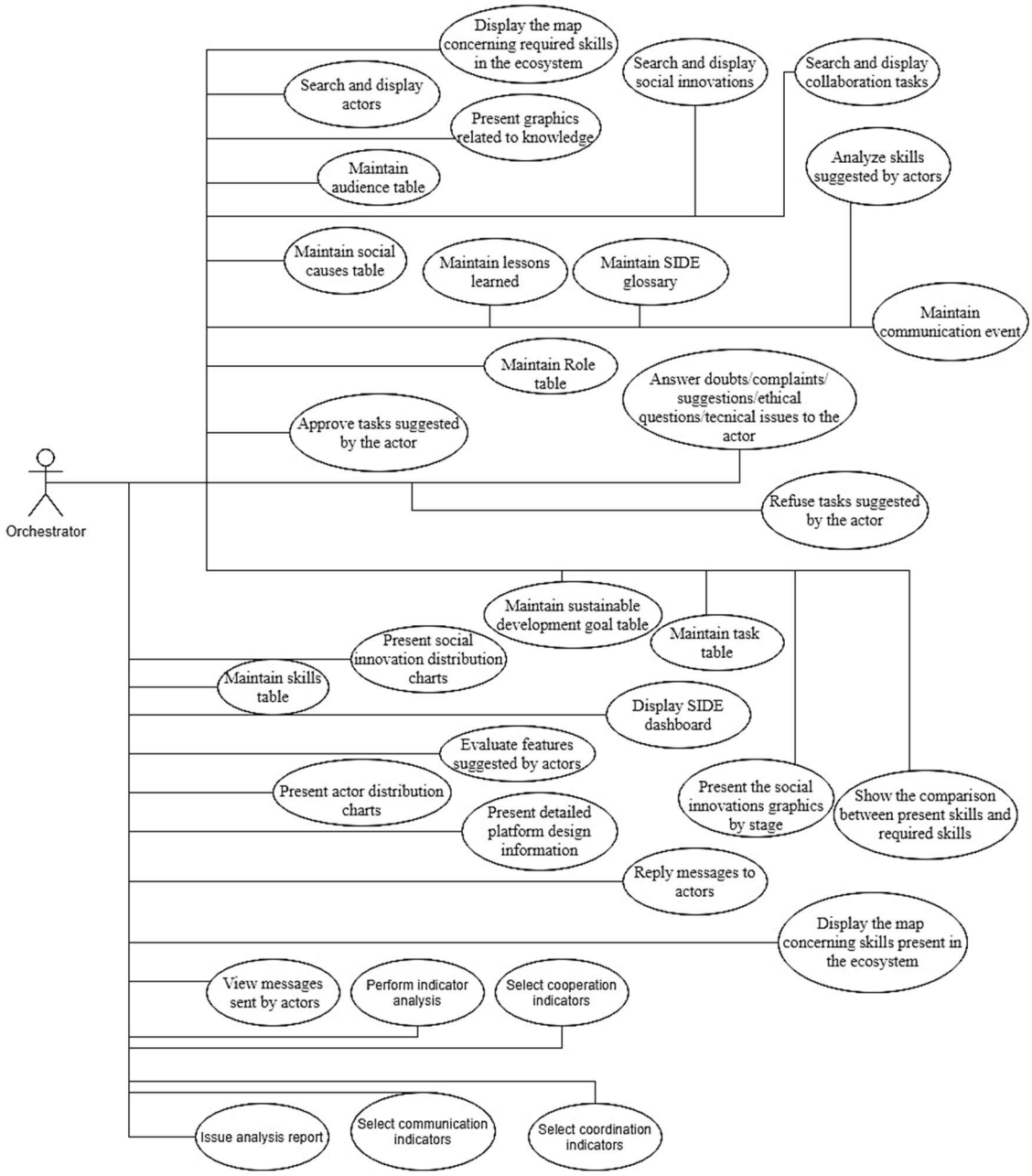


Figure 34. eSIDE Management Panel – use case diagram

We analyzed the eSIDE requirements (Section 7.1) and elaborated use cases. Table 25 presents relations between the use cases and the requirements addressed in eSIDE. However, three requirements don´t have use cases designed: i) REQ10: this one did not have a written use case as it is an intrinsic characteristic of eSIDE, which is the availability of data online; and ii) REQ16 and REQ18: concerning the integration of eSIDE with other tools and it was decided to initially address the requirements that involve features internal to the ecosystem.

Table 25. Management Panel – use cases versus requirements

ID	Use Case (code and name)
REQ1	UC-044 - Maintain glossary item; UC-045 - Search for glossary item
REQ2	UC-028 - Evaluate collaboration
REQ3	UC-042 - Maintain lessons learned
REQ4	UC-041 - Maintain artifacts
REQ5	UC-025 - Submit collaboration proposal; UC-026 - Accept collaboration proposal; UC-029 - Complete collaboration
REQ6	UC-043 - Present detailed platform design information
REQ7	UC-057 - Select indicators; UC-058 - Analyze indicators
REQ8	UC-059 - Generate ecosystem performance report
REQ9	UC-002- Maintain actors
REQ11	UC-028 - Evaluate collaboration
REQ12	UC-016: Maintain tasks
REQ13	UC-006 - View list of social innovations according to selected filters; UC-056 - Search social innovations
REQ14	UC-061 - Activate Vlibras plugin
REQ15	UC-017 - Suggest new tasks; UC-031 - Suggest new eSIDE features; UC-033 - Suggest new skills
REQ17	UC-047 - Present the ecosystem Skill Map
REQ19	UC-057 - Select indicators; UC-058 - Analyze indicators
REQ20	UC-057 - Select indicators; UC-058 - Analyze indicators
REQ21	UC-057 - Select indicators; UC-058 - Analyze indicators

7.3. Development

eSIDE intends to be a solution concerning an open ecosystem, without organizational limits, where access by people who can work geographically dispersed and in different companies is possible. Furthermore, we intend to make this solution easily

expandable. Therefore, during the development of eSIDE, we decided to use free tools, which are easily accessible and widely used in the software industry.

eSIDE was developed through the UNIRIO extension project entitled "Development of a Social Innovation Digital Ecosystem Platform"[17]. It consists of a web information system (repository) with a database of social innovation actors, artifacts, and information on social innovations and collaborations between actors.

Figure 35 presents the eSIDE development infrastructure. The back-end of the system was developed in node.js[18] using the Express framework for the development of the API (Application Programming Interface). The front-end was developed in Vue.js[19] using the CoreUI template for the development of the screens.

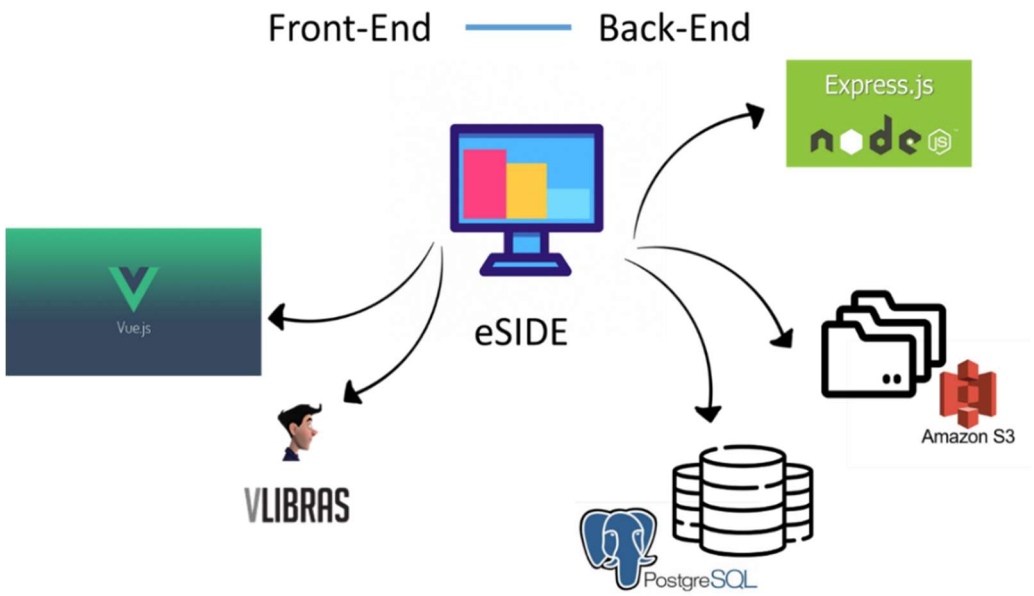


Figure 35. eSIDE development infrastructure.

The database used to store system information is PostgreSQL[20]. In developing the database structure that is one of eSIDE's components, the attributes of the elements present in the SIDE conceptual model were detailed. The experience in the observational study (Chapter 3 and Appendix 2) collaborated with the definition of attributes concerning the structuring of social innovation and actors.

[17]"Desenvolvimento da plataforma de um Ecossistema Digital de Inovação Social" – PROExC nº X0002/2019). http://sistemas.unirio.br/extensao/detalhes/index?ID_PROJETO=8629
[18] https://nodejs.org
[19] https://vuejs.org
[20] https://www.postgresql.org/

PostgreSQL is a powerful, open source object-relational database system that eSIDE uses to store information concerning to actors, the social innovations, collaboration tasks, artifacts, lessons learned, management indicators, SIDE glossary, and the categories of target audience, social causes, sustainable development goals and skills.

The front-end was developed using Vue, that is a progressive framework for building user interfaces. Vue is designed from the ground up to be incrementally adoptable.

Actor artifacts are saved in the Amazon Simple Storage Service (Amazon S3)[21]. Amazon S3 bucket is an object storage service that offers scalability, data availability, security, and performance. It has an object store built in to store and retrieve any volume of data from any location.

As eSIDE intends to be an inclusive tool, we tried to use some criteria that would facilitate its usability, despite not having developed a specific Interaction human computer project. However, we chose to use the most recommended colors for interfaces, and eSIDE presents shades of blue in all its screens. To provide greater accessibility to the tool, we use the VLibras[22] plugin, which represents a set of free and open-source tools that translate Portuguese digital content (text, audio, and video) into Libras.

Other APIs used in the development of eSIDE were: i) Gmail: allows one to do actions on an email account using an application; ii) Geocoding: generates geographic coordinates from address, to present an innovation on the map; iii) Maps: creates an interactive map of social innovations; and iv) ViaCEP: searches for an address from a zip code. All information concerning the development environment is available to the orchestrator in one of the Management Panel options.

7.4. Management Panel

This section presents the eSIDE Management Panel, which aims to support the SIDE orchestrator in answering the following questions:

- How to verify the social causes of greatest interest to ecosystem actors?
- How to verify the most required skills by the ecosystem, based on the needs reported by the developers?
- How to monitor whether the actors inserted in the ecosystem are engaged in social innovations?

[21] https://aws.amazon.com/pt/s3/
[22] VLibras — Português (Brasil) (www.gov.br)

- How to follow up suggestions sent by the actors and how to incorporate them if these do not impact the ecosystem?
- How to get an overview of the behavior of ecosystem actors concerning cooperation and engagement in developing social innovations?
- How can I get an overview of the indicator selection that the orchestrator is performing? Is there an impact on not selecting some indicators?
- How to follow up on aspects of communication, coordination, and cooperation between actors? Is it possible to set goals and keep up with them?
- How can I get an overview of the ecosystem in terms of the most selected categories, inflows, and outflows of actors and tracking of goals?

We present some screens to illustrate eSIDE Management functions, to support the orchestrators and answer some of the questions listed. Figure 36 shows the initial screen of the eSIDE tool, where it is possible to visualize a dashboard containing quantitative information about the ecosystem, such as: total number of registered actors, total number of actors per role, total number of social innovations, and total number of registered collaborations either in development or completed (UC-040).

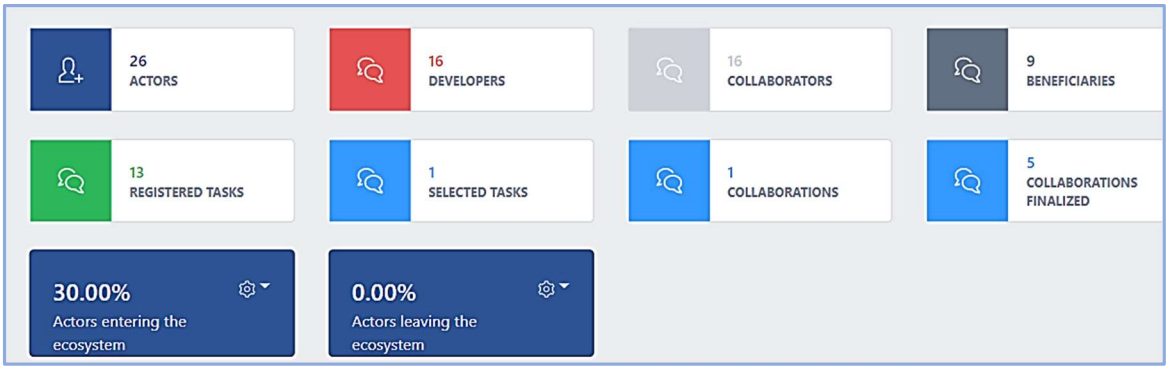


Figure 36. eSIDE Management Panel dashboard.

The Management Panel allows the orchestrator to consult all ecosystem information and input/change basic ecosystem information: target audience, social cause, development stage, and sustainable development goal (SDG). The eSIDE basic information setup screen is presented in Figure 37 and it allows the orchestrator to verify the number of social innovations associated with each category, enabling it to make several decisions based on this information. For example, suppose most social innovations fall into the stage named "development and testing". In that case, training concerning techniques for structuring projects or designing solutions can be helpful to actors in the ecosystem. These actions can increase their engagement and promote the exchange of experience between

them during these meetings. The orchestrator can also manage ecosystem glossary terms and add new skills to the ecosystem (directly or based on messages sent from actors).

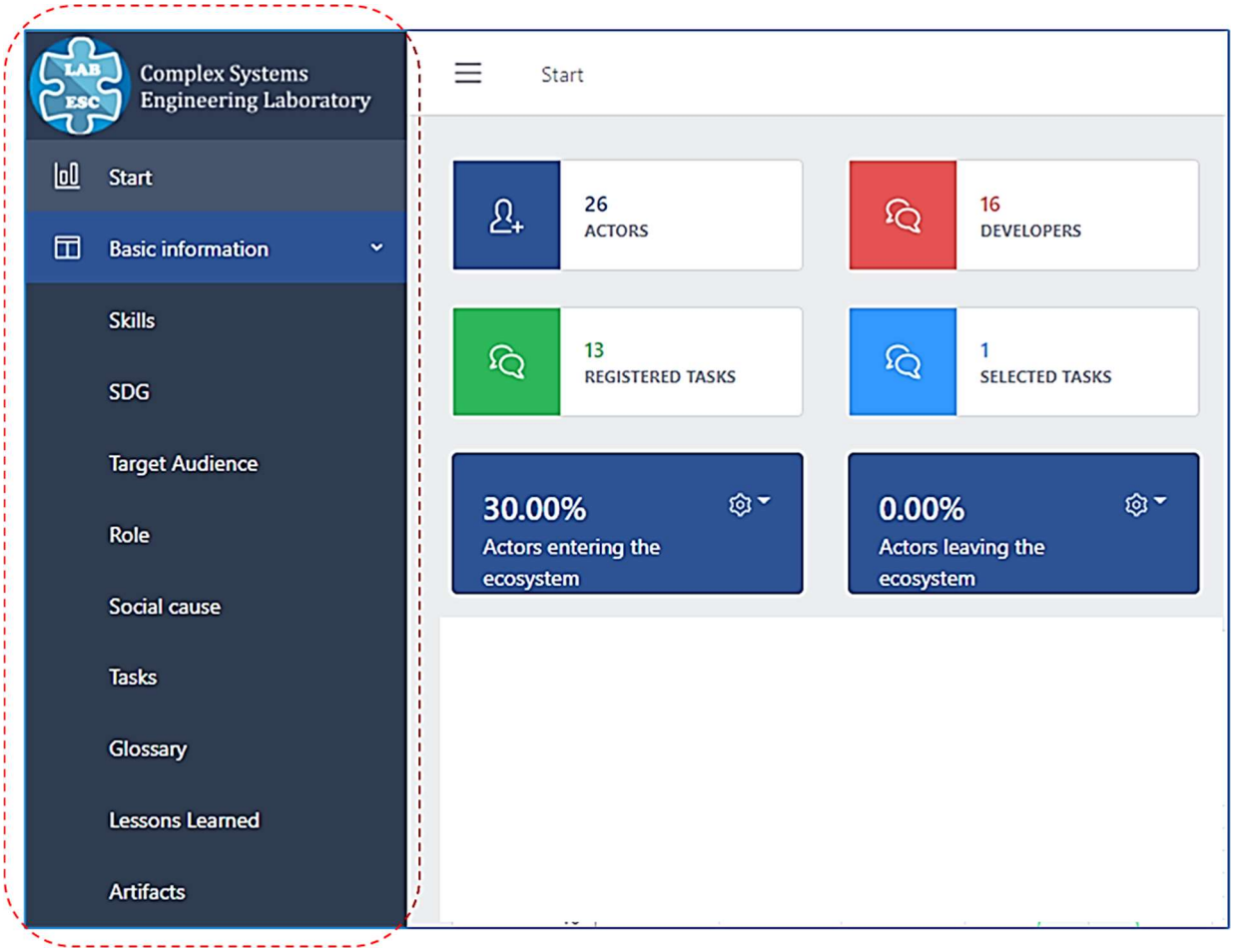


Figure 37. eSIDE basic information.

The orchestrator can query, and retrieve actor's information based on multiple filters, such as target audience, social cause, development stage, skills, and sustainable development goals. For example, suppose several social innovations contain tasks that depend on the skills concerning "Fundraising". In that case, the orchestrator may use this option to select actors who own those skills, and on the same screen, he/she may send an inviting message to the actor to collaborate with this social innovation. These actions can increase engagement and help to decrease the number of innovations that demand support concerning a specific skill. In Figure 38, we present an example of an orchestrator searching for an actor using the "skill" filter (UC-007). Finally, Figure 39 the scenario where an actor is selected by the orchestrator, eSIDE presents the actor's profile and the orchestrator may send a message (UC-036).

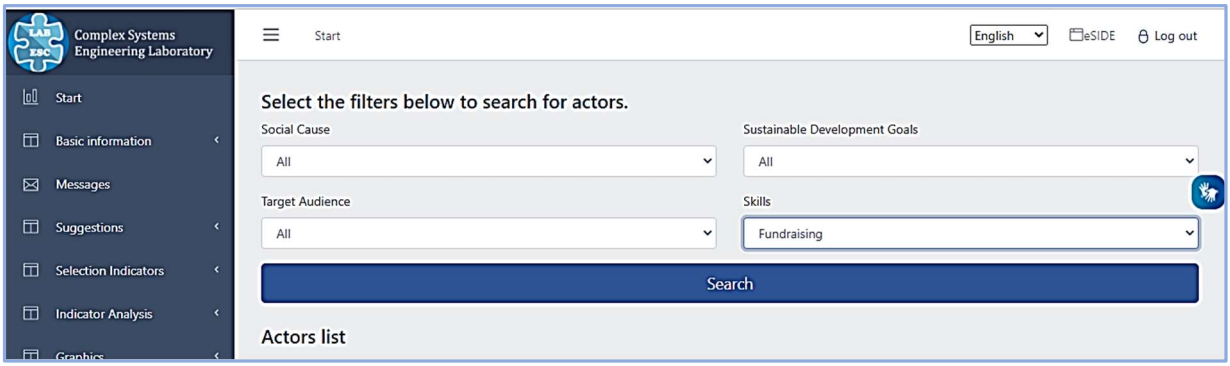


Figure 38. Search for actors with fundraising skills.

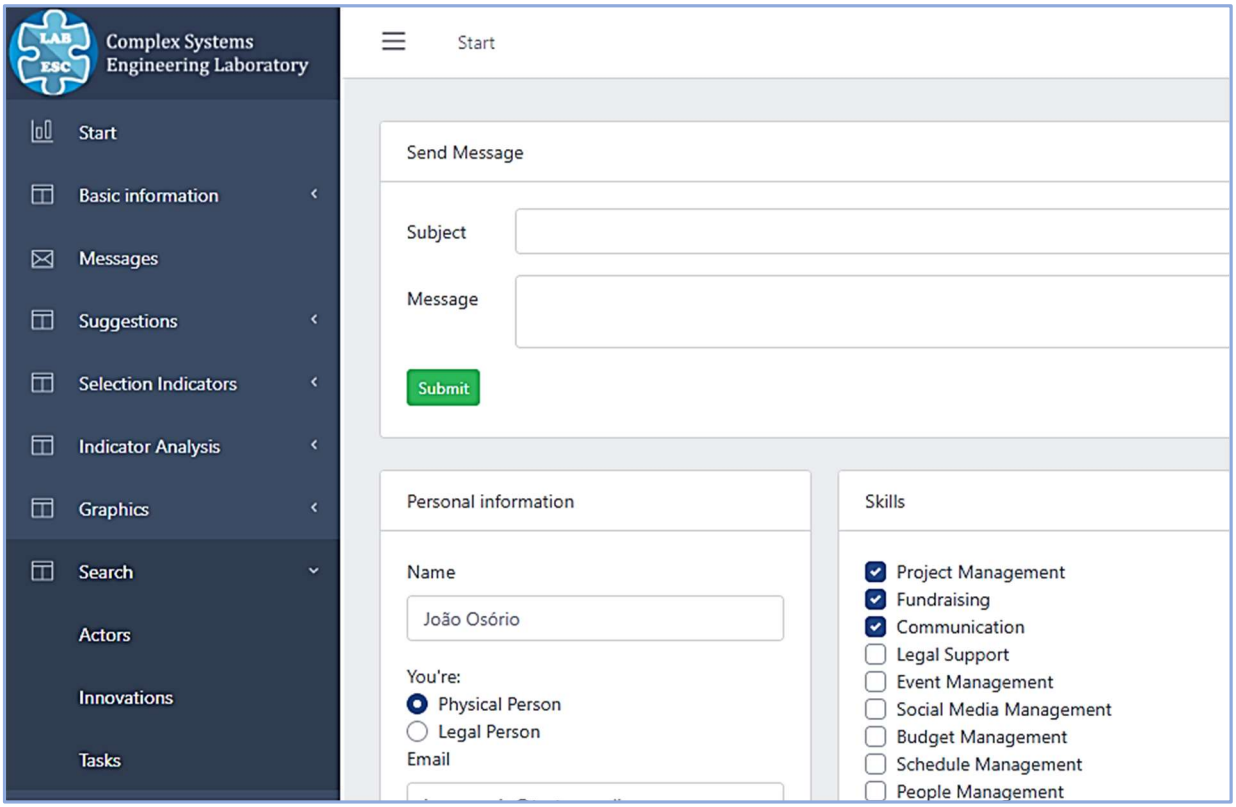


Figure 39. Message screen to an actor with fundraising skill.

According to the management dimension of the SIDE framework (Section 6.5), we grouped the most relevant SIDE indicators into three categories:

1. **Communication:** includes indicators concerning exchanging messages between actors, sending suggestions to the ecosystem, and sending messages to actors outside the ecosystem;
2. **Cooperation:** contains indicators concerning collaboration between actors, whether by selecting social innovation tasks for collaboration, completing these tasks, feedback on collaboration, and sharing artifacts and lessons learned from the ecosystem;

3. **Coordination:** presents information concerning the entry and exit of actors in the ecosystem, the number of social innovations at each development stage, and the number of actors concerning each SIDE roles.

There is a list of associated indicators in each category (presented in Section 6.5), and for each one, the orchestrator can define a goal and select its priority (UC-0057). If the priority field is set to zero, eSIDE will not track the indicator. For example, Figure 40 presents the screen for input information for cooperation indicators. After choosing all the indicators of interest in each category, the orchestrator can request the generation of indicator analysis and eSIDE presents the information illustrated in Figure 41 and Figure 42 (UC-0058).

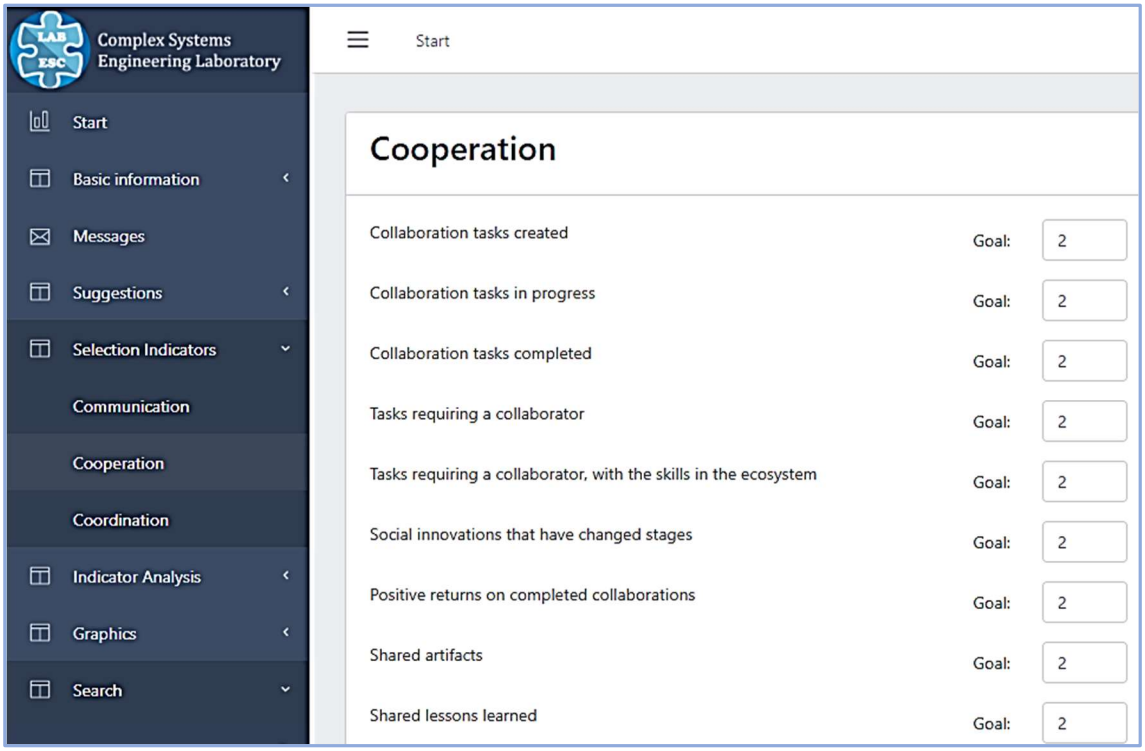


Figure 40. Cooperation indicators selection screen.

Indicator name	3C Dimension	Goal	Quantity in the period	Indicator Performance	Priority
Shared lessons learned	Cooperation	2	1	50%	5
Shared artifacts	Cooperation	2	3	150%	4
Social innovations that have changed stages	Cooperation	2	2	100%	3
Tasks requiring a collaborator, with the skills in the ecosystem	Cooperation	2	6	300%	3
Collaboration tasks created	Cooperation	2	7	350%	2
Collaboration tasks completed	Cooperation	2	1	50%	2
Lessons learned considered useful for one actor	Cooperation	2	2	100%	2
Tasks requiring a collaborator	Cooperation	2	6	300%	1
Collaboration tasks in progress	Cooperation	2	6	300%	1
Communication events created	Communication	5	3	60%	1
Suggestion of a new feature for the ecosystem	Communication	5	3	60%	1
Positive returns on completed collaborations	Cooperation	2	4	200%	1
Messages sent from collaborator to developer	Communication	5	6	120%	1

Figure 41. Analysis of cooperation indicators – tabular form.

Figure 42. Analysis of cooperation indicators – graphics.

An orchestrator can query various types of charts that show actor distributions for the basic categories and social innovations. An essential feature in eSIDE is the Skill Map (UC-047) that helps the orchestrator to follow the demand of skills (by the developers) and offer skills (by the collaborators) among the SIDE actors. By analyzing this map, the orchestrator can quickly identify the skills gap in the ecosystem, and he/she can invite actors having these skills to take part in SIDE. Figure 43 presents the Skill Map.

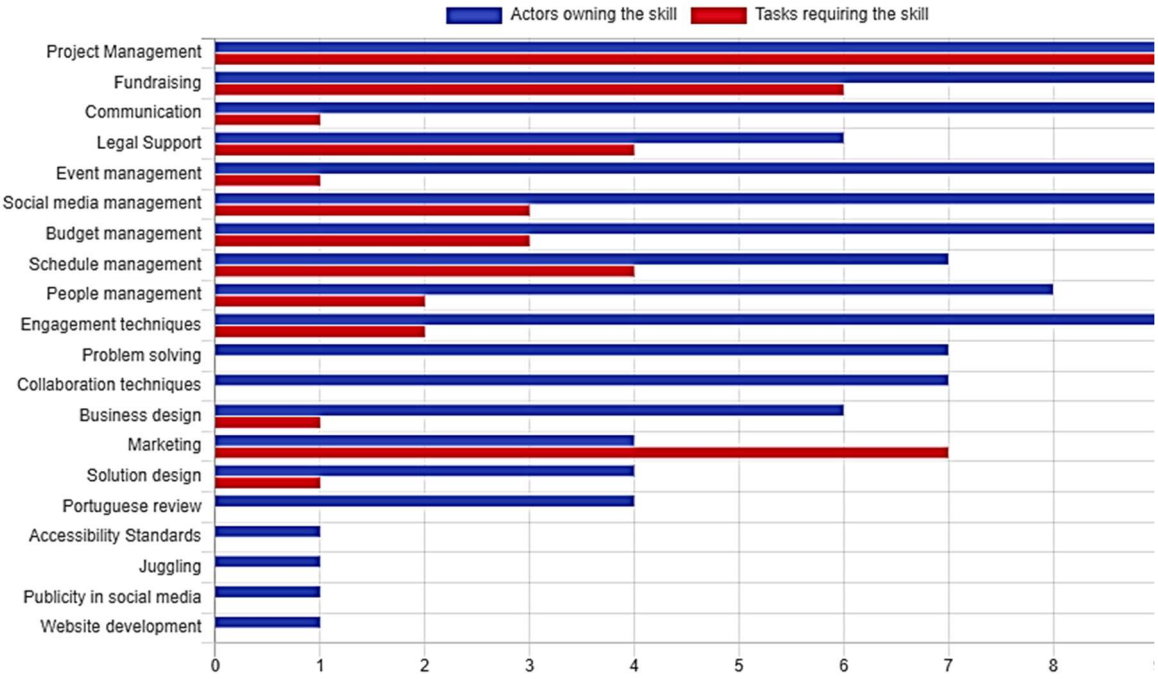


Figure 43. Skill Map.

Finally, eSIDE generates a report presenting: i) quantitative information (similar to the ones presented in the dashboard in Figure 36), ii) the analysis concerning all the indicators selected by the orchestrator (Figure 41 and Figure 42); iii) the Skill Map (Figure 43); iv) the categories most selected by the actors (skill, social cause, sustainable development goal, target audience, and task); and v) an ecosystem analysis. The analysis

indicates the impact that can occur on the ecosystem by not following one of the indicators. For example, if the orchestrator does not select any item concerning communication, a text will be presented showing the importance of communication in the context of this ecosystem. In the right corner of the screen, one can see the window concerning the VLibras API. Figure 44 presents a clipping from this report (UC-0059).

Figure 44. Clipping from the eSIDE general report.

7.5. Evaluation

This section describes the evaluation of eSIDE through two studies: i) a tool analysis carried out to verify the ease of use of the tool's functionalities (interface) and perception of usefulness, and ii) a focus group to obtain the perception of social innovation specialists about the tool's functionalities.

The main purpose of this study is to evaluate the proposed approach for SIDE management to support the activities performed by the orchestrator, more specifically communication, cooperation and coordination analysis. The study goal was defined accordingly to the Goal-Question-Metric (GQM) paradigm (BASILI, 1992): **Analyze** the eSIDE Management Panel **with the purpose of** characterizing **with respect to** ease of use and usefulness **the point of view from** the orchestrator **in the context of** SIDE management, more specifically regarding communication, cooperation, and coordination analyses.

7.5.1. Tool Analysis

This evaluation aims to analyze aspects of ease of use and usefulness of eSIDE. We used part of the Technology Acceptance Model (TAM) proposed by Davis (1993) to

achieve this goal. Furthermore, the planning and the instruments of this evaluation were inspired by the study presented in (SANTOS, 2016).

Table 26 shows eight statements (S1 to S8) from the TAM model and formulated aiming to capture the dimensions ease of use and usefulness of our approach. Four statements refer to the evaluation of the ease of use, and the others focus on the usefulness.

Table 26. Statements derived from TAM model to evaluate.

Statement	Description	Dimension
S1	I easily learn how to use the approach.	**Ease of use**
S2	I use the approach in the way I want to.	
S3	I understand what happened in the interaction with the tool.	
S4	I easily execute the proposed tasks with the tool.	
S5	I think that eSIDE is useful for SIDE management.	**Usefulness**
S6	eSIDE make it possible to relate the skills of collaborating actors to the skill demands of social innovation developers.	
S7	eSIDE support social innovation digital ecosystem management activities.	
S8	eSIDE help the ecosystem orchestrator gain an overall perception of ecosystem functioning according to coordination, communication, and cooperation.	

We defined a set of 12 tasks to be executed by the participants in the tool analysis. They were classified into three categories according to complexity in execution, based on the work of Oliveira (2011) and are presented in the Execution Form (Appendix 5.1):

- **Filtering tasks**: this category comprises simple tasks that depend on reading some information using eSIDE to answer some questions. If a participant is not able to execute such tasks, he/she should be removed from the analysis because this situation can affect the understanding of the tool or tasks;
- **Basic tasks**: this category comprises basic tasks that depend on reading some information using the infrastructure and interpreting the results to answer some questions;
- **Assimilation tasks**: this category comprises difficult, complex tasks that depend on the participant's background to understand and interpret information concerning SIDE management to answer some questions.

After defining the evaluation statements of the tool and the tasks that should be performed, we defined the instruments that should be applied during the evaluation and how the evaluation procedure should be prepared. The instruments are presented in Appendix 5 and were applied in Portuguese:

1. *Execution Form* (Section A5.1): presents the context of the work and the twelve proposed tasks. The participants are asked to play as they currently do in as they were

managing a social innovation ecosystem. This document is also used to collect answers for each task;

2. *Evaluation Form* (Section A5.2): consists of a questionnaire in which each participant should evaluate his/her experience after the study execution. Qualitative information on the study execution is collected, as well as suggestions of improvement for the approach and considerations regarding the experience in the study.

The tool analysis was conducted with three participants. A first analysis was conducted in May 29, 2021 with one participant (P1) through an individual session which lasted 01h40min. The participant has a Master's degree, with large experience in the development of web systems and collaborative tools, but not in the domain of social innovation. She executed the proposed tasks with the approach and filled in the evaluation form. However, she did not perform two out of 12 tasks, pointed them as difficult. This participant had some difficulties understanding eSIDE native terminology and graphical user interface and reported some bugs found during the execution. We realized that this first analysis was very important in refining the study's instruments and fixing bugs found in eSIDE.

A second tool analysis was conducted in June 06, 2021 with two participants (P2 and P3) through an individual session. The online session held by the first participant lasted 01h10min, and the session from the second participant lasted 01h02min. They have experience with collaborative tools, and they research social innovation for 30 months. Both are undergraduate students that had been approved in their Bachelor's final projects on the domain of social innovation ecosystem, but not in the use of digital platforms for managing it. The two participants are members of the university extension program project, which aims the SIDE development. However, they did not participate in the specification or development of the eSIDE tool, which enabled their participation in the pilot. They easily performed the filtering and basic tasks. However, they had difficulties in one assimilation task since they had just been introduced to a new tool; then, they need more time to answer the questions. On the other hand, they found information and hit more questions.

The completion of three sessions allowed the improvement of the interface, as well as the functionalities. Table 27 shows the result of the evaluations as completed by the three participants. When answering the question concerning positive aspects of eSIDE, participant P2 mentioned that: "*Easy organization of information, clarity in section objectives, use of the plug in VLibras*". The including aspect was also mentioned by P1 and P3. Regarding the question concerning "most useful features", Participant P3 quoted

that "*The menu makes it very easy to navigate the platform, the buttons are well adjusted, in addition to the graphics and texts that are easy to read*", while P2 indicated the option concerning "Generate Indicator Analysis and Report".

Table 27. Evaluation from tool analysis participants.

Statement	Totally disagree	Disagree	I do not agree nor disagree	Agree	Totally Agree
S1. I easily learn how to use the approach.				1	2
S2. I use the approach in the way I want to.				1	2
S3. I understand what happened in the interaction with the tool.					3
S4. I easily execute the proposed tasks with the tool.			1		2
S5. I think that eSIDE is useful for SIDE management.					3
S6. eSIDE make it possible to relate the skills of collaborating actors to the skill demands of social innovation developers.					3
S7. eSIDE support social innovation digital ecosystem management activities.					3
S8. eSIDE help the ecosystem orchestrator gain an overall perception of ecosystem functioning according to coordination, communication, and cooperation.					3

7.5.2. Focus Group

An obstacle faced in this context is the fact that terminology varies, few analytical models exist, and real-world data are missing – a natural fact in the trajectory of an emerging topic or concern (HANSSEN & DYBÅ, 2012). For example, Edwards-Schachter & Wallace (2017) reviewed 252 definitions of social innovation. However, as explained in Chapter 2, the use of the ecosystem metaphor represents a novelty in the technical literature, despite studies such as the one by Pulford (2019) who already reported the existence of social innovation ecosystems in different countries around the world. Thus, the body of empirical evidence is necessary to assess the SIDE perspective in the industry.

This section describes an evaluation of our approach based on a focus group. Focus groups are characterized as a form of group interview that places particular importance on interaction between participants (FREEMAN, 2006). They comprise group discussion among carefully selected individuals, guided by a moderator using a carefully designed topic guide. For the preparation of this planning, we used as an example the study presented by Farias Junior et al. (2016) and we followed some guidelines presented by Stewart & Williams (2005), Freeman (2006), and Klein et al. (2007).

The protocol for data collection was organized as follows: i) first, we made a presentation of the eSIDE platform to align the knowledge of all experts; ii) then, some

situations were presented and we made a demonstration of all functionalities; iii) the experts were asked what they thought of the tool interface and functionalities; and iv) at the end, the experts were asked what they thought of the SIDE management in eSIDE. Each topic had a limited time for discussion. We took notes, and the session was voice recorded. Next, we presented the synthesis of the focus group. For this focus group, an online session lasting 01h20min was held, with the moderation of a researcher and the participation of the developer (scientific initiation student from the Information Systems course) responsible for creating the database and programming the interface as well as eSIDE functionalities.

Focus group participants are experts and operate in a real social innovation ecosystem. The Rio DESIS Lab is a Design, Social Innovation, and Sustainability Laboratory at the Federal University of Rio de Janeiro (UFRJ). The laboratory carries out initiatives that bring together UFRJ students from different areas interested in using the discipline of Design. In addition, they use Design as a tool to support and train citizens in the city of Rio de Janeiro to act as agents of change, promoting quality of life and sustainability in public spaces and schools[23].

The meeting was attended by four experts from this real scenario, two of which act as ecosystem orchestrators and two as developers. The participation of the two actor roles allowed for a broader discussion about the functionalities and interface of eSIDE. It is important to mention that the ecosystem where the participants work does not use a technological solution (tool or platform) to manage the ecosystem.

Although the study's objective is to analyze the functionalities performed by the orchestrator, the focus group counted on the discussion of topics concerning functionalities from the developer's module and the Management Panel. For example, to demonstrate a functionality concerning tasks for collaboration in the manager panel, it was presented in the developer module how developers suggest tasks and how they are associated with innovations. The topics discussed were based on the execution tasks from the tool analysis and are presented in Table 28.

At the beginning of the focus group, the participants discussed the openness of the platform. Currently, the tool is available via the website for anyone to register and the orchestrators' approval is not necessary. However, this is an important point for discussion, and it converges to the activities of the business dimension (Section 6.2.2).

[23] https://desis.rio.br/quem-somos/

Additionally, for some real scenarios, as described by Nunes et al. (2018), it is necessary to carry out a previous selection for approval of new actors.

During the session, the experts observed some features exclusively configured to the Management Panel (operated by the orchestrator) that could be enabled for the eSIDE developer's module. For example, the functionality where the orchestrator locates contributors based on a specific skill was considered useful for the developer module. Participants felt that this functionality could streamline the approach between developers and contributors. This perception indicates the relevance of the activities proposed in the SIDE technical dimension (Section 6.4.2), where the orchestrator, according to the ecosystem context, defines which functionalities should be enabled for each role.

Table 28. Functionalities presented during the focus group.

Functionalities	
Developer / Collaborator Module	**Orchestrator Panel**
Actor registers a social innovation	Orchestrator verifies the dashboard of total indicators
Actor suggests skill	Orchestrator consults suggestion and accepts suggested skill
Actor sends message to the orchestrator, suggesting a new glossary item	Orchestrator replies to actors' message and inserts a new glossary item
Actor inserts a new collaboration task	Orchestrator defines cooperation goals
Developer accepts collaboration suggested by the collaborator	Orchestrator consult cooperation indicators and generates the performance report
Actor inserts a new collaboration task	Orchestrator checks the Skill Map and searches for actors with needed skills
Developer creates a new communication event	Orchestrator defines communication goals, verifies communication indicators, and checks the graphics concerning the target audience to help the event
Collaborator searches for social innovations in a map	Orchestrator searches for innovations that need collaborators

None of the experts totally disagreed with the effectiveness of the structure proposed by eSIDE. However, some experts managed to identify the concept concerning “tasks” could be better understood if it were called “demands” of the social innovation project. Regarding the functionality “search for social innovations” that collaborators carry out in eSIDE, the participants suggested that the platform should show additional information about the social projects and texts to motivate engagement.

One of the conclusions reached in this focus group indicated that it is necessary to carry out the following activities in order to start using the platform in a real ecosystem: i) configuration of basic ecosystem information in eSIDE; ii) verification of the need for adjustments to the tool due to some specific process carried out by the actors (and

adjustments, if applicable); and iii) training of actors in eSIDE. These activities take time to complete and must be considered while planning the use of eSIDE in a real scenario.

7.6. Limitations and Threats to Validity

The objective of the evaluations was to analyze the eSIDE functionalities according to two perspectives: i) from researchers with knowledge in web applications and social innovation processes; and ii) from researchers who work in a real social innovation ecosystem. There are some limitations and threats to validity identified in these two evaluations. The eSIDE tool analysis has some issues, that are classified into four categories (TRAVASSOS et al., 2002; WÖHLIN et al., 2012; SANTOS, 2016):

i) *internal validity*: the exchange of information with other participants who conducted the study may impact the test. So, to reduce this risk, we executed the tool analysis within 24 hours. We explicitly requested participants not to exchange information. Moreover, the learning effect can manifest itself regarding the order the study's tasks were executed – to reduce this risk, tasks were arranged in an increasing complexity sequence and without entanglement, to not affect the thinking and the execution. Thus, the participant has the chance to understand the problem by running first with simpler tasks;

ii) *external validity*: defines the conditions that make it difficult to generalize results to other contexts. It was not possible to represent all the situations of a social innovation ecosystem context, then studies in different ecosystems should be performed – unfortunately, the research community commonly faces challenges in establishing many partnerships to collect real data and to evaluate proposed solutions;

iii) *construct validity*: the selected measures might not be good indicators for the feasibility of eSIDE – to reduce this risk, measures were chosen based on the information needed to answer the tasks. Moreover, the tasks were grouped by type in order to aid data analysis and the same weight is assigned to all tasks. However, some tasks might have higher difficulty degree compared to others and this fact can influence the results – we decided to keep this setting because of the subjectivity in assessing difficulty degrees (which would introduce bias in the analysis);

iv) *conclusion validity*: the main threat is the sample size, with a small number of participants, not being ideal from the statistical perspective – to reduce this risk, our analysis included all data collected from the participants and the participants have a large experience in a social innovation ecosystem. Unfortunately, this is a recurrent difficulty

for empirical studies in a new research area, as it is the case of social innovation ecosystems, especially for approaches that require evaluation in real scenarios, as in our case. Thus, our study presents a limitation on the results, which are considered as indications (and not evidences).

In the focus group, we selected the experts from a real social innovation ecosystem to attenuate the low number of participants. Moreover, we selected participants that perform different functions in the ecosystem. This criterion aimed to obtain distinct perceptions based on the roles they have. Therefore, the amount of data collected through the experts' perceptions was mitigated by their experience in a real scenario.

Since participants are chosen for convenience, their behavior might reflect assumptions on the expected results for the focus group. Then, to reduce this risk, we executed the study in an ecosystem where participants have no academic or professional relationship with the researcher. Finally, the session duration was considered short concerning the eSIDE features that needed to be presented as well as the discussions carried out. Therefore, for future evaluations, we recommend performing a session with more time for discussion.

Although the eSIDE evaluation had few participants, it is important to emphasize that the tool construction process included the consolidation of requirements from several studies carried out with actors from real social innovation ecosystems and literature in this area. Therefore, the features developed in this version of eSIDE reflect the needs emphasized by several professionals and researchers in the field.

7.7. Related Work

As the area of social innovation ecosystem has few studies, few technological solutions were identified that were somehow concerning eSIDE, presented below:

- The Florianópolis Social Innovation Observatory (OBISF, 2019; AUDION et al., 2020) offers an online platform that aims to map, give visibility and strengthen the network of the Social Innovation Ecosystem of Florianópolis. This ecosystem includes supporting actors (collaborators) and social innovation initiatives (developers) and has the objective of mapping the network of social innovation actors in the city. In this ecosystem, formal and informal groups that promote actions aiming to respond to the city's public problems are considered social innovation initiatives. Social innovation support actors are organizations that support social entrepreneurs and social innovation initiatives in Florianópolis. As

a weakness of this platform, a functionality to support collaboration and interaction between the actors was not found. We are also unaware of the existence of a support tool for ecosystem orchestrators;

- Yunus Social Businesses (YUNUS NEGÓCIOS SOCIAIS, 2020) Financing Platform: is a crowdfunding platform for open fundraising for social businesses. It aims to connect social businesses that need financing with impact investors to expand their operations and maximize their social impact. However, it is not allowed to register projects or actors. A fundraising project is presented and interested actors must send their data, which will later be analyzed by Yunus analysts, who will formalize the investment.

7.7. Final Remarks

In this chapter, we presented eSIDE, the technological solution to support actors from a SIDE. We described eSIDE requirements as well as their origins in the studies described in Chapters 5 and 6. The tool's overview is presented and its main functionalities are divided into two eSIDE modules: the module to serve developers, collaborators and beneficiaries, and the Management Panel to support the orchestrator.

We also described two studies carried out to evaluate the functionalities of eSIDE: a tool analysis carried out to verify the ease of use and usefulness of the Management Panel. Furthermore, we carried out a focus group with the participation of actors from a real social innovation ecosystem. Both tests yielded positive results, identified opportunities for improvement, and contributed to the SIDE community research and practice.

Chapter 8. Conclusion

This chapter presents a summary of this PhD thesis (Section 8.1) and the contributions of this research (Section 8.2). Section 8.3 describes some limitations observed throughout the results discussion process. Finally, possibilities for future work are reported (Section 8.4).

8.1 Summary

This research has proposed three elements to support orchestrators from SIDE: a conceptual model (Chapters 4 and 5), a three-dimensional framework with stages and activities concerning social, business, and technical dimensions (Chapter 6), and a technological platform named eSIDE (Chapter 7). All these elements aim to support the SIDE orchestrator in management activities. The framework was inspired by an existing framework for SECO management (SANTOS & WERNER, 2012b) and was developed based on SIDE elements identified in different studies performed so far.

SIDE conceptual model was evaluated by 21 practitioners in social innovation, most of them having experience as orchestrators. As a result, the interviewees approved all the propositions that composed the conceptual model and only suggested minor changes. Next, as a result of the studies carried out and the conceptual model, a three-dimensional framework (SIDE) was developed to support the ecosystem actors (technical, business, and social) and one additional dimension for integration to help the orchestrator (management). Based on the conceptual model, the SIDE framework and studies on the business, social and technical dimensions, eSIDE was developed, which is a common technological platform to support ecosystem actors. Finally, the eSIDE features were evaluated through a tool analysis stage and a focus group, in which participants highlighted the relevance of the management dashboard functionalities to support the orchestrators.

8.2. Contribution

This PhD thesis contributes with: i) a conceptual model that represents a holistic view of the elements to be observed and governed in SIDE ecosystems and their relationships; ii) a glossary to support the understanding of a SIDE; iii) a framework with activities divided into dimensions to help SIDE orchestrators to better plan and execute the management activities (works developed based on literature reviews, a survey, and semi-structured interviews; and iv) the definition and development of a technological solution to support SIDE actors, more specifically the management activities performed by the orchestrator. In addition, other studies were carried out in line with this PhD research and with the researcher's participation as a co-supervisor, which allowed the generation of other contributions as a set of supporting processes for social innovation ecosystems and a mind map concerning collaboration in these ecosystems. In these studies, presented in Sections 6.2.1, 6.3.1, and 6.4.1, the researcher worked in the stages of planning, execution (through monitoring of activities), and analysis of results.

8.2.1. Main Contribution

This PhD thesis provided the following detailed contributions to the Information Systems research and practice community:

- *Literature review* (Chapter 2): organization and description of concepts that serve as a basis for research concerning the social innovation challenges (Section 2.2), social innovation ecosystems (Section 2.3), and digital ecosystem (Section 2.4);
- *An observational study* (Chapter 3): we performed an observational study to to investigate the characteristics and components of a real social innovation ecosystem and the challenges faced by such actors, including its management and monitoring. Moreover, we identified opportunities that a common technological platform could meet in the study to meet the challenges reported;
- *Conceptual model and glossary* (Chapters 4 and 5): design of a conceptual model to help researchers/practitioners in the SIDE domain to understand the elements and their relationships. The conceptual model evaluation performed by 21 social innovation experts was also a contribution. The development of a glossary to support the understanding of a SIDE is also a contribution (Appendix 3);

- *SIDE framework* (Chapter 6): Design of a framework to support analysis and management of social innovation digital ecosystems. The SIDE framework provides a step-by-step process to serve as an instrument to help orchestrators analyze and characterize their ecosystems concerning three dimensions – business, social, and technical –, integrated by a management dimension. The framework is helpful for orchestrators that are starting to organize the ecosystems where they act and for the ones who want to improve management of existing ecosystems. The fourth dimension presents three categories of indicators based on coordination, cooperation, and communication aspects that help orchestrators manage the ecosystem;
- *eSIDE platform* (Chapter 7): eSIDE was developed based on the requirements identified during the evaluation of the SIDE conceptual model (Chapter 5) and the specification of the SIDE framework dimensions (Chapter 6). The eSIDE tool has two modules: one for actors who are developers, collaborators, and beneficiaries of social innovations, and another that is accessible to the ecosystem orchestrator through the Management Panel. This panel focuses on helping orchestrators manage SIDE based on the visualization of information regarding the platform. It is possible to monitor the ecosystem by selecting indicators concerning coordination, cooperation, and communication categories. eSIDE was evaluated through a tool analysis and a focus group. As a result of the evaluation, participants highlighted the relevance of several functionalities, as: i) the presentation of consolidated information with the use of graphics; ii) the presence of the ecosystem skills map; iii) the possibility of using ecosystem indicators; and iv) the availability of the report containing information to support the analysis of the indicators.

8.2.2. Secondary Contribution

Some Bachelor's final projects were co-supervised in the context of this PhD research and work as follows:

- Afonso, A. T. Q., 2021, "Business Processes in Social Innovation Digital Ecosystems". Bachelor's Final Project in Information Systems. UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil, 99p. (In Portuguese);

- Pinheiro, M. C., 2021, "Collaboration in Social Innovation Digital Ecosystems". Bachelor's Final Project in Information Systems. UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil, 92p. (In Portuguese);
- Undergraduate students working in UNIRIO extension program project: "Development of a Social Innovation Digital Ecosystem Platform" (PROExC No. X0002/2019): RAMOS, M.E.L. (2019-2020) and BRANDÃO, J.P.G. (2020-2021).

Additional activities carried out:

- Acting as a mentor in the 1st mentoring cycle of the NICS/LASIN project (Latin American Social Innovation Network) carried out in the UNIRIO social innovation ecosystem (2017);
- Participation as a Moderator at the Roundtable: Social Innovation and Social Entrepreneurship, held at the *14th UNIRIO Academic Integration Week* (2017);
- Member of an evaluation board: SIQUEIRA, S.W.M.; ARAUJO, R.M.; CHUERI, L.O.V. Participation in the evaluation board of MATTOS, V.C. and DOS REIS, C.B.P. (2017), "Analysis and Implementation of a Social Business". Bachelor's Final Project in Information Systems. UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil (In Portuguese);
- Speaker in the 2nd mentoring cycle of the NICS/LASIN project (Latin American Social Innovation Network) held in the UNIRIO Social Innovation Ecosystem (2018). Theme: "*Social innovation*";
- Participation as a researcher in the UNIRIO extension program project: "Development of a Social Innovation Digital Ecosystem Platform" (PROExC nº X0002/2019) from March/2019 to July/2021.

Activities carried out in the field of Innovation:

- Organization of a book together with Prof. Renata Araujo: "Research and Innovation: Visions and Intersections", publisher PUBL!T Soluções Editoriais, Rio de Janeiro, 2017 (in Portuguese);
- Participation as co-author of the chapter: CHUERI, L.O.V.; ARAUJO, R.M.; CLASS, T.; PROCACI, T.B. "From Scientific Research to

Innovation". In: Renata Mendes de Araujo, Luciana de Oliveira Vilanova Chueri (Org.). *Research and Innovation: Visions and Intersections*. 1st. ed. Rio de Janeiro: PUBL!T Soluções Editoriais, 2017, Vol. 1, pp. 22-45;

- Co-author of the short-course with Prof. Renata Araujo: "From Research to Innovation in Information Systems" at the *14th Brazilian Symposium on Information Systems* (SBSI 2018), Caxias do Sul, Brazil.

8.2.3. Publication

Research activities performed in this PhD produced the following publications:

- **Social Innovation** (a chapter of the book Research and Innovation: Visions and Intersections): this study represents general bibliographic research on Social Innovation to identify terminology, definitions, processes, actors, characteristics, benefits and difficulties, research groups, and topics. The partial result of this activity was the chapter on social innovation in the book: *Research and Innovation: Visions and Intersections* (CHUERI, 2017).
- **How social innovation projects are managed? Answers from a literature review**: this article represents an SMS produced in the early stages of the research when the objective was to identify challenges faced by actors who participate in the development of social innovations. This activity resulted in an article published in the *European Public Social Innovation Review* - EPSIR (CHUERI & ARAUJO, 2018).
- **Una experiencia de apoyo a proyectos de innovación social en una universidad pública brasileña: NICS/UNIRIO**: This work was published at the VI Simposio Internacional de Innovación Social y Tecnológico (NUNES et al., 2018).
- **Caracterização e Gerenciamento de Ecossistemas Digitais de Inovação Social**: PhD proposal published in the extended proceedings of the *15th Brazilian Symposium on Information Systems* (CHUERI & SANTOS, 2019). The goal was to present the research at the 11th *Workshop on Theses and Dissertations in Information Systems* (WTDSI'19) in order to discuss our research and get feedback from well-known researchers in the Information Systems community;
- **An observational study on the challenges faced by actors in a social innovation ecosystem**: this paper described the observational study carried out

in a real social innovation ecosystem. This investigation sought to confirm the challenges identified in the SMS carried out previously and so to identify: i) characteristics of this environment; ii) positive points, and iii) the most critical factors faced by such actors. It was published at the *11th International Conference on Management of Digital EcoSystems* - MEDES'19 (CHUERI et al., 2019).

- **Business Process Management in Digital and Software Ecosystems: A Systematic Mapping Study:** we produced this study in the preliminary phase of the elaboration of the SIDE framework. It presents the investigation of the business dimension in digital and software ecosystems. This activity resulted in a paper published at the *IEEE/ACM Joint 9th International Workshop on Software Engineering for Systems-of-Systems and 15th Workshop on Distributed Software Development, Software Ecosystems and Systems-of-Systems* (SESoS/WDES'20) (AFONSO et al., 2020).
- **Identifying Topics and Difficulties on Collaboration in Social Innovation Environments:** we produced this study in the preliminary phase of the elaboration of the SIDE framework. It presents the investigation of how collaboration is recognized in social innovation ecosystems. This activity resulted in a paper published at the *16th Brazilian Symposium on Information Systems* - SBSI'20 (PINHEIRO et al., 2020).
- **Investigating Collaboration in Ecosystems:** we produced this study in the preliminary phase of the elaboration of the SIDE framework. It presents an **SMS** to understand how collaboration occurs in four categories of ecosystems, namely: digital, software, business, and innovation. This activity resulted in a paper published at the *6th Workshop on Social, Human and Economic Aspects of Software* - WASHES'21 (PINHEIRO et al., 2021).
- **Um Estudo Exploratório sobre Plataformas Digitais para Ecossistemas de Inovação Social no Brasil**: we produced this study in the preliminary phase of the elaboration of the SIDE framework. It presents the investigation of digital platforms in Brazilian social innovation ecosystems. This activity contributed to the studies concerning the technical dimension of the framework. It resulted in a paper published at the *5th Workshop on Social, Human and Economic Aspects of Software* - WASHES'20 (CHUERI et al., 2020).

8.3. Limitations

We identified some limitations considering the execution of SMS, survey and interviews with experts, development of the conceptual model, and evaluation of the tool. Next, we describe the main limitations observed.

Regarding the theoretical foundation of this thesis research, the approaches mentioned by BOYLE & CHANG (2007) and MAGDALENO & ARAUJO (2015) were used to substantiate digital ecosystems and ecosystems. However, the research field of digital ecosystems is broad and involves several definitions and discussions (as explained in Section 2.4), which were not addressed in this research. As examples of discussions that were not held, we mention the identification of abiotic and biotic factors[24] of the ecosystem and their relationships (REYNA, 2011), as well as the analysis on the influences of ecosystem components to achieve stability.

A limitation in the surveys and interviews with experts refers to the fact that they were conducted with Brazilian researchers and practitioners. As such, the approach developed in this PhD thesis relies on opinions that may reflect the national scenario of social innovation ecosystems. Another limitation is the number of respondents which can limit the generalization. These issues were reported in sections concerning the threats to validity in Chapter 5. Considering the observational study, some limitations can be pointed out: the number of cases analyzed (one); the impossibility of attending all the ecosystem's meetings; and the subjectivity of the researcher's impressions, opinions and thoughts. However, since it is very difficult to take part in many industrial scenarios, especially due to confidentiality reasons, the proposed approach might reflect the reality we observed.

Finally, a limitation refers to the lack of face-to-face evaluation in real scenarios due to the COVID-19 pandemic[25]. During the evaluation process of the SIDE conceptual model, some practitioners contacted were reluctant to evaluate the model online, as they were not used to carrying out activities in a non presential context. This issue contributed to the decrease in the number of respondents. This difficulty also occurred in evaluating social innovation ecosystem processes, which served as input for studies on the business dimension of the SIDE framework. Such difficulties supported the decision of starting the specification and development of the eSIDE Management Panel, instead of evaluating the

[24] An ecosystem consists of all the organisms living in a particular area (biotic component), as well as all the nonliving, physical components of the environment with which the organisms interact, such as air, soil, water, and sunlight (abiotic component).
[25] https://www.who.int/emergencies/diseases/novel-coronavirus-2019

SIDE framework at first. Another reason is that preliminary studies of the SIDE dimensions had the participation of experts in social innovation ecosystems.

It was not possible to evaluate eSIDE exhaustively, as the goal should be its use in different scenarios and considering multiple actors' roles. Thus, the results are indications and cannot be generalized, but they contributed to the identification of strengths and improvement opportunities in eSIDE. However, these limitations may represent future work that can be conducted to address the gaps mentioned.

8.4. Future Work

Some opportunities were identified from this PhD thesis:

- Evolution of eSIDE (tool) to:
  - i) improve ease of use and usefulness considering the participants' feedback and our observations;
  - ii) increase its accessibility, including interface adjustments to improve its usability by visually impaired groups, for example;
  - iii) include into eSIDE the collaboration conceptual map and the supporting glossary of collaboration elements to support SIDE actors;
  - iv) include mechanisms to insert automated suggestions concerning social innovation ecosystem processes modeled to support SIDE actors. Moreover, as the activities that make up some social innovation development processes are sometimes not fixed or sequential, developing a solution that allows flexibility and creativity is essential. It is relevant to consider approaches for using knowledge-intensive processes;
  - v) investigate and include integration with other tools such as crowdfunding platforms;
  - vi) investigate the aggregation of actors in sub-ecosystems, allowing different levels of management by the orchestrators;
  - vii) include mechanisms to assess the social impacts of ecosystem social innovations and investigate how this assessment impacts the ecosystem.
- Preparation and execution of other studies with a mass of practitioners and researchers from social innovation ecosystems. Based on these studies, define mechanisms to support the orchestrators in monitoring SIDE activities;

- Investigation and evolution of SIDE conceptual model and eSIDE to allow the creation of groups of actors, which can support the creation of partnerships between different social innovations;
- Investigation on how to adapt SIDE and eSIDE to an open world view through open data and open source applications;
- Investigation on how we can use quality assurance as a mechanism to identify other SIDE platform health indicators to support the orchestrator;
- Investigation on how to integrate project management techniques and tools to eSIDE, without harming the nature of social innovation projects, as many of them do not follow a linear trajectory;
- Investigation on how to integrate techniques to stimulate creativity and solve solutions (such as Design Thinking) in the context of eSIDE;
- Investigation on how to present individual benefits to social innovation actors to increase their engagement in the ecosystem;
- Investigation of how the use of intelligent agent-based simulations can assist SIDE orchestrators;
- Investigation on how eSIDE can support actors in the monitoring of indicators on the ecosystem self-organization and relate them to the scope of social innovations present in the ecosystem.

Considering that social innovation processes can evolve and transform ecosystem actors, it is suggested to investigate ways to define how SIDE actors may decide which eSIDE functionalities are the responsibility of the orchestrator and which are available to all profiles. Concerning future publications, we plan three submissions concerning this research. The first submissions involves SIDE conceptual modeling and its evaluation, as well as the study on the digital ecosystem theoretical foundations. Finally, the third submission involves SIDE framework and eSIDE tool development.

In summary, the social innovation digital ecosystem is an emerging theme in the area of Information Systems. This research investigated the metaphor of ecosystems concerning social innovations, including literature reviews and studies with researchers and experts in the field via surveys and interviews. The studies carried out and the development of the conceptual model, framework and tool made it possible to raise questions that need to be investigated in the next years.

References

ABDELMABOUD, A., JAWAWI, D.N., GHANI, I., ELSAFI, A., KITCHENHAM, B. (2015) "Quality of service approaches in cloud computing: A systematic mapping study", *Journal of Systems and Software*, Vol. 101, pp. 159-179.

ABNT. Associação Brasileira de normas Técnicas (2015) "*Quality management systems - Fundamentals and vocabulary*", Norma ABNT NBR ISO 9000:2015. Avaliable at: https://www.abntcatalogo.com.br/norma.aspx?ID=345040. (In Portuguese)

AFONSO, A. T. Q. (2021) "*Processos de negócio em ecossistemas digitais de inovação social*", Bachelor Monograph in Information Systems. UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil. 99p. (In Portuguese)

AFONSO, A.T.Q., CHUERI, L.O.V., SANTOS, R.P. (2020) "Business Process Management in Digital and Software Ecosystems: A Systematic Mapping Study", In: *Proceedings of 2020 IEEE International Conference on Software Architecture Companion (ICSA-C)*, Salvador, Brazil, pp. 226-233.

ALTUNA, N., CONTRI, A. M., DELL ERA, C., FRANTTINI, F., MACCARRONE, P. (2015) "Managing social innovation in for-profit organizations: the case of Intesa Sanpaolo", *European Journal of Innovation Management*, Vol. 18, No. 2, pp. 258-280.

ALVES, C., OLIVEIRA, J., JANSEN, S. (2017) "Software Ecosystems Governance - A Systematic Literature Review and Research Agenda" In: *Proceedings of the 19th International Conference on Enterprise Information Systems*, Porto, Portugal, pp. 215-226.

AMORIM, S.S., NETO, F.S.S., MCGREGOR, J.D., ALMEIDA, E.S., CHAVEZ, C.V.F.G. (2017) "How Has the Health of Software Ecosystems Been Evaluated? A Systematic Review" In: *Proceedings of 31st Brazilian Symposium on Software Engineering* (SBES'17), Fortaleza, Brazil, September, pp 14-23.

ANDERSON, M., PUERTA, S., CIPOLLA, C. (2018) "*LASIN - Latin American Social Innovation Network - Results and Reflections*", LASIN Project and Book publication, Publicaciones Vid, Glasgow, Scotland, UK.

ANDION, C., ALPERSTEDT, G. D. E GRAEFF, J. F. (2020) "Ecossistema de inovação social, sustentabilidade e experimentação democrática: um estudo em

Florianópolis", *Revista de Administração Pública*, Vol. 54, No. 1, pp. 181-200. (In Portuguese)

ANGELIDOU, M., PSALTOGLOU, A. (2017) "An empirical investigation of social innovation initiatives for sustainable urban development", *Sustainable Cities and Society*, Vol. 33, pp. 113-125.

AVELINO, F., WITTMAYER, J. M. (2016) "Shifting Power Relations in Sustainability Transitions: A Multi-actor Perspective", *Journal of Environmental Policy & Planning*, Vol. 18, No. 5, pp. 628-649.

BAJENARU, L., IANCULESCU, M., DOBRE, C. (2018) "A Holistic Approach for Creating a Digital Ecosystem Enabling Personalized Assistive Care for Elderly", In: *Proceedings of IEEE 16th International Conference on Embedded and Ubiquitous Computing* (EUC), Bucharest, Romania, pp. 89-95.

BARBOSA, P. G. F. "*Acessibilidade em museus: um estudo de caso para apoiar a visita espontânea de surdos com o uso da realidade aumentada*", Master's dissertation in Information Systems, UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil. 147p. (In Portuguese)

BASILI, V. R. (1992) "*Software modeling and measurement: the Goal/Question/Metric paradigm*", Technical Report. University of Maryland at College Park, USA.

BATURINA, D., BEŽOVAN, G. G. (2015) "Social innovation impact-review no. 9", In: *Seventh Framework Programme (grant agreement 613034)*, European Union. Brussels: Third Sector Impact.

BELAYUTHAM, S., IBRAHIM, N. (2019) "A dual-functional social innovation process model for low-cost houses through university-enabled initiative", *Construction Innovation*, Vol. 19, No. 2, pp. 126-148.

BENNEWORTH, P., CUNHA, J. (2015) "Universities' contributions to social innovation: reflections in theory & practice", *European Journal of Innovation Management*, Vol. 18, No. 4, pp. 508-527.

BIERMANN, J., EGGERS, A., CORUBOLO, F., WADDINGTON, S. (2016) "An ontology supporting planning, analysis, and simulation of evolving digital ecosystems." In: *Proceedings of the 8th International Conference on Management of Digital EcoSystems* (MEDES'16). Biarritz, France, pp. 26-33.

BIGNETTI, L. P. (2011) "As inovações sociais: uma incursão por ideias, tendências e focos de pesquisa", *Ciências Sociais Unisinos*, Vol. 47, No. 1, pp. 3-14. (In Portuguese)

BLASCHKE, M.; HAKI, K.; AIER, S.; WINTER, R. (2018) “Capabilities for Digital Platform Survival: Insights from a Business-to-Business Digital Platform”. In: *Proceedings of Thirty Ninth International Conference on Information Systems*, San Francisco, USA, pp. 1-17.

BOLEY, H., CHANG, E. (2007) “Digital Ecosystems: Principles and semantics”, In: *Proceedings of 2007 IEEE International Digital Ecosystems and Technologies Conference*. Cairns, Australia, 21-23 Fev, pp. 398-403.

BOSCARIOLI, C., ARAUJO, R.M., MACIEL. R.S.P (2017) “*I Grand Research Challenges in Information Systems in Brazil 2016-2026*”, Special Committee on Information Systems (CESI), 1ª ed. Porto Alegre: Brazilian Computer Society (SBC), 184p. (In Portuguese)

BOSCH, J. (2009) “From software product lines to software ecosystem”, In: *Proceedings of 13th International Software Product Line Conference*, San Francisco, USA, pp. 1-10.

BOUCHARAS, V., JANSEN, S., BRINKKEMPER, S. (2009) “Formalizing software ecosystem modeling”, In: *Proceedings of the 1st Internacional Workshop on Open Component Ecosystems*, Amsterdam, The Netherlands, pp. 41-50.

BOUCHARD, C. (1997) “L’innovation sociale existe-t-elle?”, *Interface*, Vol. 18, No. 6, pp: 41-42.

BRAITHWAITE, P. (2018) “Social Innovation Ecosystems: What the concept means, How it has been applied elsewhere and a proposal for Northern Ireland”, Building Change Trust, *Technical Report*, Belfast, https://www.buildingchangetrust.org/download/files/BCT_SIE_Report_Final.pdf.

BRISCOE, G., DE WILDE, P. (2009) “Digital ecosystems: self-organisation of evolving agent populations”, In: *Proceedings of the International Conference on Management of Emergent Digital EcoSystems*, (MEDES’09). New York, NY, USA: ACM, 2009, Vol. 7, pp. 44-48.

BROWN, R., WERBELOFF, L., RAVEN, R. (2019) “Interdisciplinary Research and Impact”, *Global Challenges*, Vol. 3, No. 4, pp. 1-4.

BUND, E., GERHARD, U., HOELSCHER, M., MILDENBERGER, G. (2015) “A methodological framework for measuring social innovation”, *Historical Social Research*, Vol. 40, No. 3, pp. 48-78.

BUTZIN, A., TERSTRIEP J. (2018) “Actor and roles in social innovation”, In: Howaldt, J.; Kaletka, C.; Schröder, A.; Zirngiebl, M. (eds) *Atlas of Social Innovation - New*

Practices for a Better Future, TU Dortmund University, Dortmund. pp. 77-81. Available at: https://www.socialinnovationatlas.net/.

CAJAIBA-SANTANA, G. (2013) "Social innovation: A conceptual framework", *Technological Forecasting and Social Change*, Vol. 82, pp. 42-51.

CARVALHO, I., VEIGA, W., CAMPOS, F., BRAGA, R., STROELE, V., (2017) "Quality of an e-Learning Ecosystem: Health Indicators", In: *Proceedings of the XIII Brazilian Symposium on Information Systems*, Lavras, Brazil, pp. 230-237. (In Portuguese)

CASTRO-ARCE, K., VANCLAY, F. (2020) "Community-Led Green Land Acquisition: Social Innovative Initiatives for Forest Protection and Regional Development", *Land,* Vol. 9, No. 4, pp. 1-15.

CAULIER-GRICE, J., DAVIES, A., PATRICK, R., NORMAN, W. (2012) "*Defining social innovation*", TEPSIE, European Commission - 7th Framework Programme, Brussels: European Commission, DG Research.

CHANG, E., WEST, M. (2006) "Digital Ecosystems A Generation of the Collaborative Environment". In: *Proceedings of the Eight International Conference on Information Integration and Web-based Applications*, Yogyakarta, Indonesia, pp. 3-23.

CHAZIN, A.; FREITAS, S. (2017) "Planejamento e realização de entrevista semiestruturada em estudo sobre Gestão de Projetos de Design". In: *Proceedings of Graduate Symposium in Design at the Superior School of Industrial Design*. Rio de Janeiro, Brazil, pp. 1-12. (In Portuguese)

CHUERI, L.O.V. (2017) "Inovação Social", In: Araujo, R.M., Chueri, L.O.V. (eds) *Pesquisa e Inovação: Visões e Interseções*, PUBL! T Soluções Editoriais, Rio de Janeiro, pp. 266-281. (In Portuguese)

CHUERI, L.O.V. (2018) "*Gerenciamento e monitoramento de Ecossistemas Digitais de Inovação Social*", Doctoral qualifying Exam, Graduate Program in Informatics UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil, 166p. (In Portuguese)

CHUERI, L.O.V., AFONSO, A.T.Q., PINHEIRO, M.C., RAMOS, M.L., SANTOS, R.P. (2020) "Um estudo exploratório sobre plataformas digitais para ecossistemas de inovação social no Brasil", In: *Proceedings of 5th Workshop on Social, Human, and Economic Aspects of Software* (WASHES'20), Porto Alegre, Brazil, pp. 81-90. (In Portuguese)

CHUERI, L.O.V., ARAUJO, R. M. (2018) “How social innovation projects are managed? Answers from a literature review", *European Public & Social Innovation Review*, Vol. 3, No. 2, pp. 23-36.

CHUERI, L.O.V., SANTOS, R.P. (2019) “Caracterização e Gerenciamento de Ecossistemas Digitais de Inovação Social”, In: *Proceedings of XI Workshop on Thesis and Dissertations in Information Systems* (WTDSI'19), Porto Alegre, Brazil, pp. 69-74. (In Portuguese)

CHUERI, L.O.V., VASCONCELOS, A.P.V., SANTOS, R.P. (2019) “An observational study on the challenges faced by actors in a social innovation ecosystem”, In: *Proceedings of 11th International Conference on Management of Digital EcoSystems* (MEDES’19), Limassol, Chipre, pp. 219-223.

CIPOLLA, C. (2017) “Design social ou design para a inovação social? Divergências, convergências e processos de transformação”. In: Oliveira, A.J., Franzato, C., Gaudio, C.D. (Eds.) *Ecovisões Projetuais: Pesquisas em Design e Sustentabilidade no Brasil*, Chapter: 12, Blucher Open Access. pp. 147-154. (In Portuguese)

CIPOLLA, C. (2020) “Designing with communities of place: the experience of a DESIS Lab during COVID-19 and beyond”, *Strategic Design Research Journal*, Vol. 13, No. 3, pp. 669-684.

CUNHA, J., BENNEWORTH, P. (2019) “How to measure the impact of social innovation initiatives?”, *International Review on Public and Nonprofit Marketing*. Vol. 17, pp. 59-75.

DAVIS, F.D. (1993) “User Acceptance of Information Technology: System Characteristics, User Perceptions and Behavioral Impacts”, *International Journal of Man-Machine Studies,* Vol. 38, No. 3, pp. 475-487.

DHUNGANA, D., GROHER, I., SCHLUDERMANN, E., BIFFL, S., (2010) “Software Ecosystems vs. Natural Ecosystems: Learning from the Ingenious Mind of Nature”. In: *Proceedings of the 4th European Conference on Software Architecture* (ECSA) - *2nd International Workshop on Software Ecosystems* (IWSECO), Copenhagen, Denmark, pp. 96-102.

DIAS-NETO, A. C., SPÍNOLA, R. O., TRAVASSOS, G. H. (2010) “Developing software technologies through experimentation: Experiences from the battlefield”, In: *Proceedings of XIII Ibero-American Conference on Software Engineering*, Cuenca, Equador, pp. 107-120.

DOMANSKI, D., HOWALDT, J., KALETKA, C. (2019) “A comprehensive concept of social innovation and its implications for the local context - on the growing

importance of social innovation ecosystems and infrastructures", *European Planning Studies*, Vol. 28, No. 3, pp. 454-474.

DOMANSKI, D., KALETKA, C. (2018) "Social Innovation Ecosystems", In: Howaldt, J.; Kaletka, C.; Schröder, A.; Zirngiebl, M. (eds) *Atlas of Social Innovation - New Practices for a Better Future*, TU Dortmund University, Dortmund. pp. 77-81, Available at: https://www.socialinnovationatlas.net/.

DONG, H., HUSSAIN, F. K., AND CHANG, E. (2007a) "Exploring the Conceptual Model of Digital Ecosystem", In: *Proceedings of the 2nd International Conference on Digital Telecommunications* (ICDT'07), San Jose, USA, pp. 18-18.

DONG, H., HUSSAIN, F. K., AND CHANG, E. (2007b) "An Integrative view of the concept of Digital Ecosystem". *International Conference on Networking and Services* (ICNS '07), Athens, Greece, pp. 42-42.

DRAKE, I. (2018) "*Social Innovation and Collaboration. Identifying and Engaging Stakeholders with Power, Purpose, Passion and Presence*" In: G.-E. Torgersen (Ed). pp. 213-232. Oslo: Cappelen Damm Akademisk.

DUMAS, M. ROSA, M. L., MENDLING, J. REIJERS, J. A. (2013) "*Fundamentals of Business Process Management*", Berlin, Heidelberg: Springer Berlin Heidelberg.

EDMONDSON, A., MCMANUS, S. (2007) "Methodological Fit in Management Field Research", *Academy of Management Review*, Vol. 32, pp. 1155-1179.

EDWARDS-SCHACHTER, M., WALLACE, M.L. (2017) "'Shaken, but not stirred': Sixty years of defining social innovation", *Technological Forecasting and Social Change*, Vol. 119, pp. 64-79.

FARIAS JUNIOR, I. D., MARCZAK, S., SANTOS, R., MOURA, H. (2016) "Communication in Distributed Sfotware Development: A Preliminary Maturity Model". In: *Proceedings of 2016 IEEE 11th International Conference on Global Software Engineering* (ICGSE), California, USA, pp. 164-173.

FERRI, F., GRIFONI, P., CASCHERA, M.C., D'ANDREA, A., D'ULIZIA, A. GUZZO, T. (2014) "An Ecosystemic Environment for Knowledge and Services Sharing on Creative Enterprises" In: *Proceedings of the 6th International Conference on Management of Emergent Digital EcoSystems* (MEDES'14). Association for Computing Machinery, New York, NY, USA, pp. 27-33.

FICHEMAN, I., LOPES, R. (2008) "*Digital Learning Ecosystems: Authoring, Collaboration, Immersion and Mobility*", In: *Proceedings of 2008 Eighth IEEE International Conference on Advanced Learning Technologies*, Santander, Spain, pp. 371-372.

FONTÃO, A., LIMA, F., ÁBIA, B., SANTOS, R., DIAS-NETO, A. (2017) "Hearing the Voice of Developers in Mobile Software Ecosystems". In: *Proceedings of 31st Brazilian Symposium on Software Engineering* (SBES'17), Fortaleza, Brazil, pp. 4-13.

FLICK, U. (2009) "*An Introduction to Qualitative Research*", 4th Ed., S. Netz., Sage Publications, London.

FREEMAN, T. (2006) "Best Practice in focus group research: making sense of different views", *Journal of Advanced Nursing*, Vol. 56, No. 5, pp. 491-497.

FUKS, H., RAPOSO, A., GEROSA, M. A., PIMENTEL, M., LUCENA, C. J. P. (2007) "The 3C Collaboration Model", *The Encyclopedia of E-Collaboration*, Ned Kock (Ed.), pp. 637-644.

GABISON, G., PESOLE, A. (2015) "*An Overview of Models of Distributed Innovation - Open Innovation, User Innovation and Social Innovation*", Institute for Prospective Technological Studies (Joint Research Centre), Seville, Spain.

GAWER, A. A. (2011) "*Platforms, Markets and Innovation*", US: Edward Elgar Publishing.

GLINZ, M. (2017) "*Certified Professional for Requirements Engineering Glossary*" Version 1.7 (Eds.) International Requirements Engineering Board IREB and Martin Glinz. May. 2017.

GRETZEL, U., WERTHNER, H., KOO, C., LAMSFUS, C. (2015) "Conceptual foundations for understanding smart tourism ecosystems", *Computers in Human Behavior*, Vol. 50, pp. 558-563.

HANCOCK, B., OCKLEFORD, E. AND WINDRIDGE, K. (2009) "*An Introduction to Qualitative Research*", The National Institute for Health Research Design Service for Yorkshire & the Humber (RDS EM / YH), 39p.

HANSSEN, G., DYBÅ, T., 2012, "Theoretical Foundations of Software Ecosystems". In: *Proceedings of the 4th International Workshop on Software Ecosystems (IWSECO), in conjunction with the 3rd International Conference on Software Business* (ICSOB), Cambridge, USA, pp. 6-17.

HARMON, P. (2007) *"Business Process Change - A Guide for Business Managers and BPM and Six Sigma Professionals",* 2nd. Edition, The MK/OMG Press.

HOLGADO*,* A. G., PABLOS, S. M., PEÑALVO, F. J. G. (2019) "A model to define an eHealth technological ecosystem for caregivers", In: ROCHA Á., ADELI H., REIS L., COSTANZO S. (eds) New Knowledge in Information Systems and

Technologies. WorldCIST'19 2019. *Advances in Intelligent Systems and Computing*, Vol. 932. Springer, Cham. pp. 422-432.

HOWALDT, J., BUTZIN, A., DOMANSKI, D., KALETKA, C. (2014) "*Theoretical approaches to social innovation: A critical literature review*" Available at: https://www.si-drive.eu/wp-content/uploads/2014/11/D1_1-Critical-Literature-Review_final.pdf

HOWALDT, J., KALETKA, C., SCHRÖDER, A. (2016a) "Social Entrepreneurs: Important Actors within an Ecosystem of Social Innovation", *European Public Social & Social Innovation Review*, Vol. 1, No. 2, pp. 95-110.

HOWALDT, J., SCHRÖDER, A., KALETKA, C., REHFELD, D., TERSTRIEP, J. (2016b) "Mapping the World of Social Innovation: A Global Comparative Analysis across Sectors and World Regions", In: *Deliverable D1.4 of the project "Social Innovation: Driving Force of Social Change"* (SI Drive), Available at: https://www.si-drive.eu/wp-content/uploads/2016/12/SI-DRIVE-CA-short-2016-11-30-Druckversion.pdf

IANSITI, M., RICHARDS, G.L. (2006) "The Information Technology Ecosystem: Structure, Health, and Performance", *The Antitrust Bulletin*, Vol. 51, No. 1, pp. 77-110

IMAMURA, M., FERREIRA, F. H., FERNANDES, J., SANTOS, R. P. S. (2021) "System-of-Systems Reability: An Exploratory Study in a Brazilian Public Organization" In: *Proceedings of XVII Brazilian Symposium on Information Systems* (SBSI'2021), Uberlândia, Brazil. ACM, New York, NY, USA, 8 pages. (In Portuguese)

IYAWAA, G.E., HERSELMANA, M., BOTHA, A. (2016) "Digital health innovation ecosystems: From systematic literature review to conceptual framework", *Procedia Computer Science*, Vol. 100. pp. 244-252.

JANSEN, S., CUSUMANO, M. (2012), "Defining software ecosystems: A survey of software ecosystems and ecosystem". In: *Proceedings of the 4th International Workshop on Software Ecosystems* (IWSECO), Cambridge, USA, pp. 41-58.

JANSEN, S., CUSUMANO, M. A., BRINKKEMPER, S., (2013) "*Software ecosystems: analyzing and managing business networks in the software industry*", Edward Elgar Publishing. 344p.

JANSEN, S. (2014) "Measuring the Health of Open Source Software Ecosystems: Beyond the Scope of Project Health", *Information and Software Technology*, Vol. 56, No. 11, pp. 1508-1519.

KARHU, K., BOTERO, A., VIHAVAINEN, S., TANG, T., HÄMÄLÄINEN, M. (2011) "A digital ecosystem for co-creating business with people", *Journal of emerging technologies in web intelligence*, Vol. 3, No. 3, pp. 197-205.

KIDANU, S.A., CARDINALE, Y., TEKLI, G., CHBEIR, R. (2015) "A Multimedia-Oriented Digital Ecosystem: A new collaborative environment", In: *Proceedings of IEEE/ACIS 14th International Conference on Computer and Information Science* (ICIS), Las Vegas, USA, pp. 411-416.

KIDANU, S.A., CARDINALE, Y., TEKLI, G., CHBEIR, R., DE PONTE, V., FIGUEROA, A., RODRIGUEZ, R., IBANEZ. C.A.R. (2016) "MMDES: Multimedia Digital Ecosystem - New Platform for Collaboration and Sharing" In: Proceedings of *2016 IEEE Intl Conference on Computational Science and Engineering (CSE) and IEEE Intl Conference on Embedded and Ubiquitous Computing (EUC) and 15th Intl Symposium on Distributed Computing and Applications for Business Engineering (DCABE*S), Paris, France, pp. 393-400.

KITCHENHAM, B., CHARTERS, S. (2007) "*Guidelines for performing systematic literature reviews in software engineering",* Technical Report *EBSE-2007-01*, Ver. 2.3 EBSE, UK.

KITCHENHAM B. A., PFLEEGER, S. L. (2008) "Personal Opinion Surveys". In: *Guide to Advanced Empirical Software Engineering*, F. Shull, J. Singer, and D. I. K. Sjøberg, Springer London, pp. 63-92.

KLEIN, E. E., TELLEFSEN, T., HERSKOVITZ, P. J. (2007) "The use of group support systems in focus group: Information technology meets qualitive research", *Computers in Human Behavior,* Vol. 23, No. 5, pp. 2113-2132.

KLEVERBECK, M.; TERSTRIEP, J. (2017) "Analysing the Social Innovation Process", *European Public & Social Innovation Review (EPSIR)*, Vol. 2, No. 2, pp. 15-29.

KUHLMANN, A. S. (2018) "Rip. Next-Generation Innovation Policy and Grand Challenges", *Science and Public Policy*, Vol. 45, No. 4, pp. 448-454.

LENKENHOFF, K., WILKENS, U.; ZHENG, M.; THOMAS SÜß, T., KUHLENKÖTTER, B.; MING, X. (2018) "Key challenges of digital business ecosystem development and how to cope with them" In: *Proceedings of 10th Conference on Industrial Product-Service Systems*, Linköping, Sweden, Vol. 73, pp. 167-172.

LI, W., BADR, Y., BIENNIER, F. (2012) "Digital ecosystems: challenges and prospects". In: *Proceedings of the International Conference on Management of Emergent*

Digital EcoSystems (MEDES'12). Association for Computing Machinery, New York, NY, USA, pp. 117-122.

LOZANO, V. A., MOLINER, L. A., MURILLO, D. & BUCKLAND, H. (2019) "Understanding the effects of social capital on social innovation ecosystems in Latin America through the lens of Social Network Approach", *International Review of Sociology*, Vol. 29, No. 1, pp. 1-35.

LUZ, P.B.V., FERNANDES J., VALENÇA G., SANTOS R.P. (2020) "Exploring Sustainability in Real Cases of Emerging Small-to-Medium Enterprises Ecosystems". In: Santos R., Maciel C., Viterbo J. (eds) *Software Ecosystems, Sustainability and Human Values in the Social Web*. WAIHCWS 2017, WAIHCWS 2018. Communications in Computer and Information Science, Vol. 1081, pp. 42-59, Springer, Cham.

MAGDALENO, A.M., ARAUJO, R. M. (2015) "Ecossistemas Digitais para o Apoio a Sistemas de Governo Abertos e Colaborativos", In: *Proceedings of the XI Brazilian Symposium on Information Systems,* Goiânia, Brazil. pp. 647-650. (In Portuguese)

MANIKAS, K. (2016) "Revisiting software ecosystems research: A longitudinal literature study", *The Journal of Systems and Software*, Vol. 117, pp. 84-103.

MANIKAS, K., HANSEN, K.M. (2013) "Software Ecosystems - A Systematic Literature Review", *Journal of Systems and Software*, Vol. 86, No. 5, pp. 1294-1306.

MANZINI, E.J. (2003) "Considerações sobre a elaboração de roteiro para entrevista semi-estruturada". In: M. C Marquezine; M. A. Almeida; S. Omote. (Eds.) *Colóquios sobre pesquisa em Educação Especial*. Londrina, Eduel , pp. 11-25. (In Portuguese)

MANZINI, E. (2015) "Design, When Everybody Designs: An Introduction to Design for Social Innovation", *The MIT Press*, Cambridge, Massachusetts.

MARCOS-PABLOS, S., GARCIA-HOLGADO, A., GARCIA-PEÑALVO, F. J. (2019) "Modelling the business structure of a digital health ecosystem", In: *Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality* (TEEM 2019), León, Spain, pp. 838-846.

MCGREGOR, J. D. (2012) "Ecosystem modeling and analysis", In: *Proceedings of the 16th International Software Product Line Conference* (SPLC '12), Salvador, Brazil, Vol. 2, pp. 268-268.

MISTRÍK I., GRUNDY J., VAN DER HOEK A., WHITEHEAD J. (2010) "Collaborative Software Engineering: Challenges and Prospects", In: Mistrík I., Grundy J., Hoek A., Whitehead J. (eds) *Collaborative Software Engineering*. Springer, Berlin, Heidelberg, pp. 389-403.

MOULIN, C., SUGAWARA, K., FUJITA, S. (2013) “Synchronous Remote Collaboration Using Multi-touch Devices”. In: *Proceedings of the Eighth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing*, Compiegne, France, pp. 707-712.

MULGAN, G. (2006) “The process of social innovation”, *Innovations*, Spring, pp. 145-162.

MURRAY, R. CAULIER-GRICE, J. MULGAN, G. (2010) “*The Open Book of Social Innovation*”, National Endowment for Science, Technology and the Art, Available at: https://youngfoundation.org/wp-content/uploads/2012/10/The-Open-Book-of-Social-Innovationg.pdf.

NICOLOPOULOU, K., KARATAS-ÖZKAN, M., VAS, C., NOUMAN, M. (2015) “An incubation perspective on social innovation: the London Hub - a social incubator”, *R&D Management*, Vol. 47, No. 3. n/a-n/a.

NEUMEIER, S. (2012) “Why do social innovation in rural development matter and should they be considered more seriously in rural development research? Proposal for a stronger focus on social innovation in rural development research”, *Sociologia Ruralis*, Vol. 52, pp. 48-69.

NULTY, D.D. (2008) “The adequacy of response rates to online and paper surveys: What can be done?”, *Assessment & Evaluation in Higher Education*., Vol. 33, No. 3, pp. 301-314.

NUNES, L.P., CHUERI, L.O.V., ALENCAR, M.S.M. (2018) “Una experiencia de apoyo a proyectos de innovación social en una universidad pública brasileña: NICS/UNIRIO”, In: *Proceedings of the VI International Symposium on Social and Technological Innovation*, Medellín, Colombia. (In Spanish)

OECD (2011) “*OECD Studies on SMEs and Entrepreneurship SMEs, Entrepreneurship and Innovation*”, OECD Publishing, May, pp. 196.

OH, Y., DUVAL, S., KIM, S., YOON, H., HA, T., WOO, W. (2011) “Foundation of a New Digital Ecosystem for u-Content: Needs, Definition, and Design” In: Shumaker R. (eds) *Virtual and Mixed Reality - Systems and Applications*. VMR 2011. Lecture Notes in Computer Science, Vol. 6774, pp. 377-386. Springer, Berlin, Heidelberg.

OLIVEIRA, E., VIANA, D., CRISTO, M., CONTE, T. (2017) “How have Software Engineering Researchers been Measuring Software Productivity? - A Systematic Mapping Study”. In: *Proceedings of 19th International Conference on Enterprise Information Systems* (ICEIS), Porto, Portugal, pp. 76-87.

OLIVEIRA, J.A., ALVES, C., VALENÇA, G. (2020) "A Conceptual Model for Software Ecosystem Governance", *International Journal of Business Information Systems*, Vol. 35, No. 3, pp. 265-307.

OLIVEIRA, M.S., (2011) "*Previa: An Approach for Visualizing the Evolution of Software Models*". Master Thesis in Computer Science and System Engineering. COPPE – Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, 185p. (In Portuguese)

PETERSEN, K. VAKKALANKA, S., KUZNIARZ, L. (2015) "Guidelines for conducting systematic mapping studies in software engineering: An update", *Information and Software Technology*, Vol. 64, pp. 1-18.

PINHEIRO, M. C. (2021) "*Colaboração em Ecossistemas Digitais de Inovação Social*". Bachelor Monograph in Information Systems. UNIRIO - Federal University of the State of Rio de Janeiro, Rio de Janeiro, Brazil. 92p. (In Portuguese).

PINHEIRO, M. C., CHUERI, L.O.V., SANTOS, R.P. (2020) "Identifying Topics and Difficulties on Collaboration in Social Innovation Environments", In: *Proceedings of the XVI Brazilian Symposium on Information Systems (SBSI'20), S*ão Bernardo do Campo, Brasil. (In Portuguese)

PINHEIRO, M. C., CHUERI, L.O.V., SANTOS, R.P. (2021) "Investigando Colaboração em Ecossistemas", In: *Proceedings of the 6th Workshop on Social, Human, and Economic Aspects of Software (WASHES'21)*, Florianopolis, Brazil, pp. 11-20. (In Portuguese)

PMI - Project Management Institute (2017) "*Project Management Body of Knowledge"*. 6th edition. PMI Institute. Pennsylvania, USA: PMI, 2017.

PRESENZA, A.; ABBATE, T.; CESARONI, F.; APPIO, F.P. (2019) "Enacting Social Crowdfunding Business Ecosystems: The case of the platform Meridonare", *Technological Forecasting and Social Change*, Vol. 143, pp. 190-201.

PRESKILL, H., BEER, T. (2012) "Evaluating social innovation", *Center for Evaluation Innovation*, August, Available at: https://www.evaluationinnovation.org/publication/evaluating-social-innovation/.

PURTIK, H.; ARENAS, D. (2017) "Embedding Social Innovation: Shaping Societal Norms and Behaviors Throughout the Innovation Process", *Business & Society*. Vol. 58, No. 5, pp. 1-40.

REYNA, J. (2011). "Digital Teaching and Learning Ecosystem (DTLE): A Theoretical Approach for Online Learning Environments" In: G. Williams, P. Statham, N. Brown & B. Cleland (Eds.), *Changing Demands, Changing Directions*. Proceedings ascilite Hobart 2011, pp. 1083-1088.

SANTOS, M., FERNANDES, J., VILLELA, M., SANTOS. R.P. (2019) “Human computer interaction factors in software ecosystems: A systematic mapping study”, In: *Proceedings of the XV Brazilian Symposium on Information Systems (SBSI'19).* Association for Computing Machinery, New York, NY, USA. pp. 1-8. (In Portuguese)

SANTOS, R.P. (2016) “*Managing and Monitoring Software Ecosystem to Support Demand and Solution Analysis*” Ph.D. dissertation, COPPE, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil, 228p.

SANTOS, R. P., VIANA, D., MACIEL, C. (2016) *Ecossistemas de Software: Uma Visão sobre Fatores Técnicos, Humanos e Organizacionais*, In: Gasparini, I.; Mota, M. (Org.). Livro dos Tutoriais do XV IHC. 15ed. Porto Alegre: SBC, Vol. C, pp. 70-90. (In Portuguese)

SANTOS, R. P.; FONTAO, A. L.; FERNANDES, J.C. (2020) “Ecossistemas de Software” In: Cristiano Maciel; Jose Viterbo. (Org.). *Computação e Sociedade: A Tecnologia*, 1ed. Cuiaba: EdUFMT, Vol. 3, pp. 198-223. (In Portuguese)

SANTOS, R.P., WERNER, C.M.L. (2011a) “A Proposal for Software Ecosystems Engineering”. In: *Proceedings of the 3rd International Workshop on Software Ecosystems* (IWSECO), in conjunction with the *2nd International Conference on Software Business* (ICSOB), Brussels, Belgium, pp. 40-51.

SANTOS, R.P., WERNER, C.M.L. (2011b) “Treating Business Dimension in Software Ecosystems”. In: *Proceedings of the 3rd ACM/IFIP International Conference on Management of Emergent Digital EcoSystems* (MEDES), San Francisco, USA, pp. 197-201.

SANTOS, R.P., WERNER, C.M.L. (2012a) “Treating Social Dimension in Software Ecosystems through ReuseECOS Approach”. In: *Proceedings of the 6th IEEE International Conference on Digital Ecosystem Technologies - Complex Environment Engineering* (DEST-CEE), pp. 1-6, Campione d’Italia, Italy, June. Workshop on Distributed Software Development (WDDS), Porto Alegre, Brazil, pp. 60-65.

SANTOS, R.P., WERNER, C.M.L. (2012b) “ReuseECOS: An Approach to Support Global Software Development through Software Ecosystems”, In: *Proceedings of 2012 IEEE Seventh International Conference on Global Software Engineering Workshops* (ICGSEW), Washington D.C., USA, pp. 60-65.

SEAMAN, C.B. (1999) “Qualitative Methods in Empirical Studies of Software Engineering”, *IEEE Transactions on Software Engineering*, Vol. 25, No. 4, pp. 557-572.

SECCHI, P. (1999) “Alerts and Lessons Learned: An Effective way to prevent failures and problems”. *Technical Report WPP-167*. Noordwijk, The Netherlands: ESTEC.

SGARAGLI, F. (2014) “*Enabling Social Innovation Ecosystems for Community-led Territorial Development*”, Rome, Fondazione Giacomo Brodolini.

SILVA, S. B., BIGNETTI, L.P. (2012) “A inovação social e a Dinâmica de Inovação Aberta na Rede Brasileira de *Living Labs”*. In: *Proceedings of XXXVI Seminar of the National Association of Graduate Studies and Research in Administration.* Rio de Janeiro, Brazil, pp. 1-16.

SILVA JUNIOR, S.D.; COSTA, F. J. (2014) “Mensuração e Escalas de Verificação: uma Análise Comparativa das Escalas de Likert e Phrase Completion”, *PMKT – Revista Brasileira de Pesquisas de Marketing, Opinião e Mídia*, Vol. 15, pp. 1-16. (In Portuguese)

SJØBERG, D.I.K.; DYBÅ, T.; ANDA, B.C.; HANNAY, J.E. (2008) “Building theories in software engineering” In: Shull *et al.* (Eds.): *Guide to Advanced Empirical Software Engineering*. Springer, London, pp. 312-336.

SLIMANE, K.B.; LAMINE, W. (2017) “A transaction-based approach to social innovation”, *The International Journal of Entrepreneurship and Innovation,* Vol. 18, No. 4, pp. 231–242.

STEWART, K., WILLIAMS, M. (2005) “Researching online populations: the use of online focus groups for social research”, *Qualitative Research*, Vol. 5, No. 4, pp. 395-416.

TANG, T., ZHENYU W., KARHU, K., HÄMÄLÄINEN, M., JI, Y. (2010) “An internationally distributed ubiquitous living lab innovation platform for digital ecosystem research”. In: *Proceedings of the International Conference on Management of Emergent Digital EcoSystems* (MEDES’10). Association for Computing Machinery, New York, NY, USA, pp. 159-165.

TAYLOR, S.J., BOGDAN, R., (1984) “*Introduction to Qualitative Research Methods*”, New York, John Wiley and Sons, 416p.

TERSTRIEP, J., REHFELD, D., KLEVERBECK, M. (2020) “Favourable social innovation ecosystem(s)? - An explorative approach”, *European Planning Studies*, Vol. 28, No. 5, pp. 881-905.

TERSTRIEP, J., KLEVERBECK, M., DESERTI, A., RIZZO, F. (2015) "Comparative Report on Social Innovation across Europe. Deliverable D3.2 of the project "Boosting the Impact of Social Innovation in Europe through Economic Underpinnings" (SIMPACT). *European Commission - 7th Framework Programme.* DG Research and Innovation: Brussels.

THE ECONOMIST INTELLIGENCE UNIT (2016) "*Social Innovation Index 2016 - Old problems, new solutions: Measuring the capacity for social innovation across the world*", Nippon Foundation, September, Available at: https://eiuperspectives.com/technology-innovation/old-problems-new-solutions-measuring-capacity-social-innovation-cross-world-0.

TILAKARATNA, P., RAJAPAKSE, J. (2017) "Evaluation of the Ontological Completeness and Clarity of Object-Oriented Conceptual Modelling Grammars", *Journal of Database Management*, Vol. 28, No. 2, pp. 1-26.

TRAVASSOS, G.H., GUROV, D., AMARAL, E.A.G. (2002) "*Introduction to Experimental Software Engineering*". Technical Report PESC/COPPE – ES-590/02, Federal University of Rio de Janeiro.

TREISMAN, C., KELLEY, T.M., JOHNSTON, E.W. (2016) "Designing Successful Participatory Platforms with a Public Intent: Lessons Learned from Practitioners, Scholars, and Citizen Participants". *International Journal of Organization Theory And Behavior*, Vol. 19, No. 4, pp. 179-513.

UNITED NATIONS. (2020) "*The Sustainable Development Agenda"*, Available at: https://www.un.org/sustainabledevelopment/development-agenda/

VASILĂŢEANU, A., ŞERBĂNAŢI, L.D. (2011) "Towards an agent-oriented architecture of the digital healthcare ecosystem". *The Scientific Bulletin*, Vol. 74, No. 2, pp. 87-102.

WESTLEY, F., ANTADZE, N., RIDDELL, D. J., ROBINSON, K., GEOBEY, S. (2014) "Five Configurations for Scaling Up Social Innovation Case Examples of Nonprofit Organizations From Canada", *The Journal of Applied Behavioral Science*, Vol. 50, No. 3, pp. 234.

WHELAN, R. J. (2010) "Ecological system meets 'digital ecosystem': Can ICT benefit from understanding biology?", In: *Proceedings of 4th IEEE International Conference on Digital Ecosystems and Technologies* (DEST 2010), New Jersey, USA, pp. 103-106.

WIERINGA, R., MAIDEN, N, MEAD, N., ROLLAND, C. (2006) "Requirements engineering paper classification and evaluation criteria: a proposal and a discussion", *Requirements engineering*, Vol. 11, No. 1, pp. 102-107.

WÖHLIN, C. (2014) "Guidelines for snowballing in systematic literature studies and a replication in software engineering", In: *Proceedings of 18th International Conference on Evaluation and Assessment in Software Engineering*, New York, USA, pp.1-10.

WÖHLIN, C., RUNESON, P., OST, M. H., OHLSSON, M. C., REGNELL, B., WESSL'EN, A. (2012) "*Experimentation in software engineering*", Springer-Verlag Berlin Heidelberg, 236p.

WOUTERS, J., RITMEESTER, J.R., CARLSEN, A.W., JANSEN, S., WNUK, K. (2019) "A SECO Meta-model - A Common Vocabulary of the SECO Research Domain", In: Proceedings of the *International Conference on Software Business (ICSOB'19) , Vol. 30 of Lecture Notes in Business Information Processing,* pp. 31-45.

WU, C., CHANG, E. (2007) "Exploring a Digital Ecosystem Conceptual Model and Its Simulation Prototype". In: *Proceedings of 2007 IEEE International* Symposium on Industrial Electronics, Vigo, Spain, pp. 2933-2938.

YUNUS NEGÓCIOS SOCIAIS (2020) "Yunus Negócios Sociais lança Plataforma de Financiamento Coletivo", August, Available at: https://www.yunusnegociossociais.com.br/noticias/2020/8/13/yunus-negcios-sociais-lana-plataforma-de-financiamento-coletivo. (In Portuguese)

ZIEGLES, R. (2017) "Social innovation as a collaborative concept", *Innovation: The European Journal of Social Science Research*, Vol. 30, No. 4, pp.388-405.

Appendix 1. How Social Innovation Projects are Managed? Answers from a literature review

This appendix details the SMS on social innovation projects, mentioned on Chapter 2, Section 2.2.5.

A1.1. Research Method

The research method adopted in this study is based on the approach presented in Brereton et al. (2007) and on the quasi-systematic review presented in Magdaleno & Araujo (2015) considered as an exploratory study, designed to characterize a research area. The survey follows a well-defined sequence of steps (planning, execution and report), defined in a mapping protocol, presented on Table 29. The objective of this study is to identify all supporting elements used during the development of a social innovation (SI) project aiming at answering the following main (MQ) and secondary questions (SQ):

- MQ: How are SI projects developed?
- SQ1: What are the challenges in SI projects?
- SQ2: What methods and technological solutions have been applied for SI projects?
- SQ3: What results have been achieved by communities and government when SI projects are developed?

A1.2. Search Results

Table 30 shows the number of items returned from the digital libraries selected in the review during each step of the filtering process. The first search round in each of the selected digital libraries Scopus, IEEE, Compendex and Web of Science was performed in June 2017. The second search round, specific for Google Scholar, was performed in September 2017. The reading of the 28 studies remained after the filtering process helped us to answer each research question as follows.

MQ: How are SI projects developed?

Although SI is studied based on distinct theoretical and methodological angles, the conditions under which SI flourish are developed, and sustained, finally leading to societal change, are not yet fully understood both in political and academic circles (HOWALDT et al., 2016). This statement was proven true during the deep analysis of the retrieved studies.

Table 29. SMS on social innovation projects – SMS protocol.

Scope

The literature review scope was defined according to the PICO approach (Pai et al., 2004, apud Magdaleno et al., 2012), which structures the research question into four basic elements: i) **Population:** academic papers reporting experience with the development of social innovation projects; ii) **Intervention:** process, methods, methodologies; iii) **Comparison:** not applied in this study; and iv) **Outcomes:** Activities performed during each social innovation development stage, challenges for social innovation development, tools, methods or methodologies used during social innovation development; and results obtained from social innovation projects development.

Search strategy

The search strategy included the following electronic databases: Scopus, Compendex, IEEE Xplore, and Web of Science. The ACM Library, despite its importance, overlaps with the IEEE Xplore library; its content is also indexed by the Scopus library. As social innovation has received attention from many organizations and foundations globally, and Google scholar contains many reports generated by these initiatives, decision was made to include a sample of documents from this electronic database.

Keywords

Keywords were constructed considering (Kitchenham et al., 2007): terms in population and intervention (Section 3.1.2); alternative spellings and synonyms for these terms.

The complete list of keywords used in this systematic literature mapping is given below. Population and intervention are the same to the main question (MQ) and to every secondary question (SQ), since these comprise subsets of the main question.

Research questions keywords, according to PICO:

- Population: “social innovation project” “social innovation implementation”
- Intervention: methodology, technique, network, ecosystem, method, process, framework
- Comparison: not applied.

Inclusion and exclusion criteria

This mapping includes every article returned by the protocol which meets **at least one of the following criteria for inclusion** (IC) and does not meet any of the criteria for exclusion (EC):

- IC1—Documents must address social innovation;
- IC2—Documents must discuss challenges for the development of social innovation projects;
- IC3—Documents must present proposals for the development of social innovation projects;
- IC4—Documents must report experiences from organizations or communities which have implemented one social innovation.

Publications satisfying at least one of the following EC were excluded:

- EC1—Documents not written in English;
- EC2—Documents whose full text is not available;
- EC3—Documents not addressing the development of social innovation projects;
- EC4—Documents clearly dealing with topics irrelevant to the purpose of this mapping;
- EC5—Documents addressing social innovation, but focusing on legal or social aspects and not on the development process itself;
- EC6—If the same study has been published more than once, the most relevant version (i.e., the one explaining the study in greatest detail) will be used and the others will be excluded;
- EC7—If a given study has been selected for a broader research question, it must be excluded from the list of selections for the narrower research question.

Selection Process

The process related to the selection of articles occurred in four steps: i) Selection and preliminary organization of selected documents: preliminary selection of publications was made by applying the search string to selected data sources; ii) Selection of relevant papers: primary selection using the search string. After the identification of publications via search engine, documents were retrieved in view of the inclusion and exclusion criteria; iii) Evaluation of relevant papers: the other author evaluated the list of documents selected; iv) Information extraction from relevant documents: after defining the final list of relevant documents, one of the authors read the latter to extract information on how social innovation projects are developed.

Table 30. Filtering process

	Scopus	Compendex	IEEE Explore	Web of Science	Google Scholar	Total
Results of search engines	215	46	30	144	141	576
After duplicates excluded	213	1	9	49	69	341
After title and abstract filter	74	0	1	10	72	157
After text available filter	52	0	1	4	45	102
After content filter	14	0	1	1	12	28

From all the studies, no consensus was found on the stages and steps described during the development of a SI project. Even when the term "project" was identified, most of the studies did not explain the project into detail, only emphasizing some particular stage, or telling a story about it based on interviews (HARRISSON, 2012; NEMES, 2017; ROCLE & SALLES, 2017). Table 311 presents the result considering which phases are approached by each one considering the six-staged model conceived by MULGAN (2006).

Table 31. Distribution of studies by stage of development.

Paper	Prompts	Proposal	Prototyping	Sustaining	Scaling and diffusion
Neumeier, 2016	X	X			
Schaffers et al, 2009		X	X		
Obata, 2012		X	X		
Fuger et al, 2017	X	X			
Rensburg et al, 2016		X	X	X	
Marti et al, 2016		X	X		
Altuna et al, 2015		X	X	X	
Ferrario et al, 2014		X	X		
Westley et al, 2014					X
Mazzarella et al, 2017	X	X			
Chou, 2017	X	X			

Neumeier (2017) presents a SI process based on a participatory process divided into three distinct stages: 'Problematisation', 'Expression of interest', and 'Delineation and co-ordination'. Problematisation is the identification of a need by a small group of actors, triggered by an initial impetus, external or internal to the actors involved (like a threat or impairment, emotional issues, or themes of interest to potential regional actors). This need leads to initial groups of actors looking for solutions to the identified need. Expression of interest: other actors join the core group of actors as they see advantages by taking part on it. Delineation and co-ordination: interested actors negotiate the new form of collaborative action/organization.

Schaffers et al. (2009) presents a methodology using living labs as an instrument for SI in rural areas and displays a model that comprises four major stages: 'Preparation', 'Prototyping examples and limited scale experimentation', 'extensive application development and field experiments', and 'user-led co-creation'.

Obata et al. (2012) presented a case study where the Fujitsu Lab researchers chose a participatory design method for conducting a Product Development project on SI for the aging society. They used the four phases presented by the MUST method. In the Initiation phase the main objectives are clarifying project objectives and the resources set aside to meet them. Stakeholders are to be identified, the project organization is formed, and an initial plan is produced. In the In-line analysis phase the main objective is clarifying and adjusting project relation to business and strategies concerning information technology in order to identify the domains to be focused. In the In-depth analysis phase the purpose is to develop a detailed understanding of the domains and to establish a basis for prioritizing problems, needs, and ideas for improvements. Finally, in the Innovation phase the purpose is developing coherent visions for change including prototypes, ideas for re-organizing the work in question, an overview of new qualifications if needed, and a plan for visions.

Fuger et al. (2017) described an initiative using a crowdsourcing approach to SI and to improve conditions of low-income communities, comprising four phases. The "research phase" has the aim of motivating all participants to share inspirations, stories, tools and successful examples on the challenge topic. In the "idea phase" participants were asked to propose solutions to the given problem. Best ideas were then selected via an applause phase by the community and experts to advance to the "refinement phase" where the community collaboratively refined those ideas. In the "evaluation phase", final ideas are selected to be funded.

Marti et al. (2016) developed the Experiential Design Landscapes (EDL) method, a design research method aimed at designing for, and with people, in their natural environment, to find ways to support them in structurally changing their behavior on a local scale and to address global societal issues in the long run. EDLs are environments, be them physical or virtual, which are part of society (e.g., designated areas in cities, sports parks, virtual platforms, etc.) in which a design research team meets people in their everyday lives. The EDL method is based on four processes: i) envisioning, ii) designing interventions, iii) acquiring data, and iv) analyzing and validating this data.

Altuna et al. (2015) presented a case study where the SI development process comprises four stages: i) Explorative phase, which leads to the identification of the social need to be addressed; ii) Strategic design, during which the intervention model is defined and where and how to change and innovate the process is decided; iii) Operative design, where the implementation of the intervention model occurs, the specific features of the new service are defined and the eventual system developed; and (iv) Launch and management, which consists in the launch of the new service in its operating management.

Ferrario et al. (2014) described a project management framework, which integrates agile and iterative development methods with approaches, namely Action Research (AR) and Participatory Design (PD). This framework aims to enable software development with an emphasis on SI in tightly constrained environments in a four-step process model: i) The Prepare step is grounded on action research principles and deploys qualitative research methods for initial user requirement capture; ii) the design step embeds Action Research and Participatory Design principles into the design process and aims to visualize and design systems which can address user needs; iii) the build step adopts a more traditional agile approach with short development cycles; it further refines user requirements and concludes with the release of a stable technology prototype; and iv) the sustain step where wider partnerships are sought to support prototype long-term development and deployments.

Westley et al. (2014) proposed a model with five distinct pathways of scaling up SIs shaped by: i) approach to change is revealed in the way an organization perceives its goals for change, and its vision of how institutions and structures could be altered to respond to particular social needs; ii) strength refers to the special advantages of the organization's chosen change strategies; iii) challenge refers to the difficulties inherent in the chosen change strategies which may hinder a move toward tackling system-level goals; iv) pathway for scaling up describes openings perceived by the organization for moving from scaling out to scaling up, conditioned by their earlier strategies and choices; and v) risk refers to the inevitable downside associated with any chosen pathway for scaling up.

Chou (2017) proposed applying the design thinking method into social projects. The design thinking process is defined through three spaces which can be overlapped: i) inspiration is the cause of searching for solutions, such as social problems or possible opportunities appeared to surface; ii) ideation is the process of identifying ideas, developing and deepening targeted ideas and then testing them through experimentation or simulation; and iii) implementation, which places selected project into the realization stage.

Mazzarella et al. (2017) proposed a service design framework which supports the initial stages: ideation and design. This framework include multiple service design and co-design data collection methods were adopted as they complemented each other: ethnography (current state of the art of the local context), storytelling, sense making and co-creation.

SQ1: What are the challenges in SI projects?

The diversity of challenges faced by SI projects development are categorized in the following dimensions: Political, Processual, Institutional, Environmental, Human, Financial and Infrastructure (Table 32). The most cited challenges are concerning the actors: lack of competencies, capabilities and skills to successfully develop SI projects and lack of engagement/commitment/involvement (locals, sponsors, social entrepreneurs and others).

It is clear that the SI process requires attention to individuals; to what they think, to what they value, to how they behave, and to how interrelations between actors and social systems take place. Another challenge is lack of incentives and support in municipal, state, and local policies. Since SI bears, as a main goal, causing positive impacts on society which sometimes involves a change in legislation, it is expected that this kind of innovation may, in some cases, depends on government support. The number of challenges concerning procedural and human dimensions is remarkable, thus proving that this is an area which presents several gaps in the whole development process and demands additional research.

SQ2: What methods and technological solutions have been applied for SI projects?

The methods and technological solutions identified were organized in Table 33 according to the SI stages where they are applied, mainly according to the purpose of each phase (MULGAN, 2006). Most of the occurrences of methods reported are located during the Proposal stage. This demonstrates that an effort exists to use methods and generate ideas and proposals for SI.

It is common to hear about challenges, ideas, competitions, hackathons, and other initiatives dedicated to discussing and raise proposals for important societal issues. On the prototyping stage, most of the methods used were not detailed in the study where they were mentioned. There was lack of reporting on how the SI projects were developed, managed and how the relationship between the SI actors during the development.

About technological solutions, only a few were reported. Marti et al. (2016) report the importance of interconnected products and services ecosystems, to successfully cope with the complexity of social challenges, although specific features of a supporting technological solution are not described. Schaffers et al. (2009) propose a platform based on open service-oriented architecture which allows for reusing and sharing services and applications.

Table 32. Key challenges for social innovation projects.

	Category	Challenge description	Studies
1	Political	Lack of incentives and support in municipal, state and local policies	(DUFOUR *et al.*, 2014), (TELLO-ROZAS, 2016), (QUANDT *et al.*, 2017), (ROCLE & SALLES, 2017)
2	Processual	Involvement of users in the design process	(FERRARIO *et al.*, 2014), (MARTI *et al.*, 2016)
		Lack of engagement of actors (locals, sponsors, social entrepreneurs and other)	(DUFOUR *et al.*, 2014), (FERRARIO *et al.*, 2014), (JUDIT *et al.*, 2016), (FUGER *et al.*, 2017), (STOKES *et al.*, 2017)
		Lack of understanding and measurement of social innovation impact	(STOKES *et al.*, 2017)
		Lack of common vocabulary and understanding between all the actors involved	(DAVIES & GAVED, 2017)
		Project management issues	(OBATA *et al.*, 2012)
		Gathering feedback to enable comparative evaluation of the pilots	(DAVIES & GAVED, 2017)
		Tools and techniques for engaging stakeholders in analysis and design	(OBATA *et al.*, 2012)
3	Institutional	Alignment of goals and priorities	(OBATA *et al.*, 2012), (RENSBURG *et al.*, 2016)
		Risk-averse and cautious organisational cultures of administrations	(NEUMEIER, 2017)
		Lack of planning for growth and developing sustainable business models	(STOKES *et al.*, 2017)
		Lack of institutionalisation	(JUDIT *et al.*, 2016)
		Changes in the project team (when an actor leaves the project)	(DUFOUR *et al.*, 2014), (TELLO-ROZAS, 2016), (MAZZARELA *et al.*, 2017)
		Institutional change	(RENSBURG *et al.*, 2016)
		Pursuing a scaling up pathway	(WESTLEY *et al.*, 2014)
4	Environment	Dependence on its local context	(JUDIT *et al.*, 2016)
		Lack of serious partners to dialogue with and the unavailability of partners to work with	(ALTUNA *et al.*, 2015)
		Lack of clarity about the return on investment.	(GASCÓ, 2016)
		Closed systems favouring single-issue solutions developed within clusters of organisations lacking mutual awareness, communication, networking and trust	(NEUMEIER, 2017)
		Participation of non-profit organizations	(ALTUNA *et al.*, 2015)
5	Human	Resistance to proposed changes	(DUFOUR *et al.*, 2014)
		Dependence on the individual, the agentic engine, who initiates and carries out the innovation.	(JUDIT *et al.*, 2016)
		Reluctance of some members to establish trust and dialog with outside institutions	(QUANDT *et al.*, 2017)
		Lack of human resources	(GASCÓ, 2016), (HOWALDT *et al.*, 2016)
		Lack of competencies, capabilities and skills to successfully develop social innovation projects	(DUFOUR *et al.*, 2014), (WESTLEY *et al.*, 2014), (ALTUNA *et al.*, 2015), (HOWALDT *et al.*, 2016a), (NEUMEIER, 2016), (RENSBURG *et al.*, 2016), (NEMES, 2017), (STOKES *et al.*, 2017)
6	Financial	Availability and accessibility of funding	(HOWALDT *et al.*, 2016), (STOKES *et al.*, 2017)
7	Infrastructure	Issues related to network communications performance, quality and reliability among several distributed data (video, voice, images, text, etc.) entities	(MARCHETTA *et al.*, 2012)

Table 33. Methods according to social innovation development stage.

Social Innovation Stage	Method and Paper
Prompts	Ethnography, Storytelling, Sensemaking, Co-creation workshops, Roundtable discussion (Mazzarella et al., 2017)
Proposals	Design Thinking (Chou, 2017) (Matsushita et al., 2015) (Tello-Rozas, 2015) (Garcia et al., 2010) (Rensburg et al., 2016) Hackathon (Tena-Espinoza-De-Los-Monteros, 2016) Ethnography, Storytelling, Sensemaking, Co-creation workshops, Roundtable discussion (Mazzarella et al., 2017) Public-Private Partnership (P3) (Abe et al., 2016) Design Science Research methodology (Rensburg et al., 2016) Communities of Practice (Rensburg et al., 2016) Agile development (Ferrario et al., 2014) (Schaffer et al., 2009) Action Research (Schaffer et al., 2009) (Ferrario et al., 2014) Data-enabled design (Marti et al., 2016) Experiential Design Landscapes (EDL) method (design research method) (Marti et al., 2016) Prince2 Management methodology (Ferrario et al., 2014) Participatory Design (Ferrario et al., 2014) (Obata et al., 2012) Open development model in form of a crowdsourcing initiative (Fuger et al., 2017)
Prototypes	PPP : Public Private Partnership (Abe et al., 2016) Design Science Research methodology (Rensburg et al., 2016) Communities of Practice (research, teaching and community engagement) (Rensburg et al., 2016) Experiential Design Landscapes (EDL) method (Marti et al., 2016)
Sustaining	PPP: Public Private Partnership (Abe et al., 2016) Open development model in form of a crowdsourcing initiative (Fuger et al., 2017)

Most of the studies did not mention how the project would be managed according to scope, cost, time or stakeholder management. Rensburg et al. (2016) proposed a Research and Project Office responsible for project operational requirements and ensured that project deliverables are met to specification and within budget. Ferrario et al. (2014) was the only study that mentioned the use of a project management methodology (PRINCE), but the study didn't presented detailed information according to this topic. Additionally, there was lack of information on how the SI project was assumed to be integrated with all the organizations and institutions involved. Although some studies had reported lack of funding or government support, there was no mention as to the adoption of methods to deal with this issue.

SQ3: What results have been achieved by the communities and government when SI projects are developed?

The main results achieved by SI projects were categorized in terms of the impact: impact on innovation system and sectoral strength, impact on regional policy instruments, business and entrepreneurship impacts, improvement of social and individual wellbeing

(Table 34). Half of the studies mentioned information concerning the impact or consequence of the SI project, most of them are concerning economic impacts.

Table 34. Key results for the development of social innovation projects.

#	Impact categories	Description	Studies
1	Impact on innovation system and sectoral strength	Improvement of information technology infrastructure availability and capacity due to enhanced attractiveness of rural area. Strengthening the local industry-university cooperation.	(SCHAFFERS *et al.*, 2009)
		Activation of regional economy and employment increases locally.	(ABE *et al.*, 2017)
		Several new co-operations, joint strategic thinking, planning in the field of rural tourism were identified, and local networks were significantly developed.	(NEMES, 2017)
		Social networks development and improved information flows have enhanced the development capacity of the whole region, thus benefitting everyone	(NEMES, 2017)
2	Impact regional policy instruments	Impact on regional development plans and part of economic development mechanism in the region.	(SCHAFFERS *et al.*, 2009)
		Recycling law has been approved to regulate the activities of informal recyclers	(TELLO-ROZAS, 2016)
		Success of the initiative prompted municipal authorities to try to copy it in other neighborhoods	(TELLO-ROZAS, 2016)
		Build trust and social learning in local policy networks where experimentation occurred.	(ROCLE & SALLES, 2017)
3	Business and entrepreneurship impacts	New business possibilities in different sectors under the umbrella of new market regulation. Several examples related to business related cost and/or time savings	(SCHAFFERS *et al.*, 2009)
		Locals have their own webshop, and also deliver to five restaurants, some bio-shops, bakeries	(JUDIT *et al.*, 2016)
		More than 2,500 entrepreneurs and small technological-based enterprises had participated in the project from which 75 functional prototypes were produced	(TENA-ESPINOZA-DE-LOS-MONTEROS, 2016)
		Generating jobs and income within the cooperative territories so that farmers could improve their quality of life, as well as place sustainability.	(QUANDT *et al.*, 2017)
		Inhabitants have found many business opportunities connected to the folktale route	(JUDIT *et al.*, 2016)
		Initiative obtained high consideration by different stakeholders thereby attracting more economical resources	(SCHAFFERS *et al.*, 2009)
4	Improvement of social and individual wellbeing	Seniors involved are not afraid of technology anymore Increasing of number of citizens with innovation competencies and skills.	(GASCÓ, 2017)
		Launching of new initiatives to improve other aspects of living conditions in Cerro el Pino.	(TELLO-ROZAS, 2016)
		Improvement, perceived by the students, of linguistics and communication skills, self-direction and positiveness, a spirit for challenge, cooperation and flexibility, a sense of responsibility and mission, understanding of other cultures, sense of identity, sense of social contribution to local people and communities	(MATSUSHITA *et al.*, 2015)
		Many stakeholders have recognized the positive effect of the exploratory reflection they conducted, thus allowing coproduction of knowledge and a questioning of critical assumptions about the future of their activity, their city and their lives.	(ROCLE & SALLES, 2017)

A1.3. Main findings

This systematic mapping study raised a number of important observations:

- **Underdeveloped status of conceptualization of SI:** wide multiplicity of SI definitions was observed according to its concepts and process. There is no shared understanding of SI is to be had, including clear differentiation from other concepts such as social entrepreneurship or technology innovation.

- **Reports on the development of SI projects:** a scarcity of reports about the development of SI projects was ascertained. Although significant effort has been expended in approaching a definition for the term 'social innovation', little attention has yet been paid to the mechanisms that made it happen.
- **Focus on Proposal stage:** most of the studies mentioned processes and methods concerning the Proposal stage demonstrating that this stage may display higher level of maturity compared to the others. It may also portray projects emphasis on generating innovative ideas and not yet attention to their implementation and sustainability.
- **Lack of development details**: considering that "Prototype" stage comprises development and prototyping activities, it was observed that, from the studies which mention activities concerning this stage, only a few presented more information on prototype construction.
- **Lack of project management practices**: most of the studies did not mention how the SI project was managed according to scope, cost, time or stakeholder management. Moreover, the monitoring aspect of these projects was not clear.
- **Open innovation paradigm**: since SI involves the participation of several actors from different organizations and different sectors, it is natural that open innovation paradigm appears in this literature mapping. This paradigm pursues the collaboration of external resources (volunteers, innovation communities, third sector institutions, universities) which potentially create value for the project. Non-profit organizations and entrepreneurs represent an external source of new ideas, by bringing complementary competencies, such as knowledge of societal needs from particular disadvantaged social categories.
- **Government participation**: Success is somehow dependent to government support. When government decides not to support the project anymore, the SI initiative faces difficulties.
- **Social actor engagement**: The most-cited challenges are lack of competencies, capabilities and skills to successfully develop SI projects, and lack of actors' engagement/commitment/involvement (locals, sponsors, social entrepreneurs and others). These results are in line with the Social Innovation Index Report (THE ECONOMIST INTELLIGENCE UNIT, 2016), where the biggest barriers for SI are lack of time and talent to reach the best work done. Information related on what techniques and tools are used to maintain actors involved and how they relate and communicate along the project was also missing.

- **Technological solutions to support the development process**: only a few were reported, and they focus on technological platforms to support the SI ecosystem, although these supporting platforms features are not yet clearly defined.
- **Results time-frame**: No time restriction was placed on the search, but the majority of results date from 2012-2017, showing a degree of novelty of this research field and the need for more scientific research on the topic. The field gained interest after the global financial crisis in 2008.
- **Social innovation results**: most studies do not present any information concerning the impact (positive or negative) of SI developed. Those which reported some impact, showed mostly economic results.

A1.4. Conclusions

This paper reported a systematic literature mapping in the field of social innovation (SI), with the goal of identifying the state of art on the development of SI projects. 28 studies from a gross total of 576, were selected and evaluated. It was shown that research on several topics concerning the development of SI projects is still scarce. SI development processes, from ideation to implementation and scalability, are not completely described, no detailed information exists about the use of methods and tools, lack of implementation results, lack of project management information, and very limited knowledge on relationship between social actors or on how skills can be developed to manage SI projects.

This raises the question: why are there so few studies presenting the development of SI projects? Probably, this is so because SI may not be seen by all authors and researchers as the result of a development process, considering that these projects are conducted in an ad-hoc basis. Since a project is an endeavor undertaken to create a unique product or service and that many authors identify SIs as a response to the greatest social challenges that the world currently faces, why do not consider the development of a SI as a temporary endeavor undertaken to create a unique social product or social service, that is, a project? Or maybe it is an open project once it is developed crossing organizational boundaries?

Considering that there are thousands of SI initiatives around the world (HOWALDT et al., 2016), methodological approaches which improve and support this development process, engage the actors, support knowledge exchange, and respect the requirements of this type of innovation, have the potential to increase the number of SI projects that reaches implementation, scalation and, in the end, effective social impact.

To take into account the complexity of SI, further research is needed for proposing development methodologies considering an environment formed by multiple actors, the local context needs, the relationships between actors, where cross-sector collaboration is crucial to overcome social demands and societal challenges, actively involving public, economic and civil society partners (HOWALDT et al., 2016). Probably these solutions call for significant collaboration and co-creation methodological and technological solutions based on participatory design and a human-centered approach.

What is clear is that SI is already a force for positive change in many developed and developing markets alike; that it is being incorporated in public and private administration, analyzed by a variety of, and pursued by entrepreneurs and investors. Future studies concerning its development process will raise the positive results achieved by this type of innovation.

References

ABE, H., WATANABE, S., ONODERA, A., ISHIKI, Y. (2016) "PPP (Public Private Partnership) frontier; A study on Local Abenomics driven social innovation", In: *Proceedings of Portland International Conference on Management of Engineering and Technology* (PICMET '16), Honolulu, USA, pp. 314-333.

ALTUNA, N., CONTRI, A. M., DELL ERA, C., FRANTTINI, F., MACCARRONE, P. (2015) "Managing social innovation in for-profit organizations: the case of Intesa Sanpaolo", *European Journal of Innovation Management*, Vol. 18, No. 2, pp. 258-280.

ANGELIDOU, M., PSALTOGLOU, A. (2017) "An empirical investigation of social innovation initiatives for sustainable urban development", *Sustainable Cities and Society*, Vol. 33, pp. 113-125.

BENNEWORTH, P., CUNHA, J. (2015) "Universities' contributions to social innovation: reflections in theory & practice", *European Journal of Innovation Management*, Vol. 18, No. 4, pp. 508-527.

BRERETON, P., KITCHENHAM, B.A., BUDGEN, D. (2007) "Lessons from applying the systematic literature review process within the software engineering domain", *Journal of Systems and Software (JSS),* Vol. 80, No. 4, pp. 571–583.

CAULIER-GRICE, J., DAVIES, A., PATRICK, R., NORMAN, W. (2012) "*Defining social innovation*", TEPSIE, European Commission - 7th Framework Programme, Brussels: European Commission, DG Research.

CHOU, D. C. (2018) “Applying design thinking method to social entrepreneurship project”, *Computer Standards & Interfaces*, Vol. 55, pp. 73-79.

DAVIES, G., GAVED, M. (2017) “Seeking togetherness: moving towards a comparative evaluation framework in an interdisciplinary DIY networking project”, In: *Proceedings of the 8th International Conference on Communities and Technologies* (C&T '17), 2Troyes, France, pp 1-4.

DUFOUR, S., LESSARD, D., CHAMBERLAND, C. (2014) “Facilitators and barriers to implementation of the AIDES initiative, a social innovation for participative assessment of children in need and for coordination of services”, *Evaluation and Program Planning*, Vol. 47, pp. 64–70.

FERRARIO, M. A., SIMM, W., NEWMAN, P., FORSHAW, S., WHITTLE, J. (2014) “Software engineering for “social good”: integrating action research, participatory design, and agile development”, In: *Companion Proceedings of the 36th International Conference on Software Engineering - ICSE Companion 2014*, Hyderabad, India, pp. 520–523.

FUGER, S., SCHIMPF, R., FÜLLER, J., KATJA HUTTER, K. (2017) “Network structure and user roles of a crowdsourcing community – The context of social innovations for a development project”, In: *Proceedings of the 50th Hawaii International Conference on System Sciences*, Hawaii, USA, pp. 647-656.

GARCIA, A., MARSH, J., TREJO, F., SWITTERS, J. (2010) “Living Labs and regional innovation policies in the Mediterranean area” In: *Proceedings of eChallenges e-2010,* Warsaw, Poland, pp. 1–8.

GASCÓ, M. (2017) “Living labs: Implementing open innovation in the public sector”, *Government Information Quarterly*, Vol. 34, pp. 90–98.

HARRISSON, D., CHAARI, N., COMEAU-VALLÉE, M. (2012) “Intersectoral Alliance and Social Innovation: When Corporations Meet Civil Society”, *Annals of Public and Cooperative Economics*, Vol. 83, No. 1, pp. 1–24.

HOWALDT, J., KALETKA, C., SCHRÖDER, A. (2016) “Social Entrepreneurs: Important Actors within an Ecosystem of Social Innovation”, *European Public Social & Social Innovation Review*, Vol. 1, No. 2, pp. 95-110.

JANSE VAN RENSBURG, N., MEYER, J., NEL, H. (2016) “Social innovation, research and community engagement: Managing interdisciplinary projects for societal change”, In: *Proceedings of IEEE International Conference on Industrial Engineering and Engineering Management,* Bali, pp. 1785–1789.

JUDIT, K. K., VARGA E., NEMES, G. (2016) "Understanding the process of social innovation in rural regions: some Hungarian case studies", *Studies in Agricultural Economics*, Vol. 118, pp. 22-29.

KITCHENHAM, B., CHARTERS, S. (2007) "*Guidelines for performing systematic literature reviews in software engineering",* Technical Report *EBSE-2007-01*, Ver. 2.3 EBSE, UK.

KITCHENHAM, B., BRERETON, O.P., BUDGEN, D., TURNER, M., BAILEY, J., LINKMAN, S. (2009) "Systematic literature reviews in software engineering - A systematic literature review", *Information and Software Technology*, Vol. 51, No. 1, pp. 7-15.

MARCHETTA, P., SALVI, A., NATALE, E., TIRRI, A., TUFO, M., DE PASQUALE, D. (2012) "S2-MOVE: Smart and Social Move", In: *Proceedings of 2012 Global Information Infrastructure and Networking Symposium (GIIS)*, Choroni, Venezuela, pp. 1-6.

MARTI, P., MEGENS, C., HUMMELS, C. (2016) "Data-Enabled Design for Social Change: Two Case Studies", *Future Internet*, Vol. 8, No. 46, pp 1-16.

MATSUSHITA, O., TSUDA, A., SAKAMOTO, M., FUJII, K., OTA, S. (2015) "Effects of Design Thinking on transnational collaborative projects in engineering", In: *Proceedings of IEEE 7th International Conference on Engineering Education (ICEED)*", Kanazawa, Japan, pp. 112-117.

MAZZARELLA, F., MITCHELL, V., ESCOBAR-TELLO, C. (2017) "Crafting sustainable futures: the value of the service designer in activating meaningful social innovation from within textile artisan communities", *The Design Journal*, Vol. 20, pp. 2935-2950.

MULGAN, G. (2006) "The process of social innovation", *Innovations*, Spring, pp. 145-162.

MURRAY, R. CAULIER-GRICE, J. MULGAN, G. (2010) "*The Open Book of Social Innovation*", National Endowment for Science, Technology and the Art, Available at: www.socialinnovator.info.

NEMES, G. (2017) "Failing To Connect: Superfast Broadband, Rurality & The Failing Governance Of Rural England", In: *Proceedings of the XXVII Congress. Uneven processes of Rural Change: On Diversity, Knowledge and Justice*, Kraków, Poland, pp. 46-50.

NEUMEIER, S. (2017) "Social innovation in rural development: identifying the key factors of success", *The Geographical Journal*, Vol. 183, No. 1, pp. 34–46.

NEUMEIER, S. (2012) “Why do social innovation in rural development matter and should they be considered more seriously in rural development research? Proposal for a stronger focus on social innovation in rural development research”, *Sociologia Ruralis*, Vol. 52, pp. 48-69.

OBATA, A., OHORI, K., KOBAYASHI, N., HOCHREUTER, H., KENSING, F. (2012) “Challenges of participatory design for social innovation a case study in aging society” In: *Proceedings of the 12th Participatory Design Conference: Exploratory Papers, Workshop Descriptions, Industry Cases* (PDC '12), Roskilde, Denmark, Vol. 2, pp. 9-12.

PAI, M., MCCULLOCH, M., D GORMAN, J., PAI, N., ENANORIA, W., KENNEDY, G., THARYAN, P. COLFORD Jr, J.M., (2004) “Systematic reviews and meta-analyses: an illustrated, step-by-step guide”, *The National Medical Journal of India*, Vol. 17, No. 2, pp. 86-95.

QUANDT, C., FERRARESI, A., KUDLAWICZ, C., MARTINS, J. MACHADO, A. (2017) "Social innovation practices in the regional tourism industry: case study of a cooperative in Brazil", *Social Enterprise Journal*, Vol. 13, No. 1, pp. 78-94.

ROCLE, N., SALLES, D. (2018) “Pioneers but not guinea pigs: experimenting with climate change adaptation in French coastal areas”, *Policy Sciences*, Vol. 51, No. 2, pp. 231–247.

SCHAFFERS, H., MERZ, C., GÚZMAN, J. (2009) “Living Labs as Instruments for Business and Social Innovation in Rural Areas”, In: *Proceedings of the 15th International Conference on Concurrent Enterprise (ICE)*, Leiden, The Netherlands, pp. 1-8.

STOKES, M. BAECK, P., BAKER, T. (2017) “What next for digital social innovation? Realising the potential of people and technology to tackle social challenges”, *Technical report* - DSI4EU project, European Comission, Nesta, May, 2017.

TAYLOR, J.B. (1970) “Introducing Social Innovation”, *The Journal of Applied Behavioral Science*, Vol. 6, No. 1, pp. 69-77.

TELLO-ROZAS, S. (2016) “Inclusive Innovations Through Social and Solidarity Economy Initiatives: A Process Analysis of a Peruvian Case Study”, *Voluntas*, Vol. 27, No. 1, pp 61–85.

TENA-ESPINOZA-DE-LOS-MONTEROS, M. A. (2016) “Civic innovation as a response to social problems”, *Proceedings of the Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality - TEEM ’16*, Salamanca, Spain, pp. 447–453.

THE ECONOMIST INTELLIGENCE UNIT (2016) "*Social Innovation Index 2016 - Old problems, new solutions: Measuring the capacity for social innovation across the world*", Nippon Foundation, September, 2016, Available at: https://eiuperspectives.com/technology-innovation/old-problems-new-solutions-measuring-capacity-social-innovation-cross-world-0.

WESTLEY, F., ANTADZE, N. (2010) "Making a difference: strategies for scaling social innovation for greater impact", *Innovation Journal*, Vol. 15, No. 2, pp. 1-19.

WESTLEY, F., ANTADZE, N., RIDDELL, D. J., ROBINSON, K., GEOBEY, S. (2014) "Five Configurations for Scaling Up Social Innovation Case Examples of Nonprofit Organizations from Canada", *The Journal of Applied Behavioral Science*, Vol. 50, No. 3, pp. 234–260.

Appendix 2. Social Innovation Ecosystem Conceptual Model derived from the Observational Study

This appendix details the development of the conceptual model concerning in a real scenario of a social innovation ecosystem, as described in Chapter 3.

Introduction.

The work carried out during the observational study made it possible to identify elements that compose a real social innovation ecosystem. In this way, we took the opportunity to develop a conceptual model with the data collected in this study. The model was developed using the Unified Modeling Language[26] (UML) notation and Astah[27] tool. The UML notation was chosen, given its wide adoption in conceptual models' development and ease of use and interpretation (TILAKARATNA & RAJAPAKSE, 2017). A brief guide to the UML notation symbols is shown in Figure 45.

The conceptual model represents the current situation of the social innovation ecosystem as it is, without incorporating any changes or improvements. Its purpose is to summarize in a single picture the critical aspects of the social innovation ecosystem investigated in our study, helping to answer questions such as who the key actors and their roles of the ecosystem are and how these entities (actors, roles, infrastructure, etc.) interact with each other.

The social innovation ecosystem observed was composed of the following main elements:

- *Actors* are ecosystem stakeholders. They are volunteers, which means that they have no economic gain, but they expect to achieve professional and personal gain from helping others in the ecosystem;
- *Infrastructure* represents the physical and digital support for the communication and mentoring activities which were used during the mentoring cycle;
- *Social innovations* that are currently being developed by the mentees; and

[26] https://www.omg.org/spec/UML/2.5.1/PDF
[27] https://astah.net/

•*Events* are elements used for promoting communication, training, knowledge sharing, and mentoring. They are also used for planning and monitoring ecosystem activities.

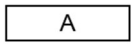
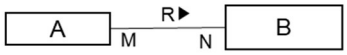
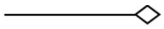
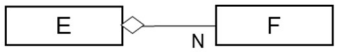
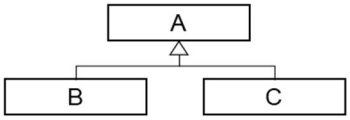
Notational Symbols	Description
	A is an element of the conceptual model
	The line indicates the relationship between elements. R indicates the relationship name and the arrow represents the direction of the relationship.
	The letters M and N represent the number of values that can be involved in a given relationship. Element A relates R to N values of element B and element B relates to M values of element A.
	This arrow represents an aggregation (it is part of).
	Element E is composed of N values of element F.
	This arrow represents an inheritance.
	Elements B and C are subtypes of element A and consequently inherit the characteristics of element A. However, B and C have particular characteristics.

Figure 45. UML notation symbols.

In this model, presented in Figure 46, an *Actor* has the following registered information: *name, formal id, date of birth, availability, internal function,* and *occupation*. It is important to register his/her availability because it indicates the number of weekly hours that an actor dedicates to the ecosystem activities, as all actors have their own professional occupations (e.g., university researcher, consultant, PhD student). The actor may have an internal function in the university, playing as a researcher, technician, or student, or he/she has an external function not concerning study or work at the university. This information is used for communication and security purposes. For instance, as some meetings took place into the university's spaces and during some weekends; so, it is necessary to inform and register external visitors at the university's security department.

An *Actor* plays one or more *Roles,* such as *Mentor*, *Mentee*, *Collaborator*, or *Ecosystem manager*. A Mentor suggests strategies and presents new ideas for a Mentee to run the social innovation project actions, taking a specific area into consideration. He/she uses his/her expertise to advice a Mentee, who has specific needs. In this specific ecosystem case, needs are concerning guidance regarding leadership, teamwork, communication skills, project planning, fundraising, and technological support. An actor playing different roles is common in other social innovation ecosystems, as reported by Butzin & Terstriep (2018).

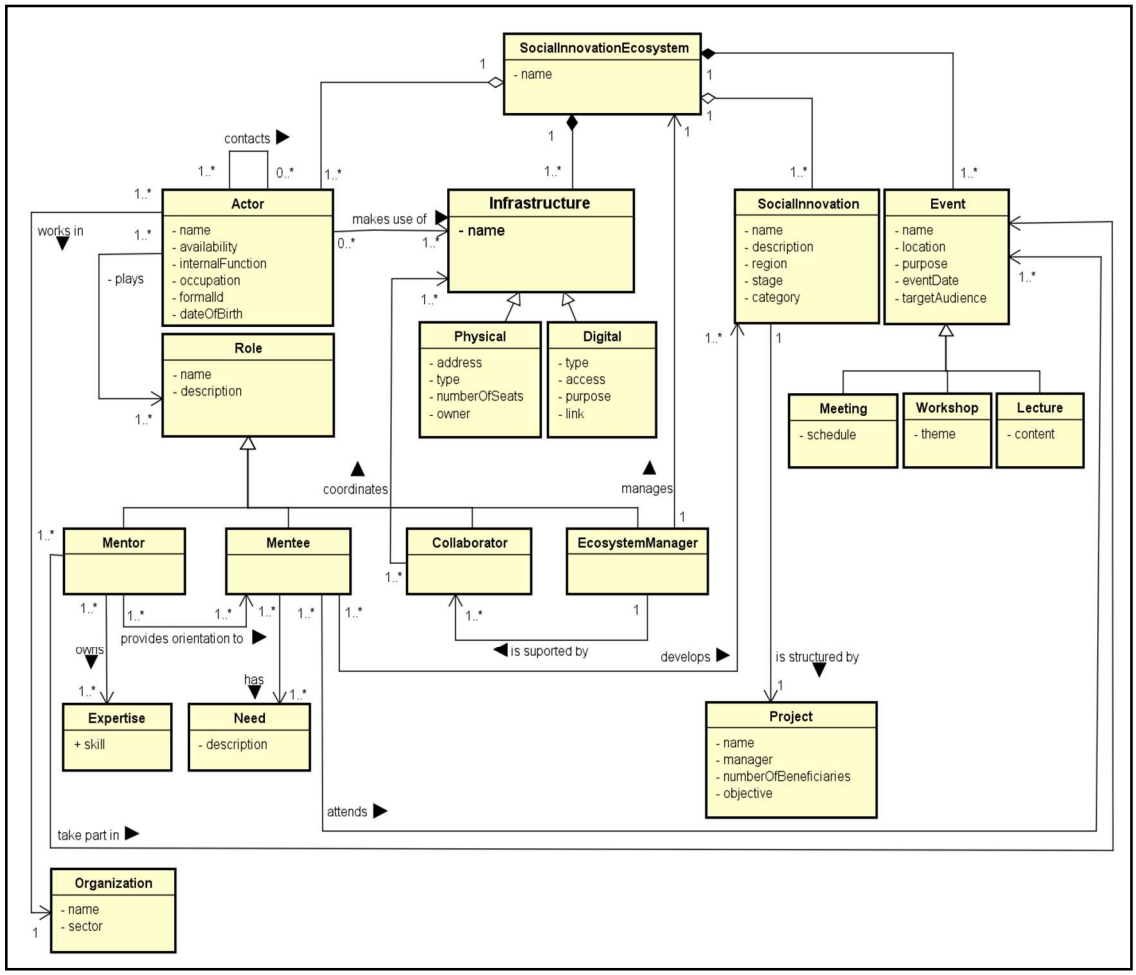


Figure 46. Conceptual model developed from the observational study.

In our observational study, there were two situations where an actor played as a mentor in a project and as a mentee in another project. It happened when an actor who had strong leadership skills to advice several mentees at the same time had his/her own project that needed fundraising support from another mentor, for instance. A *Collaborator* may provide support to the *Ecosystem Manager*, may coordinate physical and digital Infrastructure, or may give lectures. The ecosystem manager is a role responsible for managing the ecosystem's actors and activities. Once again, the ecosystem manager defines that one actor can provide mentorship from 1 to 4 social innovation projects, because the involved actors are not dedicating his/her efforts exclusively to the ecosystem.

An *Actor* works at one *Organization* which has a name and is concerning an economic sector. An economic sector is: i) first sector: public companies and government; ii) second: private for-profit businesses; and iii) third: voluntary associations, charities, non-profit organizations, community groups, and foundations. The ecosystem observed in our study had developers from all sectors, since there was a mentor from a federal

university (first sector); a mentor from an enterprise (second sector); and project developers from several nonprofit organization (third sector).

An *Actor* uses an *Infrastructure* that supports the ecosystem. An Infrastructure may be physical, such as a meeting room, a classroom, or an auditorium. In this case, it may be used for: i) meetings held by *Mentor* and *Mentee*; ii) meetings held by *Collaborators* and *Ecosystem Manager* for planning the ecosystem's activities; and iii) workshops and lectures involving all ecosystem actors. In order to set an event in a physical infrastructure, a *Collaborator* provides its address, number of seats and type (meeting room, auditorium or classroom) to book a specific place. *Digital Infrastructure* concerns software used to support communication and knowledge sharing, such as *Facebook* or *Google Mail*.

A *Mentee* develops a *Social Innovation* which has a name, description, location (place where the social innovation occurs), category and stage. Category is a social innovation domain, for instance, health, sport, education, or culture. A stage is a group of activities which are developed during the social innovation process. According to Murray et al. (2010), a social innovation may be developed according to a process comprising some stages: i) prompts; ii) proposals; iii) prototypes; iv) sustaining; v) scaling; and vi) systemic change. A *Social Innovation* is structured as a *Project*. A *Project* has a name, a manager (who is responsible for it), the amount of people that will benefit from the results provided by the social innovation (beneficiaries), and a project objective.

An *Event* has a name, location (where it takes place), a purpose, a place in a Physical Infrastructure, a date, and a target audience. *Meetings* follow a schedule previously defined by a mentor or a collaborator. Other possible events are *Workshops* to introduce a new concept or demonstrate and encourage the practice of current methods (e.g., design thinking). It is useful to allow mentors and mentee to apply some methods and work together. *Lectures* are provided to ecosystem actors to present real social innovations from other countries, and they have an associated content.

Appendix 3. SIDE Conceptual Model Glossary

This appendix contains the glossary of elements that compose the SIDE conceptual model, presented on Chapter 5. For each element, its definition and references are presented. The elements added to the model after expert evaluation are presented with a bold indication.

Actor	individual or organization capable of performing functions and representing a participant in the social innovation ecosystem, being able to assume one or more roles (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018).
Artifact	product, information, content, model that an actor uses or provides (DONG et al., 2007a; KIDANU et al., 2015).
Beneficiary	an individual to whom a social innovation is directed. (HOWALDT et al., 2016).
Benefit	a social or economic advantage that an actor gains from participating in an ecosystem (DONG et al., 2007; WU & CHANG, 2007; GRETZEL et al., 2015).
Collaboration	the recursive process in which two or more people or organizations work together to intersect common goals. It is also understood as articulating a common effort towards an objective (MISTRÍK et al., 2010).
Collaboration Technique	a technique that provides a means to support collaboration between ecosystem actors (DONG et al., 2007).
Collaborator	an actor who works in a social innovation ecosystem in collaborative activities, assisting developers of social innovations (CHUERI et al., 2019).
Common Vocabulary	common terms used by the actors to communicate with each other (DONG et al., 2007).
Communication	any act by which a person provides or receives from another person information about that person's needs, desires, perceptions, knowledge, or affective states (FERRI et al., 2014).
Communication Event	an event to foster communication between the actors of the ecosystem. It can be a meeting, a lecture, a workshop etc. (CHUERI et al., 2019).
Developer	the inner core of social innovation initiatives, responsible for transforming unsatisfactory social circumstances into innovative ideas and developing and implementing the idea to make it a social innovation (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018).
Evaluation	a periodic, systematic assessment of a project's relevance, efficiency, effectiveness, and impact on a defined population. Evaluation draws from data collected during monitoring, as well as data from additional surveys or studies to assess project achievements against set objectives (PRESKILL & BEER, 2012).
Impact Metrics	metrics used to assess the impact, durability, and success of social innovation
Interoperability	the ability of two or more systems or components to exchange information and to use the information that has been exchanged (FERRI et al., 2014; KIDANU et al., 2015)
Knowledge Item	Knowledge Item: an artifact that may be a lesson learned, which is knowledge or understanding gained by experience, which may be positive, as in a successful test or mission, or negative, as in a failure (DRAKE, 2018).
Knowledge Service	knowledge management processes necessary to organize, maintain and distribute knowledge to all the actors (FERRI et al., 2014)
Knowledge Provider	actor who provides relevant specialist knowledge to stimulate and enrich the development process. They can provide knowledge through lectures, courses, or artifacts, in the form of dialogues, feedback, knowledge sharing, and suggestions for further improvements (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018).
Mentor	a specialist professional who advises, suggests strategies, and presents new ideas for the project team to carry out the social innovation project's necessary actions, taking into account a specific area (CHUERI et al., 2019).

Metric	quantitative measures, such as the number of on-time projects. They are used in improvement programs to determine whether improvement has taken place or whether goals and objectives have been met (PRESKILL & BEER, 2012).
Orchestrator	someone who coordinates activities in the ecosystem. An actor who performs the following activities: i) invite organizations, professionals, researchers, representatives of social innovation to join the ecosystem; ii) define how ecosystem activities are monitored; iii) identification of possible partners, iv) identification of the main events; v) definition of the digital presence; vi) establishment and use of communication channels; vii) monitor ecosystem activities; and viii) define and monitor ecosystem governance (KIDANU et al., 2016; CHUERI et al., 2019).
Organization	company or institution that participates in a digital ecosystem (CHANG & WEST, 2006).
Person	a human as an individual.
Platform	component, providing an essential function to a technological system, acts as a basis for developing complementary products, technologies, or services.
Platform Administrator	an actor (individual or organization) who is responsible for: i) support the ecosystem actors; ii) manage the design and operation of the platform throughout the ecosystem's lifecycle; iii) integrate new functionalities into the platform where feasible; and iv) offer supporting tools, materials, specific guidance, and resources that orient actors to the platform. Adapted from (TREISMAN et al., 2016)
Policy	a guideline that defines the desired state within an ecosystem expressed through agreements and restrictions. It covers mandatory, legal, and aspirational policies (VASILĂŢEANU & ŞERBĂNAŢI, 2011).
Privacy	the state of being free from danger or threat. (KIDANU et al., 2015).
Privilege	special right or advantage that a particular person or group has (KIDANU et al., 2015).
Process	consists of steps concerning the operationalization of ecosystem policies (VASILĂŢEANU & ŞERBĂNAŢI, 2011).
Process Index	is a type of performance measurement. Also known as Key Performance Indicator (KPI), it is a set of quantifiable measures that an ecosystem uses to gauge and compare performance in terms of meeting their strategic and operational goals.
Product	a type of artifact ready to be used by an actor. It may be information, data, spreadsheet, template, or other digital content.
Profile	set of information describing an actor with his/her preferences. A profile can define preferences in social innovation, such as social causes, target audience, etc. (KIDANU et al., 2015).
Project	it is a temporary effort to create an exclusive product, service, or result (PMI, 2017).
Promoter	actors involved in social innovation processes such as partners providing infrastructure equipment, financing, and connecting initiatives to public policy programs (TERSTRIEP et al., 2015; BUTZIN & TERSTRIEP, 2018).
Quality Requirement	a requirement that pertains to a quality concern that is not covered by functional requirements (ABNT, 2015).
Requirement	conditions or tasks that must be completed to guarantee the success or completion of the project (PMI, 2017).
Role	an act played by an actor in interacting with other actors (KIDANU et al., 2016).
Service	software functionality or a set of software functionality with the aim that different actors can use them for different purposes, following the policies that should control their use (based on the customer's identity requesting the service, for example) (FERRI et al., 2014)
Skill	ability to achieve a particular goal quickly and efficiently (DOMANSKI & KALETKA, 2018).
Social Cause	an issue that society has recognized as a problem that prevents society from functioning at an ideal level and influences many citizens (TERSTRIEP et al., 2015).
Social Innovation	new solutions that simultaneously address a social cause more efficiently than existing solutions, bring new or improved capabilities (and relationships), and enable better use of resources, improving society's capacity to act (CAULIER-GRICE et al., 2012).
Social Innovation Digital Ecosystem	an ecosystem that provides the interaction of a community of actors formed by organizations (social or profit-oriented), universities, entrepreneurs, individuals, and government, to generate social innovations (products, processes, and services) to meet the challenges of society through a technological platform (supporting actors, their relationships and artifacts) and a collaborative, inclusive and open process (CHUERI, 2018)
Sustainable Development Goals (SDG)	A goal that offers clear guidelines and targets for all countries to adopt by their environmental priorities and challenges worldwide (KULMAN & RIP, 2018; UN, 2020).

Social Needs	social needs are concerning achieving the well-being of the individual and society. For example, needs concerning health, education, housing, among others (MULGAN, 2006).
Social Network	web-based services that allow individuals to 1) build a public or semi-public profile in a limited system; 2) articulate a list of other users with whom they share a connection; and 3) view and scroll through a list of connections and those made by others within the system (FERRI et al., 2014).
Stage	A group of activities that social innovation actors execute to take ideas from inception to impact (MURRAY et al., 2010).
Target Audience	category of people who benefit from social innovations (CHUERI et al., 2019). For example: people with some physical disability, low-income families, unemployed immigrant women, among others.
Task	a mission that an actor is performing to achieve his/her goals in an ecosystem environment (DONG et al., 2007a; KIDANU et al., 2015)
Tool	a type of software that helps develop, operate, and maintain systems (GLINZ, 2017)
Web Service	a specific type of service identified by a URI (Uniform Resource Identifier), whose description of service and transport uses open Internet standards (FERRI et al., 2014).

Appendix 4. SIDE Conceptual Model Evaluation Instrument

This appendix presents the evaluation instrument of the SIDE conceptual model, described in Chapter 5 and is developed in Portuguese.

Seção 1. Termo de Consentimento Livre Esclarecido

PROCEDIMENTO.

A avaliação ocorrerá de forma virtual e será dividida em duas etapas:
(1) Questionário fornecendo informações demográficas.
(2) Entrevista sobre ecossistemas digitais de inovação social. Para esta etapa será disponibilizado um link com as informações a serem avaliadas.

Solicitamos a sua especial colaboração em: (1) responder às questões com as suas impressões sobre o modelo de ecossistema digital de inovação social apresentado; e (2) permitir que os dados resultantes da sua participação sejam estudados.

Estima-se que, para realizar a primeira etapa, sejam necessários cerca de 5 (cinco) minutos e, para a segunda etapa, cerca de 20 (vinte) minutos.

CONFIDENCIALIDADE

Eu estou ciente de que os dados obtidos por meio deste estudo serão mantidos sob confidencialidade e os resultados serão posteriormente apresentados de forma agregada, de modo que um participante não seja associado a um dado específico. Da mesma forma, me comprometo a não comunicar meus resultados enquanto o estudo não for concluído, bem como manter sigilo das informações fornecidas e documentos apresentados.

BENEFÍCIOS E LIBERDADE DE DESISTÊNCIA

Eu entendo que, uma vez que a entrevista tenha terminado, serão desenvolvidos trabalhos visando trazer melhorias para ecossistemas de inovação social.
Entendo que sou livre para realizar perguntas a qualquer momento, solicitar que qualquer informação relacionada à minha pessoa não seja incluída no estudo ou comunicar minha desistência de participação, sem qualquer penalidade. Por fim, declaro que participo de livre e espontânea vontade com o único intuito de contribuir para a avaliação e posterior melhora do modelo do Ecossistema Digital de Inovação Social.

Seção 2. Perfil Acadêmico e Profissional do Entrevistado

Qual sua formação acadêmica? *

- ◯ Ensino Fundamental
- ◯ Ensino Médio
- ◯ Ensino Superior
- ◯ Especialização
- ◯ Mestrado
- ◯ Doutorado

Em que setor você atua? *

- [ ] Público
- [ ] Privado
- [ ] Terceiro Setor (por exemplo: Organizações Não Governamentais, Associações, Entidades sem fins lucrativos)

Há quantos anos você trabalha com inovação social? *

- ◯ Menos de 1 ano
- ◯ Entre 1 e 5 anos
- ◯ Entre 5 e 10 anos
- ◯ Entre 10 e 15 anos
- ◯ Mais de 15 anos

Assinale os tipos de ambientes de inovação social em que você trabalhou: *

- [ ] Laboratório
- [ ] Hub
- [ ] Ecossistema
- [ ] Coletivo
- [ ] Grupo de Pesquisa
- [ ] Outro: _____

Indique sua experiência na utilização das seguintes categorias de ferramentas de tecnologia de informação: *

- [ ] Redes Sociais (Facebook, Instagram, por exemplo)
- [ ] Ferramentas de Colaboração (Monday, Google Docs, por exemplo)
- [ ] Ferramentas de Compartilhamento de Informação (Google Drive, por exemplo)
- [ ] Ferramentas de Apoio à Gestão de Projetos (Trello, Microsoft Project, por exemplo)
- [ ] Ferramentas de Apoio à Reuniões (Skype, Google Meet, por exemplo)
- [ ] Ferramentas de Gestão de Tarefas (Trello, Monday, por exemplo)
- [ ] Outro: _____

Você trabalha com desenvolvimento de sistemas de informação e software? Há quantos anos? *

- ◯ Não possuo experiência
- ◯ Menos de 5 anos
- ◯ Entre 5 e 10 anos
- ◯ Entre 10 e 15 anos
- ◯ Mais de 15 anos

Você conhece ou ouviu falar do termo "ecossistemas digitais"? *

- ◯ Sim
- ◯ Não

Avaliação Parcial do Modelo com base em Evidências

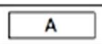
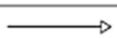
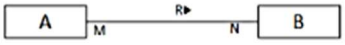
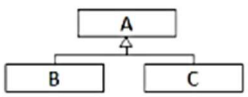
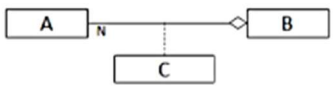
Um modelo conceitual é a representação de um conjunto de entidades e relacionamentos entre essas entidades, que fazem parte de um determinado domínio de conhecimento e que ajudam a entender o domínio em questão. O modelo apresentado nesta avaliação representa uma visão holística dos elementos e relacionamentos envolvidos em um Ecossistema Digital de Inovação Social (ECODIS).

Nesta seção um conjunto de proposições é proposto para explicar as construções e os relacionamentos do Ecossistema Digital de Inovação Social. Cada proposição inclui evidências de estudos publicados na área de ecossistemas digitais e na área de ecossistemas de inovação social. Esses estudos podem ser conferidos nas referências, apresentadas no link: https://bit.ly/Documentos_do_Modelo_ECODIS. Neste mesmo endereço apresenta-se a imagem do modelo completo e o glossário de termos utilizados.

Orientações para análise das proposições:
1. Leia as evidências;
2. Analise a proposição associada à evidência;
3. Verifique a parte do modelo que representa a proposição;
4. Marque sua resposta (eu concordo / não concordo / desconheço);
5. Justifique sua opinião com comentários e exemplos. Por favor, ajude-nos a melhorar o modelo conceitual, adicionando sugestões.

O modelo conceitual foi construído usando UML (Unified Modeling Language). Caso não conheça a notação, não há problema. Você pode ver um resumo dos elementos utilizados nesta linguagem no quadro a seguir ou acessar o documento oficial da UML (https://www.omg.org/spec/UML/2.5.1/PDF).

Notação utilizada no modelo conceitual

Símbolo utilizado no modelo	Descrição
	A letra *A* representa um elemento do modelo conceitual.
	O símbolo da linha representa o relacionamento entre elementos, a letra R representa o nome do relacionamento e a seta representa a direção do relacionamento.
	Esta seta representa uma agregação (é parte de).
	Esta seta representa uma herança.
	As letras *M* e *N* representam o número de valores que podem estar envolvidos em uma determinada relação. O elemento *A* se relaciona *R* com *N* valores do elemento *B*. Enquanto que o elemento *B* se relaciona com *M* valores do elemento *A*.
	O elemento *E* é composto de *N* valores do elemento *F*.
	Os elementos *B* e *C* são subtipos do elemento *A* e consequentemente herdam as características do elemento *A*. No entanto, *B* e *C* possuem características particulares.
	C está associado ao relacionamento entre A e B.

Após cada conjunto de proposições e evidências apresentados é apresentado o quadro a seguir contendo as opções e a pergunta para o participante explicitar sua concordância com o trecho do modelo apresentado e com a proposição, além da questão para ele contribuir com comentários:

- ◯ Concordo
- ◯ Não concordo
- ◯ Desconheço

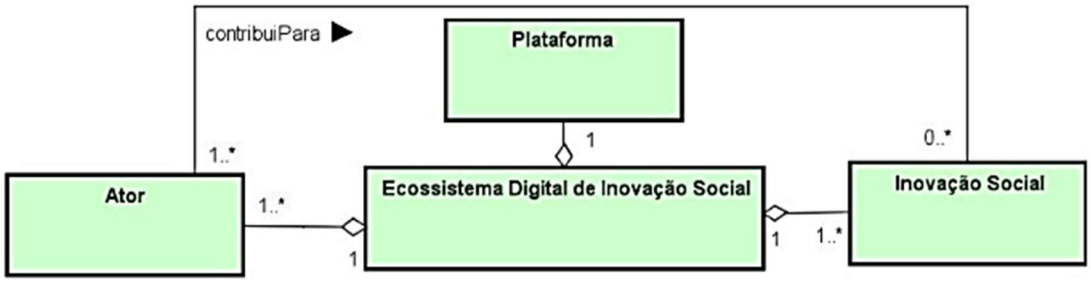
Comente sua resposta e, se desejar, registre sugestões e/ou exemplos.

Sua resposta

Proposição 1 - Um Ecossistema Digital de Inovação Social (ECODIS) é formado por atores, inovações sociais e uma plataforma.

Descrição (opcional)

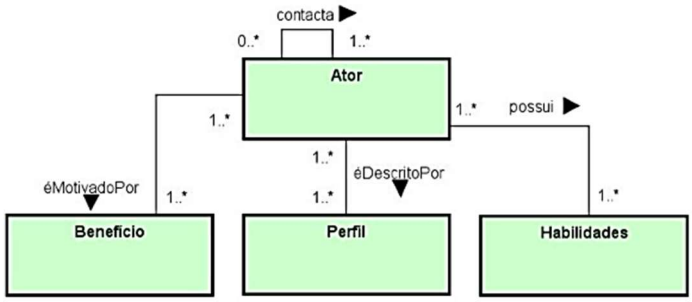
Evidências 1 - Um ECODIS é um ecossistema em que os atores da inovação social interagem e colaboram por meio do suporte fornecido por uma plataforma tecnológica comum para o desenvolvimento de inovações sociais (ou seja, produtos, processos ou serviços) para enfrentar os desafios da sociedade [1] *



Proposição 2 - Os atores de um ECODIS possuem habilidades e competências, são descritos por um perfil e são motivados por benefícios que podem obter pela sua participação no ecossistema.

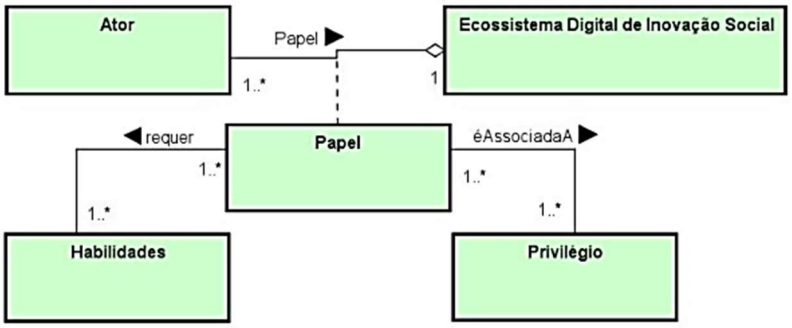
Descrição (opcional)

Evidências 2 - Um ator é um indivíduo ou organização capaz de desempenhar funções e que representa um participante do ecossistema [2]. Um ator interage com pelo menos um outro ator [3]. Um perfil é um conjunto de informações que descrevem um ator com suas preferências [3] e é possuído por um ou mais atores. O benefício representa uma vantagem social ou econômica que o ator recebe por participar do ecossistema digital [4]. *



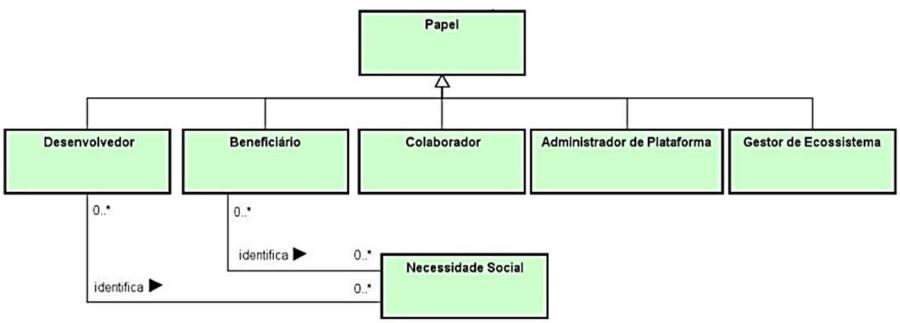
Proposição 3 - Cada ator pode desempenhar um ou mais papéis na sua relação com o ecossistema.

Evidências 3 - Um papel é a forma de atuação de um ator na interação com outros atores [2] no ecossistema. Atores em um ecossistema digital podem atuar por meio de mais de um papel ao mesmo tempo. [2]. As inovações sociais são caracterizadas por uma ampla gama de atores envolvidos, que podem ter vários papéis que variam entre diferentes inovações e no processo de desenvolvimento de uma única inovação [5][6]. Cada papel possui um conjunto de privilégios associados [2] e necessita de habilidades para ser realizado. *



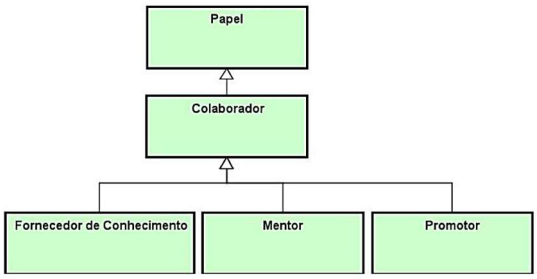
Proposição 4 - Atores podem assumir o papel de desenvolvedor, colaborador, beneficiário, administrador da plataforma e gestor do ecossistema. Desenvolvedores e beneficiários podem identificar necessidades sociais que servirão de inspiração para o desenvolvimento de inovações sociais.

Evidências 4 - Em um ecossistema de inovação social, atores podem assumir o papel de desenvolvedores e de colaboradores, como os promotores, apoiadores e provedores de conhecimento [6]. Um Beneficiário é um indivíduo ou um grupo de indivíduos que compartilham algumas necessidades a quem a inovação social é direcionada [7]. O Desenvolvedor [5] [6] é responsável por transformar uma ideia inovadora e desenvolver a solução associada à inovação social. O Gestor do ecossistema é responsável por definir os processos internos como a inserção de novos atores no ecossistema, planejamento e realização de ações de monitoramento do ecossistema, entre outras [1]. O Administrador da plataforma é responsável pela gestão e configuração dos serviços da plataforma. Beneficiários ou Desenvolvedores identificam necessidades sociais, que podem inspirar projetos de inovação social [1]. *



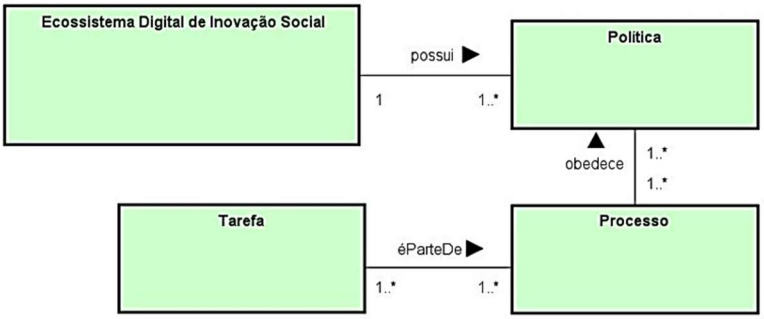
Proposição 5 - Atores podem contribuir com uma inovação social atuando como um mentor, provedor de conhecimento ou promotor.

Evidências 5 - Um fornecedor de conhecimento fornece conhecimento especial relevante para estimular e enriquecer o processo de desenvolvimento de uma inovação social [5][6]. Um promotor é um ator que atua como parceiro, fornecendo equipamentos de infra-estrutura, financiamento e conexão de iniciativas a programas de políticas públicas. Um mentor é um especialista que aconselha, sugere estratégias e apresenta novas idéias para o desenvolvedor executar as ações necessárias do projeto de inovação social [1]. *



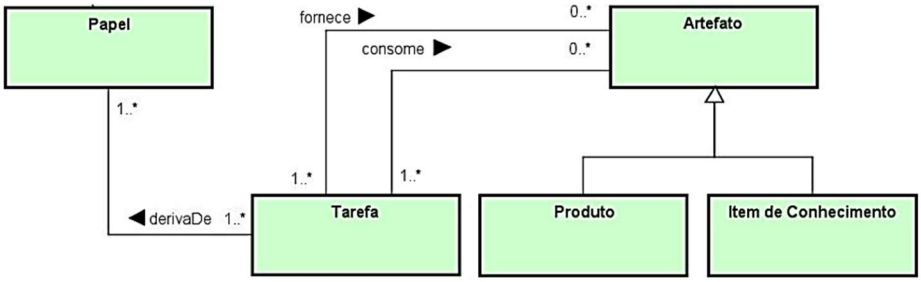
Proposição 6 - Atores realizam tarefas que são derivadas do papel que eles assumem. Estas tarefas fazem parte de processos que podem implementar a política do ecossistema.

Evidências 6 - Um ator realiza uma tarefa para atingir seus objetivos no ecossistema digital [4]. O ator segue as políticas (normas ou regulamentos) do ecossistema [8] Uma política é uma diretriz ou uma meta que define o estado desejado dentro do ecossistema, expresso com restrições e que envolve políticas obrigatórias, legais e aspiracionais [8]. Uma política é realizada por um ou mais processos e uma política pode restringir o comportamento e a evolução de qualquer elemento no ecossistema digital [8]. O objetivo do ecossistema é atingido pela execução dos processos, compostos por tarefas [9]. *



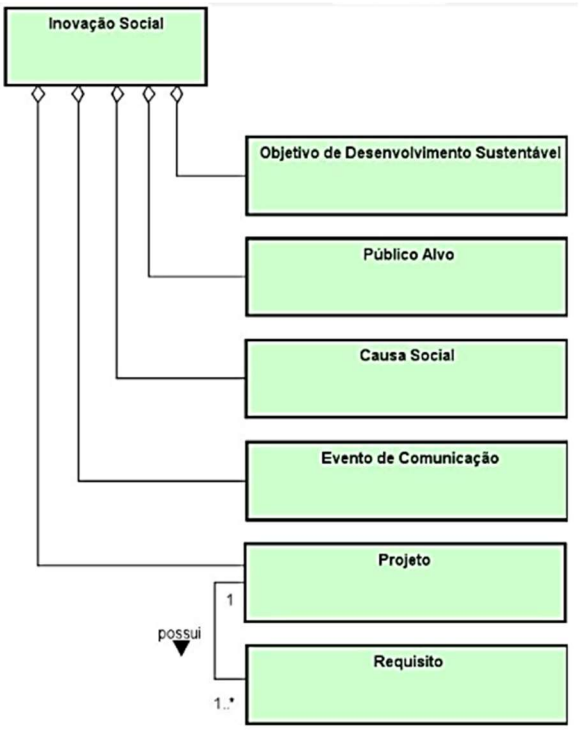
Proposição 7 - Cada tarefa ao ser executada por um ator pode fornecer ou utilizar um artefato do ecossistema.

Evidências 7 - Um ator fornece ou consome um artefato por meio de uma tarefa que ele executa [4][8][9]. O ator executa as tarefas [4][8][10]. As tarefas contribuem para a geração de itens de conhecimento [11][9], que podem ser lições aprendidas ou sugestões para melhorias [6]. Um artefato pode ser um produto [12] ou item de conhecimento. *



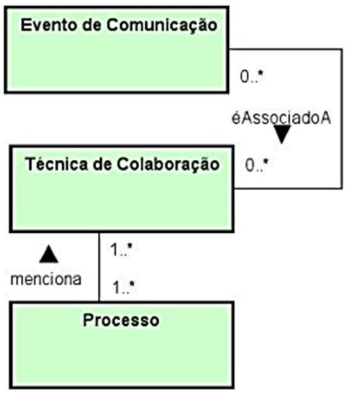
Proposição 8 - Uma inovação social objetiva atender a uma causa social, é relacionada a um objetivo de desenvolvimento sustentável e beneficia um publico alvo. Ela é desenvolvida por meio de projetos.

Evidências 8 - Inovações sociais são novas soluções que simultaneamente atendem a uma causa social de forma mais eficiente que soluções existentes, trazem novas ou melhoradas capacidades (e relacionamentos) e também viabilizam um melhor uso de recursos, melhorando a capacidade de atuação da sociedade [13]. Uma inovação social é desenvolvida por meio de projetos [1][14], que são compostos por requisitos [14][15]. O publico-alvo para o qual é direcionada uma inovação social representa a categoria de beneficiários da mesma [5]. No desenvolvimento de uma inovação social são realizados vários eventos de comunicação [1]. Uma inovação social está relacionada a um ou mais Objetivos de Desenvolvimento Sustentável (ODS) [24]. *



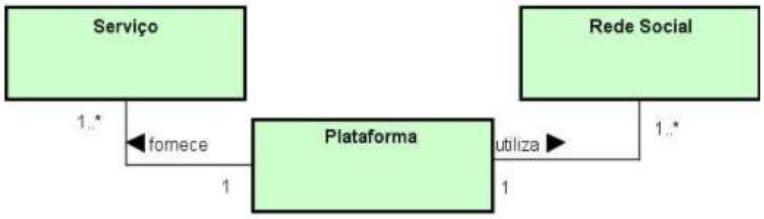
Proposição 9 - Um projeto de inovação social utiliza eventos de comunicação e técnicas de colaboração para promover maior interação entre os atores.

Evidências 9 - Técnicas de colaboração são usadas em ambiente de inovação social para fomentar a colaboração entre os atores destes ambientes [16][17]. Os eventos de comunicação servem para promover a comunicação, o compartilhamento de conhecimentos e a colaboração entre os atores [1].



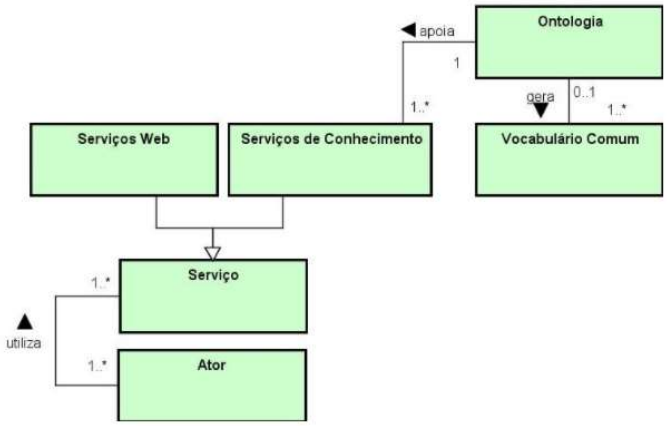
Proposição 10 - O ecossistema possui uma plataforma responsável por apoiar os atores do ecossistema.

Evidências 10 - A plataforma fornece serviços aos atores do ecossistema [4]. A plataforma faz uso das redes sociais para apoio aos atores [11] . Uma plataforma pode prover as seguintes funcionalidades aos atores: i) serviços de informação: aconselhar sobre o que fazer e como, além de criar repositórios de experiências; ii) serviços de colaboração: apoiar atividades de cocriação e colaboração; iii) serviços de comunicação: apoiar a comunicação entre atores; iv) serviços de avaliação: monitorar atividades e resultados; e v) serviços de infraestrutura: conceber, desenvolver e sistematizar os serviços [1]. Uma plataforma auxilia a compreensão das redes sociais, comportamento de atores do ecossistema e interação entre diferentes culturas e contextos [19].



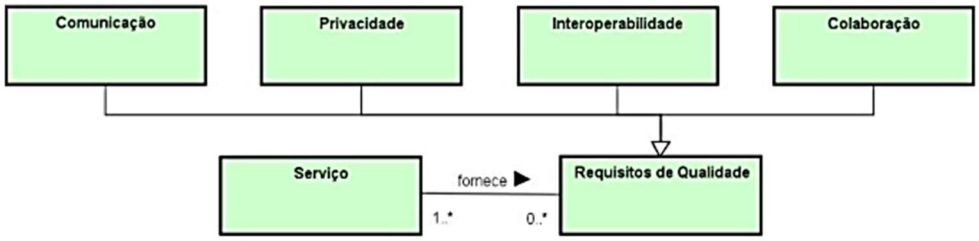
Proposição 11 - Serviços web e serviços de gestão de conhecimento são disponibilizados aos atores por meio da plataforma.

Evidências 11 - O ator se comunica por meio de um vocabulário comum, que é baseado em uma ontologia [18]. A ontologia suporta os serviços de Gerenciamento de Conhecimento ao ser utilizada para facilitar o compartilhamento de conhecimento multidisciplinar entre atores de diferentes setores [2][11]. A plataforma oferece serviços diferentes, incluindo gerenciamento de conhecimento e serviços da web [11]. *



Proposição 12 - Os serviços oferecidos aos atores possuem como requisitos de qualidade a interoperabilidade, privacidade, a colaboração e comunicação.

Evidências 12 - A plataforma possibilita aos atores do ecossistema serviços que envolvem comunicação, colaboração, interoperabilidade [11] [12] [19] [20] [21]. No contexto da inovação social, a colaboração é fator primordial [17]. A privacidade garante aos usuários a proteção de seus dados no ecossistema [2]. Um dos objetivos do ecossistema digital é melhorar a eficiência da comunicação entre os atores [8]. A composição de serviços é um resultado do ambiente dinâmico criado pelo ecossistema, aumentando as habilidades e competências dos atores nos ecossistemas [4].



Em sua opinião o que é um ecossistema de inovação social? *

Texto de resposta longa

Avaliação do Modelo Completo do Ecossistema Digital de Inovação Social

Nas próximas questões da pesquisa, você irá avaliar o modelo completo de acordo com os critérios de Sjøberg et al. (2008), descritos a seguir:

- Testabilidade: Consiste no quanto uma teoria construída é passível de ser empiricamente refutada.
- Suporte experimental: grau em que uma teoria é apoiada por estudos experimentais que confirmam sua validade.
- Poder explicativo: o quanto o escopo de uma teoria é simples, com poucas suposições ad hoc e relacionado com o que já é bem entendido na área.
- Parcimônia: grau em que uma teoria é economicamente construída com o mínimo de conceitos e proposições.
- Generalidade: amplitude do escopo de uma teoria e o grau em que é independente de configurações específicas.
- Utilidade: grau em que uma teoria suporta as áreas relevantes da indústria de software.

O modelo completo do ECODIS é apresentado de forma minimizada a seguir. Contudo, sugerimos que para responder às questões seguintes, consulte o modelo completo no link: https://drive.google.com/file/d/10oVAJqkgItqeEI2uqvYNO4Gse4Gk-Zbq/view?usp=sharing.

Testabilidade: Os elementos e as relações do modelo estão isentos de ambiguidades? *

- ◯ Sim
- ◯ Não
- ◯ Não sei

Suporte experimental: Existem estudos que você conhece que confirmem os elementos e relações do modelo?

- ◯ Sim
- ◯ Não
- ◯ Não sei

Poder explicativo: Os elementos do modelo são compreensíveis pela comunidade de inovação social?

- ◯ Sim
- ◯ Não
- ◯ Não sei

Parcimônia: Na sua opinião, foram utilizados o mínimo de elementos e relacionamentos para construir o modelo?

- ◯ Sim
- ◯ Não
- ◯ Não sei

...

Generalidade: Na sua opinião, o modelo apresentado contempla diferentes cenários de ambientes de inovação social? Caso você não concorde, aponte diferentes cenários que este modelo não contemplaria.

- ◯ Sim
- ◯ Não
- ◯ Não sei

Utilidade: Você considera que o modelo é útil para a teoria e para a prática ou somente para uma das perspectivas?

- ◯ Útil para a teoria e a prática
- ◯ Útil para a prática
- ◯ Útil para a teoria

Appendix 5. Tool Analysis Evaluation Instrument

This appendix presents the instruments applied in the tool analysis described in Chapter 7, performed to evaluate the Management Panel in the eSIDE platform. It is developed in Portuguese.

Appendix 5.1. Study Execution Form

INVESTIGAÇÃO SOBRE ECOSSISTEMAS DIGITAIS DE INOVAÇÃO SOCIAL

Formulário de Execução do Estudo

Contextualização:

Você é um dos integrantes da equipe de gestão de um ecossistema de inovação social e atua apoiando o orquestrador do ecossistema nas atividades de planejamento e acompanhamento. A organização onde você atua fornece apoio na gestão do ecossistema visando apoiar os desenvolvedores de projetos de inovação social, seus colaboradores e beneficiários. Você é responsável pela gestão das informações básicas do ecossistema, como a inclusão de um novo público-alvo ou de uma nova causa social atendidos pelo ecossistema. Sua tarefa é analisar demandas dos atores em relação às inovações sociais em desenvolvimento no ecossistema, os aspectos relacionados ao compartilhamento de conhecimento, à cooperação e comunicação entre os atores. Você também analisa as sugestões enviadas pelos atores com relação a novas habilidades necessárias ao ecossistema, novas tarefas que precisam ser realizadas, mensagens de dúvidas e sugestões de mudança de processo. Você também analisa a taxa de entrada e saída de atores dos diferentes perfis no ecossistema. Outra análise realizada é em relação à satisfação dos desenvolvedores em relação às tarefas realizadas pelos colaboradores. Você analisa se as habilidades requeridas nas tarefas relacionadas às inovações em desenvolvimento estão presentes no ecossistema (por meio dos atores cadastrados) ou se é necessário convidar novos atores para ingressar ao ecossistema. Você analisa os aspectos relacionados ao engajamento dos atores com base na quantidade de tarefas selecionadas pelos atores para colaboração. Além disso, você atende às mensagens dos atores de diversos perfis, buscando sanar dúvidas e conversar sobre as sugestões enviadas.
De acordo com estas características, é possível perceber que, sem um mínimo de organização, rapidamente o controle sobre estas informações pode se perder, deixando o ecossistema passível de desaparecer, seja por desmotivação por parte dos desenvolvedores (ao não contar com o apoio dos colaboradores) ou por parte dos atores colaboradores.

INSTRUÇÕES
Para a execução desta atividade, siga as instruções abaixo:

- Resolva as tarefas do formulário **na ordem em que elas são apresentadas;**
- Registre o **horário de início** e o **horário de término** de cada atividade sempre que solicitado. Se for gasto algum tempo no entendimento da questão antes das atividades, este tempo não deve ser contabilizado;
- **Caso não consiga determinar a resposta, mas tenha uma medida de quanto tempo levaria para executá-la, por favor, responda com o valor em questão e com a palavra "estimativa" entre parêntesis e some as estimativas ao horário de término.**
- O campo Percepção indica a sua certeza na realização da atividade.

Tempo total	
Início:	
Término:	

A1. Qual o número de atores cadastrados no ecossistema que é apresentado na tela principal do painel do gestor?

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A2. Quantos atores estão relacionados ao público-alvo 'Infância e Adolescência'?

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A3. Cite duas causas sociais atendidas pelo ecossistema.

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A4. Quantas mensagens foram enviadas ao gestor pelos atores do ecossistema?

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A5. Quais as **siglas** dos dois objetivos de desenvolvimento sustentáveis (ODS) que possuem uma maior preferência por parte dos atores?

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A6. Cite uma sugestão de tarefa feita por atores do ecossistema ao orquestrador.

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A7. No gráfico de público-alvo e atores, identificar a categoria de público-alvo que possui a maior quantidade de atores interessados nela.

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A8. Cite dois dos indicadores que precisam ser acompanhados para identificar se é necessário investir em ações para melhorar a **comunicação** no ecossistema.

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A9.Selecione cinco os indicadores relacionados à **coordenação** do ecossistema, marcando a prioridade de cada um com um valor de 1 a 5. Depois, faça a análise dos indicadores para o período de 01/05/2021 a 15/05/2021. Cite dois que possuem resultados acima da meta?

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

_____

A10. Ao selecionar apenas indicadores de coordenação para a análise do ecossistema, cite um dos impactos que você acredita que pode acontecer no ecossistema pela não seleção do acompanhamento de indicadores relacionados à cooperação? Agora, gere o Relatório Geral do ecossistema para o período de 01/05 a 15/05/2021. A análise apresentada no relatório gerado corrobora suas opiniões?

Percepção: ___ (0 - 10) Hora Início: ___ Hora Término: ___

A11. Ao analisar o Mapa de Habilidades, qual a habilidade que é mais necessária (possui um maior número de tarefas precisando dela) no ecossistema? O número de atores que possuem esta habilidade é maior, igual ou menor a quantidade de tarefas que precisam da habilidade?

Percepção: ___ (0 - 10)

Hora Início: ___

Hora Término: ___

A12.Ao analisar o Mapa de Habilidades, qual a habilidade que possui mais tarefas precisando dela do que atores com a habilidade?

Percepção: ___ (0 - 10)

Hora Início: ___

Hora Término: ___

Obrigado pela sua colaboração,

Luciana de Oliveira Vilanova Chueri
Aline Pires Vieira de Vasconcelos
Rodrigo Pereira dos Santos

Appendix 5.2. Study Evaluation Form

Formulário de Avaliação do Estudo

Prezado(a) participante,

Esta é a última parte do estudo. O objetivo deste questionário é obter informações adicionais e a sua percepção sobre o estudo, a partir das respostas às questões listadas a seguir:

1) Você conseguiu efetivamente realizar todas as tarefas propostas?

( ) Sim ( ) Não

Comentários:

_____

_____

2) Você ficou satisfeito com o resultado final das tarefas?

( ) Sim ( ) Parcialmente ( ) Não

Comentários:

_____

_____

3) No seu ponto de vista, é possível perceber como atividades de gestão do ecossistema de inovação social, mais especificamente a análise dos aspectos de comunicação, coordenação e cooperação entre atores, podem ser beneficiadas pela visão de Ecossistemas Digitais usando as informações apresentadas?

( ) Sim ( ) Parcialmente ( ) Não

Comentários:

_____

_____

4) Qual o grau de dificuldade na realização das tarefas?

( ) A execução das tarefas é muito difícil

( ) A execução das tarefas é difícil

( ) A execução das tarefas é fácil

( ) A execução das tarefas é muito fácil

Comentários:

_____

_____

5) Qual a maior dificuldade encontrada na realização das tarefas?

Comentários:

_____

_____

6) Ferramenta eSIDE

Por favor, indique o seu grau de concordância com as afirmações colocadas na tabela abaixo:

Afirmação	Discordo totalmente	Discordo	Não concordo nem discordo	Concordo	Concordo totalmente
Foi fácil aprender a usar a eSIDE.					
Consegui utilizar a eSIDE da forma que eu queria.					
Entendi o que acontecia na minha interação com a eSIDE.					
Eu executei facilmente as tarefas com o uso da eSIDE.					
Considero a eSIDE útil para gerenciamento de ecossistemas digitais de inovação social.					
A eSIDE permite relacionar as habilidades dos atores colaboradores com as demandas de habilidades das inovações sociais em desenvolvimento.					
A eSIDE apoia as atividades de gestão de ecossistemas digitais de inovação social.					
A eSIDE auxilia o orquestrador do ecossistema a ter uma percepção geral do funcionamento do ecossistema de acordo com a comunicação, coordenação e cooperação.					

Comentários:

_____

7) Quais as funcionalidades da ferramenta eSIDE que foram mais úteis na realização das tarefas?

Comentários:

_____

8) De acordo com sua opinião, liste os aspectos positivos da utilização da ferramenta eSIDE.

Comentários:

_____

9) De acordo com sua opinião, liste os aspectos negativos da utilização da ferramenta eSIDE.

Comentários:

_____

10) Você possui alguma sugestão para melhoria da ferramenta eSIDE? Em caso positivo, por favor, especifique-a(s). ( ) Sim ( ) Não

Comentários:

_____

11) Quais conclusões ou observações você pode extrair sobre o grau de importância da colaboração entre os atores que desenvolvem inovações sociais e os atores que colaboram nas inovações?

Comentários:

_____

12) Este espaço é reservado para quaisquer comentários adicionais (dificuldades, críticas e/ou sugestões) a respeito do estudo executado. Contamos com sua contribuição para o aprimoramento deste trabalho.

Comentários:

_____

Novamente, gostaríamos de agradecer por sua disponibilidade e participação neste estudo.

Luciana de Oliveira Vilanova Chueri
Aline Pires Vieira de Vasconcelos
Rodrigo Pereira dos Santos