Inter-InnoLab Collaboration

Conceptualization, Assessment, and Technological Supportive Artifact of the Interconnection among Innovation Laboratories

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Abstract

Over the recent years, the paradigm of Innovation Laboratories (abr. InnoLabs) is gaining an increasing attention among business organizations as a potential source of assistance in the process of the development of new or the improvement of their existing products and/or services. Business organizations approach the InnoLabs in the search for assistance in dealing with the challenges of the often times complex and uncertain innovation process, and ultimately become successful in their innovation projects. Although the overall goal of the existing InnoLabs is to support the systematic, effective, and efficient innovation development, they target different innovation challenges and thereby vary in their focus and service offerings. As a consequence, all the innovation support that might be needed in the course of an innovation process remains dispersed among different InnoLabs. In this esteem, this thesis aims to centralize all the mediated support offered by the existing InnoLabs by bringing them into a collaborative network. In pursuance of this, initially, the diversity among the existing InnoLabs in terms of their structural and functional manifestations is explored by employing a triangulation of online survey and in-depth expert interviews with the InnoLab facilitators. Subsequently, based on the diversity observed herein, the incentives, approaches, and possibilities of interconnection among InnoLabs are determined.

Having conceptualized the framework for inter-InnoLab collaboration, the next part of this thesis deals with facilitating such collaborations in an online space. The internet, since its inception, has drastically altered the practices of intra- and inter-organizational connectivity. Recently, one could observe a growing interest among all types of organizations towards the social networking sites (abr. SNSs) as an effective medium for reaching out to a global audience. As a result, a significant amount of business related information is already available and continuously accumulating on SNSs. However, the SNSs fall inadequate in supporting the inter-InnoLab collaboration because of the missing dedicated functionalities, isolated platform boundaries, platform dependencies, lack of support for domain-specific features, privacy concerns, and issues of data transparency. In response to this, this thesis advocates the designing of dedicated inter-organizational collaboration platforms with seamless integration of SNSs’ data. Successively, employing a design science research approach, a dedicated, domain specific, and SNSs integrated web-based collaboration platform (the InnoLab_Net) is designed for supporting inter-InnoLab collaborative activities.
List of Relevant Publications

Following publications have arisen from the work described in this thesis.

Journal publication, peer reviewed


Journal publication, under review


Conference publications


Electronic publication

Preamble and Acknowledgements

The research work contained in this thesis has been conducted between 2013 and 2016. The first idea of this thesis was developed in September 2013 when I joined the Round-Trip Innovation for System services (ROUTIS)\(^1\) project team at the University of Leipzig. The main objective of the project was the development of a reference model for the roundtrip engineering of services with special attention being given to the question that how innovation can be stimulated and evaluated in such a process. The project intended to adapt the roundtrip engineering method from the production industry to the services sector and implement it in test cases using existing Innovation Laboratories. Therefore, the role of Innovation Laboratories that they play in acting as intermediaries between different stakeholders and providing tools and expertise for the innovation process was being explored. In this regard, during the preliminary investigation of Innovation Laboratories from their web representation, it was realized that the term ‘Innovation Laboratory’ is used as a hypernym where the underlying concepts vary in their structure as well as functioning. This diversity raised the questions that ‘if and how are the existing Innovation Laboratories collaborating with each other in order to leverage the diverse competencies of each other?’ Being the computer science enthusiasts, another main question popping in our minds was ‘how can we connect the geographically apart Innovation Laboratories and assist them in collaborating with each other in an online space?’ These two questions collectively shaped this research work and have been pursued till its completion.

During my thesis I was enrolled as a PhD student at the University of Leipzig. Doctoral studies, being a journey of discovery, is impossible without the support and help of so many individuals whom I would like to express my sincere appreciation.

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\(^1\) http://www.routis.de/
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Finally, I am thankful to my parents for their unconditional love and prayers, and all of my friends and family for their continuous support throughout this journey.

Atia Bano Memon
Leipzig, Germany
October, 2016
For my parents

Afroze Bano & Munawar-ud-din Memon

who are the most precious asset of my life
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List of Abbreviations

AJAJ  Asynchronous JavaScript and JSON
API   Application Programming Interface
B2B   Business-to-Business
CoDiT Company Discovery Tool
DSR   Design Science Research
ENoLL European Network of Living Laboratories
EnP   Entry Point
ExP   Exit Point
HTML  HyperText Markup Language
ID    Identification
IIC-MM Inter-InnoLab Collaboration Maturity Model
IICP  Inter-InnoLab Collaboration Platform
InnoLab Innovation Laboratory
IT    Information Technology
JSON  JavaScript Object Notation
LCC   Leipzig Corpora Collection
MySQL My Structured Query Language
Net_Map Network Map
OAuth Open Authentication
OCP   Online Community Platform
PHP   Hypertext PreProcessor
SIDIL Social networks interlinked Directory of Innovation Laboratories
SNS   Social Networking Site
SQL   Structure Query Language
UI    User Interface
URL   Universal Resource Locator
WAMP  Windows + Apache + MySQL + PHP
WFGM  Want, Find, Get, and Manage
Chapter 1
Introduction

“The last thing one discovers in composing a work is what to put first.”

— Blaise Pascal

This thesis presents the outcome of an exploratory and investigative study of the phenomenon of Innovation Laboratories, and the design, development and evaluation of a novel web-based collaboration platform for Innovation Laboratories in eight self-contained chapters. This chapter being the first one sets the stage by introducing the research context and the relevant problem, and explaining why this topic was chosen for the study. Besides introducing the research topic, this chapter also provides a succinct overview of the research objectives together with the relevant research questions, main contributions, research design, and the organization of this thesis.

1.1 Research context

The central question guiding this research work is ‘how can we connect the structurally and functionally diverse Innovation Laboratories in a collaborative network in order to centralize all the mediated support that they offer for the systematic, effective, and ultimately successful development of the innovative products and services of business organizations?’ Accordingly, this work lies on the junction of two research areas: 1) an empirical investigation of the paradigm of Innovation Laboratories and their interconnection, and 2) a design science research corresponding to the web-based support for inter-InnoLab collaboration.

1.1.1 Innovation Laboratories

Innovation has always been a driving force for the growth of business organizations (Zahra & Covin, 1994). Increasingly, over the recent years, it has become the key for survival. In the past, many businesses were able to survive even only by providing quality products and maintaining them at their level of competitiveness. Currently, however, the recent technological advancements, increasing globalization, so-called knowledge based economy (Godin, 2006), and continuously changing markets have triggered the demand for innovation so immensely that the organizations often find themselves in a ‘innovate or die’ situation, whereby they are challenged to continually innovate new technologies and new capabilities (Benbasat & Zmud, 2003; Mueller, Rosenbusch, & Bausch, 2013; Storey & Salaman, 2009) not only to gain lead in the business competition but even to survive in the market (Ettlie & Reza, 1992; Howell & Higgins, 1990).

On the other hand, innovation process is an inherently complex and uncertain activity (Jalonen, 2011) with high risk and reward factors attached to it (Demirbas, Hussain, & Matlay, 2011). Accordingly, while undertaking innovation activities, business
organizations, especially the SMEs, encounter several endogenous or exogenous challenges (Madrid-Guijarro, Garcia, & van Auken, 2009); such as difficulties in obtaining resources (technological information, raw materials, and finance), assessing markets (customers’ needs, demands and perceptions), and lack of internal resources (funds, technical expertise or management time) (Hadjimanolis, 1999).

Consequently, for overcoming the innovation barriers and unlocking the innovation potential, business organizations have started seeking assistance from outside the organizational boundaries. In this regard, one of the potential sources of assistance for business organizations are the innovation intermediaries who enhance their innovation capacities by serving as an agent of information exchange (Haakanson, Caessens, & MacAulay, 2011; Smedlund, 2006), technology transfer (Hargadon & Sutton, 1997) and network formation (Batterink, Wubben, Klerkx, & Omta, 2010) between two or more organizations, or by providing innovation services directly to a business organization on a one-to-one basis where no third party is involved (Howells, 2006). An emerging type of such innovation intermediaries providing one-off services to business organizations are the Innovation Laboratories, hereafter referred to as InnoLabs.

An InnoLab is a creative physical space (Magadley & Birdi, 2009) and/or group of facilitators (Gey, Meyer, & Thieme, 2013) enabling the configuration of new innovation projects (Lewis & Moultrie, 2005) through the provision of the creativity tools and technical resources for the generation, discussion and assessment of ideas (Thieme & Meyer, 2011), and the mediated services for the systematic, efficient, and effective implementation of the innovation process (Memon, Meyer, Meyer, & Fähnrich, 2014). During the last two decades, the phenomenon of InnoLabs has gained rapid popularity among all sectors of the world. Nevertheless, the extent of their service exploitation by business organizations suffers from two problems:

1. Depending on the individual lacking and challenges of the innovation process, business organizations strive for different types of innovation assistance. Consequently, a business organization seeking innovation assistance needs to understand where a certain InnoLab depending on the offered functionality may be able to support and where it might not be able to. However, the existing definition of InnoLabs gives only a holistic view of their construct and functioning and is, therefore, deficient for understanding what type of innovation assistance can be solicited at these facilities and how a business organization may be benefited out of the mediating support offered by them.

2. Albeit the resulting impact of various services offered at different InnoLabs is the systematic innovation process that yields successful innovation in the market and brings growth to the implementing organization, they observe innovation process from different perspectives, address different innovation challenges, and attempt to solve the respective challenges in a different way. Henceforth, the range of innovation support that might be needed in the course of a single innovation project remains fragmented among different autonomous and geographically distributed InnoLabs. As a result, in order to get all the required support, a business organization may need to consult more than one InnoLab in
the course of a single innovation project. This results in higher demands of resources (time and effort) on the part of businesses and therefore may cause the less fruition of innovative ideas in the market if the business organization is not able to find all the support or is not willing to indulge in multiple alliances with different InnoLabs.

In this esteem, this thesis deals with the following research areas:

- The investigation of overall construct of InnoLabs in terms of their structural and functional aspects in order to disseminate a conclusive description of the paradigm and augment the extant literature in explaining that how InnoLabs are a potential source of assistance for business organizations in undertaking innovation projects.

- The inquiry of the necessity, incentives, and current state of interconnection among InnoLabs in order to outline the possibilities of centralizing all the mediated support offered by InnoLabs and thereby improving their potential in supporting innovation process.

1.1.2 Web-based support for inter-InnoLab collaboration

The advent of the internet and new mechanisms of communication, especially the web 2.0 tools, have dramatically changed the practices of inter- and intra-organizational connectivity. Recently, one could observe the rapid growth and popularity of web-based communication and collaboration tools for the inter-organizational interconnection. Nevertheless, their application in the context of Business-to-Business (B2B) collaboration in general and inter-InnoLab collaboration in particular, is limited by the fact that different collaboration tools focus on supporting only a certain collaboration activity or phase. For example, where the communication and networking tools facilitate the information exchange and interaction among the participating parties, the project management tools like Basecamp\(^2\), and Trello\(^3\) support them in coordinating and managing the tasks in the course of a certain project. As a result, the necessary support for the whole collaboration process (from networking to partnering to collaboration) is dispersed among different types of tools.

In such realm, one of the existing approaches integrating several necessary functionalities for interconnection is the paradigm of social networking sites (SNSs). The SNSs offer a great deal for organizations in introducing and promoting their products and/or services and reaching out at a global audience and are thereby gaining high popularity among business organizations as a potential tool for connecting with their customer base and other businesses. Increasingly, nowadays almost every organization uses one or another social media channel for achieving one or another organizational goal, and therefore, a significant amount of business information is already available on these sites. However, there exists a rich and diverse ecology of SNSs that vary in terms of their scope and functionality (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). All of these sites

\(^2\) https://basecamp.com/
\(^3\) https://trello.com/
work in isolation from each other resulting in the clustering and scattering of businesses and the related data within specific platform boundaries (Memon & Meyer, 2015). Furthermore, the SNSs support the collaboration activities in a general context lacking the support for domain specific features and dedicated functionalities of a particular business domain.

To this end, this study seeks to create an effective artifact for supporting the inter-InnoLab collaboration and thereby address the inadequacies of existing solutions by employing a Design Science Research (DSR) approach. The DSR with its roots in engineering and ‘the science of the artificial’ (Simon, 1996) seeks in the creation of IT artifacts that are the innovations embodied by the ideas, practices, products, or technical capabilities helping to solve real-life problems effectively (Hevner, March, Park, & Ram, 2004; Simon, 1996). DSR is contrasted from the social / behavioral science paradigm that has been dominating the information systems research for a long time by ‘the behavioral science seeks to understand what is true’, whereas ‘the DSR seeks to create what is effective’ (Hevner et al., 2004). DSR artifacts include both purely (or nearly purely) technical and socio-technical artifacts (Venable, Pries-Heje, & Baskerville, 2012). This thesis seeks to create a socio-technical artifact aiming to support the inter-InnoLab collaboration process. Specifically, to this direction, current thesis deals with the following research areas:

- Conceptualization of web-based B2B collaboration platforms supporting whole collaboration process within a particular business domain with dedicated functionalities and seamless integration of their information hosted on the existing SNSs.

- The requirement elicitation, design, and development of a technological supportive artifact for the InnoLabs in order to assist them in identifying and exploiting the opportunities for collaboration and thereby attaining higher levels of inter-InnoLab collaboration.

1.2 Motivation

This section outlines the rationale and motivation underlying the work presented herein.

Motivation 1. The extant literature on InnoLabs is segmented and lacking large-scale empirical evidence from field settings

Notwithstanding, over the recent years the phenomenon of InnoLabs has gained much attention in economic markets, the concept has largely remained scientifically unexplored and unstructured (Burger & Hermann, 2010). Amongst the existing studies on InnoLabs, the scholars have focused on describing the structure and behavior of an InnoLab either abstractly (e.g. Gey et al., 2013; Schmidt, 2009), based on individual case studies (e.g. Lewis & Moultrie, 2005; Magadley & Birdi, 2009), or focusing on a specific type of InnoLabs (e.g. Konsti-Laakso, Pihkala, and Kraus (2012) and Kusiak (2007) have explicitly focused on the properties and effectiveness of living laboratories). The case-based and focused nature of these studies restricts the general portrayal of identified
characteristics and functionalities. As a result, a conclusive definition and description of the paradigm of InnoLabs is still lacking in the extant literature.

**Motivation 2. There is dearth of the awareness of incentives and possibilities of inter-InnoLab collaboration**

In the literature on innovation, the positive impact of inter-organizational collaboration towards the innovation potential of participating organizations is widely acknowledged (e.g. Ahuja, 2000; Goes & Park, 1997; Willoughby & Galvin, 2005). Assuming InnoLabs as a class of organizations seems logical in that they offer their services directly to the customers on a one-to-one basis and every InnoLab operates as an autonomous unit. Accordingly, it becomes obvious that the structurally and functionally diverse InnoLabs may also gain similar economical and functional advantages if they exercise inter-InnoLab collaboration. Furthermore, since the field of InnoLabs is in emerging state, the possibilities of supporting business organizations in their quest to develop and implement successful innovations are continuously being investigated and new needs for the innovation support are being outlined. Therefore, the practice of inter-InnoLab collaboration seems to be a necessary step towards supporting sustainable innovations. Nevertheless, the academic literature has not yet taken the concept of inter-InnoLab collaboration under consideration and therefore the motivation, necessity, incentives, and possibilities for InnoLabs for engaging in collaborative activities with their peers are largely left unidentified.

**Motivation 3. There is scarcity of dedicated web-based tools facilitating inter-InnoLab collaboration**

The existing general web-based communication and/or collaboration tools suffer from two limitations in supporting inter-InnoLab collaboration: 1) Because the InnoLabs are in incepting stage and experience business competition with each other, they are reluctant to disclose their detailed technical information on open platforms such as SNSs where the user privacy can be compromised in many ways (Lucas & Borisov, 2008). 2) Since the InnoLabs are a different type of organizations, their collaboration requires the definition and identification of each other with respect to several domain-specific attributes, and the dedicated functionalities that are not supported by the existing tools. This highlights the need for dedicated web-based tools facilitating inter-InnoLab collaboration while maintaining the data transparency and domain specificity of shared information and offered functionalities. In this regard, to the best of researcher’s knowledge, there exist only three networking websites dedicated for the InnoLabs: Innovation Lab network⁴, i-Lab Net⁵, and European Network of Living Labs⁶. Furthermore, these platforms are mainly focused on the communication and networking activities between InnoLabs with a very little support for subsequent stages of the collaboration process. Thus, the tools facilitating the whole inter-InnoLab collaboration process are still missing in practice.

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⁴ [http://innovation-lab.org](http://innovation-lab.org)
⁵ [https://ilabnet.essex.ac.uk](https://ilabnet.essex.ac.uk)
⁶ [http://www.openlivinglabs.eu](http://www.openlivinglabs.eu)
Motivation 4. There is lack of applications integrating business information available on SNSs within domain-specific B2B collaboration platforms

The existence of several SNSs with specific platform boundaries restricts the information retrieval without actually getting on the particular platform and in turn necessitates the organizations to regenerate same information on multiple platforms in order to disseminate it to their audience. Moreover, the customer oriented business information available on existing SNSs might also be desirable for sharing with other businesses and thus need to be integrated within dedicated B2B collaboration platforms. However, despite that the SNSs have opened up their data for third party applications in the form of Application Programming Interfaces (APIs), there exists no known service that may facilitate the cross-platform exchange and/or information synchronization across multiple SNSs and B2B platforms.

1.3 Research objectives, questions, and contributions

In the light of aforementioned motivations, the work presented herein seeks to achieve following research objectives:

Objective 1: A comprehensive study of the phenomenon of InnoLabs

RQ1. What are the InnoLabs and how they support successful innovation management of products and/or services of business organizations?

In response to this question, the study followed an empirical investigation of current practices and functioning of InnoLabs through the triangulation of an online survey and in-depth expert interviews. As a result, the study establishes a well-defined definition of the concept of InnoLabs (Section 4.1), and frames a service based classification of InnoLabs (Section 4.2). It was observed that, in addition to the offered services, InnoLabs differ in terms of several other structural and functional aspects as well. Accordingly, the primary and secondary differentiating traits of InnoLabs are highlighted (Section 4.3) that serve to differentiate InnoLabs within and across categories. Finally, the study identifies 30 service offerings of InnoLabs and successively maps them into 8 key functionalities that add substantial value in maximizing the chances of the success of innovation project (Section 4.4).

Objective 2: An investigation of the state of the art of inter-InnoLab collaboration

RQ2. Why InnoLabs should exercise inter-InnoLab collaboration and what is the current extent of interconnection among InnoLabs?

In response to this question, the study employed an analytical investigation of the overall construct of InnoLabs and identified the determinants that reflect the necessity for inter-InnoLab collaboration (Section 5.2.1), and the potential benefits that inter-InnoLab collaboration is likely to generate for the participating InnoLabs, their customers, and the innovation environment as a whole (Section 5.2.2). Successively, the study proposes a reference architecture of a collaborative network of InnoLabs framed on the basis of their
service based classification (Section 5.3) and depicts that how such network may enhance the potential of participating InnoLabs for supporting the innovation development throughout the innovation process. In pursuance of examining the current extent of interconnection among InnoLabs, an inter-InnoLab collaboration maturity model (IIC-MM) is devised that depicts the various degrees on integration that an InnoLab may exhibit while proceeding from a non-collaborating to a collaborating state (Section 5.4). Subsequently, the proposed model is used to assess the current maturity of inter-InnoLab collaboration (Section 5.5). The findings show that the collaboration among InnoLabs is very sparse. Accordingly, three main factors that hinder the InnoLabs from engaging in collaborative activities are identified (Section 5.6).

Objective 3: Development of the technological supportive artifact for inter-InnoLab collaboration with seamless integration of data from SNSs

RQ3. How can we support the diverging InnoLabs in attaining the higher levels of inter-InnoLab collaboration in an online space?

To answer the RQ3, a list of required functionalities for assisting the InnoLabs in attaining higher levels of inter-InnoLab collaboration is derived by employing an analytical examination of their functioning and the IIC-MM (Section 6.1). Subsequently, the required functionalities are compared with the offerings of existing web-based collaboration tools in order to identify the areas where the existing tools fall inadequate (Section 6.2). From this analytical framing, it was recognized that there is a need for a dedicated platform for InnoLabs for addressing the specific requirements of inter-InnoLab collaboration. However, the SNSs are vastly being used by InnoLabs and consequently a significant amount of their relevant data is already existing there that might be useful for inter-InnoLab collaboration. In response to this, the potential of APIs available from different SNSs was examined to outline the possibilities of their integration within the dedicated platform for InnoLabs. Subsequently, a novel domain-specific web-based inter-InnoLab collaboration platform (the InnoLab_Net) is developed that integrates business pages and relevant information from SNSs with the domain specific attributes and dedicated functionalities of inter-InnoLab collaboration (Chapter 7).

To this end, current study besides facilitating a dedicated platform for inter-InnoLab collaboration makes three generic contributions. One, it offers a tool for supporting integrated search for business pages hosted on multiple SNSs with business specific features (Section 7.3.4.1). Two, it elucidates that how domain specific business directories can be designed while integrating them with the members’ business pages and the associated data from existing SNSs. The concept has been operationalized in the form of Social networks Interlinked Directory of InnoLabs (Section 7.3.4.2). Three, it presents a novel methodology for retrieving and categorizing (for further query refinement) the information resources through the corpus-based semantical equivalents and significant co-occurrences. The proposed methodology has been implemented in the ‘Information Search’ module that facilitates an integrated search for the local (platform owned) and the remote (SNSs owned) information resources (Section 7.3.4.7).
Chapter 1

1.4 Research structure and thesis organization

The abovementioned research objectives are achieved by a two-phase research approach consisting of an empirical research corresponding to the development of a theoretical framework of the InnoLabs and inter-InnoLab collaboration, and a DSR corresponding to the development of technological support for inter-InnoLab collaboration. Figure 1.1 depicts the overall research procedure of the study. A brief overview of individual chapters of this thesis follows:

Chapter 2 provides a broad survey of scientific information on key areas of the study. The major focus of the survey is to collate up-to-date information and synthesize the theoretical perspectives and roadmap of the study. The chapter starts by surveying the current state of the art on innovation management in general, and on InnoLabs in particular. The comments are based on theoretical analysis of interesting parameters such as definition, identified characteristics, and focused functionalities of InnoLabs, and the generalizability and reliability of the findings presented therein. The chapter then recapitulates the essential facts concerning the existing web-based collaboration tools applicable for inter-organizational connectivity. Finally, three dedicated community platforms for InnoLabs are introduced and analyzed in terms of supported collaboration activities.

Chapter 3 presents the research design and methodological approach of the study. The chapter starts with a description and justification for the selection of the data collection methods (online survey and in-depth expert interviews) employed in this study and outlines the design and administration procedure of each research instrument. Subsequently, the chapter provides a brief introduction of DSR and describes how the development phase of current study adopts a DSR approach.

Chapter 4 presents the first set of empirical findings of the study and establishes the comprehensive theory on the phenomenon of InnoLabs. The chapter starts with the definition of the concept followed by a service based classification, and structural and functional characterization of InnoLabs, respectively. Successively, the chapter debates on the functional roles of InnoLabs towards the successful innovation management of products and/or services.

Chapter 5 establishes the theoretical framework concerning the inter-InnoLab collaboration. In the beginning, the chapter outlines the need and benefits of inter-InnoLab collaboration and thereby presents a motivation for the InnoLabs towards engaging in collaborative activities. Subsequently, the chapter proposes a reference architecture for a collaborative network of InnoLabs. The next part of the chapter presents an analysis of the current extent of interconnection among InnoLabs, and accordingly debates on the main obstacles curtailing the InnoLabs from collaborating with each other.

Chapter 6 presents an analytical investigation on how a dedicated web-based collaboration platform for InnoLabs can assist them in attaining higher levels of inter-InnoLab collaboration. The chapter identifies the required functionalities and analyzes the potential of existing solutions in facilitating the identified functions. Subsequently, the chapter presents an analysis of the APIs available from four leading SNSs with an
aim to identify the opportunities for their cross platform integration. Finally, the chapter presents the proposed design of a web-based inter-InnoLab collaboration platform (abr. IICP).

Chapter 7 presents the design, development, and evaluation of the InnoLab_Net. The chapter begins with the illustration of high-level architecture and implementation technologies of the InnoLab_Net, and then moves to the description of the functional modules of the platform. The chapter concludes with a discussion on the evaluation of the InnoLab_Net.

Chapter 8 concludes the thesis. It summarizes the previous chapters, recapitulates the contributions made and points out their limitations, and gives an outlook to interesting future work.

Figure 1.1 - Research procedure of the study and organization of the thesis
Chapter 2

Theoretical Foundations

“A successful man is one who can lay a firm foundation with the bricks others have thrown at him.”

― David Brinkley

This chapter summarizes the relevant aspects of three areas of literature/practice which helped to locate the research carried out for this thesis, identify specific research gaps, and inform the development of a conceptual framework of the technological supportive artifact for inter-InnoLab collaboration. The chapter starts with a background information on collaborative innovation and the role of innovation intermediaries in supporting collaborative innovation. The review then moves to the summary of the relevant literature on the topic of InnoLabs and identifies the relevant knowledge gaps that shape the rationale for undertaking this research (Section 2.1). The next part of the chapter introduces the various web-based communication/collaboration technologies and identifies their potential applications and shortcomings in inter-organizational context (Section 2.2). The last part of the chapter introduces three online community platforms dedicated for InnoLabs and provides a comparative analysis of identified platforms in terms of integrated technology, and usability and sociality features (Section 2.3).

2.1 Paradigm of Innovation Laboratories

This section explores the concept and rationale of collaborative innovation starting from the wide perspective of the field and gradually converging and focusing on the intermediaries offering one-to-one innovation assistance to the business organizations – the dedicated innovation spaces. The review then turns to the studies explicitly focusing on the topic of InnoLabs and elaborates the previous research regarding their structure and functioning and thus specifies the open research questions for the current study.

2.1.1 From in-house to collaborative innovation

Innovation has long been acknowledged as one of the critical driving forces for the long-term growth and survival of business organizations (Zahra & Covin, 1994) among continually growing competition (McGrath, Tsai, Venkataraman, & MacMillan, 1996). Innovation is initiated by the perception of a new market opportunity which leads to the design, development, production, and marketing of novel products and services. Since organizations use innovation as a tool to influence or response their internal or external environments (Damanpour, 1991), it is tightly coupled to changes depending on the organization’s resources, capabilities, strategies, and requirements (Baregheh, Rowley, & Sambrook, 2009) that result in the design of new products, new materials, new processes, new services, and new organizational forms (Ettlie & Reza, 1992). Accordingly, innovation can broadly be defined as “the creation of new products, processes, knowledge or services by using new or existing scientific or technological
knowledge, which provides a degree of novelty either to the developer, the industrial sector, the nation, or the world in order to succeed in the marketplace.” (Galanakis, 2006).

Increasingly, the innovation strategies of business organizations not only need to address the improvement and further development of existing products and services but also the development of new technologies and competencies – the exploitation and exploration of innovation, respectively (March, 1991; McGrath, 2001). Whereas the exploitative innovation primarily builds on improvements and refinements of current skills and processes (Holmqvist, 2004; Levinthal & March, 1993) and lead to incremental product changes (Amason, Shrader, & Tompson, 2006) which mainly aim at penetrating existing markets, the exploratory innovation primarily involves the challenging of existing approaches and thereby is best captured by the notions like search, discovery, experimentation, and risk taking (March, 1991; McGrath, 2001).

Nowadays, pertaining to the recent globalization, accelerating technological advancements, and the increasing unpredictability and demanding nature of clients, the issue for many organizations is not a question of whether or not to innovate but rather how to do it successfully (Prajogo & Ahmed, 2006). Innovation, by definition, is an evolving process with high risk and reward factors attached to it (Demirbas et al., 2011) and thereby demands intertwined processes of ideation, creation, design and delivery, supported by an appropriate managerial infrastructure to balance risks against rewards. Moreover, innovation activities are increasingly targeted at organizations’ ability to create more value. Thus, the complexities that arise when designing and implementing an innovation are directly related to the multitude of objectives and capabilities of adapting organization. Nearly all organizations, both large and small, struggle with the organizational aspects of innovation. Research shows that despite of their best intentions to give structural attention to innovation, they experience difficulty in finding the right balance between innovation exploitation and exploration (March, 1991). Additionally, their potential for undertaking innovation activities is fraught with several endogenous (internal to the organization) or exogenous (external to the organization) innovation barriers (Madrid-Guijarro et al., 2009); such as difficulties in obtaining resources (technological information, raw materials, and finance), assessing markets (customers’ needs, demands and perceptions), and lack of internal resources (funds, technical expertise or management time) (Hadjimanolis, 1999).

In such a complex realm, for enabling the best possible value creation and fostering and developing the innovation potential, the context in which organizations operate and organize innovation has changed. In previous years organizations would keep the innovation process solely in-house, nowadays the doors of the R&D department are wide open (Chesbrough, 2003; Chesbrough, 2006). It is currently more and more essential to collaborate with other businesses, customers, institutions and even with competitors (Thieme & Meyer, 2011), even more in an international context, in order to combine different knowledge and assets (Jørgensen & Ulhøi, 2010) into the innovation process. Therefore, the innovative solutions and products are increasingly created cooperatively through an entire value chain with several organizations involved (Coombes, Allen, Humphrey, & Neale, 2009; Coombs, Harvey, & Tether, 2003; Meyer & Thieme, 2010) selected according to their comparative advantages (MacCormack, Forbath, Brooks, & Kalaher, 2007).
In this new model of collaborative / dispersed innovation (also known as open innovation model), organizations employ both internal and external pathways to exploit technologies and concurrently to acquire knowledge from external sources (Chesbrough, 2003). Even though the proposals for collaborative innovation differ in depth and scope, the core suggestion is similar that the innovation process is opened up to a diversity of actors across hierarchies and organizational boundaries (Corley & Gioia, 2011; Nambisan, 2008), and thereby the actors are integrated into the innovation cycle (idea generation, selection, implementation, and diffusion) from the earliest stage onwards (Bommert, 2010). The principal assumption underlying this model is that valuable ideas can come from inside or outside the organization and can go to market from inside or outside the organization as well (Chesbrough, 2003) and tapping into the vast innovation assets across organizational boundaries will increase the quantity and quality of innovations. Accordingly, the recent innovation processes can be regarded as complex, dynamic, and a result of cumulative dynamic interaction and learning processes involving many actors (Bessant & Tidd, 2007).

### 2.1.2 Role of innovation intermediaries in collaborative innovation

Engaging in effective and successful collaborative innovation alliances is not a straightforward exercise. The open innovation efforts of an organization flow through four phases: Want, Find, Get, and Manage (WFGM) (Witzeman et al., 2006). The WFGM framework suggests that an effective open innovation strategy should encompass four questions; what external assets are required (Want), what possible sources of these assets are (Find), which source’s assets are superior and how to acquire access to those assets (Get), and how to coordinate and integrate those assets to meet the objectives (Manage). As a result, the success of open innovation alliances highly depends on the right selection of business partners; which in turn is influenced by the organization’s capacity to identify possible sources of the required complementary assets (Memon & Meyer, 2015). Screening and monitoring the technological environment to search and decide whom to collaborate with is not a trivial task for the organizations. This is particularly true for the companies who are neither equipped with sufficient information sources nor are they financially capable to run an information system.

In this respect, a set of actors has emerged who may be broadly termed as ‘intermediaries’ performing a variety of tasks within the collaborative innovation process. There is no defined nomenclature and semantic conventions best suited for their description and analysis. In the literature, they have been variously termed as ‘third parties’, ‘intermediary firms’, ‘bridging institutions’ (Bessant & Rush, 1995; McEvily & Zaheer, 1999), ‘brokers’ (Batterink et al., 2010; Hargadon & Sutton, 1997; Provan & Human, 1999), ‘information intermediaries’ (Popp, 2000) and ‘superstructure organizations’ (Lynn, Reddy, & Aram, 1996). In general, innovation intermediaries are the organizations or groups of people within organizations that work to enable innovation, either directly by enabling the innovativeness of one or more firms, or indirectly by enhancing the innovative capacity of regions, nations, or sectors (Dalziel, 2010).
Theoretical foundations

The goals and missions of an intermediary vary according to the level of observation. On the baseline, an innovation intermediary is supposed to provide value to its clients in the identification and facilitation of a fruitful cooperation between agents who were not previously aware of one another and their potential synergies or were for other reasons unable to pursue such opportunities. Within this role of innovation intermediaries, the unique value of intermediation is created by their ability to successfully search for and match partners across geographical, industry and disciplinary boundaries more effectively than individual agents can do on their own (Haakanson et al., 2011). However, the organizations also seek help to identify what they might need from partners or even more generally what their innovation and business strategy should be. A number of intermediaries provide such services, usually they are organizations which already provide scanning and technology intelligence functions, and essentially go back to supporting the client with even more fundamental issues concerning where they should be searching and seeking information in the first place. As a result, Howells (2006) has identified ten functions of innovation intermediaries, including ‘foresight and diagnostics’, ‘scanning and information processing’, ‘knowledge processing and combination/recombination’, ‘gatekeeping and brokering’, ‘testing and validation’, ‘accreditation’, ‘validation and regulation’, ‘protecting the results’, ‘commercialization’, and ‘evaluation of outcomes’.

Increasingly, there is also the issue of ‘when is an innovation intermediary not an innovation intermediary’? Besides the traditional roles of innovation intermediaries as an agent of information exchange (Haakanson et al., 2011; Smedlund, 2006), technology transfer (Hargadon & Sutton, 1997) and network formation (Batterink et al., 2010) between two or more firms, lately, they are often involved in supplying services direct to their clients on a one-to-one basis, where no third party is involved (Howells, 2006). Such innovation intermediaries providing one-off services to their clients can, therefore, be considered as collaborating agencies themselves and are commonly referred as ‘innovation spaces’ where the innovation potential of organizations is enhanced through mediating services that encompass the non-brokerage activities as well.

2.1.3 Innovation within innovation spaces

The emergence of non-traditional types of innovation niches – the dedicated innovation spaces - has gradually surfaced since the mid 2000’s. Innovation spaces can be understood as catalysts for an organization’s innovation capabilities, and that no way resembles the organization’s normal working environment. They facilitate a space for technologies and analysis techniques to be tried rapidly and iteratively, where teams can learn from each other and contribute knowledge to a larger ecosystem. They come in different flavors: hubs, centers, accelerators, libraries, maker spaces, hackerspaces, co-working spaces, incubators, tech shops, and others that are established with a focus on supporting innovation within a particular organization or environment (Tiesinga & Berkhout, 2014). Although each of them possesses individual features, they share converging aims of enabling and supporting the innovation process and enhancing innovation capabilities of those who participate in the space. Yet all provide opportunities to (1) engage with people, ideas, and technologies, (2) experience the participatory
culture, and (3) acquire the literacies and skills needed to prosper in the 21st century (Gathege & Moraa, 2013). According to Puttick (2014), innovation teams or spaces can be created for a number of reasons. None are mutually exclusive, but some common motives include: 1) tackle the dissatisfaction with current innovation capabilities in achieving improved outcomes and cost savings, 2) improve specific stages of the innovation process, such as idea generation testing or implementation and scale, by bolstering innovative capabilities, 3) tackle seemingly unsolvable and entrenched challenges of the environment, 4) provide a novel or unique method, such as design thinking or behavioral economics, to foster a structured approach to the innovation process, and 5) listen to citizens and others outside of the organization in ways that have traditionally been problematic.

Lately, a stylish term ‘laboratory’ has got impetus while referring to these new innovation milieus. The term ‘laboratory’, more commonly seen in the physical and natural sciences, conjures a sense of a safe haven for experimentation, focused problem-solving and solution creation (Bloom & Faulkner, 2015). Laboratories are not actual “laboratories” in the traditional sense of the word, but the spirit is same. They provide a mechanism to allow for experimentation and collaboration in a way that existing institutions do not have the freedom to do because of their powerful, enduring, and rigid structures that dominate the landscape leaving little space for innovation (Tiesinga & Berkhout, 2014). Thus, a laboratory for innovation can be understood as a hub or a platform that seeks to catalyze emergent innovations in a particular domain through diverse strategies and interventions (Tiesinga & Berkhout, 2014) that allow the groups and teams to explore and extend their thinking beyond the normal boundaries of assumptions and constraints (Jones et al., n.d.). Further, the entire process of framing, exploring, and finding solutions is guided by or co-created with the people who are affected by or involved in the problem at hand (Tiesinga & Berkhout, 2014). Adding to this momentum of laboratories, two emerging paths are the phenomena of ‘Living Laboratories’ and ‘Innovation Laboratories’. While both of these concepts are not fully interchangeable, yet not completely diverging.

The concept of ‘Living Laboratory’ is originated from William J. Mitchell with a proposal to move innovation research from in vitro to in vivo settings. More specifically, he suggested wiring ‘living’ spaces like a real home where the routine activities and interactions of everyday home life can be observed, recorded for later analysis, and experimentally manipulated, and where volunteer research participants individually live in, treating it as a temporary home (Eriksson, Niitamo, & Kulkki, 2005). Living laboratories can thus be conceived as spaces where designers and researchers find inspiration by observing users in their everyday habitat (Niitamo, Kulkki, Eriksson, & Hribernik, 2006) and where they may test hypotheses through experimentation (Dutilleul, Birrer, & Mensink, 2010) in collaborative, multi-contextual, and empirical real-world environments. Concurring with the open innovation paradigm, crowdsourcing, and lead-user innovation, Living Laboratories draw on the notion of external ideas as a resource in innovation; i.e. to open organizations’ boundaries toward their environment and to harvest creative ideas and work capabilities existing among different stakeholders. While a Living Laboratory has been attributed varying definitions dependent on the author, there is general consensus on two main ideas that a Living
Laboratory is driven: 1) experimentation in real world settings by offering access to the up-to-date competing technologies, and 2) involvement of all the relevant stakeholders as co-creators on equal grounds in the innovation process (Almirall & Wareham, 2009). Regarding the stakeholder involvement, a Living Laboratory integrates three types of stakeholders: researchers, developers, and end-users. The researcher is focused on the production of new knowledge of technologies or methodologies that are relevant to the open innovation process. The developer is a stakeholder that aims to develop products or services able to fulfill the end-user needs. The end-user is a stakeholder looking for better ways to satisfy his/her needs and better ways to handle his/her current situation (Levén & Holmström, 2008).

Increasingly, Kviselius, Ozan, Edenius, and Andersson (2008, p. 844) argue that Living Laboratories constitute a “new focal point for multi-organizational collaboration on innovation”. A considerable number of arguments suggest that a Living Laboratory may constitute an innovation system consisting of organized and structured multi-disciplinary networks fostering interaction and collaboration by providing a mechanism for bringing innovation enthusiasts including businesses, public institutions, and innovation-focused researchers in contact. Dutilleul et al. (2010) have summarized that such networks may contribute to the standardization of regional technological infrastructures, the harmonization of approaches, methods and tools necessary to intensify knowledge sharing and mutual learning, and the fostering of inter-regional collaborations. To this end, according to the level of observation of networking activities, the Living Laboratories could be arranged into three classes: local (micro) Living Laboratories focusing more on supporting the experimentation in real world settings and involving the individual users only on an ad hoc basis, the regional (meso) Living Laboratories giving considerable attention to orchestrating collaboration between the key actors in a region and thus creating and managing small (e.g. regional) innovation networks, and the national (macro) Living Laboratories supporting the inter-organizational networking at a larger level, even in an international context.

Whereas a Living Laboratory exclusively focuses on fostering open innovation practices, the term ‘Innovation Laboratory’ also encompasses the innovation spaces that may be used in a closed innovation settings integrating only two types of stakeholders: researchers (facilitators), and developers (business organizations). They come in a variety of sizes, use a range of techniques, are equipped with different resources, and try to tackle different issues and challenges. What unites them together is that they all are adopting experimental methods and are driven to create change by testing and applying new approaches, products, and services. They largely function as public-private-partnerships where firms, academics, public sector authorities, and citizens work together for the creation, development and implementation of new products, processes, services and technologies (Memon, Meyer, Meyer, & Fähnrich, 2014).

The magnitude of divergence or convergence between a Living Laboratory and an Innovation Laboratory depends on how much a particular Living Laboratory stresses on supporting user involvement and networking in the innovation process. Accordingly, while moving down from macro to the micro level of Living Laboratories, the distinction gradually diminishes and may even blur at the lower (micro) level leaving both concepts
similar in their focus and objectives. Hence, the current study considers the term ‘Innovation Laboratory’ in its broader sense covering a wide variety of innovation activities (dedicated structures) aiming at supporting the innovation process in one or other way, and that may or may not characterize themselves as Innovation Laboratories. In doing so, Living Laboratories are also considered as a part of this wider family of Innovation Laboratories.

2.1.4 Innovation Laboratories: state of the art

This section closely looks at the research that has explicitly focused on the paradigm of InnoLabs in order to explore their structural and functional configurations and successively identify research gaps that inform the objectives of the current research.

The concept of InnoLabs is fairly recent, and has largely remained scientifically unexplored and unstructured (Burger & Hermann, 2010). Though recently the topic has got considerable attention from the academia, the extant literature is filled with partial and inconclusive research findings. The concept is often discussed abstractly (e.g. Gey et al., 2013; Schmidt, 2009) or based on experiences specific to a particular case study (e.g. Lewis & Moultrie, 2005; Magadley & Birdi, 2009). Moreover, the extant studies have explored the concept from diverse perspectives. Some are focused on their definition, others are focused on their differentiation, and others are focused on their effectiveness. Thus, the literature is somewhat fragmented and is lacking large-scale empirical evidence from field settings. Consequently, there is no general and conclusive consensus on ‘what an InnoLab may refer to’ and ‘how the intent of supporting successful innovation process is realized?’

In the literature, the concept of InnoLabs has been attributed with varying terminologies dependent on the author that vary in their focus and approach. While some definitions are focused on the structural and physical components of an InnoLab, others describe an InnoLab with respect to its intangible services. Examining the available definitions, given in Table 2.1, one can find that “an InnoLab is a dedicated physical structure (Magadley & Birdi, 2009) together with a group of people (Gey et al., 2013) providing the innovation support and enabling the configuration of new innovation projects (Lewis & Moultrie, 2005) through the provision of creativity and technical resources (Thieme & Meyer, 2011) and facilitation services”. This anticipates that an InnoLab has three interlinking components (cf. Figure 2.1): physical environment, resources, and facilitation.
<table>
<thead>
<tr>
<th>Study</th>
<th>Level of the focus</th>
<th>Method of the study</th>
<th>Focus of the study</th>
<th>Definition of an InnoLab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lewis and Moultrie (2005)</td>
<td>Primary</td>
<td>Case-study</td>
<td>Benefits and effectiveness</td>
<td>An innovation laboratory comprises specific structural and infrastructural content […..] in a physical research setting dedicated to conducting specific types of experiment (Lewis &amp; Moultrie, 2005, p. 74).</td>
</tr>
<tr>
<td>Magadley and Birdi (2009)</td>
<td>Primary</td>
<td>Case-study</td>
<td>Benefits and effectiveness</td>
<td>Innovation laboratories are dedicated physical environments or facilities with collaborative workspaces in which groups and teams of employees can engage with each other in order to explore and extend their creative thinking beyond and above normal boundaries (Magadley &amp; Birdi, 2009, p. 315).</td>
</tr>
<tr>
<td>Schmidt (2009)</td>
<td>Primary</td>
<td>Abstract</td>
<td>Catalog for comparison</td>
<td>An innovation laboratory is a physical working environment for the processing and development of innovative products or services (Schmidt, 2009, p. 3).</td>
</tr>
<tr>
<td>Thiene and Meyer (2011)</td>
<td>Secondary</td>
<td>Abstract</td>
<td>Application</td>
<td>The innovation laboratory is a physical environment located at a research institute that provides creativity tools and technical resources (Thieme &amp; Meyer, 2011, p. 625).</td>
</tr>
<tr>
<td>Gey et al. (2013)</td>
<td>Primary</td>
<td>Abstract</td>
<td>Conceptual understanding</td>
<td>An innovation laboratory is a dedicated physical environment where suitable tools and methods are applied to assist in the process of idea creation or innovation development (Gey et al., 2013, p. 6).</td>
</tr>
<tr>
<td>Meyer, Schultz, Foradi, Thieme, and Meyer (2015)</td>
<td>Primary</td>
<td>Web-research</td>
<td>Identification of diverse attributes</td>
<td>An innovation laboratory is an ideal physical or virtual collaborative work environment where companies can develop, test and enhance innovations (Meyer et al., 2015, p. 2).</td>
</tr>
<tr>
<td>Bustamante, Camargo, DuPont, and others (2015)</td>
<td>Primary</td>
<td>Literature and author experiences</td>
<td>Effects of physical space</td>
<td>An innovation laboratory is a room or a set of rooms designed for spatial reconfiguration, participant observation, writing spaces, materials for visualization, and ICT to support brainstorming and distributed group working (Bustamante et al., 2015, p. 1).</td>
</tr>
</tbody>
</table>

Table 2.1 - Definitions of an InnoLab available in the literature
1. **Physical environment:** Since the architecture, decor and layout of physical environment is believed to have a positive influence on human’s behaviour (Davis, 1984; Vischer, 2007), a creative and distinct physical space is considered fundamental to the structure of an InnoLab for promoting the out-of-the-box thinking of the participants and thereby enhancing the novelty of the ideas (Lewis & Moultrie, 2005, 2005). It is argued that the vibrant and inspiring design produces a ‘dislocation’ effect that enables participants to lose their links with their normal working environment and make them feel they are back in their childhood when their creativity was at its highest (Jones et al., n.d.).

2. **Resources:** Besides a creative space, an InnoLab needs to provide a set of necessary resources to be dynamically configured dependent on the project. It needs to bring access to the state-of-the-art technology of not only one kind but often competing technologies for the generation, discussion, assessment, and implementation of the ideas. According to Thieme and Meyer (2011), an InnoLab facilitates the multidisciplinary creativity tools and technical resources for the generation, discussion and assessment of ideas to assist the organizations in predicting future obstacles and thus reducing the risk factor involved in the innovation process, and the special field specific software and hardware tools.

3. **Facilitation:** Facilitation is the third component required to make things happen in an InnoLab. Facilitators are supposed to mediate and guide the innovation process with their methodological skills and technical expertise. This is to bring the group dynamics and other techniques to manage the process so that the participants get the most out of their ideas (Jones et al., n.d.).

![Figure 2.1 - Essential components of an InnoLab structure as identified in the literature](image-url)

The aforementioned description of InnoLabs gives only a holistic view of their functioning and is, therefore, deficient for understanding their comprehensive implications. Specifically, the notion of ‘necessary resources and mediating services’ is ambiguous and therefore it is still not clear that what type of innovation assistance can be solicited at these facilities?
In this respect, some preliminary work has been conducted by Lewis and Moultrie (2005) and Magadley and Birdi (2009) based on the case studies of innovation facilities in the UK. They have attempted to analyze the benefits that InnoLabs bring to their clients while explicitly focusing on their physical embodiment (space and infrastructure). Lewis and Moultrie (2005), through the interviews with managers and technical staff responsible for running the selected InnoLabs, have concluded that an InnoLab with its dedicated infrastructure (space and tools) is beneficial in enhancing the problem solving and learning process that leads to the increased creativity. Subsequently, arguing that the findings of this study needs further verification from the laboratory users’ perspective, Magadley and Birdi (2009) have taken an in-depth examination of one of these facilities by employing field experiments and subsequent interviews with its users. They have also reported positive perceptions of the participants towards the impacts of InnoLabs in promoting their innovative thinking and decision making individually and in teams.

The empirical focus of these studies is on how the physical manifestation and facilitation services of InnoLabs influence the creative behavior of their participants. Therefore, while these studies provide substantial knowledge in understanding the role of InnoLabs in idea generation process, they are deficient in highlighting the potential contributions of InnoLabs in further stages of the innovation process. Moreover, due to the case-based and focused nature of these studies, here comes the question that do the other InnoLabs existing worldwide echo similar structure and offer similar propositions? In other words, is creativity stimulation the only supported task at InnoLabs? If so, why are they referred as Innovation Laboratories, rather than with some conceptually representative and accurate label relating to creativity, as Magadley and Birdi (2009) pointed out? Furthermore, Burger and Hermann (2010) have argued that the physical space of an InnoLab may vary from a simple meeting room to a highly creative space. Increasingly, Tiesinga and Berkhout (2014) have reported that many of the existing InnoLabs are dispersed and oriented around people rather than places. None or only a simple meeting room like physical place suggests that such an InnoLab might be focusing on some other type of innovation support for addressing a different innovation challenge, rather than the creativity part of the innovation process. This warrants the need for further investigation on what such InnoLabs are aiming at? And what contributions do they make to the innovation process?

Increasingly, in a practice guide of InnoLabs and innovation teams, the innovation skills team of Nesta advocate that InnoLabs can be distinguished on several main axes: the methods they use, the field in which they work, where they focus their efforts in the innovation process, how they work, and the extent to which they are directly involved with business organizations (Puttick, 2014). Similarly, Schmidt (2009) has identified 18 criteria for differentiating InnoLabs oriented in four dimensions: physical construction (location, room size, room design, furniture, and flexibility), infrastructure (availability of IT tools, software support, access to information, and modelling and simulation possibilities), organizational structure (supported type of innovations, targeted customer group, participant capacity, methodological approach, time interval of sessions, and group support), and documentation and review (feedback acquisition, session evaluation, and quality assurance). These studies evident that InnoLabs offer great diversity and highlight several features for their differentiation and comparative evaluation. However,
they provide only an abstract catalog for their comparison with no possible values pertaining to different identified criteria. For example, Puttick (2014) has argued that InnoLabs can be differentiated on the basis of the fields and innovation stages that they target, but does not describe what different fields and functionalities the existing InnoLabs are focusing, indeed.

Given the above-mentioned limitations of previous research and escalating number and popularity of innovation laboratories, lately, researchers have begun to explore the phenomenon in a broader and general context. In a recent study, Meyer et al. (2015) have attempted to identify the existing InnoLabs from their web representation. To address the terminology problem of InnoLabs, the authors have used different keywords with the search engines and manually filtered the result lists to discard any duplicates and irrelevant results. As a result, 190 InnoLabs have been identified. Analyzing the information available on the websites of identified InnoLabs respective to different categories, the authors have concluded that the existing InnoLabs are diverging in terms of their size, service focus, sources of financing, regional orientation, thematic orientation, and methods and tools applied for the innovation process. This study represents a foundational step towards the large-scale empirical research on InnoLabs, however, it relies only on the limited data available on the websites of identified InnoLabs which do not provide a detailed description of their functionalities and methodological approaches. Specifically, the information is analyzed more in terms of the structural features of InnoLabs and little attention is paid to their service portfolios, applied practices, and diverse competencies that call for drilling down on the particular relevance to each InnoLab.

In conclusion, there is still a little known about the role of InnoLabs as a potential source of assistance for business organizations towards the successful implementation of innovative products and services. Specifically, there is the question that how can an organization facing a problem know if the InnoLabs might be helpful in solving it? Or how can organizations come to know that what complementary resources the InnoLabs have that may foster synergies or innovation? This entails for further investigation on existing InnoLabs in the field settings to examine their structural as well as functional characteristics and thereby disseminate a conclusive description of their functioning and capabilities. Increasingly, the identified divergences and strong arguments of the diversity of InnoLabs anticipate that there might be existing some common and differentiating patterns that may enable their further classification which in turn may help organizations in knowing that which InnoLab might be more capable of solving their respective problems.
2.2 Web-based collaboration tools for inter-organizational connectivity

The World Wide Web (commonly known as the web) is not synonymous with the internet but is the most prominent part of the internet that can be defined as a techno-social system enabling the humans interaction - human cognition, communication, and co-operation (Fuchs et al., 2010) - based on technological networks (Aghaei, Nematbakhsh, & Farsani, 2012). Increasingly, the notion of web-based communication technologies have drastically altered the practices of not only interpersonal communication but also the inter- and intra-organizational connectivity. The practices and supporting technologies of web-based communication have been continually evolving since their inception and are commonly delineated into two incarnations: Web 1.0 and the Web 2.0 communication technologies.

**Web 1.0** (also known as read-only web) refers to the first implementation of the web that was created in 1989 by Tim Berners-Lee with an idea to create a global hypertext space in which the items of interest, referred to as resources, would be identified by global identifiers called Uniform Resource Identifiers (Al-Khalifa & Al-Salman, 2006) so that the people can communicate and exchange information in a common information space (Berners-Lee, 1998). It served as a web of information connections, or a web of cognition/percipience (Patel, 2013) allowing the people to search for and read the information with a very little user interaction or content contribution. For the businesses, web 1.0 introduced a new mechanism of disseminating somewhat mono-directional information. They could provide online catalogues or brochures similar to the advertisements in newspapers and magazines in order to present their productions that the other people could read (Aghaei et al., 2012). Two widely used communication tools of this web incarnation are the website and the email.

**Web 2.0** (also known as read-write web, or social media) refers to the second generation of the web that was created to advance the read-only web into ‘The web as a platform’ (O’reilly, 2007) whereby the content and applications are no longer created and published by individuals, but instead are continuously modified in a participatory and collaborative fashion (Kaplan & Haenlein, 2010) by all the users with common interests involving the formal and informal spheres of daily activities (Patel, 2013). For the businesses, web 2.0 offers both; the platform on which innovative technologies are built and the space where users (the consumers of goods/services) are considered as important as the content shared by the organizations. Thus, being a bidirectional (read and write) web, it enables the direct, effective and timely communication between the producers and consumers of the products and services. Web 2.0 is an umbrella term encompassing several new web technologies (Murugesan, 2007) including the blog, syndication, wiki, tagging and folksonomy, mashups, social networking, social bookmarking, and instant messaging/chat and conversational arenas (Conole & Alevizou, 2010).

Currently, there exist a myriad of web-based communication tools (technologies, applications, platforms). During the recent years, such tools have become pervasive and part of everyday life, both in personal and business contexts by offering a wide variety of support ranging from information exchange to the coordination and collaboration of
the teams. Depending on the type and complexity of the functionality they provide, they are commonly referred as either web-based communication tools or web-based collaboration tools. Nevertheless, since the communication is also a part of the collaboration process, in the course of current study, all the tools that support any sort of interaction activities (communication, coordination or collaboration) are referred as web-based collaboration tools. Taking all together, the tools offer varying degrees of support for participants’ interaction with each other. They differ in both the media richness and the integration and complexity of their offered functionality. For the brevity, this study organizes the existing web-based collaboration tools into five classes structured in an increasing order of their media richness and service complexity (cf. Figure 2.2). It is necessary to note that while there exist other collaboration tools that may not completely fit in any of these categories and thereby may form new categories (e.g. online games, virtual world, etc.), the study concentrates only on the media applicable in the context of inter-organizational connectivity. A brief definition of proposed classes and their supporting technologies is given below. For a more detailed description, see Appendix A-1.

![Figure 2.2 - Classification of web-based collaboration tools for inter-organizational connectivity](image)

1. **Communication tools**: The web-based communication is put in practice since the internet has started out as a giant bulletin board system allowing the users to exchange software, data, messages, and news with each other in a seamless manner across the geographic borders. The basic communication media available today include the two traditional technologies of web 1.0 – websites and email – and a web 2.0 based technology – weblogs. The websites enable the users to establish an online presence and share their somewhat static and unidirectional information with a wider audience. An email service enables the exchanging of digital messages from one-to-one or one-to-many recipients. Weblogs (or blogs) enable the users to build easily updatable web diaries or online journals (Kamel Boulos, Maged N & Wheeler, 2007) containing the text, photographs, videos, or audio clips (Aghaei et al., 2012; Patel, 2013).

2. **Conversation tools**: The web-based conversational tools extend the concept of traditional in-person discussions to the online space by enabling the users to engage
in real-time conversations involving textual as well as the audio/video messages. Such tools range from simple instant messengers to discussion forums to complete web conferencing suites. The instant messaging or chat tools allow the users to share short messages - usually text messages - in an asynchronous mode. The discussion forums allow the people with common interests to debate and share certain information, questions, comments, and opinions. The web conferencing suites facilitate real-time conversation involving text-based as well as voice and video messages among geographically dispersed participants.

3. **Coordination tools:** The web-based coordination tools support a group of two or more individuals to accomplish a common goal or objective by integrating them in a virtual work environment that facilitates the teamwork spanning across the geographical boundaries. On the baseline, coordination tools include the simple collaborative authoring tools such as Wiki that facilitate the collaborative creation and editing of documents in real time along with the revision mechanisms supporting the monitoring (Razmerita, Kirchner, & Sudzina, 2009) and rolling back of the changes (Patel, 2013). Business organizations use such applications to keep track of internal procedures and knowledge by storing documents in a centralized knowledge repository and thus enabling the asynchronous contribution by a group of people, information annotation, efficient communication and productivity, harnessing of the power of diverse individuals to create collaborative works, and support for the content to evolve, expand, and improve incrementally over time (Murugesan, 2007). On an advanced level, coordination tools include the complex project management tools that facilitate the users to collaborate on a certain project covering all aspects of managing a project from its genesis to its completion. Typical task supported by such tools include project planning (mapping of project tasks and task interactions), task management (assignments, deadlines, and status reports of tasks), document sharing and collaboration (central document repository accessible to project stakeholders), calendar and contact sharing (scheduled meetings, activity dates and automatically updating contacts), bug and error management (error reporting, viewing, notifying and updating for stakeholders), and time tracking (ability to track time for all tasks).

4. **Content sharing tools:** Content sharing tools allow the users to share the various types of user generated content in centralized online spaces. Content sharing tools can broadly be lined up in two classes. First, the cloud-based shared repositories (e.g. Dropbox) where the users can store the electronic documents and anyone with appropriate permissions can access them. With nearly ubiquitous internet connectivity these days, storing files remotely rather than locally boasts an array of advantages for the users including the wider accessibility, lower costs, improved security, easy syncing, sharing and collaboration, and more protection. Business organizations build on cloud-based file sharing in order to give their employees flexibility in file accessibility and reducing the costs of setting up virtual private networks and in-premise file servers. Second, the media sharing platforms (e.g. YouTube) whereby the users interact with each other by sharing a variety of different types of user generated content via digital channels. These platforms are often focused on a specific type or theme of the content often referred as media object.

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3 https://www.dropbox.com/
4 https://www.youtube.com/
5. **Community platforms:** The online community platforms (abr. OCPs) facilitate the building of online communities that allow the members to connect with each other, share information and engage in multiple activities as in a physical community. Porter (2004) has defined an online community as “an aggregation of individuals or business partners who interact around a shared interest, where the interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms”. The paradigm of OCPs which arrived commercially about a decade ago has rapidly gained momentum over the recent years and currently there are tons of different networks available for individual as well as professional purposes. In the course of business or professional organizations, the online community building brings a number of advantages including the self-disclosure, identity over the world, sharing of knowledge and the like. From the business perspective, OCPs can broadly be characterized as social networking sites, and business-specific networking platforms.

*Social networking sites* (abr. SNSs) facilitate the creation and management of the connections with people based on similar interests or professions by constructing a public or semi-private profile within a bounded system (boyd & Ellison, 2007). Increasingly, the paradigm has provided many opportunities for intra- and inter-organizational connectivity that were either unavailable or very difficult to obtain for most of the organizations on their own (Jefferson III, Carl E & Traughber, 2012). For example, leading SNSs offer the creation and hosting of the business pages (also referred as company pages) that enable the business organizations to introduce themselves, list and promote their products and/or services, post updates, advertise their events, solicit product reviews, interact directly with customers, and engage the user community in co-creation of innovative products and services. The current study builds upon four SNSs that support business pages, namely Facebook⁹, LinkedIn¹⁰, Google+¹¹, and Xing¹² (cf. Table 2.2 for a brief introduction).

Whereas the SNSs are open to a wide variety of users, the *business-specific networking platforms* allow business organizations to create business networks oriented around a particular theme, interest, or industry, and thereby facilitate the sharing of business specific content with business professionals. Such platforms support business identity meaning the profiles are created with respect to business specific information rather than the biographical information of users. The business-specific networking platforms may be oriented around a single business domain, or may support more than one business sector. In the latter case, the platforms usually enable the creation of smaller networks oriented around different themes. A prominent example of business specific networking platforms is the British ‘_Connect_’ platform (cf. Table 2.2 for a brief introduction).

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⁹ https://www.facebook.com/
¹⁰ https://www.linkedin.com/
¹¹ https://plus.google.com/
¹² https://www.xing.com/
## Social networking sites

| Facebook | Facebook (abr. FB) platform developed in 2004 by then Harvard undergraduate Mark Zuckerberg is the dominant social networking site (Tess, 2013). It allows users to maintain a profile with biographical information and interests, and share information in many ways; for example, update their statuses as a way to describe their daily activities and whereabouts, upload photos, send messages to other users, and hold public conversations by writing on each other’s walls (Lucas & Borisov, 2008). Among the internet community networks, FB stands out for three reasons: its success among the crowd; the amount and the quality of personal information users make available on it; and the fact that, unlike other networks, the information is personally identified (Acquisti & Gross, 2006). As a result, FB is of particular interest for business organizations in reaching its vast and global audience for marketing and other organizational purposes. |
| LinkedIn | LinkedIn (abr. IN) platform, a business oriented social networking site (Papacharissi, 2009) was launched in May 2003 (Tess, 2013). The platform mainly focuses on exchanging professional information (Skeels & Grudin, 2009) by allowing the working people to make connections with their colleagues and other business contacts. IN platform facilitates the people to post their resume, and solicit and make available recommendations from other members (e.g. colleagues, former employers, and employees). A core notion is that the members can explore direct connections of their connections. It can thus also serve as a means to make contacts with potential customers, clients, employees, and partners. |
| Google+ | Google + (pronounced as Google Plus) is a SNS operated by Google Inc. that was launched into a field trial in 2011. The Google+ has evolved rapidly and used some of the most compelling features of existing SNSs in carving out its own set of unique capabilities. It has leveraged the tried-and-true features of existing networks such as marking content with hashtags and maintaining a profile according to customizable privacy settings, with additional novelties such as a fresh take on content sharing called circles, video chats called hangouts, and extensive integration with other Google services such as Gmail contacts (Russell, 2013). |
| Xing | Xing (formerly known as OpenBC / Open Business Club) platform is a Germany based career oriented SNS launched in 2003 and renamed in 2006. The platform enables small-world network for professionals. It visualizes small-world phenomenon by displaying how each member is connected to any other member ("Xing," n.d.). The platform offers basic features including the personal profiles, groups, discussion forums, event coordination, and other common social community features free of cost; however, the advanced business services are accessible only after paying a subscription fee. |

## Business specific networking platforms

| Connect | Connect is owned and operated by Innovate UK (formerly Technology Strategy Board) which is a business-led, non-departmental, public body funded by the United Kingdom Government Department for Business, Innovation and Skills. The main aim of the platform is to connect the professionals and business organizations with an aim to jointly address the challenges of the innovation process and accelerate sustainable economic growth ("_Connect," n.d.). The platform offers the creation of networks oriented on particular topics of interest. A member of the platform may become the part of more than one network. Within the network the platform facilities the discussions, event listing, blog of articles, document sharing, news regarding funding and partnering opportunities, etc. |

Table 2.2 - An introduction of leading SNSs and business networking platform
The diversity in service integration and complexity of aforementioned tools result in the scattering of all the support that might be needed in a collaboration process. Consequently, for addressing the particular requirements of different levels of the collaboration process, an organization might need to exploit multiple tools in course of a single collaboration. This turns the management of web-based collaborations very challenging and demanding task for organizations. Furthermore, even if the organizations invest substantial efforts in this process, there is an issue of information integration. For example, if two organizations utilize the conversation tools for initial discussions, the collaborative work environments for simultaneous work on files, and project management tools for scheduling and tracking the project tasks. How can the dispersed information be aggregated for the purpose of documentation and further reference during and after the completion of the project?

In such circumstances of distributed collaboration support, the SNSs are believed to be integrating several necessary services for collaboration on one platform and are thus considered as a new wave of dissemination of digitalized information both in interpersonal and inter-organizational contexts. The paradigm has got such a rapid popularity that nowadays almost every organization uses one or another SNS for achieving one or another organizational goal. Organizations are using SNSs for the promotion of their products and/or services, strengthening their relation with customers through easy, timely and direct communication, invading in new markets, undertaking market research, identifying emerging trends and customer demands, and involving users in co-creation, and like. The most cited goal of organizations in exploiting SNSs is for the marketing purposes. According to a social media marketing industry report for the year 2014, 97% of the 2887 marketers use social media marketing (Stelzner, 2014).

The resulting availability of significant information about the products, services and specialties of organizations over SNSs, and the advantages that SNSs bring to them might also draw them to utilize SNSs for inter-organizational networking and thereby bring a new framework for inter-organizational collaboration. Nevertheless, the extant scholarship concerning SNSs has mainly been focusing on their application and effectiveness in interpersonal and business-customer interaction, and surprisingly little attention has been paid to their use for inter-organizational communications, interconnections, and goal achievements. In the organizational context, scholars are documenting the implications of SNSs mainly with respect to cutting marketing expenses, raising customer base, soliciting market demands, and engaging users in co-creation. There is no reliable data regarding if and how organizations are using SNSs in connecting with other businesses.

Furthermore, the existing SNSs vary enormously with respect to the targeted audience, scope, and functionality and collaboration services. In a review of 47 collaboration systems, Bafoutsou and Mentzas (2002) have retrieved a list of 18 collaboration services that are most commonly encountered on collaboration systems. An examination of leading SNSs and business specific networking platforms against the given list of collaboration services (cf. Table 2.3) indicates that while there is a variance in the offered services of different platforms, a common strong emphasis towards the general communication services rather than the sophisticated collaboration services is apparent.
This warrants the inadequacy of existing platforms in supporting the advanced stages of collaboration process. Nonetheless, this is only a hypothetical claim, and a strong affirmation needs a thorough analysis of their capabilities against the desired functionalities. However, in spite of several years of practice and research on desirable functionalities of SNSs for inter-personal networking, there is a dearth of research on what a SNS must facilitate functionally and non-functionally in order to support inter-organizational networking. Since creating and managing inter-organizational connections is no way similar to inter-personal connections, such a specific reference framework is fundamental for cross-comparing and evaluating the potential of SNSs for inter-organizational connectivity.

<table>
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<tr>
<th>Collaboration Services based on Bafoutsou and Mentzas (2002)</th>
<th>Facebook</th>
<th>LinkedIn</th>
<th>Google+</th>
<th>Xing</th>
<th>Connect</th>
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</tbody>
</table>

Table 2.3 - Collaboration services offered on community platforms for the members and business pages
2.3 Dedicated online community platforms for Innovation Laboratories

For the identification of the dedicated networking websites / platforms for InnoLabs, a web research was conducted using the ‘Google’ search engine with different combinations of three keywords. The three groups of words forming search strings were:

1. Online community | virtual community | network cluster | network hub | online platform
2. For | of
3. Innovation | innovation laboratories | InnoLabs | research laboratories | laboratories

The search hits located several community platforms dedicated for InnoLabs; however, most of them were the networking events taking place in physical environments. Since the main interest of the current study was to identify the platforms enabling the inter-InnoLab collaboration over the internet; the result sets were manually filtered for the websites providing an online space for the InnoLab facilitators and supporting them in information sharing and undertaking of mutual collaborative activities. As a result, following three online networks for InnoLabs could be identified.

1. **Innovation Lab network:** The Innovation Lab network\(^\text{13}\) website has been designed as part of the Advanced Institute of Management Research (AIM) sponsored ‘Innovation Lab initiative’ project that started parallel in Denmark, Germany, and UK in 2006. The website is built with an aim to collaboratively identify and explore the best practices to deal with the challenge of innovation and facilitate a space where the researchers and companies can share the experiences about innovation management in a stable environment (“Innovation Lab,” n.d.). The website is oriented on the topic of InnoLabs, however, it mainly provides an open platform for all the stakeholders (InnoLab facilitators, business organizations, as well as the researchers) and does not exclusively target the inter-InnoLab collaboration.

2. **I-Lab Net website:** The i-Lab Net\(^\text{14}\) is a virtual community website developed as part of the European i-Lab Competence Development Project which was supported by the European Commission Leonardo da Vinci Community Vocational Training Action Programme 2000-2006. In this project, the term ‘i-Lab’ was used as an abbreviation for the word ‘Innovation Laboratory’. The i-Lab Net website is hosted by the University of Essex, UK and is designed to bring together individual InnoLab enthusiasts (owners, facilitators, and clients) to share ideas and experience, provide mutual support to the existing InnoLab enthusiasts, reduce their isolation, and accelerate the development of improved practices for InnoLabs (Jones et al., n.d.). The i-Lab Net exclusively supports the interaction between InnoLabs and their customers in a closed virtual environment.

3. **European network of Living Laboratories website:** The European network of Living Laboratories (ENoLL)\(^\text{15}\) website is the official website of the ENoLL network which

\(^{13}\) [http://innovation-lab.org/](http://innovation-lab.org/)
\(^{14}\) [https://ilabnet.essex.ac.uk/](https://ilabnet.essex.ac.uk/)
\(^{15}\) [http://www.openlivinglabs.eu/](http://www.openlivinglabs.eu/)
is a pan-European network of Living Labs created to allow the conceptualization, and standardisation of benchmarked Living labs in Europe and across the world and thereby facilitate their international collaboration. Registering with the ENoLL organization requires the member to be a registered Living lab and pay a subscription fee. The network offers several online and offline services for the registered members including a directory of Living Labs with personal pages of each member, an event calendar, and an intranet facility.

The identified platforms were examined in terms of the technology used to facilitate communication between members, and the sociability and usability criteria. The sociability and usability criteria include the presence of motivational statement, language support, search functionality, community features, and member personalization. The basic characteristics, communication technology and sociability and usability criteria of these identified networks are summarized in Table 2.4.

<table>
<thead>
<tr>
<th>Innovation Lab\textsuperscript{16}</th>
<th>i-Lab Net\textsuperscript{17}</th>
<th>ENoLL\textsuperscript{18}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purpose</td>
<td>To build an international network in which the researchers and companies can share their experiences about innovation management and collaboratively identify and explore best practices to deal with this challenge.</td>
<td>To facilitate interaction among the facilitators and users of InnoLabs around the world in order to promote the development of InnoLabs.</td>
</tr>
<tr>
<td>Starting year</td>
<td>2010</td>
<td>2008</td>
</tr>
<tr>
<td>Administrator</td>
<td>University of Erlangen, Germany</td>
<td>University of Essex, UK</td>
</tr>
<tr>
<td>Members</td>
<td>Researchers and companies</td>
<td>InnoLab users and facilitators</td>
</tr>
<tr>
<td>Current status\textsuperscript{19}</td>
<td>Running</td>
<td>Deprecated since 2012</td>
</tr>
<tr>
<td>Open/close</td>
<td>Partially closed</td>
<td>Partially closed</td>
</tr>
<tr>
<td>Registration/ connection based</td>
<td>Registration based</td>
<td>Registration based</td>
</tr>
</tbody>
</table>

\textsuperscript{16} The information about the supported features has been collected from the administrator of the website through a questionnaire

\textsuperscript{17} Pertaining to the inaccessibility to the website, the supported tasks could not be determined completely

\textsuperscript{18} Most of the networking activities are undertaken in the physical space.

\textsuperscript{19} As on August 24, 2016
<table>
<thead>
<tr>
<th>Feature</th>
<th>Innovation Lab16</th>
<th>i-Lab Net17</th>
<th>ENoLL18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology overview (based on Bafoutsou and Mentzas (2002))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulletin board</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Discussions</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Email</td>
<td>✓</td>
<td>?</td>
<td>✓</td>
</tr>
<tr>
<td>Email notifications</td>
<td>✓</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Online messaging</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Chat</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Whiteboard</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Web conferencing</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Task list</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Contact management</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Screen sharing</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Surveys/polling</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Meeting minutes/records</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Presentation capability</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Project management</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>File sharing</td>
<td>✓</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Document management</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
<tr>
<td>Synchronous work on files</td>
<td>✗</td>
<td>?</td>
<td>✗</td>
</tr>
</tbody>
</table>

**Sociability and usability features**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Innovation Lab16</th>
<th>i-Lab Net17</th>
<th>ENoLL18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation (statement of purpose)</td>
<td>Present but not on homepage</td>
<td>Present on homepage</td>
<td>Present but not on homepage</td>
</tr>
<tr>
<td>Language support</td>
<td>English</td>
<td>English, Polish, Romanian, Turkish, and Greek</td>
<td>English</td>
</tr>
<tr>
<td>Searching/browsing</td>
<td>Simple search, advanced search (filtering on the type, time, author, and group)</td>
<td>Simple and advanced search</td>
<td>Keyword search for the Living Labs</td>
</tr>
<tr>
<td>Community features</td>
<td>Lab directory, interactive map, event listing</td>
<td>Event listing, lab directory</td>
<td>Event listing, lab directory, interactive map</td>
</tr>
<tr>
<td>Personalization</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
</tbody>
</table>

Table 2.4 - Basic characteristics, technology, and sociability and usability criteria of dedicated InnoLab networking websites
Chapter 3
Research Methods and Instruments

“Research is a systematic process of collecting, analysing, and interpreting information (data)”
— Paul D. Leedy & Jeanne Ellis Ormrod

This chapter presents the methodological approach of the study. Following an overview of study design (Section 3.1), the chapter discusses the research instruments used to collect the empirical data for answering the research questions (Section 3.2) and the research approach undertaken for designing, developing, and evaluating the InnoLab_Net platform (Section 3.3).

3.1 Research design

The research objectives and the corresponding research questions set out in Chapter 1 emphasized for a two-phase approach consisting of an empirical phase followed by an artifact development phase (cf. Figure 3.1).

The empirical phase corresponds to building a generalizable theory concerning the overall construct of InnoLabs (Chapter 4) and inter-InnoLab collaboration (Chapter 5). The empirical data was gathered by employing a triangulation of online survey, and in-depth expert interviews with the InnoLab facilitators in concurrence with the personal observation of informants’ workplaces. The quantitative findings based on the survey data were used to prioritize the structural and functional aspects of the field and spot interesting relations based on statistical evidence, and the qualitative findings primarily based on the interviews data strived to explore the phenomenon in depth and inform the establishment of a generalizable theory.

The artifact development phase of the study corresponds to the requirements elicitation (Chapter 6) and the subsequent development of the InnoLab_Net platform (Chapter 7) following a design science research approach.

![Figure 3.1 - Research design of the study](image-url)
Chapter 3

3.2 Empirical Phase

At the outset, the empirical part of the current study is exploratory in nature and thus led to the selection of a flexible research design that evolved as the research proceeded. A flexible design was considered to be suitable because the study addresses a relatively unexplored area where bottom-up theory building, based on rich qualitative data, was required. For this reason, and corresponding to the researcher’s initial expectations, an inductive qualitative research style was appropriate to collect the data from field related informants, explore the key concepts of the phenomenon, and ultimately develop the theory by analysis. Accordingly, the fundamental intention of the study was to use in-depth expert interviews with the InnoLab facilitators.

Given that so little is known in the literature about the topic of investigation, it was primarily necessary to conduct the interviews from a ‘wide angle research lens’ and be open to data relating to new concepts, trends, and aspects of the field. However, such approach poses problems in terms of the time and efforts to collect the data which could not be useful at the end and that can be a key drawback if the research is time bounded (Millen, 2000). Therefore, to prevent the study scope not growing beyond which could feasibly be completed in a doctoral thesis and not to deviate from the main interest of study, it was necessary to adapt the ‘metaphor of a telephoto lens’ meaning to narrow the view of the field sufficiently so that data collection yields the useful and actionable data. This suggests that the research questions should be well defined and the researcher has a pretty good idea where to aim the camera (Millen, 2000). This requires the identification of key concepts of interest that enable the collection of data that can guide the creation, description, explanation, and validation of an informed theory (Gioia, Corley, & Hamilton, 2013) possessing the qualities of originality, utility and prescience (Corley & Gioia, 2011). Furthermore, in the interpretive studies, the pre-understanding of the researcher towards the topic being studied also play a major role. Only a reflective researcher can properly understand the gained knowledge and thereby respond to informants’ answers efficiently, prompt follow up questions wisely, and ultimately accumulate more useful information and insights into the field (Stenbacka, 2001). Hence, it was necessary in the course of this study to remain open towards the new concepts and themes while simultaneously being informed and focus on the relevant concepts.

Pertaining to the novelty of the topic under study, considerable difficulties were observed while designing the concepts for the interviews and developing a pre-understanding of the field. To the best of researcher’s knowledge, the literature on InnoLabs does not evident any study on the phenomenon as a whole except a preliminary investigation of web-based information of InnoLabs conducted by Meyer et al. (2015). The said study highlights few essential criteria of the field for further exploration, however, due to the indirect mode of data collection (no interaction with the subjects of the study) and interpretive nature of the data analysis, the findings are subjected to the issues of reliability and completeness of the information. Thus, it became apparent to collect first-hand data for developing the initial understanding of the phenomenon and determining the potential aspects of interest for further investigation during the interview process. Accordingly, it was decided to conduct an initial survey with InnoLab facilitators in order
to develop a holistic vision of expected data and decide where to look next while being open to the emergence of new concepts during the interviews. Thus, the current study incorporated both the quantitative and qualitative forms of data analysis. The next two subsections, respectively, describe the instrument design, participant selection, and data collection and analysis procedure of each of the empirical research methods used in this study.

### 3.2.1 Online survey

The first step of the data collection process of the study involved the administration of an online survey that was conducted with InnoLab facilitators during 2013. As indicated earlier, the main purpose of conducting the survey was to establish the basic understanding of the phenomenon in order to be able to frame the questionnaire for further investigation and to convene interviews as an informed researcher. Moreover, since the main goal of the study was to identify theoretical foundations and subsequently develop supportive artifact for inter-InnoLab collaboration, the survey was essential to confirm the research hypothesis that the existing InnoLabs do exhibit diversity in several attributes which may form the basis for their interconnection. The survey method was chosen as it allows to ask participants about their activities directly, rather being forced to rely on outside observation (Ulmer & Wilson, 2003). This is of prime importance in the current study as it is incompatible to determine what InnoLabs are and what they offer to their clients without involving the contribution of those actors who are themselves the subject of the study. Hence, the survey was conducted directly with the InnoLab facilitators. Figure 3.2 depicts the overall surveying procedure of the study.

![Image of survey procedure]

Figure 3.2 - Online survey procedure of the study
3.2.1.1 Survey participants’ selection and recruitment

For the selection of participants, the study considered three attributes of InnoLabs as the inclusion criteria. First, it should be facilitating the ideation, development, and/or testing of innovations in an ideal physical work environment. This entails that the study did not include the innovation mediators supporting the innovation development in a virtual space through online innovation communities or other web-based tools. Second, it can be used in closed innovation settings meaning that it offers mediating services to organizations intending to develop innovative products or services on a one-to-one basis without the necessary involvement of any third party. Third, its offered services should be open for external utilization by other business organizations. For example, some big organizations such as design consultancy IDEO, Philips, and Royal Mail have established their own dedicated and creative spaces for undertaking their innovation related activities therein (Moultrie et al., 2007). While such structures enable the innovation development, they are only used by their owning organizations. They are therefore not considered as InnoLabs unless they offer their services to other businesses as well.

Accordingly, as the starting source, the study considered 190 InnoLabs identified by Meyer et al (2015). It is important to mention here that this list was considered a suitable source because it is retrieved according to same properties of InnoLabs as the inclusion criteria of the study. The authors have identified the existing InnoLabs by employing a systematic web search using the ‘Google’ and ‘Bing’ search engines and subsequent manual analysis of linked websites. Initially, they have used the terms ‘Innovation Lab’ and ‘Innovation Laboratory’ as search terms and manually filtered the result hits for discarding the duplicates and irrelevant results. In order to overcome the vocabulary mismatch problem and ensuring the comprehensibility of results, they have performed additional searches with other relevant terms such as the ‘Laboratory of Innovation’, ‘Open Innovation Lab’, ‘Lab of Innovations’, ‘Lab for Innovations’ and ‘Laboratory for Innovation’ and extended the result list accordingly. For ruling out the language bias, they have repeated similar searches in Spanish as well, however, this had not yielded any significant extension to the result set. As the next step, authors have analysed the websites of identified InnoLabs in order to retrieve the links of partner sites and recursively included them in the result set according to their suitability (cf. Meyer et al. (2015) for more details on the search approach and description of identified InnoLabs). In pursuance of validating the completeness of identified list of InnoLabs, the researcher, in addition, searched the web with the ‘Innovation Laboratory’ and related keywords, but, this does not yield any new result. It is quite likely that more spaces providing innovative services would also be existing which have not been identified because either they are not listed on the web, or they are not listed in combination with the search terms.

The identified InnoLabs were approached and invited for participation in the survey via an e-mail giving a clear consent of data privacy policy. A few days later, the InnoLabs who did not respond to the first invitation were sent a reminder for participation in the survey. At maximum three reminders for participation were sent to the invited InnoLabs at regular intervals. As a result, 35 out of 190 invited InnoLabs participated in the survey. Out of this more than three-fourth of respondents (27 labs) completed the survey while
the rest of the participants (08 labs) answered it only partially. The anonymized descriptions of the survey participants are given in Appendix B-2.

The participants of the survey were found to be located in different regions of the world. Most of them are situated in developed countries while few are in BRIC countries. The participating InnoLabs have originated over the years. More than 74% of the InnoLabs have been established after the year 2007. The participants’ distribution warrants that either the InnoLabs have a short life span or the number of InnoLabs has really increased around 2007. Figure 3.3 shows the geographic distribution of the survey participants (left side) and the number of survey participants founded in each year (right side).

3.2.1.2 Questionnaire design and dissemination

Fundamentally, the empirical part of the study intended to find answers of the questions regarding the phenomenon of InnoLabs (research objective 1) and their collaboration (research objective 2). However, because of no prior information on the need and/or undertaking of any sort of collaborative activities among InnoLabs, it was unsuitable to ask the survey participants that whether and how they collaborate with each other before confirming the necessity and possibilities of their collaboration. Hence, the survey was intended to capture the phenomenon of InnoLabs only, and the investigation of InnoLab collaboration was reserved for the interviews. Thus, the survey data was expected to reveal that if the existing InnoLabs possess diverse characteristics and if collaboration will be beneficial for them.

The survey questionnaire was comprised of open-ended and nominal scale items (cf. Appendix B-1). Depending on the type and nature of the aspect to be assessed, the respondents were allowed to provide single or multiple answers for a particular question. The questions were structured and a brief explanation was provided for the complex terms used therein. Additionally, the questionnaire also offered an opportunity for the respondents to supplement their answers with additional information. The questionnaire was consisted of 32 questions arranged in seven sections with each section regarding a different area of information to be collected: 1) introductory information, 2) innovation offerings, 3) undertaking of innovation processes, 4) application of methods and tools, 5) facilities provided by the InnoLab, 6) process related statistics, and 7) other supplementary information.
In order to maximize the response rate while keeping the cost of surveying at its minimum, the survey was administered online as the comparison of offline and online surveying methods in psychological research suggests that they are likely to be equivalent (Riva, Teruzzi, & Anolli, 2003). Accordingly, for creating and conducting the survey, an open source software Lime survey\textsuperscript{20} was used. Lime survey was selected because it is a free and open source tool which allows to develop and publish surveys using a web interface, collect responses, create statistics, and export the resulting data to other applications without imposing any limits on the number and types of questions and the number of responses. In addition to recording the answers to survey questions, the survey code was designed to record several other pieces of useful information about the response such as the selected language, IP address, start date, completion date, last accessed page, contact email, number of reminders sent, and the like.

3.2.1.3 Data analysis

For the analysis of the collected data of the survey, the software package R\textsuperscript{21}, a programming language and software environment for statistical computing and graphics supported by the R Foundation for Statistical Computing, was used in version 3.0.1.

For the analysis, at first, the data was manually analysed to remove any discrepancies and in some cases replace the long open-ended answers with their equivalent short codes. Substituting lengthy answers to short codes enabled the effective visualization of data and thereby creation of any new categories of answer based on their repetitive occurrence in the sample. For instance, the question regarding the offering of innovation services allowed the respondents to select other service and specify the service in next text field, if the particular service was not available in the given list of services. Later on, it was observed that the training service is recurrently specified when the other service option is selected and thus it indicates a substantially important group of innovation services. Accordingly, it was decided to include a new service category for the training, instead of leaving the recurrent answers in the other service category. As the next step of data analysis, the function codes were written in R language for generating the diagrams for the statistical evaluation of the survey data\textsuperscript{22} given in Appendix B-3.

3.2.2 In-depth expert interviews

In the second stage of data collection procedure, in-depth expert interviews (Coombes et al., 2009) were conducted with practitioners running an InnoLab. The major advantage of in-depth interviews is that they allow the researcher to dig into the details of a significantly less explored field by engaging in a guided conversation directly with the subjects of the study. All Interviews of the study were conducted between April 2014 and August 2014. Figure 3.4 depicts the overall interviewing procedure of the study.

\textsuperscript{20} https://www.limesurvey.org/
\textsuperscript{21} http://www.r-project.org
\textsuperscript{22} The results of survey have been published as Memon, Meyer, Meyer, and Fähnrich (2014)
3.2.2.1 Informants selection and demographics

Given the global list of InnoLabs retrieved by Meyer et al. (2015), for the selection of interview participants, the study employed the purposive sampling. Purposive sampling, a non-probability sampling technique, relies on the judgement of the researcher when it comes to selecting the units that are to be studied. The logic and power of purposive sampling lies in the selection of information rich cases (Patton, 1990) that manifest the phenomenon of interest intensely. Thus, it allows the researcher to focus on particular characteristics of the population and take a decision on who would be most likely to contribute appropriate data, both in terms of relevance and depth. Purposive sampling can be applied in different flavours depending on the intent of the research. Given that
the intent of present study was to explore the diverse nature of InnoLabs, maximum variation sampling was used whereby the participants were selected according to their capacities to contribute more unique information. To achieve this, the informants were recruited in two steps. In the beginning, the available information on the official websites of identified InnoLabs was analysed in order to select few most active and promising places that conform to the inclusion criteria and seem to yield significant information on the identified topics of interest. Afterward while selecting the next interview participant every time, the available information of InnoLabs was compared against the already collected data in order to select the places that offer different innovation services and are thus likely to yield different insights on the particular topics. In addition, during the interview some participants recommended other places to interview. Such recommendations were recorded and their publicly available information was evaluated similarly in order to decide if they could be the potential contributors of varying data. It is particularly interesting that most of the recommended places were already identified by Meyer et al. (2015) and were working in a similar fashion as the participants recommending them. We contacted the selected informants for an interview appointment via an email first; wherever possible correspondence was done directly with the head of the lab.

The selected informants were contacted for an appointment for the interview via an email first; wherever possible correspondence was done directly with the head of the lab. The correspondence with the participants included the clarification of the interview purpose and the exchange of the interview guide – a set of interview questions (cf. Appendix C-1). After the invitee agreed to participate, a meeting for the interview was scheduled with the participant. In total, the interview sample consisted of 21 InnoLabs comprising nine labs located in the eastern part of the United States of America and Canada, and another twelve labs situated in central Europe, particularly UK, Germany, Hungary, and Denmark. The anonymized descriptions of the informants in terms of their history, size, location (country), business model, management structure, and interview mode are given in Appendix C-2.

### 3.2.2.2 Interview protocol

The interview protocol was framed according to the grounded theory approach. The grounded theory approach is based on two principles, the first one pertains to change while the other pertains to a clear stand on the issue of determinism (Corbin & Strauss, 1990). The principle of change suggests to build change through the process into the method by identifying new concepts emerging from the collected data and including them in the process of ongoing investigation, while the principle of determinism calls to determine if the new concept is relevant to the overall goal of the research and decide accordingly. Accordingly, the interviews were convened in a semi-structured fashion (Knox & Burkard, 2009) whereby the researcher was equipped with a moderator’s guide with pre-written questions (cf. Appendix C-1) to assist the discussion areas. This allowed the researcher to ask structured questions, enabling comparable responses across participants while providing flexibility in drilling down on areas of particular relevance to each participant. Most of the interviews took place at the participant’s workplace,
which in many cases is the lab itself, while few interviews were taken over the phone. Conducting interviews at participants’ workplaces allowed the researcher to personally observe the working environment of the lab; and in some instances participate in innovation related activities as well. Each interview began by asking the expert to briefly describe the respective lab in terms of structure and functioning, and then followed a conversation with open-ended questions covering six aspects of InnoLabs:

1. General conditions, focus and business models
2. Procedure models and service portfolios
3. Application of methods and tools
4. Success factors and statistics
5. Interconnection with other InnoLabs
6. Use of web-based collaboration tools in connecting with other InnoLabs

The identification of these concepts was only done to provide an initial structure of the interview and ensure that all relevant topics are discussed with each participant. However, the researcher believed that discussion of these features will yield significant data for answering research questions of the study. While some of these sections, for example ‘interconnection with other InnoLabs’, were aimed to explicitly address a single aspect of research, other sections, such as ‘procedural models and service portfolio’, were intended to contribute in dealing with more than one aspect of research. Each interview lasted for 60 – 90 minutes. All interviews were tape-recorded (voice only) with the given participant’s permission. In addition to recording tape, hand written notes were also taken during and after the interview. Moreover, few labs also provided written material for further reference and analysis.

3.2.2.3 Data analysis

For the purpose of content analysis of the data, the interviews were pseudo-transcribed (summary of participants’ responses for each question was recorded) in a spreadsheet. Wherever necessary, the direct quotations from the participants’ response were recorded as well. The study did not opt the verbatim transcription as it is not cost-efficient in the case where the objective of research is to identify common themes and patterns in participants’ responses (Halcomb & Davidson, 2006).

The category scheme for recording the interviews data was built in two steps. Initially, the abstract categories aligning with the identified concepts included in the interview questionnaire were identified. Later on, during the analysis it was found that the data coming for a particular question can be further classified into more concrete sub-categories. The new themes arising from the ongoing investigation also required the new categories of information to be included in the category scheme. Thus, the category scheme evolved iteratively on the basis of incoming data. The final category scheme of the study is shown in Figure 3.5.

For recording the information under relevant categories, open coding was used with a combination of in-vivo and constructed codes. For example, when the participants were asked about the offered services, they supplied user-specific descriptions of the similar
services such as ‘expert advice’, ‘management workshops’, and ‘moderated sessions’; all referring to the similar concept of ‘consultation’. Such services were, therefore, recorded as ‘consulting services’ together with the example of words used by the participant. This enabled the effective comparison of the responses and thus drawing the similarities and divergences with respect to particular aspects.

Figure 3.5 - Information map of the interviews data

Hence, the study followed an approach similar to the reflexive and iterative data management process proposed by Halcomb and Davidson (2006). In doing so, the data coming from a particular interview was analysed immediately after it took place in order to build insights and incorporate emerging themes into the ongoing investigation. The data analysis was carried out in three steps. During the first step, as soon after the interview as possible the handwritten notes were reviewed and extended with the reflections collected through personal observations. During the second step, the extended notes were reviewed along with the supplementary material provided by the participant in order to extend them with more concrete observations. During the third step, the audio
tape was listened in conjunction with the written notes and successively the relevant and interesting information was recorded in the spreadsheet against particular categories of information. During this step, the category scheme and interview themes were continuously extended with the new concepts emerging from the ongoing data analysis. Finally, all the data collected from analysed and synthesized into a series of findings\textsuperscript{23}. The conclusions were made based on the most frequent opinions encountered in all interviews.

### 3.3 Artifact development phase

The design, implementation, and evaluation of the InnoLab_Net is achieved following a design science research approach.

#### 3.3.1 Design science research

Design science research (DSR) aims at solving practical and theoretical problems by creating new and innovative artifacts (Hevner et al., 2004) that reach the ‘Pasteur quadrant’, i.e., combine the highest standards of rigour with a high level of relevance (Winter, 2008). As a consequence, contributions of design science research are in the combined novelty and utility of constructed IT artifacts. There have been several attempts in the academic community to define an IT artifact (Benbasat & Zmud, 2003; Orlikowski & Iacono, 2001; Venable, 2006b; Weber, 2006). According to an influential suggestion coming from March and Smith (1995), IT artifacts can be differentiated into four types. One, constructs which provide the language concepts in which the problem is described and the solution is communicated. Two, methods which explicate the processes of how to solve a problem and offer guidance how to search the solution space. Three, models which utilize the constructs to represent an application domain and express the problem and solution space. Models are the result of applying a method. Four, Instantiations which constitute the technical realization of constructs, models, and methods in a working system.

The DSR framework found in Hevner et al. (2004) demonstrate that the design science activities for IT artifacts relate to two major components: the environment and the knowledge base (cf. Figure 3.6). The environment defines the problem space (Simon, 1996) where the phenomena of interest resides, comprising of the business organization and the technology. The business organization specifies the problems, opportunities, organizational context, and business processes that define business needs. The technology component demonstrates the existing infrastructure, information systems, applications, and communications architecture that must be replaced by or integrated with any new artifact. The knowledge base provides the materials (theoretical foundations and research methodologies) from and through which artifacts are constructed and evaluated. Thus, the framework overlays a focus on three inherent research cycles: the relevance cycle, design cycle, and the rigor cycle (Hevner, 2007). The Relevance Cycle bridges the contextual environment of the research project with the

\textsuperscript{23} Summary of findings has been published as Memon, Meyer, Meyer, Thieme et al. (2014)
design science activities. It inputs requirements from the contextual environment into the research and introduces the research artifacts into environmental field. The *Rigor Cycle* connects the design science activities with the knowledge base of scientific foundations, experience, and expertise that informs the research project. It provides grounding theories and methods from the knowledge base into the research and adds the new knowledge generated by the research to the growing knowledge base. The central *Design Cycle* iterates between the core activities of constructing and evaluating the design artifacts and processes of the research. Since design science research aims to build purposeful artifacts to address unsolved problems, the resulting artifacts are evaluated with respect to the utility they provide in solving those problems. Evaluation generates feedback that improves the researcher’s understanding of the problem and the artifacts’ ability to address it. This ‘build and evaluate’ loop typically repeats numerous times, improving both the artifacts and the design processes at each iteration.

![Design science research framework](image)

*Figure 3.6 - Design science research framework (Hevner et al., 2004)*

### 3.3.2 Design science research of the study

The DSR of current study comprises the development of the *constructs* involving the identification of domain specific knowledge and terminology of InnoLabs and their collaboration with each other (Chapter 4 and Chapter 5), *methods* including the searching of effective solution of the identified needs and problems of facilitating inter-InnoLab collaboration (Chapter 6), *models* of the architecture, properties, and functional attributes of solution framework (Chapter 6), and subsequently a *working model* of InnoLab_Net that operationalizes the developed constructs, methods and models (Chapter 7). Accordingly, in the sense of March and Smith (1995) the final deliverable of this work falls into the category of instantiation.

The research framework of InnoLab_Net incorporates the field of InnoLabs as its environmental component and the domain of web-based collaboration tools, methods, and platforms as its knowledge base. The relevancy is achieved through the investigation
of the organizational settings of InnoLabs, and their collaboration practices, methods, and tools. The investigation reveals the problem and establishes the acceptance criteria for the InnoLab_Net. The rigor of the research is achieved by developing a novel web-based collaboration platform that makes the theoretical and practical contributions to the practice of designing web-based B2B collaboration platforms. The main generic contribution of InnoLab_Net is that it demonstrates how dedicated and domain specific B2B collaboration platforms can be designed while simultaneously integrating them with the existing SNSs and thereby allowing the data integration and interoperability.

The DSR holds the potential for three types of research contributions. One, the design artifact itself which enables the solution of the heretofore unsolved problem. Two, the theoretical foundations in the relevant knowledge base extended from the creative development and use of new artifacts. Three, evaluation methodologies including the creative and new evaluation methods and new evaluation metrics employed in the research. As of this study, there are two contributions: the InnoLab_Net itself solving the identified problems of inter-InnoLab collaboration, and the theoretical foundations that InnoLab_Net contributes to the practice of designing web-based B2B collaboration platforms.


The current study specifies four phases of DSR process (cf. Figure 3.7) drawn upon Takeda et al. (1990) and Peffers et al. (2007).

1. **Identification of the problem:** In the first phase, the awareness of the problem was established following the process of problem-driven investigation (Wieringa, 2009). In this regard, the state of the art of inter-InnoLab collaboration, and the relevant challenges are revealed from the empirical part of the study. The problem scope comprises the scarcity of collaborative activities among InnoLabs and the obstacles that hinder the extent of inter-InnoLab collaboration (cf. Chapter 5), and the inadequacy of existing web-based communication / collaboration tools in addressing the identified challenges of inter-InnoLab collaboration (cf. Chapter 6).

2. **Objectives of the solution:** In the second phase, the objectives of InnoLab_Net were established through the conceptual analysis of the problem scope, and the inter-InnoLab collaboration maturity model (cf. Section 5.4). As a result, desired functionalities and general characteristics that a web-based IICP must facilitate were extracted and subsequently an assessment of the potential of existing solutions in supporting the identified functionalities was undertaken. The analysis provided the basis for framing the objectives of the InnoLab_Net (cf. Chapter 6).
3. **Artifact development:** In the third phase, the architecture and functionalities of InnoLab.Net were designed and implemented (cf. Chapter 7). The efficacy and performance of each module of the InnoLab_NET was tested during the development process resulting in the iterations between the designing and evaluation stages of ongoing implementation.

4. **Artifact evaluation:** In the fourth phase, the InnoLab_NET was evaluated in terms of its effectiveness, usability, and completeness in achieving the set goals. For the evaluation of DSR artifacts, Pries-Heje, Baskerville, and Venable (2008) suggest to define three parameters: ‘*when*’ (ex-ante meaning before construction, or ex-post meaning after construction of the artifact), ‘*what*’ (design process, or design product), and ‘*how*’ (artificial form meaning evaluation in synthesized settings, or naturalistic form meaning the evaluation in the real environment with real users of the designed artifact).

Accordingly, for the evaluation of the InnoLab_NET, an ex-post naturalistic evaluation strategy was adopted. In connection to this, several methods have been applied for evaluating the designed artifacts. The most common methods reported in the literature on DSR include logical argumentation, expert evaluation, technical experimentation, subject-based evaluation, action research, prototyping, case study, and illustrative scenario (Peffers, Rothenberger, Tuunanen, & Vaezi, 2012). Accordingly, for the evaluation of the InnoLab_NET, ‘subject-based’ evaluation was undertaken whereby the InnoLab_NET prototype was introduced to the InnoLab facilitators (the intended audience of the system) and subsequently they were asked to evaluate the system in terms of its effectiveness, usability, and completeness by filling out the evaluation questionnaire given in Appendix D-1. A detailed description of the chosen evaluation strategy (approach, method, and criteria) is given in Section 7.4.1 alongside the evaluation results in Section 7.4.2.

![Figure 3.7 - Design science research process of the study](image-url)
Chapter 4
Innovation Laboratories

“In an idea that is developed and put into action is more important than an idea that exists only as an idea.”
— Edward de Bono

In this chapter, the first set of empirical results from the data analysis described in Chapter 3 is presented. The chapter explores the overall construct of the phenomenon of InnoLabs, starting with the definition of the concept (Section 4.1), and then moving on to the service based classification (Section 4.2), and to the characterization in terms of structural and functional aspects of InnoLabs (Section 4.3). Finally, the chapter debates the functional contributions of InnoLabs towards the successful innovation management of products, processes, and services of business organizations (Section 4.4). In drawing the conclusions discussed herein, the data from online survey and expert interviews is integrated, unless explicitly stated otherwise.

4.1 Defining an Innovation Laboratory

As discussed in Section 2.1.4, the earlier studies attempting to define an InnoLab (e.g., Gey et al., 2013; Lewis & Moultrie, 2005; Magadley & Birdi, 2009; Memon, Meyer, Meyer, & Fähnrich, 2014; Meyer et al., 2015; Schmidt, 2009) have characterized it as a physical structure reflecting that an InnoLab should and does have its own dedicated physical space to carry out innovation activities therein. Conversely, this study shows that a number of InnoLabs exist which function in a way that does not necessitate for a dedicated innovation space on their own. Undoubtedly, dedicated and stimulating environments boost cognitive thinking by bringing the people out of their usual work environments and thereby promote creativity (Amabile, 1988), which in turn enhances innovation performance (Moultrie et al., 2007). However, since an innovation is the invention effectively put in commercialization (Amabile, 1988; Amabile, Conti, Coon, Lazenby, & Herron, 1996; Anderson, Potočnik, & Zhou, 2014; Denning, 2004; Fagerberg, 2004), besides the creation of new ideas there are several other necessary and probably more crucial activities to be undertaken in course of an innovation process; the identification of the problem, recognition of potential solutions, exploration of market opportunities, discovery of market needs and wants, and analysis of the success of prior innovations in marketplace, just to name a few. Consequently, an InnoLab does not only support the production of creative ideas, but also other necessary steps for effective and successful innovation implementation. In pursuance of such activities, several offerings of InnoLabs (e.g., moderated consulting workshops) do not require any special infrastructure and thereby do not necessarily need to be conducted outside the usual work environment of an organization. Such mediated services can also be provided easily as well as efficiently either at the client’s site or at a third party site. As a result, existing InnoLabs are found undertaking their innovation related activities inside as well as outside the boundaries of their own dedicated space. Accordingly, the mobility of
InnoLabs can be represented on a 3-point continuum as depicted in Figure 4.1.

Figure 4.1 - Mobility spectrum of InnoLabs

On one side of the scale stand the lab-bounded labs possessing a dedicated physical space of their own and supporting all the innovation related activities therein. Undertaking innovation activities in a dedicated environment allows the labs to control the environmental variables of an organization affecting its innovation potential, examine the construct out of the institutional context, and support out-of-the-box innovation development. On the other side of the continuum are the mobile labs who are oriented around the group of people and all of their activities are conducted either at a clients’ site or a third party site. Conducting activities at the client's site is desirable in two circumstances. Firstly, some of the innovation projects, such as process improvement and optimization projects require a deep analysis of the customer’s business processes. Therefore, lab personnel may prefer to go to the client’s site to investigate the clients’ business environment more thoroughly, examine the problem in its real context, and thus support the innovation process accordingly with more viable solutions. Secondly, in the case of training sessions, it seems to be a cost efficient choice for the lab personnel (fewer in numbers) to go to the client’s site rather than invite the management team (relatively larger in number) to the lab.

"If a company is located in [name of the country wherein the lab operates], and in course of a certain project multiple activities with the client are needed, then it is likely for the company to invite the lab people to their place rather than coming to the lab."

— Participant’s response

In the middle of the scale are the flexible labs that do possess their dedicated environment but are flexible to conduct innovation activities outside of their lab boundaries as well. The decision of location of innovation sessions depends on the suitability for the respective innovation project and/or a particular activity. As a result, this group of labs may gain benefits of both models of InnoLabs. In the cases where more control over the environmental variables is required (e.g. brainstorming and creativity sections), they function as lab-bounded labs, while in the cases where more insights into the real work environment of customers are necessary (e.g. management training and process optimization), they behave as mobile labs.
This ascertains that the term ‘Innovation Laboratory’ does not merely refer to some physical structure, but may also denote a group of people who facilitate innovation process with their methodological expertise outside the boundaries of a particular space. By saying so, the study defines an InnoLab as:

“A dedicated physical or virtual (mobile) structure which mediates innovation process and enables the effective development of innovations through the provision of collaborative services and necessary resources (equipment, methods, and tools).”

Out of 21 interview participants of the study, 15 labs (about 71%) are lab-bounded labs, 2 labs (about 10%) are mobile labs, and the remaining 4 labs (about 19%) are flexible regarding the location of innovation sessions. The statistics indicate that more labs are bounded to their lab premises, nevertheless, considerable interest towards the mobile model of innovation labs can also be observed. In one of the interview participant cases, the lab started as a lab-bounded lab and currently has adopted both models. Further, the lab management presumes that it may completely turn into a mobile lab in the future.

### 4.2 Service based classification of Innovation Laboratories

The proposed definition of an InnoLab given in the preceding section describes its construct in a broader sense. Given the phenomenon of InnoLabs has recently emerged, the field yet remains unstructured in the practice. In the absence of a structured and conclusive description of phenomenon, in pursuance of the overarching aim of fostering the innovation process and enhancing the innovation capacity of organizations, the existing InnoLabs are far from working alike and are thus aiming to achieve different objectives that fall into four broad categories:

1. Disseminating knowledge and enhancing human skills,
2. Creating new value propositions,
3. Supporting entrepreneurial ideas,
4. Solving market problems.

The goals that a particular InnoLab tries to achieve are also reflected in its service portfolio that it offers to its clients. Increasingly, with respect to their service portfolios many of them appear working analogous to other existing concepts of innovation intermediation such as living laboratories, fab laboratories, business incubators, co-working spaces, and the like. Accordingly, the existing InnoLabs can be classified into nine different types which are defined below. The numbers in parentheses represent the percentage of the interview sample falling in each category. It is necessary to note that these categories are not disjoint. Therefore, a certain InnoLab may fall in more than one category depending on its offered service portfolio. For instance, an InnoLab focusing on service innovations (a service laboratory) can be further classified depending on the type of support it provides to service industries. It can additionally be recognized as a consulting lab if it focuses on training and coaching services, or as a business incubator if it helps the start-ups in establishing their service oriented businesses.
1. **Service / process laboratory (62%)**: An InnoLab can be regarded as a service or process laboratory if it mainly focuses on the innovation in the services or business processes. A service lab targets the service businesses and assists them in developing new services, and improving or optimizing the service processes. Such InnoLabs provide the mediating services and necessary tools for idea generation and assessment, and the development of the proof of concept through service simulation and service visualization techniques.

2. **Product / production laboratory (33%)**: An InnoLab can be characterized as a product or production laboratory if it mainly focuses on the innovations in tangible goods. A product laboratory supports the manufacturing firms in idea generation and assessment, and in prototyping and testing the visual and operational functionalities of physical products.

3. **Consulting laboratory (47%)**: An InnoLab falls in the category of consulting labs if it mainly provides coaching and mentoring services. A consulting lab offers expert knowledge and technical expertise in understanding the problem, and thereby devising most viable solutions. The overall motive of consulting labs is to articulate the knowledge and build human capacities for successful innovation management. In addition to the individual and on-the-topic consultation services, consulting labs also offer the moderated innovation sessions regarding innovation strategy, and management and marketing approaches and thereby help the business organizations in improving their business performance and competitiveness.

4. **Co-working space (19%)**: Co-working spaces are the InnoLabs that facilitate innovation process through the provision of an open and flexible workspace, and shared equipment. They facilitate a creative environment outside of a usual work environment to stimulate cognitive behaviour and enable organizations to think “out of the box”. The shared equipment ranges from the usual office amenities such as printer, fax, internet, phone, etc. to low- and high- tech multidisciplinary or field specific special equipment.

5. **Business incubator (14%)**: A business incubator is an InnoLab assisting the business start-ups in flourishing their entrepreneurial ideas and accelerating their new businesses. A business incubator supports the idea hatching and evaluation, business potential (market-fit and profitability) and feasibility assessment, and the acquisition of seed money for the proposed ideas of new businesses.

6. **Network coordinator (19%)**: A network coordinator is an InnoLab that supports innovations by bringing different stakeholders of the value chain in a network. The services offered by network coordinators include, but are not limited to, network formation and management, assistance in the discovery of potential partners through the exchange of technical information, and facilitating the interaction among the participating actors.

7. **Living laboratory (10%)**: A Living laboratory is an InnoLab that supports innovation of products and services in a collaborative, multi-contextual, and empirical real-world environments. A living lab facilitates a dedicated physical environment together with the specialized tools (hardware and software) relevant to a particular theme or a business process, and thereby enable various actors of a value chain to
work together towards common goals. It also enables the organizations to involve end users in the development of new products and services.

8. **Fabrication laboratory (14%)**: A fabrication laboratory focuses on the provision of engineering and manufacturing tools for digital fabrication. The fab labs facilitate an open and flexible technical prototyping platform for designing physical components of innovations.

9. **Research and development lab (14%)**: A research and development lab is the internal part of a business organization and is mostly engaged in research and development of new solutions (products and services) particular to that organization. A R&D lab can be regarded as an InnoLab if it offers its services to other parties (customers, partners, and other businesses) as well.

### 4.3 Characterization of Innovation Laboratories

The study has confirmed that the term ‘Innovation Laboratory’ is used as a hypernym where the underlying entities differ remarkably from each other in terms of several structural and functional aspects. This section discusses nine identified differentiating traits of innovation laboratories which are classified into two groups: primary differentiating factors and secondary differentiating factors. These attributes serve as the criteria for characterizing a particular InnoLab and accordingly establish the basis for differentiating a particular InnoLab from others within and across categories. Figure 4.2 summarizes the identified features of an InnoLab together with their possible values occurring across the masses.

#### 4.3.1 Primary differentiating factors

The primary factors of an InnoLab compose what, where, and how an InnoLab assists the innovation projects. The ‘what’ factor specifies the type of innovations supported by an InnoLab, the ‘where’ factor indicates the part of innovation cycle covered by the offered services of an InnoLab, and ‘how’ factor determines the type of resources that an InnoLab provides during the specified stages of the innovation cycle. The existing InnoLabs exhibit diversity in all three factors which are defined below.

1. **Innovation object**: The innovation object of an InnoLab refers to the type of innovations it supports. Innovation object is the most basic and important attribute for characterizing an InnoLab. The existing InnoLabs appear supporting innovations in three domains: product development, business processes, and service development. Accordingly, the innovation object of a particular InnoLab may be specified as either product if the lab targets the radical and/or incremental innovations in the tangible goods offered by the manufacturing companies, process if the lab supports the innovation in the business processes, or service if the lab focuses on the innovations in the services.

2. **Innovation understanding**: The innovation understanding of an InnoLab refers to the scope of innovation cycle covered by its offered services. The study reveals that not all labs support entire innovation cycle. A particular InnoLab may cover...
innovation cycle partially meaning that it supports only a few selective phases of innovation process, entirely meaning that it supports innovation cycle from the idea generation to the market launch, or continuously meaning that it supports innovation process also beyond the market launch by evaluating the offered innovation in the market and thereby supporting the continuous improvement of the product or service.

3. **Innovation resources**: The innovation resources of an InnoLab refers to the types of the resources which it invests into the innovation process. The existing InnoLabs offer three types of resources: *soft skills* such as the knowledge, technical and methodological expertise, *hardware* including the tangible operational and technological resources, and *finance*.

### 4.3.2 Secondary differentiating factors

Besides the diversity in primary factors discussed above, InnoLabs also differ in terms of other attributes. These attributes together with the primary factors create the domain specific profile of InnoLabs. Two of these factors (innovation focus and innovation process maturity) are related to their operational structure, the other two (innovation scope and customer locus) are related to their customer market, and the remaining two (business model and management structure) are related to their organizational structure. A brief description and variety of these factors follows:

1. **Innovation focus**: The innovation focus of an InnoLab refers to how it perceives and undertakes the innovations in the innovation environment. In this esteem, the innovation focus of a particular InnoLab may be either the *autonomous innovations* meaning the standalone innovations which can be pursued independent of other components of the system, or the *networked / systemic innovations* meaning the innovations interlinked with other innovations within a particular system.

2. **Process maturity**: Owing to the fact that the paradigm of InnoLabs is in its emerging state, every lab works in its own way with a unique methodology. The study has revealed that very few labs employ a fixed methodology; while others employ varying approaches in different projects depending on the nature and requirements of the project, suitability to the customer, or the preference of personnel working on the specific innovation project. Accordingly, the maturity of methodological approach of a particular InnoLab can be classified as either *no defined methodology* if the lab does not have a fixed methodological structure for undertaking innovation projects and always employs flexible procedural models, *methodology as a business model* if the lab has a fixed and well-defined methodology but does not disclose it publicly, or *clear or transparent methodology* if the lab shares its methodology with the clients at the beginning and/or during the innovation project, and also specifies it in the project documents.

3. **Innovation scope**: The innovation scope of an InnoLab refers to the business sector of its main customer market. While most of the InnoLabs are open for any business sector, there exist few InnoLabs who target only selective business sector(s). Accordingly, their innovation focus may be classified as either *thematic* if the lab supports innovations in a specific business sector, or *multidisciplinary* if the lab works multidisciplinary and is open for every business sector.
4. **Customer locus**: The customer locus of an InnoLab refers to the geographic span of its customers which can be specified as *local / regional* if most of its customers are located within a particular region, or *international* if its customers are located across regional and national borders.

5. **Business model**: On the basis of the business model, an InnoLab can be classified as either *profit oriented* or a *non-profit oriented* lab. The non-profit oriented InnoLabs further classify according to the financing source, i.e. *public finance* or *private finance*.

6. **Management structure**: In terms of the management structure, an InnoLab can be characterized as either *company owned* if the lab is established and managed by a business institution, *university hosted* if the lab is established and controlled by a university or a research institute, or *private*. The study has revealed that most of the university hosted labs are based on a non-profit oriented business model, works with the students, and their thematic focus is confined to the areas that the managing department is concerned with. It is also observed that the thematic focus of company owned labs is also confined to the theme of the owning company.

![Differentiating traits of InnoLabs](image)

Figure 4.2 - Primary and secondary differentiating traits of the InnoLabs. Numbers in parentheses indicate the percentage of interview sample matching with each value (N=21)
4.4 Functional roles of Innovation Laboratories

The preceding sections of this chapter discussed several structural and functional aspects of InnoLabs and described how an InnoLab can be defined, classified, and differentiated from other InnoLabs within and across categories. The current section elaborates the functional contributions of the InnoLabs towards the systematic, efficient, effective, and ultimately successful innovation management of products, processes, and services of business organizations.

Corresponding to the different types of innovation support focused by InnoLabs, their offered services range from facilitating simple meeting rooms to highly specialized play areas, disseminating knowledge from ‘what to do’ to ‘how to do’ aspects of innovation process, providing equipment from simple office accessories to high-tech and field specific tools, aiding software tools from simple office applications to proprietary software programs, and facilitating from individual consultation to networking activities. The offered services tend to cluster around eight key functionalities that add substantial value in maximizing the chances of success of an innovation project (cf. Figure 4.3).

![Figure 4.3 - Functional roles of InnoLabs and the associated offerings](image)

The identified functionalities impact innovation process at a different stage and in a different manner. Figure 4.4 indicates the phases of innovation process affected by each functionality. The relative impacts of each functionality are summarized in Figure 4.5. It is important to note that a certain InnoLab may focus on only certain functionalities, and thereby not capable of mediating whole innovation process. Therefore, the given list of functionalities should not be considered as a criterion for assessing the potential of InnoLabs. Rather, it determines what kind of support is available at InnoLabs and how business organizations may exploit such facilities in addressing their individual innovation challenges.

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24 This section is based on Memon and Meyer (2017)
25 The stages are taken from simplified version of innovation process as discussed in Denning (2004)
Innovation Laboratories

Figure 4.4 - Influence of InnoLab functionalities on the stages of the innovation process. The solid line indicates the direct project based support facilitated by the InnoLabs. The dashed line shows the indirect influence on the prescribed stages where the services are provided out of the context of a particular project.

Function 1 - Creativity stimulation

The foremost contribution of the InnoLabs is the creativity stimulation which has already been identified and discussed in previous studies (e.g. Lewis & Moultrie, 2005; Magadley & Birdi, 2009). The features of InnoLabs fostering the creative thinking of people and thereby supporting the conception of more novel ideas include a dedicated space with a creativity conducive physical layout such as rooms with curved walls, multiple working rooms with differently painted walls, round tables, and portraits, and a range of high- and low-tech supporting tools including the white and interactive boards, electronic brainstorming systems, cinematic theatres, idea generation and assessment techniques and software tools, pictures, electronic gadgets, play tools, and multimedia projection facilities. The infrastructure is mostly kept flexible so that it can be arranged in different settings to match with the project requirements, and the individual likings and work styles. Furthermore, in addition to changing the structural settings, a facilitator at the InnoLabs also moderates the problem solving or brainstorming sessions and is responsible for tailoring the group discussions according to the needs of clients, coordinating the group discussion activities, and preparing the post-session recommendations. The creative infrastructure and expert moderation together improves the likelihood of coming up with more novel and better solution of the problem under discussion. Moreover, the idea assessment under the expert facilitation with appropriate tools also helps to see if the chosen idea is feasible in terms of technology, finance, adapting firm’s structure, and the market, and thereby assists in picking up the most viable ideas for further implementation and actualization.

Function 2 - Knowledge dissemination

The second contribution of InnoLabs is the knowledge transfer and creation of new knowledge by offering three distinct services. Firstly, they articulate the explicit and tacit pieces of organizational knowledge, respectively through the teaching and training programs. The special courses on the advanced topics of innovation management and the training programs on handling the specific technological equipment build internal human capabilities for innovation management. The gained knowledge and acquired skills at the
InnoLabs are then applied by the people in different organizational contexts and thereby result in increased productivity and competitiveness of organizations. Secondly, InnoLabs support the integration of expert knowledge and technical expertise into the innovation process by offering consultancy services that assist the organizations in understanding the problem, devising most viable solutions, and finding answers for their individual questions. Thirdly, in addition to the individual and on-the-topic consultation, InnoLabs offer moderated innovation sessions on the topics of innovation strategy, management, marketing, and like, for enhancing the leadership skills of the participants and training them on how to foster a conducive environment for innovation within their organizations. The workshops, thus help to eliminate the ‘Not invented here’ syndrome - the most common innovation barrier -, and consequently cultivate a culture of innovation. The knowledge disseminating services at the InnoLabs are offered in or out of the context of a particular project. In either way, the acquired human competencies may then be applied in various organizational contexts and also in the creation of new knowledge. Thus, the influence of this functionality cannot be determined at a particular stage of the innovation process, but indirectly influences whole innovation process. In the course of this study, it has been observed that almost every lab facilitates the knowledge dissemination in one or other way; the consultation and workshop services are offered to some extent, at least.

Function 3 - Business incubation

Another functionality of the InnoLabs is the support for start-ups by means of four types of business accelerating services. Firstly, through the coaching and mentoring services, InnoLabs assist the start-ups in refining their new business ideas, evaluating the potential of proposed business (market-fit, profitability), and developing the feasible business plans. In guidance of the lab mentors, start-ups carry out the feasibility and profitability analysis of the proposed ideas by means of several tools (e.g. business canvas, financial projections, etc.), and consequently they are able to foresee the future obstacles, determine the success probability, and refine their ideas into more viable ones with higher chances of market acceptance. Secondly, InnoLabs offer co-working space and shared equipment ranging from necessary amenities such as fax, printers, and office supplies to high- and low-tech industry-specific tools. The provision of necessary resources lower the initial setup costs for the start-ups and thereby enable them to launch their products and/or services in the market quickly. Thirdly, InnoLabs financially assist the start-ups by directly investing into their businesses as a loan or a partnership, or putting them in contact with potential investors. In the latter case, the InnoLabs either organize the networking events for the start-ups giving them an opportunity to present their ideas before the potential investors, or guide them on where and how they can acquire funding for their businesses. Finally, InnoLabs support communication and networking among start-ups and other established companies by organizing networking events for their linked organizations to get in touch with each other, make contacts, and align in new co-operations.

Function 4 - Network formation

InnoLabs also act as a networking platform for the organizations to share their diverse
competencies, expertise, knowledge, and other complementary resources, and eventually configure new innovation projects that cross the organizational boundaries, and often multiple disciplines. In order to ensure that the network creates value among the network participants, a facilitator at InnoLabs establishes and strengthens network ties by actively moderating the stakeholders’ meetings, managing group discussions, recommending the methodological approaches, and maintaining the network structure. The networking capabilities of InnoLabs are different from the traditional networking agents in that the networking services of InnoLabs go beyond providing a platform for bilateral and multilateral exchanges or communication. They, in addition to the aggregation and exchange of partnering information, also provide the infrastructure, tools, and special equipment (relevant to a particular theme or multidisciplinary) which enable the partners to develop and experiment the proposed innovations effectively. Furthermore, InnoLabs themselves search and transform ideas, provide solutions with new combinations, and thereby act as knowledge repository as well. They bring insights from the earlier projects and transfer knowledge to new projects that fit to individual clients. The networking supported by InnoLabs result in cost sharing of innovation projects among participating agencies, and thus enable the businesses with shallower pockets to design, develop and commercialize the innovations which they otherwise would not be able to implement. Since InnoLabs bring businesses with diverse talents together, they encourage the utilization of existing resources in different ways, the creation of new knowledge, and reconfiguration of different projects.

**Function 5 - Resource provision**

InnoLabs unlock the resource shortage of business organizations by offering the necessary resources for prototyping, experimentation, development, and market launch of innovations on their disposal. They alleviate the lack of operational resources of businesses by offering shared office spaces together with usual office amenities, and the shared high- and low- tech equipment including the multidisciplinary tools (e.g. idea generation and assessment tools, prototyping and simulation tools, and modelling and visualization tools), and the special domain specific tools (e.g. the equipment used in biotechnology, digital designing, or technology companies). Furthermore, InnoLabs gear up the technical expertise of businesses by articulating the knowledge and practice of latest technological tools. The availability of sufficient technological resources and technical expertise promote technology integration in innovation projects, and thereby allow the organizations gain efficiencies and differentiation simultaneously. Besides, the appropriate use of cutting edge technology ensures the market desirability, shortens the development time, increases the chances of market acceptance, and enables faster adoption.

**Function 6 - Process intermediation**

Another contribution of InnoLabs is the systematic and methodical development of innovative products and services. Facilitators of InnoLabs with their expert knowledge select, recommend, and apply appropriate methodical approaches to various stages of the innovation process. Because innovation projects tend to differ from each other and in the absence of structure and clear cut guidelines an innovation project may fail dramatically,
they decide and select a systematic approach in accordance with the project nature, requirements, and adapting firm’s structure. Furthermore, in the course of different projects, they continuously build new knowledge on the technical and methodical aspects of the innovation process, and therefore they do not only possess and convey information on existing methodologies, but also devise new methodologies and adapt them to different contexts, domains, and types of innovations. Accordingly, in the case of unsuitability of any existing methodology for a certain project, they are able to modify an existing or build a new methodology for the project. Their technical expertise helps the businesses in undertaking activities appropriately and finding out errors, if any, and taking appropriate actions at an early stage. This, in turn, lowers the development time and risks associated with the innovation process.

**Function 7 - Research and development**

Besides undertaking customer innovation projects, InnoLabs also engage in research projects either individually or in collaboration with other industry partners and research institutes concerning the market analysis, development and testing of new methodologies, technological advancements and opportunities, and the establishment of best practices and guidelines for innovation management. As a result, they identify the emerging trends in the market and subsequently revise the existing or devise the new strategies for dealing with the challenges posed by these trends. The documentation of on-goings and results of the innovation projects undertaken by them in the form of internal project documents and/or scientific publications promotes the introduction and articulation of new concepts, standardization of new methods, and organizational learning from success and failure stories and their associated factors. Moreover, InnoLabs also develop the necessary tools (mostly used internally) for supporting the specific phases of innovation process (e.g. IdeaNet platform developed by HYVE Innovation Community that facilitates the collaborative idea generation, exploration, and assessment (Matt, 2011)) and the tools for achieving certain capability for the innovation process (e.g. Technology Radar developed by the Deutsche Telekom Laboratories that supports the acquisition of technology intelligence (Rohrbeck, Heuer, & Arnold, 2006)).

**Function 8 - Market research**

InnoLabs offer sophisticated consumer research services for identifying opportunities in the marketplace, minimizing risks, uncovering potential problems, spotting emerging trends, discovering customer needs and demands, and evaluating the success in the market. InnoLabs carry out consumer research for two purposes. Firstly, consumers are studied during the idea generation phase with an aim to understand environment, needs and demands of customers, and thereby generate appropriate ideas and ensure that the innovative offering will generate demand and value in the market. Secondly, the consumer research is conducted to acquire feedback regarding the existing product/service in order to evaluate the success, identify the problem if any, and devise solutions for improvement. In the course of this study, it has been observed that most of the labs follow a user-centered design approach whereby the consumers are always studied in the beginning of the innovation process by employing different ethnography tools such as the 360 degrees recording cameras (for catching the users’ actions and the
associated environment), users’ diary (users record their activities and report), text messaging service, online and offline surveys, interviews, discussions, polls, and other software tools. The method of investigation vary on the project basis; sometimes real end users are involved in the process and the other times the lab personnel perceive users’ activities themselves. Another approach employed at InnoLabs for user-centered design is the idea contests whereby the ideas are drawn from the community and are then analysed by lab personnel to identify what most users need or will accept readily.

Figure 4.5 - InnoLab contributions towards the successful innovation process

4.5 Chapter summary

This chapter has explored the overall construct of InnoLabs. The investigation of the undertakings and functioning of existing InnoLabs discussed in this chapter leads to the conclusion that although the overarching goal of all InnoLabs is to foster the innovation process and assist business organizations towards the systematic and successful innovation process, InnoLabs vary in their focus, and accordingly their methods and offered services. As a result, the existing InnoLabs are capable of assisting the business organizations in generating and assessing creative ideas, building human capacities, acquiring knowledge and the technical expertise, dissolving management barriers for innovation, reducing initial costs of new businesses, accessing the complimentary assets, reducing the risks associated with innovation, sharing the costs for innovation projects, lowering the time to market, alleviating the dearth of resources, integrating technology into innovation projects, collecting feedback, applying systematic innovation methodologies, learning emerging trends and innovation related problems and their solutions, and financing the innovation projects. Nevertheless, because of the complexity and intensity of innovation process, a particular InnoLab only supports a subset of aforementioned tasks. Consequently, the different types of innovation support, knowledge, and the competencies that might be required in course of an innovation process remains fragmented among different innovation laboratories. Accordingly a business seeking innovation assistance from the InnoLabs may need to consult more than one InnoLab in the course of a single innovation project in order to solicit all the necessary support for the innovation process.
Chapter 5

Inter-InnoLab Collaboration

“Unity is strength... when there is teamwork and collaboration, wonderful things can be achieved”

— Mattie Stepanek

This chapter deals with the concept of inter-InnoLab collaboration and answers the second research question of the study set out in Chapter 1. Following a conceptualization of inter-InnoLab collaboration in the beginning (Section 5.1), the chapter builds upon the empirical findings discussed in the preceding chapter and postulates why InnoLabs should undertake collaborative activities with their peers within and across categories (Section 5.2). Subsequently, the chapter presents the conceptual framework of a collaborative network of InnoLabs (Section 5.3). The next part of the chapter presents the inter-InnoLab collaboration maturity model (Section 5.4), and successively uses the proposed model to evaluate the current extent of interconnection among InnoLabs (Section 5.5). Finally, the chapter discusses the main factors curtailing the InnoLabs from collaborating with each other (Section 5.6). The empirical findings presented in this chapter are solely based on the data coming from in-depth expert interviews.

5.1 Concept

Inter-organizational collaboration can broadly be defined as “a cooperative, inter-organizational relationship that is negotiated in an ongoing communicative process, and which relies on neither the market nor the hierarchical mechanism of control” (Hardy, Phillips, & Lawrence, 2003, p. 323). This anticipates that the collaboration is not undertaken as a buying and selling mechanism or as an ownership among participating agencies. Rather, the participation is to exchange the diverse resources and mutually share the responsibilities and risks of innovation projects. This type of collaborations result in organization’s continuous integration and disintegration with other organizations in order to create new value propositions and thereby result in a collaborative network of connected organizations. Accordingly, a collaborative network of organizations can be defined as an association of largely autonomous, geographically distributed, and heterogeneous organizations in terms of their operating environment, culture, social capital, and goals that have come together to collaborate in order to better achieve common or compatibles goals (Camarinha-Matos & Afsarmanesh, 2005). Collaborative networks allow the leveraging and rapid configuration of resources in order to integrate the intellectual and technical leaderships of different organizations’ competencies.

Assuming InnoLabs as a class of organizations seems logical in that they offer services to the customers on a one-to-one basis and each InnoLab operates as an autonomous unit possessing own specific strengths and weaknesses (availability and shortage of different types of resources). This suggests that InnoLabs may also benefit similar economical and functional advantages if they exercise collaborative activities with other InnoLabs.
Depending on the missing competencies and desirable benefits, an InnoLab may collaborate with others offering similar services and thereby falling in the same category, or the ones offering different services and thereby falling in the different categories. As a result, two forms of inter-InnoLab collaboration can be distinguished: *Horizontal inter-InnoLab collaboration* meaning the collaboration among InnoLabs who belong to same category and/or provide a similar set of services and are thereby primarily potential competitors of each other, and *Vertical inter-InnoLab collaboration* meaning the collaboration among InnoLabs who belong to different categories and/or provide different sets of services and fundamentally work on different levels of value chain. Taking this view of horizontal and vertical collaborations among InnoLabs, inter-InnoLab collaboration is defined as:

“the horizontal (within category) or vertical (cross-categorical) collaboration (exchange and exploitation of knowledge, competencies, and other resources while sharing the responsibilities and risks) among the autonomous, geographically distributed, homogenous or heterogeneous (in terms of structural or operational characteristics) innovation laboratories”.

It is necessary to note that InnoLabs may collaborate in three contexts; research projects, third party projects, and the customer innovation projects. While the current study mainly focuses on the collaboration in undertaking customer projects, it neither completely excludes nor does it intends to exclude other two types of projects.

### 5.2 Why should InnoLabs exercise inter-InnoLab collaboration?

This section discusses the factors that collectively postulate that InnoLabs should look for opportunities to acquire and exploit complementary resources and services from outside the lab boundaries, and simultaneously open up their resources and expertise for external utilization in order to enhance their mediation capacities and strengthen their business.

#### 5.2.1 Need determinants for inter-InnoLab collaboration

The need for inter-InnoLab collaboration arises from three aspects of existing InnoLabs emerging from their structural and functional differentiation (cf. Figure 5.1).

![Figure 5.1 - Relation of InnoLab differentiation and need for inter-InnoLab collaboration](image-url)
1. **Service diversity:** As discussed in Chapter 4, the detailed analysis of the current practices and functioning of InnoLabs elucidate that the InnoLabs offer varying mediated services to their clients. The service diversity results in scattering of innovation support that might be needed in the course of an innovation process in hands of different autonomous and geographically distributed InnoLabs.

2. **Fragmented support:** The offering of diverse services and resources results in the fragmented innovation support among InnoLabs. Increasingly, a higher number of InnoLabs only support the earlier stages of the innovation process, i.e. conceptualization. As illustrated in Figure 5.2, as the stages of the innovation process proceed towards commercialization, the support provided by the InnoLabs becomes scarce. Out of 21 interview participant InnoLabs of the study, 18 InnoLabs (about 86%) support the phase of idea generation (first phase of the innovation cycle), whereas the number declines to only 3 labs supporting the phase of innovation commercialization (last phase of the innovation cycle).

In the current scenario of operation, an InnoLab provides its services to the client and feels itself responsible only for the acceptance of the proposed solution by the client. The implementation and other follow-up activities are either solely relied on the client or very little support is provided. Consequently, many ideas are left unimplemented in the market, as either the clients cannot invest all the necessary resources in the process or they cannot acquire sufficient support during the later phases of the innovation process. This, in turn, introduces the possibility of the generation of similar ideas by different people, resulting in wastage of the efforts (time and resources). The interviews of the study reflect that implementation of the proposed solution and the post implementation tasks are often not supported because either the certain InnoLab does not have enough resources (including human expertise, equipment, or finance) to invest in the implementation phase or it is difficult for the InnoLab to assess how much effort (time and resources) it will cost to support the later phases of the innovation process.

"We can design and say ok, here is what you should develop, then we can develop but we are not good to develop that."

—Participant’s response

![Figure 5.2 - Innovation support offered by the participant InnoLabs during the innovation process (N= 21)](image)
3. **Local and/or thematic focus**: The discussion with the interview participants of the study regarding the type of targeted customers indicated that their customer market is mostly localized and/or thematic. In most cases, the geographic span of the customers is up to the country borders with the majority located within the city of the lab. One of the observed reasons for the locality of customer market is the lack of proper advertisement of the lab’s work and services. Most of the labs do not employ specific promotional activities, and thereby customers are caught by word-of-mouth recommendations (i.e. the customers come to know about the lab either through former customers or through the face to face contact with lab members). Consequently, prospective customers are likely from the same region and similar business sectors wherein the lab has previously worked. This makes the labs working for a specific group of customers and/or within a specific region. This implies even to the labs who are by themselves open to all and willing to work multidisciplinary.

"We do not actively go to people, it is like you know the people and through them the others reach out."

— Participant’s response

5.2.2 **Potential benefits of inter-InnoLab collaboration**

This section discusses the threefold benefits that inter-InnoLab collaboration is likely to generate for the participating InnoLabs, their customers, and the innovation environment as a whole (cf. Figure 5.3).

![Potential benefits of inter-InnoLab collaboration](image)

**Figure 5.3 - Potential benefits of inter-InnoLab collaboration**

5.2.2.1 **Potential benefits for the participating InnoLabs**

Inter-InnoLab collaboration will be beneficial for the participating InnoLabs in extending their business by enabling the aggregation of competencies and resources, improved quality of service, extension of service portfolios, and the discovery and invasion in new markets.
1. **Increased competencies**: Through the collaboration, the participating InnoLabs can access and successively leverage the resources and competencies held by each other, and thereby enhance their capabilities for supporting the innovation process. For example, if an InnoLab (say lab A) can only support the conceptualization phase of the innovation process, it may collaborate with another InnoLab (say lab B) which is capable of supporting the later phases of the innovation process. As a result of this competency sharing, the lab A can increase its competencies and be able to support the entire innovation process.

2. **Better quality of service**: In addition to allowing the participating InnoLabs to exploit the external resources, inter-InnoLab collaboration will also enable them to better use their internal resources through the knowledge exchange and mutual learning. Information sharing regarding the best practices, methodological approaches, market trends, as well as the success and failure cases will assist them in understanding their market and customers, assessing the problems more appropriately, and thereby improving their quality of service by designing the solutions which are more viable for their customers to implement in the market.

3. **Extended service portfolios**: Through vertical collaborations, participating InnoLabs would have an opportunity to integrate new and promising skills and tools in their infrastructure resulting in their extended service portfolios. For instance, a co-working space and a business incubator may integrate their services while looking over the edge of their current service portfolios. As a result, they both would be able to support the new innovative businesses not only in conceptualization and acquisition of seed money (services of business incubators) but also facilitating the operational resources (services of co-working spaces) resulting in the early market launch of the new business. It is interesting to note that in the course of this study, examples of such cross category collaborations have been found that have evolved over time and are perceived useful by the participating InnoLabs.

4. **Invading in new markets**: Being in a collaborative network, the participating InnoLabs will have a chance to recommend each other to their potential customers. Specifically, an InnoLab after providing its services to the client, may advise them on where they could solicit further assistance. Furthermore, by the integration of the skills and resources of each other, the participating InnoLabs may even invade in new markets of innovation support and thereby generate more revenue out of their invested resources.

### 5.2.2.2 Potential benefits for the customers of InnoLabs

The inter-InnoLab collaboration will not only benefit the participating InnoLabs, but also the customers of the labs by facilitating them to acquire extended services at one place and receiving improved quality of service.

1. **Extended services at one place**: As mentioned earlier, in the case of non-collaborating InnoLabs, because of their fragmented innovation support, a customer may need to engage in multiple co-operations with different InnoLabs in order to acquire all the required support in the course of a single innovation project. On the contrary, in the case of collaborating InnoLabs, a customer would only need to initiate a single co-operation and may get all required support at one place (cf. Figure 5.4).
Furthermore, the inter-InnoLab collaboration across the regional borders will enable the customers of participating InnoLabs to seek the innovation support that they cannot solicit otherwise at the local InnoLabs that they have access to.

2. **Improved quality of service:** In addition to extended services, as a result of inter-InnoLab collaboration, the lab customers would be able to receive better support with the reduced risk of innovation failure as the lab itself will have access to more resources and expertise.

![Interaction scenario of InnoLab and its customer in case of non-collaborating and collaborating InnoLabs](image)

**Figure 5.4** - Interaction scenario of InnoLab and its customer in case of non-collaborating and collaborating InnoLabs

**5.2.2.3 Potential benefits for the innovation environment**

Inter-InnoLab collaboration will also enhance the innovations in the market. The comprehensive service portfolios of participating InnoLabs will yield more innovative solutions, and more fertilization of good ideas in the market. The optimized innovations implemented in the market will in turn satisfy more needs of the global market. Furthermore, the collaboration among InnoLabs will enable them to solve innovation challenges spanning across the disciplines and thereby support the development of sustainable innovations in this globalized era.
5.3 Conceptual framework of a collaborative network of InnoLabs

This section presents the conceptual framework of an inter-InnoLab collaborative network. The proposed model illustrates the possibilities of collaboration among different types of InnoLabs in order to centralize all the innovation support and simultaneously allow the InnoLabs to enhance their service portfolios and service quality by leveraging the diverse competencies of each other. The theoretical underpinnings of proposed model are based on two concepts: service-based classification of InnoLabs (cf. Section 4.2) and the concept of horizontal and vertical inter-InnoLab collaboration (cf. Section 5.1). While the service-based classification postulates that the existing InnoLabs offer varying set of services, the concepts of horizontal and vertical collaboration suggest that the categorical and cross-categorical inter-InnoLab collaborations are beneficial for InnoLabs in improving their service quality and extending their service portfolios respectively. Accordingly, the proposed network model is comprised of four horizontal networks and the successive vertical collaborations among the players of different horizontal networks. Figure 5.5 depicts the proposed model of collaborative network of InnoLabs.

1. **Network of mentors**: The network of mentors includes the ‘consulting labs’ and the ‘business incubators’. While these two types of InnoLabs focus different types of customers, their offered services are very much identical in nature. In the proposed model, the players of this network are supposed to support the activities related to the identification of the problem, analysis of the need for innovation, identification of opportunities, and the understanding of the business/market environment.

2. **Network of process intermediaries**: The network of process intermediaries includes the ‘service InnoLabs’, ‘product InnoLabs’, and the ‘R&D laboratories’. Since a single InnoLab is not capable of mediating all the innovation process, particular types of InnoLabs within this network may again align in small networks depending on the phase of the innovation process that they support. Accordingly, the network of process intermediaries may be divided into three sub-networks:

   - **Conceptualization loop**: The conceptualization loop consists of InnoLabs that support the front end of the innovation process through the initial consultation (insights into the business environment and the understanding of the problem), consumer research (insights into the needs and demands of end users and determination of acceptance criteria), and the creativity (the generation of novel ideas as the potential solutions of problem under discussion). This network aligns in a vertical collaboration with the mentors’ network to receive the business consulting services.

   - **Actualization cluster**: The actualization cluster consists of InnoLabs that help to actualize the generated idea. Depending on the innovation object (product, service, or product related services), the actualization of the generated idea can be supported by the product InnoLabs, service InnoLabs, or both respectively. This network may align in a vertical collaboration with the resource providers in order to leverage the available resources during the implementation phase of the innovation process.
- **Commercialization team:** The commercialization team includes the InnoLabs helping the clients to launch their developed innovation in the market and the labs undertaking market research. The findings of the market research will serve twofold purposes. Firstly, if some improvement is needed in the implemented innovation, another cycle of innovation process may be initiated by the conceptualization loop. Secondly, the findings will assist the InnoLabs in the mentors’ network to improve their understanding of the market and thereby their quality of service.

3. **Network of resource providers:** The network of resource providers comprises of the ‘co-working spaces’, ‘fabrication laboratories’, and the ‘living laboratories’. These types of InnoLabs mainly facilitate the operational and technical resources for the clients. The members of this network jointly create a pool of necessary resources which are leveraged by the actualization cluster during the implementation of proposed innovations.

4. **Network of network coordinators:** In the proposed model, the network coordinators are supposed to initiate and manage the networking activities among the various players of the network. The tasks include coordinating the activities among different collaborating InnoLabs, outsourcing the required resources from external resource providers in the case the resource needs cannot be fulfilled by internal resource pool, and contacting and involving all the stakeholders into the innovation process.

The proposed model suggests the systematic process flow starting from initial consulting to the acquisition of feedback in four steps with possible iterations between the
consecutive stages depending on the need of any refinement in the output of earlier stage (cf. Figure 5.6).

In the first step, the idea is generated at the creativity labs where the initial consultation undertaken by the players of mentors’ network and the consumer research undertaken by market research labs are embedded into the idea generation process in order to generate the idea that is viable for the implementing business, acceptable for the market, and creative in nature. In the second step, the developed idea is picked up by the InnoLabs supporting the prototyping and testing of the ideas for developing the proof of concept. In the third step, the developed proof of concept is actually implemented by the InnoLabs supporting the implementation phase of the innovation process. Here, the resources are drawn from the internal resource pool of the network. In the case, the resource need cannot be fulfilled internally, the network coordinators locate and outsource the required resources. In the fourth step, the implemented innovation is launched in the market and feedback is collected by the market research labs. Depending on the feedback, if some improvement is needed in the implemented innovation, another cycle of innovation process may be initiated.

It is necessary to note that not all the projects at InnoLabs start from initial consultation and not all last up to the market launch. Accordingly, there are four possible entry (initiation) and exit (termination) points for a client soliciting innovation assistance from the proposed network of InnoLabs. Each entry point requires certain specific input, and similarly each exit point produces certain specific output. (cf. Table 5.1 for a description of entry and exit points along with their respective input and output requirements).

Figure 5.6 - Workflow of an innovation project in an inter-InnoLab collaborative network
Inter-InnoLab collaboration

### Entry points

<table>
<thead>
<tr>
<th>Entry Point</th>
<th>Input to the network</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnP 1</td>
<td>A felt problem or need for innovation</td>
<td>A client realizes a problem or a need to innovate its products and/or services and consults an InnoLab for assistance in identifying and understanding the problem.</td>
</tr>
<tr>
<td>EnP 2</td>
<td>Well defined problem or need specification</td>
<td>A client faces a problem and contacts an InnoLab for the assistance in designing the possible solution framework for the identified problem.</td>
</tr>
<tr>
<td>EnP 3</td>
<td>An innovative idea</td>
<td>A client has an idea for an innovative product or service and contacts an InnoLab for the assistance in determining the feasibility and developing the proof of concept of the given idea.</td>
</tr>
<tr>
<td>EnP 4</td>
<td>A validated idea or proof of concept</td>
<td>A client has an established idea and approaches an InnoLab for assistance in implementing the given idea.</td>
</tr>
</tbody>
</table>

### Exit points

<table>
<thead>
<tr>
<th>Exit Point</th>
<th>Output of the network</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExP 1</td>
<td>Well defined problem or need specification</td>
<td>A client receives the initial consultation and has a better understanding of the problem and the causes of the identified problem.</td>
</tr>
<tr>
<td>ExP 2</td>
<td>An innovative idea</td>
<td>The client gets a feasible and acceptable idea / possible solution of the given problem.</td>
</tr>
<tr>
<td>ExP 3</td>
<td>A validated idea / proof of concept</td>
<td>The client receives a validated idea as most viable and feasible solution of the problem.</td>
</tr>
<tr>
<td>ExP 4</td>
<td>An innovating product or service</td>
<td>The client gets the innovative product or service actually implemented that is ready to be launched in the market.</td>
</tr>
</tbody>
</table>

Table 5.1 - Description of entry and exits points of a client for undertaking an innovation project with the inter-InnoLab collaborative network

### 5.4 Inter-InnoLab collaboration maturity model

In this section, the inter-InnoLab collaboration maturity model (IIC-MM) is discussed which illustrates the roadmap of the transition of an InnoLab from the state of working in isolation (where it does not possess any information about other peers) to the state of working in collaboration (where it collaborates with other InnoLabs on a long term basis). An InnoLab achieves such transition through the different levels of integration with its peers that are reflected by their mutual activities. The IIC-MM is thus developed to act as a reference for the assessment of the extent of inter-InnoLab collaboration with respect to the mutual activities of interacting InnoLabs.
Previously, in the literature on inter-organizational collaboration, various models have been suggested to assess the maturity of collaboration, such as the community linkage model (Hogue, 1994), the levels of integration model (Gajda, 2004), the seven-stage model (Frey, Lohmeier, Lee, & Tollefson, 2006), the levels of organizational integration rubric (Woodland & Hutton, 2012), and the Peterson model (Peterson, 1991). However, for the assessment of inter-InnoLab collaboration at the foundational level with no previous information on its practices, none of the existing models was completely suitable because of one of the following reasons:

1. Whilst each of the available models presents a different number of collaboration levels and differentiates them with respect to different dimensions and/or in a different context, most of the models aim to evaluate the maturity of collaboration once it is initiated among the participating actors. Conversely, because of no prior evidence or information on inter-InnoLab collaboration, the first goal of the current study was to examine whether any sort of collaboration occurs among InnoLabs? If labs do collaborate, the study aimed to construct how they are interlinked and how strong their ties are. Therefore, it was necessary to consider that ‘while both groups exist, there may be no collaboration whatsoever between them’.

2. While few of the existing models such as seven stage model (Frey et al., 2006) and the levels of organizational integration rubric (Woodland & Hutton, 2012) do include the level of coexistence, they differentiate the levels of integration in terms of the purpose of integration, structure of decision making or leadership, and strategies for collaboration. Since the main aim of current study is to explore the context in which the InnoLabs collaborate with each other, the study aimed to assess the degree of integration among InnoLabs solely on the basis of the type and complexity of actions/tasks, and the formalization and frequency of communication.

Accordingly, to comply with specific research purposes of current study in the particular context of InnoLabs, IIC-MM was developed which is inspired from the community linkages - choices and decision model purposed by Hogue (1994). Hogue arranges the extent of community linkage across five levels: networking, cooperation or alliance, coordination or partnership, coalition, and collaboration. The IIC-MM adapts the community linkage model with two modifications (cf. Figure 5.7).

1. It includes the level of coexistence in the beginning to include the situations where InnoLabs exist but do not exhibit any sort of interconnection with other InnoLabs.

2. It merges the two higher levels of the community linkage model into a single level of collaboration. The levels of coalition and collaboration are condensed as these levels differentiate themselves in terms of structure and purpose of the integration, while the mutual activities undertaken during these stages remain similar.
Thus, the IIC-MM consists of five stages (from zero/none to four): coexistence, networking, cooperation, partnering and collaboration (cf. Figure 5.8). A brief definition of each level and its indicators is given below:

1. **Level 0 – Coexistence:** This state corresponds to the situation where an InnoLab works in isolation from its peers, i.e. different InnoLabs exist in the ecosystem but do not possess any information about each other.

2. **Level 1 – Networking:** As an InnoLab tries to seek information about the existence of other InnoLabs, it attains the state of networking. This stage is characterized by the awareness of the existence, competencies, offered services, and the resources of other InnoLabs. While during this phase the InnoLabs do possess information about each other, none or only minimal interaction takes place. Information exchange with other InnoLabs may take place in sporadic and informal meetings such as academic conferences, research talks, expos, and the like. As during this stage, the InnoLabs actually start looking for the potential places to interact, this stage can be regarded as the preparation phase toward the inter-InnoLab collaboration.

3. **Level 2 – Cooperation:** This stage is an intermediate stage where an InnoLab actually progresses from a non-collaborating to a collaborating state. During this stage, the InnoLabs identify common interests and engage in short-term mutual activities. This may involve carrying out short-term research activities together, supporting each other to achieve individual objectives, or working on third party projects (indirect collaboration). The communication during this stage is formal and frequent.

4. **Level 3 – Partnering:** The phase of partnering denotes the initial stage of inter-InnoLab collaboration where signs of inter-InnoLab collaboration appear. During this phase, an InnoLab starts engaging in collaborative projects with other InnoLabs to achieve mutual goals with the defined roles and responsibilities while sharing the costs and risks of the innovation project (direct collaboration). Communication during this stage is formal and frequent. Nevertheless, the connection lasts only throughout the course of a particular project.

5. **Level 4 – Collaboration:** This is the higher level of inter-InnoLab collaboration whereby the InnoLabs engage in long-term collaboration, creating collaborative networks. All resources such as information, expertise, and physical tools are shared and utilized in independent projects of participating InnoLabs as well. Very frequent, and formal communication is prominent during this stage.
Assessment of current extent of inter-InnoLab collaboration

When the interviewees of the study were asked ‘Is your lab, as a center for innovation, connected with any other InnoLab? If so, which activities are undertaken in collaboration?, different patterns of the interconnection emerged from the participants’ responses. Figure 5.9 shows the different interaction activities which the interview participants mentioned together with their rate of occurrence across the interview sample of the study. It is eminent that two most recurring traits of the interconnection are ‘awareness of up to three labs’ (mentioned by about 71% of the participants) and ‘informal communication in sporadic meetings’ (exercised by about 57% of the participants). These two activities correspond to the second level of IIC-MM presented in Figure 5.8. This leads to the conclusion that the InnoLabs are mostly in the preparatory phase for the inter-InnoLab collaboration.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Rate of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term collaboration</td>
<td>1</td>
</tr>
<tr>
<td>Resource utilization</td>
<td>3</td>
</tr>
<tr>
<td>Mutual customer projects</td>
<td>4</td>
</tr>
<tr>
<td>Participation in third party projects</td>
<td>1</td>
</tr>
<tr>
<td>Mutual research projects</td>
<td>4</td>
</tr>
<tr>
<td>Formal and regular communication</td>
<td>2</td>
</tr>
<tr>
<td>Informal and irregular communication</td>
<td></td>
</tr>
<tr>
<td>Aware of other InnoLabs (&lt;=3)</td>
<td>15</td>
</tr>
</tbody>
</table>

Figure 5.9 - Interconnection activities undertaken by the participant InnoLabs (N= 21)

It is also important to mention that whilst the InnoLabs appear interacting with the peers, the interaction is sparse. In the case of most of the interview participants, the degree of the interconnection is maximal three; i.e. an individual InnoLab is aware of only three...
other InnoLabs, at maximum. Moreover, the existing interconnection is grounded on different motivating factors including the geographic proximity, thematic similarity, same ownership, lab-client relationship, and the training. A brief description of these motivating factors, their occurrence rate in the interview sample, and the possible intention of connection is given in Table 5.2. Apparently, the interest of an InnoLab towards seeking and acquiring information about other InnoLabs is due to either business competition or inherent relationship. Furthermore, it was also frequently mentioned by the interviewees that the interaction among each other is the friendly exchange of knowledge in informal and irregular face-to-face meetings occurring in the academic conferences, research talks, expos, etc.

The collaborative activities indicating the higher levels of collaboration were rarely mentioned by the interview participants. About 19% of the participants mentioned some form of cooperation with other InnoLabs for either mutual research projects or third party projects. In the course of research projects, the InnoLabs jointly attempt to answer some research question concerning the field of innovation or they support each other through the teaching and training activities. When it comes to the participation in third party projects, only one InnoLab reported the participation in a third party innovation project where other InnoLabs were also involved.

Direct collaboration among the InnoLabs for mutual customer projects and long-term collaboration have been exercised by 19% and 5% of participant InnoLabs respectively. It is also worth noting that these InnoLabs are the ones that are the part of large networks and work in collaboration with each other. Direct collaboration for innovation specific projects between the independent InnoLabs was not reported by any InnoLab. Thus, the awareness of and interaction with geographically apart and/or not directly connected InnoLabs is still in a very emerging state.

<table>
<thead>
<tr>
<th>Motivating factor</th>
<th>Description</th>
<th>% of participants (N = 21)</th>
<th>Possible interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic proximity</td>
<td>The labs located in the nearby regions or in same country</td>
<td>29%</td>
<td>Business competition</td>
</tr>
<tr>
<td>Thematic similarity</td>
<td>The labs providing the same set of services or working for the same business sector</td>
<td>43%</td>
<td>Business competition</td>
</tr>
<tr>
<td>Same ownership</td>
<td>The labs managed by the same organization (academic institution such as university or a business organization)</td>
<td>19%</td>
<td>Inherent relation</td>
</tr>
<tr>
<td>Lab - client relationship</td>
<td>The labs (research or innovation labs) hosted by the customers of the lab</td>
<td>5%</td>
<td>Inherent relation</td>
</tr>
<tr>
<td>Training</td>
<td>The labs supported by the lab during their establishment through the training and related activities</td>
<td>14%</td>
<td>Inherent relation</td>
</tr>
</tbody>
</table>

Table 5.2 - Motivating factors for existing interconnection among InnoLabs
5.6 Obstructions curtailing the inter-InnoLab collaboration

The three most prevailing and influencing obstructions which curtail the inter-InnoLab collaboration are the business competition among InnoLabs, the limited awareness of each other, and the partial awareness of other types of innovation support.

1. Business competition: InnoLabs perceive their work as a business and thereby despite of the awareness of the existence and competencies of few other InnoLabs, they do not engage in collaboration with each other. They are reluctant to disclose their detailed procedural and methodological approaches to other peers fearing that information may go into the hands of their existing or potential competitors who may exploit their shared knowledge and eventually take over their existing customers. Thus, the business competition resists the collaboration among homogeneous InnoLabs who provide a similar set of services and are thus competing with each other for the same customer market.

"But at the moment I would not like to do it [referring to cooperation]. Because I know they could then immediately also go to the customers we target."

— Participant’s response

2. Limited awareness of each other: The business competition among InnoLabs also results in their limited openness towards sharing their knowledge. The resulting inability to discover and/or unavailability of enough information to screen and decide whom to collaborate with reduces the chances of collaboration among the homogeneous as well as the heterogeneous InnoLabs.

"[After mentioning two names] I don’t know with whom else one should cooperate. And who else really has expertise in [name of the country lab is located]."

— Participant’s response

The possibilities of discovering and negotiating with the other InnoLabs are also hindered by the non-utilization of proper promotional channels and extensive advertising of InnoLabs’ products and services. The InnoLabs advertise their work partly in the form of booklets or other local media. In most cases, the customers are caught by personal recommendations in face-to-face meetings. Therefore, the know-how of a particular InnoLab remains confined to the people who have access to this information. Moreover, InnoLabs are not aware of any dedicated online or offline platform which may function as a network coordinator between them facilitating the knowledge exchange while maintaining the transparency of the shared information.
"We do not actively go to people, it is like you know the people and through them the others reach out."

— Participant’s response

3. **Partial awareness of the other types of innovation support:** Another limiting factor for the inter-InnoLab collaboration is the partial knowledge of other types of innovation support which are currently not being addressed by a particular InnoLab. The field of InnoLabs is an emerging field and the possibilities of supporting business organizations in their quest to develop and implement successful innovations are continuously being investigated and new needs for the innovation support are being outlined. However, as discussed earlier, the InnoLabs provide fragmented innovation support and focus on a particular type of innovation support. As a result of the focused nature of InnoLabs and the unawareness of other types of innovation support, the InnoLabs are not looking for opportunities to collaborate with the InnoLabs who address different types of innovation support. Thus, the possibilities of integrating new and promising innovation services and tools in the lab’s structure are largely left unidentified.

### 5.7 Chapter summary

The fragmented innovation support, the varying set of offered services and resources, and the localized and/or thematic customer market of the InnoLabs highlight that the InnoLabs should exercise inter-InnoLab collaboration for generating various economic and functional benefits for themselves, their customers, and the innovation environment as a whole. The empirical findings of the study presented in Figure 5.9 reveal that notwithstanding the need and obvious potential benefits, the inter-InnoLab collaboration is still in its incipient stage. The current interconnection among InnoLabs is limited to the friendly information exchange in face-to-face meetings. Furthermore, the interconnection is based on either geographic proximity, thematic similarity, same ownership, customer-client relationship, or training support. The interconnected InnoLabs also cooperate on some mutual research projects, however, mutual collaborative projects with defined goals and the responsibilities are very rare. The three most prevailing barriers curtailing the inter-InnoLab collaboration are the business competition among them, the limited awareness of each other, and the partial awareness of other types of innovation support. In addition, the limited openness to share knowledge, and lack of appropriate channels for the representation and exploration of the InnoLabs make it difficult for them to discover each other, get to know the competencies and resources held by each other, explore new types of innovation support, and thereby explore the possibilities of collaborations.
Chapter 6
Web-based Support for Inter-InnoLab Collaboration

“When we design systems and applications, we are, most essentially, designing scenarios of interaction”

— John Carroll

This chapter deals with the third research objective set out in Chapter 1. The chapter begins by undertaking a requirements analysis for a web-based inter-InnoLab collaboration platform (abr. IICP) in terms of necessary functionalities that it must support with respect to each level of inter-InnoLab collaboration (Section 6.1). Having developed the conceptual model of IICP, the chapter evaluates the potential of existing solutions in facilitating the identified functionalities (Section 6.2). Finally, the chapter debates the inadequacies and challenges of existing tools and presents the proposed solution framework (Section 6.3).

6.1 Functional requirement elicitation for a web-based inter-InnoLab collaboration platform

This section debates the core functionalities that a web-based IICP must facilitate. The requirements are elicited according to the stages of inter-InnoLab collaboration maturity model (cf. Section 5.4). According to the said model, the extent of inter-InnoLab collaboration matures through 5 hierarchal levels of collaborative activities. In order to qualify for a higher level in collaboration hierarchy, an InnoLab must confirm the undertaking of the specified set of activities corresponding to its immediate lower level. Accordingly, a system intending to support inter-InnoLab collaboration needs to empower all the collaborative activities pertaining to various phases of collaboration cycle. Figure 6.1 presents the proposed conceptual framework of a web-based IICP in terms of the necessary functionalities that it must offer in order to support the InnoLabs in attaining higher levels of collaboration maturity.

6.1.1 Functional requirements for supporting the transition from ‘Coexistence’ to ‘Networking’ level

While the coexistence level is characterized by the unawareness of the existence, offerings, and competencies of other InnoLabs, the networking level entails that the InnoLab is aware of the existence of other InnoLabs and has developed an understanding of their structural and functional characteristics. In other words, the transition from coexistence to the networking level requires developing the know-how of other peers existing in the ecosystem by locating them and exploring their capabilities.
Accordingly, the preliminary requirement of a web-based IICP is to facilitate a ‘define and discover’ mechanism that enable the InnoLabs to describe their profile and look up other InnoLabs with respect to several domain specific attributes (cf. Section 4.3). A required key attribute of such service is the facilitation of efficient and effective means of locating, navigating, and visualizing the available information. Subsequently, once an InnoLab discovers another InnoLab, the networking among the two requires developing acquaintance with each other through the communication and information exchange for a mutual benefit (Camarinha-Matos, Afsarmanesh, Galeano, & Molina, 2009). Thus, the platform should also encapsulate a mechanism of information dissemination which in turn may involve accumulating the information available from different sources (such as websites, weblogs, social networking sites, and like) and presenting it in an aggregated and effective form.

6.1.2 Functional requirements for supporting the transition from ‘Networking’ to ‘Cooperation’ level

Having attained the level of networking in the collaboration hierarchy, moving to the cooperation level requires the participating agencies to actively interact with the identified peers, share resources and engage in mutual activities in order to achieve compatible goals (Camarinha-Matos et al., 2009). Since all the existing InnoLabs do not work in a similar way and focus on different aspects of the innovation process, interacting and engaging in mutual activities primarily needs the identification of the goals and the activities undertaken by different InnoLabs. This involves determining the InnoLabs that work similar and dissimilar with respect to several criteria. The similarity indexing would allow the InnoLabs to identify the basis for helping each other, and thereby jointly address the targeted innovation challenge and achieve intended goals – the horizontal inter-InnoLab collaboration. The dissimilarity indexing would allow the InnoLabs to identify the diverse competencies of each other and leverage them in addressing their individual lacking and achieving own goals – the vertical inter-InnoLab collaboration.

Accordingly, a web-based IICP must facilitate an ‘identify and interact’ service. The service at first instance should enable the matching of InnoLab descriptions according to relevant criteria and thus determining the degree of homogeneity and heterogeneity of InnoLabs. At the second instance, the service should provide the effective and appropriate mechanisms for the interaction and active communication at peer and group levels. An essential requirement of such facility is to guarantee the data transparency, meaning that the shared data should be dealt in a protected space where the creator of the information is given explicit control over the access rights for the shared information. This is necessary to overcome the limited openness of InnoLabs in sharing their detailed technical information. This, in turn, will enable the exploration of their diverse competencies, resources, and services and thereby encourage and foster the inter-InnoLab collaboration.
6.1.3 Functional requirements for supporting the transition from ‘Cooperation’ to ‘Partnering’ level

During the cooperation stage, the mutual activities may be undertaken by the InnoLabs in a spontaneous and informal way whereby each participating agency may have a different goal and create values at the individual level. However, the partnering stage (often subsumed as collaboration stage) requires that the participating entities share information, resources, and clearly defined responsibilities to jointly plan, implement, and evaluate a program of activities for achieving the common goals and thereby jointly generating value (Camarinha-Matos et al., 2009). Accordingly, engaging in collaborative innovation projects involves two critical activities: the search and right selection of partners, and the proper and effective undertaking of collaborative activities from the beginning to the completion of the project. Hence, in pursuance of supporting partnering stage, a web-based IICP should facilitate a ‘select and collaborate’ mechanism.

While the task of goal matching supported at cooperation level may provide the initial basis for the identification and selection of partners, it is also necessary to be able to determine the record of previous projects and activities that a particular InnoLab has been engaged in order to determine the firm abilities and proven capacities of potential partners. This will also assist the InnoLabs in ranking and selecting the most suitable partner among the several potential partners. Subsequently, the platform must support the undertaking of collaborative activities including the project based formal communication, and task management and coordination in the course of a certain collaborative project.

6.1.4 Functional requirements for supporting the transition from ‘Partnering’ to ‘Collaboration’ level

After that an InnoLab exercises the undertaking of collaborative projects, going to further require the partnering parties to evaluate the success of the team and performance of each team member. This is necessary to determine the compatibility of different partners towards the mutual engagement in problem-solving and building trust and dedication for each other. Accordingly, for supporting the transition from partnering to the collaboration level a web-based IICP should facilitate a ‘measure and evolve’ mechanism. The performance evaluation of team members, their project history, and success record will not only facilitate the involved parties to decide on their future collaborations but will also assist the others in the selection of their potential partners.
6.2 Comparative evaluation of existing tools for supporting inter-InnoLab collaboration

This section examines the potential of existing web-based tools/platforms in supporting the inter-InnoLab collaboration with respect to the conceptual model of web-based IICP framed in the preceding section. The list of tools taken into consideration is derived from two sources.

1. The tools currently being used by the InnoLab facilitators as mentioned by them during the interviews. It is particularly interesting that the interviewees mentioned only the standard web 1.0 and web 2.0 technologies and associated platforms discussed in Section 2.2. The rate of occurrence of each tool across the interview sample is given in Figure 6.2. It is necessary to mention that the InnoLabs might be using other tools as well, the website and email at least. However, the statistics are based on the tools that the interviewees clearly mentioned while responding to the question: ‘Which online communication tools do you employ for information sharing?’

2. The tools that possess an obvious potential for supporting inter-InnoLab collaboration. This includes the business-specific networking platforms and the community websites dedicated for the InnoLabs (cf. Section 2.3).
Accordingly, the list of tools included in the evaluation consists of the Communication tools (website, email, and blogs), Conversation tools (instant message / chat software, web-conferencing tools), Coordination tools (collaborative work environments, project management tools), Content sharing platforms (media sharing platforms and cloud-based document sharing services), and Community platforms (general social networking sites supporting businesses’ representation, business-specific networking platforms, and dedicated InnoLab platforms).

The selected tools and platforms were examined from an exploratory perspective. In doing so, they were applied in different contexts and successively their respective communication and collaboration services were identified. A particular emphasis was given to the services applicable in the organizational settings. For example, the Facebook platform provides many services such as the support for discussions oriented on particular topics, audio/video calling, and organization of friend list into groups for the platform members. However, these services are not available for the business pages and thereby are not counted in the current evaluation. Table 6.1 presents the results of the comparative evaluation of aforementioned tools in supporting the necessary inter-InnoLab collaborative activities identified in the preceding section.
Web-based support for inter-InnoLab collaboration

# Required functionalities for supporting inter-InnoLab collaboration

## Activities / tasks

<table>
<thead>
<tr>
<th>Activities / tasks</th>
<th>Website</th>
<th>Email</th>
<th>Blogging</th>
<th>Wiki</th>
<th>Instant messengers</th>
<th>Conversation tools</th>
<th>Media sharing platforms</th>
<th>Cloud services</th>
<th>Project management tools</th>
<th>Social networking sites</th>
<th>Business networking platform</th>
<th>Innovation Lab</th>
<th>i-Lab Net</th>
<th>ENoLL</th>
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<td>Events / event calendar</td>
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</table>

## Table 6.1 - Comparative analysis of the potential of existing collaboration tools in supporting inter-InnoLab collaboration (continue on next page)
### Table 6.1 - Comparative analysis of the potential of existing collaboration tools in supporting inter-InnoLab collaboration (continued)

<table>
<thead>
<tr>
<th>Required functionalities for supporting inter-InnoLab collaboration</th>
<th>Existing tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities / tasks</td>
<td>Communication tools</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Project history</td>
<td>Website</td>
</tr>
<tr>
<td>Collaboration metrics (No. &amp; Role)</td>
<td>✔️</td>
</tr>
<tr>
<td>Performance rating / reviews</td>
<td>✗</td>
</tr>
<tr>
<td>Profile matching</td>
<td>✗</td>
</tr>
<tr>
<td>Project-based formal communication</td>
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</tr>
<tr>
<td>Task management and coordination</td>
<td>✗</td>
</tr>
<tr>
<td>Previous success record</td>
<td>✗</td>
</tr>
<tr>
<td>Team performance rating</td>
<td>✗</td>
</tr>
<tr>
<td>Mutual project record</td>
<td>✗</td>
</tr>
<tr>
<td>Mutual collaboration metrics</td>
<td>✗</td>
</tr>
</tbody>
</table>
The evaluation given in Table 6.1 elucidates that many of the existing tools possess the potential for supporting the communication activities among participating InnoLabs. Nevertheless, following the networking stage, the partnering and collaboration activities are rarely supported. It can also be observed that the support for the necessary tasks throughout the collaboration process remains dispersed among different tools. For example, where the project management tools like Basecamp, and Trello support the team members in coordinating and managing the tasks at the partnering stage, the conversational tools (email, web conferencing, and the social and professional community platforms) are helpful for the InnoLabs in discovering and interacting with each other.

The SNSs, especially, integrate a number of necessary community services that enable the acquaintance development, interaction, and networking among InnoLabs. They are, therefore, widely used by the InnoLabs and other business organizations. Nevertheless, the SNSs facilitate the communication and information dissemination in a general fashion lacking the B2B oriented features such as business specific filtering, profile matching, and homogeneity and heterogeneity based searching, and the like. This warrants that the existing SNSs are the community platforms more suitable for general interaction, rather than the collaboration platforms supporting inter-organizational interconnectivity. In addition to the outlined functional inadequacies of SNSs, the application of their offered services in a B2B context general and inter-InnoLab context in particular is attributed to following operational challenges:

1. **Isolated platform boundaries:** There exists a number of SNSs supporting the creation and hosting of business pages that vary in terms of their scope and functionality. Interestingly, all of these platforms work in isolation from each other. Because establishing an online presence on all the existing platforms and/or putting all the information everywhere is not a trivial nor the desirable task for business organizations, useful information remains dispersed among various platforms and confined to specific platform boundaries. This, in turn, makes the discovery, information retrieval, and communication impossible without actually getting on the specific platform.

2. **Platform dependencies:** Every SNS uses its own platform dependent method for information collection, exploration, and presentation. Increasingly, each platform collects different pieces and types of business related information, imposes different structure in information collection and presentation, offers varying search procedures, and facilitate different search management and page interaction functionalities. Moreover, each platform uses platform dependent taxonomy for categorizing the business pages, and nomenclature for the information fields. The differences in the features and facilitated services for the business pages offered on four SNSs - Facebook, LinkedIn, Google+, and Xing - are summarized in Table 6.2.

3. **Lack of domain specificity:** The business pages hosted on existing SNSs are structured in a manufacturing firm style focusing on the marketing oriented services that are necessary for creating a buyer-seller relationship. Typical information fields appearing on business pages include basic information, business category, contact details, and a listing of the products, services, and specialties. Interestingly, in case of the special type of business organizations such as a science laboratory, a research
institute, or an InnoLab, there are no manufactured products or services offered for sale. Rather, there are a number of different pieces of domain specific information that need to be stated, especially when it comes to describing a business for B2B interaction. Similarly, for inter-InnoLab collaboration, it is necessary to define an InnoLab in terms of InnoLab-specific characteristics discussed in Section 4.3. However, the existing platforms are not enough flexible in allowing the definition of varying information fields that jointly designate the domain specific corporate profile of InnoLabs.

<table>
<thead>
<tr>
<th>Facebook</th>
<th>LinkedIn</th>
<th>Google+</th>
<th>Xing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Available information</strong></td>
<td><strong>Profile, company updates, employees using LinkedIn platform</strong></td>
<td><strong>Profile, posts, photos, videos, reviews</strong></td>
<td><strong>Profile, updates, reviews, statistics for employees using Xing platform, and jobs</strong></td>
</tr>
<tr>
<td><strong>Search interface</strong> (search method and depth, query structure, and complexity, faceted filtering)</td>
<td>Direct, Free text (keyword), single valued search over structured data fields without faceted filtering</td>
<td>Faceted, free text, multivalued (Boolean queries), full-text search with flat, single valued facets on structured data fields with forward highlighting</td>
<td>Direct, Free text (keyword), single-valued (with additional location information) search over structured data fields without faceted filtering</td>
</tr>
<tr>
<td><strong>Search management</strong> (Sorting, bookmarking, networking, geographic mapping)</td>
<td>Individual map</td>
<td>---</td>
<td>Individual and integrated map</td>
</tr>
<tr>
<td><strong>Page interaction</strong></td>
<td>Liking the page, posting on the page, sending message to the page, calling the company on given number in the profile, and liking, sharing and commenting on any post of the page</td>
<td>Following the page, and liking, sharing, and commenting on any company update</td>
<td>Sharing or following the page, uploading the public photos to the page, rating or adding a review to the page, sharing any existing review of the page</td>
</tr>
</tbody>
</table>

Table 6.2 - Comparison of business page features and offered services on four existing SNSs

4. **Poor data transparency**: Data transparency is an important concern of business organizations, particularly the ones in the emergent state like the InnoLabs. The
Incepting organizations experience higher levels of business competition with each other and thus need the platforms that guarantee the complete privacy and security of shared information. On the contrary, the extant community platforms severely suffer from various security and privacy exposures (Strufe, 2009). There are many possible ways that the shared data can be compromised: publication of specific information on the network to unintended recipients due to poorly understood defaults, or a lack of awareness regarding the consequences of simple and presumably private actions, accidental data release, intentional use of private data for marketing purposes by the service provider, and so on (Lucas & Borisov, 2008).

### 6.3 Discussion and solution framework

For overcoming the functional and non-functional inadequacies of extant SNSs identified in the preceding section, a paradigm shift from general community platforms – currently more suitable for business-customer relationships – to the business-oriented platforms supporting the inter-organizational connectivity in a particular business domain is necessary. This implies that collaboration applications based on an analysis of the collaboration activities of users in their particular working environment should be designed and applied. Accordingly, it elucidates the need for a dedicated IICP serving as a hub for the InnoLab facilitators and enabling their interconnection while maintaining the domain specificity, data transparency, suitability, and relevancy of shared information to their common and individual needs. Nevertheless, the design and adaptation of distinct platforms for Inter-InnoLab collaboration does not seem to be an optimum solution because of the two main limitations.

1. Firstly, the existing SNSs offer the InnoLabs an easy and cost efficient medium for establishing an online presence, describe their services, and publish and promote their events. As a result, many InnoLabs are represented on one or another SNS and thereby a significant amount of data is already available on existing platforms and growing day by day. The resulting customer oriented data being shared on SNSs might be desirable to share with other businesses as well. In such realm, establishing a separate platform for inter-InnoLab collaboration independent of existing SNSs will leave this rapidly accumulating data unexploited in building awareness of each other and subsequently necessitate the interacting InnoLabs to regenerate any customer oriented data on the new platform.

2. Secondly, establishing a distinct platform for inter-InnoLab collaboration will definitely address the challenges posed by the lack of domain specificity and data transparency. However, the issues of isolated platform boundaries and platform dependencies will remain intact meaning that the new platform will be an addition to the stack of existing platforms. In addition, as shown in Table 6.1, the extant SNSs offer a number of communication services that can easily be leveraged in B2B interaction. An isolated platform will necessitate developing the similar services once again.

Accordingly, the new systems aiming at supporting inter-InnoLab collaboration in a dedicated manner should also integrate the existing SNSs so that the data from the SNSs can be fetched, aggregated and tailored in accordance with the specific structure and
needs of InnoLabs. This will, additionally, allow the integration of data scattered on multiple platforms and leveraging of supported communication services (e.g. expressing affinity by liking / following the business page or its content, engaging in the discussion by commenting on the business page content, etc.).

The integration of SNSs’ data with other web applications has, fortunately, been possible over the recent years since the leading SNSs have started exposing their network and the related data to other web-based applications by means of their Application Programming Interfaces (APIs). The social networking APIs provide a first step towards bringing down the isolated walls of SNS by allowing the third-party developers to access the user data (Felt & Evans, 2008) hosted on their servers, and fetch, aggregate, and create content according to users’ specific interests. The APIs available from different SNSs differ in the naming and hierarchical arrangement of data objects referring to identical notions, however, they all provide access to two valuable assets: the user-generated content and the social graph (Tserpes et al., 2012).

The two classes of web applications leveraging the SNS data are the embedded applications hosted by SNS servers themselves, and the standalone applications hosted on the separate servers. In the former case, the applications intend to serve the audience of the respective platform with formatted data addressing their specific needs. In the latter case, the applications intend to serve the specific purposes of the general audience who are not necessarily the audience of the respective platform. However, there is a lack of the applications integrating multiple SNSs with each other, and with other third-party applications.

In this regard, the current study considers the potential of four APIs from leading SNSs – Facebook graph API, LinkedIn companies and company search API, Google+ API, and Xing API. A brief description of these APIs and their potential for supporting interoperability of respective platforms is given in Table 6.3. The potential of these APIs makes it possible to develop a web-based IICP seamlessly integrating the business information hosted on SNSs with the dedicated collaboration functionalities required for supporting inter-InnoLab collaboration.
### Web-based support for inter-InnoLab collaboration

<table>
<thead>
<tr>
<th>Facebook Graph API</th>
<th>LinkedIn API</th>
<th>Google + API</th>
<th>Xing API</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Facebook platform, released its first API in May 2007 (Felt &amp; Evans, 2008). Recently, it has released its graph API which allows third party applications to read and write to its social graph representing the objects in the graph and the connections between them uniformly (Weaver &amp; Tarjan, 2013). Facebook graph API’s page node calls enable to fetch information from business pages.</td>
<td>The LinkedIn platform, released its first API in 2009. LinkedIn has released a set of APIs which allow third party developers to access (read and write) the member profiles, connections, companies’ information, and jobs hosted on LinkedIn data servers. The two APIs for retrieving the business page information are ‘companies’ and ‘company-search’ APIs.</td>
<td>Google+ platform released it first open REST API in September 2011. The API is currently read-only meaning that it allows only searching and retrieving resources. It supports retrieving the three types of resources: persons, activities, and comments (Togias &amp; Kameas, 2012), and do not provide any specific calls for business pages.</td>
<td>Xing REST API enables to access the core functionalities of Xing platform. It provides read and write access to the user profiles and feed, jobs and recommendations, events, and companies.</td>
</tr>
<tr>
<td><strong>Supported search for business pages</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keyword search without field restriction</td>
<td>Keyword search with field restriction</td>
<td>Not supported</td>
<td>Keyword search</td>
</tr>
<tr>
<td><strong>Retrievable profile fields for the business pages</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID, name, category, description, overview, founded year, mission, location, phone, website, likes, check-ins, talking count, visitors, cover image, and company logo</td>
<td>ID, name, company type, website, industries, employee count range, specialties, status, location, description, foundation year, and number of followers</td>
<td>Retrieving the business page information is currently not supported</td>
<td>ID, name, description, location, fax, phone, website, industries, company size, employees count, rating count and average, foundation year, and follower count</td>
</tr>
<tr>
<td><strong>Retrieval information types from the business pages</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profile, offers, milestones, events, feed, photos, albums, videos, insights, likes, ratings</td>
<td>Profile, status, product and job updates/shares and their comments</td>
<td>Not supported</td>
<td>Updates and their comments, employees, and contacts of the company</td>
</tr>
<tr>
<td><strong>Supported writing tasks over the business pages</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking and posting on page, Liking and commenting on any post</td>
<td>Following a company, liking and commenting on a company update</td>
<td>Following (+1) the page</td>
<td>Following the business page</td>
</tr>
<tr>
<td><strong>Required authentication for retrieving business information</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application level authentication</td>
<td>Application level + user level authentication</td>
<td>Application level authentication</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

Table 6.3 - Potential of SNS APIs in supporting aggregation of business information
Chapter 6

6.4 Chapter summary

In this chapter, a conceptual model of web-based IICP has been proposed. The model suggests that any platform aiming at facilitating inter-InnoLab collaboration must facilitate four necessary services: 1) define and discover, 2) identify and interact, 3) select and collaborate, and 4) manage and evolve. Subsequently, the potential of existing web-based collaboration tools was examined against the proposed model. The findings reveal that while existing SNSs provide substantial support for the interaction, the support for collaborative activities is sparse. In addition, the effective application of SNSs in B2B context suffers from the limitations of isolated platform dependencies, cross-platform variations, lack of domain specificity, and the data privacy concerns. However, SNSs are already being used by InnoLabs and thereby a significant amount of customer oriented data is already available continuously accumulating there. In this realm, the study proposes the designing of domain-specific IICP that support the dedicated functionalities while simultaneously integrating with existing SNSs. Figure 6.3 summarizes the proposed approach for designing a dedicated and domain specific web-based IICP.

![Figure 6.3 - Proposed approach for designing dedicated domain specific inter-InnoLab collaboration platform](image)

- Access to widespread customer base
- Widely used by business organizations
- A significant amount of business information is already existing
- Suitable to share customer targeted data

- Data transparency
- Domain specificity
- Interoperability
- Dedicated functionality

- Social networking sites
- Domain specific platforms
- Proposed approach

- Data transparency
- Domain specificity
- Central dedicated resources
- Well suited for sharing business specific information
This chapter presents the design, implementation, and evaluation of InnoLab_Net platform aiming to support inter-InnoLab collaboration throughout the collaboration process. The chapter begins with a brief introduction of the platform and its core functionalities (Section 7.1). Successively, a description of the high-level architecture of the platform and the tools and techniques used in its implementation are given (Section 7.2). The next part of the chapter describes the features and technical implementation of the functional modules of the platform (Section 7.3). Finally, the results of subject based evaluation of InnoLab_Net platform undertaken by the InnoLab facilitators are presented (Section 7.4).

### 7.1 Introduction to InnoLab_Net

The InnoLab-Net is a prototype of a web-based IICP designed as part of this thesis that facilitates the collaborative networking among InnoLabs in a dedicated and domain specific manner. The design of InnoLab_Net platform is oriented on the proposed approach of designing domain specific IICP (cf. Figure 6.3) meaning that the platform supports dedicated functionalities of the domain while maintaining the data transparency of shared information and integrating the existing data from SNSs.

The design of the InnoLab_Net is driven on three principles: service diversification and the resulting service fragmentation among InnoLabs, the horizontal and vertical models of inter-InnoLab collaboration, and the inter-InnoLab collaboration maturity model. The basic values stem from the fact that the InnoLabs offer varying services and thus innovation support is fragmented (cf. Section 5.2.1), and the belief that collaboration among the homogeneous and heterogeneous InnoLabs is likely to enhance their service portfolios, performance and service quality (cf. Section 5.2.2). The IIC-MM stresses starting the collaboration support from the dissemination of awareness going through the search and selection of partners to the management of the long-term relationship among collaborating InnoLabs (cf. Section 5.4).

The functional modules of the InnoLab_Net platform are built according to the proposed framework of a web-based IICP (cf. Section 6.1). Accordingly, the platform supports following core activities of inter-InnoLab collaboration within 9 different functional modules (short: modules). Figure 7.1 presents the modules supporting each stage of collaboration against the conceptual framework of a web-based IICP.
- Creation and navigation of corporate profile of InnoLabs based on their domain-specific attributes.

- Discovery of homogeneous and heterogeneous InnoLabs and exploration of their competencies through the aggregation of the platform’s native data with the data available on the InnoLabs’ business pages hosted on SNSs.

- Undertaking of interconnecting activities such as discussions, polling, and file sharing in and out of the context of a particular project with the complete user authorization and rights control.

- Search and selection of right partners for inter-InnoLab collaborative projects with respect to the various stages of innovation process.

- Management of the innovation projects and their associated resources including the discussions, polls, files, team evaluations, and project reviews.

- The self-assessment of network composition and collaboration maturity metrics.

- Integrated information search and navigation over the native data of the platform and the data available on SNSs

Figure 7.1 - Conceptual framework of InnoLab_Net platform
7.2 InnoLab_Net architecture and implementation tools

The architecture of the InnoLab_Net is technically based on a three-tier web application model comprising of a presentation tier, logic tier, and a data tier. The InnoLab_Net is implemented in Hypertext Pre-Processor (PHP) and JavaScript using a relational database backend (MySQL). The prototype is constructed and configured upon a WAMP (Windows + Apache + MySQL + PHP) platform. Figure 7.2 depicts the schematic overview of the InnoLab_Net framework and the technologies used for implementing each layer.

1. **Presentation tier:** The presentation tier contains the UI (user interface) elements of the platform and includes all the logic that manages the interaction between the user and the logic layer of the application. The presentation layer adopts a modular design pattern where each core functionality is implemented as an individual module (discussed in next section) and subsequently integrated with other modules within the platform. All the modules are then directly accessible from the main page of the application. The web pages are designed using HyperText Markup Language (HTML) and JavaScript with jQuery library\(^{26}\). For generating the dynamic content on user request asynchronously, the InnoLab_Net relies heavily on AJAX (Asynchronous JavaScript calls with JavaScript Object Notation - JSON) formatted data. The sorting and filtering of data on the client side is achieved using JavaScript Underscore library\(^{27}\). The geographical maps are generated using the Google Maps JavaScript API\(^{28}\) in version 3.

2. **Logic tier:** The logic tier receives the requests from the presentation tier, decodes the requests, interfaces with the MySQL database and the remote data stores of SNSs, manipulates the data depending on the business logic it contains, and returns the results to the presentation layer. The server side functionality is achieved with PHP5 scripts. Local MySQL database is accessed by the Structured Query Language (SQL) queries, while the interconnection with the remote SNSs’ data stores is achieved through the appropriate social networking APIs.

For achieving the semantic and natural language related functionalities such as generating the semantically similar and neighbouring words of the given keywords, the system employs the corpus-based webservice available from Leipzig Corpora Collection\(^{29}\) (LCC) using its REST API\(^{30}\). LCC is the collection of a large corpus of freely available electronic media consisting of the web, newspapers, and Wikipedia. The resources are collected by employing different data collection methods. The resulting crawled resources are processed, and for each language, a full form dictionary with frequency information for each word is calculated. In addition, the significant co-occurrence statistics (the words that co-occur significantly often with a given word) are precomputed and two kinds of co-occurrence data are stored: words occurring together in sentences, and words found as immediate (left or right) neighbours (Biemann, Heyer, Quasthoff, & Richter, 2007; Richter, Quasthoff, Hallsteinsdóttir, & Biemann, 2006). The LCC collects corpora for more than 200

\(^{26}\) [https://jquery.com/](https://jquery.com/)

\(^{27}\) [http://underscorejs.org/](http://underscorejs.org/)

\(^{28}\) [https://developers.google.com/maps/documentation/javascript/](https://developers.google.com/maps/documentation/javascript/)

\(^{29}\) [http://corpora.uni-leipzig.de/](http://corpora.uni-leipzig.de/)

\(^{30}\) [http://wortschatzwebservices.informatik.uni-leipzig.de/ws/swagger-ui.html](http://wortschatzwebservices.informatik.uni-leipzig.de/ws/swagger-ui.html)
languages and for each language different corpora releases are available. For the implementation of the InnoLab_Net, the English language corpus based on Wikipedia with 1M sentences (eng_wikipedia_2012_1M) is referenced. The lemmatization and morphological analysis of the text is achieved by leveraging the PHP based phpMorphy library. The phpMorphy morphological analysis library provides the dictionary based morphological services for the English, Russian, German, Ukrainian, and Estonian languages. For every word, phpMorphy provides three types of information: a base form of the word (lemma), all morphological forms of the word, and grammatical information of the word (part of speech, case, etc.).

3. **Data tier:** The data tier is responsible for storing the application’s data and sending it to the business tier when requested. The data layer of the InnoLab_Net platform is comprised of one local database, the data stores of four connected SNSs, and Leipzig corpora collection data server. The local database schema of InnoLab_Net is presented in Figure 7.3.

![High-level architecture and implementation tools of the InnoLab_Net](http://phpmorph.sourceforge.net/dokuwiki/)

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Figure 7.3 - ER diagram of the local database of the InnoLab_Net
7.3 InnoLab_Net implementation

This section describes the search strategy (Section 7.3.1) and text matching approach (Section 7.3.2), the workflow of domain specific registration and SNS integration (Section 7.3.3), and the purpose, design, and technical implementation of the functional modules (Section 7.3.4) of the InnoLab_Net platform.

7.3.1 Searching approach

The search facility within different functional modules of the InnoLab_Net is offered with an auto-completion feature at the individual word level. The auto-completion suggestions are generated through the LCC web service for prefix words that returns the selected corpus-based suggestions with a given prefix of at least four characters. It is noted that the intention of the system is to generate the suggestions on the basis of its native data, however, in the prototyping stage where no real data is available in its repositories, the general English language corpus is used. On the server side, the search request is executed in following steps (cf. Figure 7.4):

1. **Search phrase normalization:** As the first step, the search phrase is normalized by converting it into lower case and stripping the trailing whitespaces. This also involves replacing the multiple whitespaces between the words with a single whitespace.

2. **Tokenization:** As the second step, the search phrase is tokenized into individual search terms. For example, if a given search phrase is the ‘innovation and innovation management’, the tokenization returns as array (T) of four keywords:

   \[
   T = \{T_1, T_2, T_3, T_4\} = \{\text{‘innovation’}, \text{‘and’}, \text{‘innovation’}, \text{‘management’}\}
   \]

3. **Parsing:** As the third step, the array of keywords is filtered to discard any duplicates and remove the stop words. The stop words are filtered against a list of frequently occurring words of the language such as the prepositions, adjectives, adverbs, and the articles. The result is a list of unique and absolute keywords:

   \[
   T = \{T_1, T_2\} = \{\text{‘innovation’}, \text{‘management’}\}
   \]

4. **Semantical features:** As the fourth step, the query is expanded with the corpus-based semantically similar words of the original keywords in order to overcome the vocabulary mismatch problem. For example, the resources for ‘consultation’ can also be retrieved with keyword ‘mentoring’. Therefore, the query terms are expanded with their semantical equivalents for retrieving more relevant results. The semantically similar words are generated through the LCC web service that calculates the term relatedness on the basis of the similarity of their significant co-occurrences in a reference corpus. The semantical equivalents that overlap with the original keywords already included in the list, or with the stop words are ignored. The resulting array can be described as

   \[
   T = \{T_1, T_1S_1, \ldots, T_1S_n, T_2, T_2S_1, \ldots, T_2S_n\}
   \]

   where T represents the original terms and S represents their semantical equivalents.
5. **Lemmatization and morphological features:** As the fifth step, all the original keywords and their semantical equivalent terms are translated to their respective normal (base) forms – the lemmas. Successively, their morphological forms (different tenses of the verbs, and both the singular and plural forms of the nouns) are generated through the dictionary-based text analysis approach using the phpMorphy. This results in a vector space of the word representing the original keywords and all their semantical and morphological equivalents. The resulting array can be described as:

\[
T = \{T_1M_1, \ldots, T_1M_n, T_2M_1, \ldots, T_2M_n, T_1S_1M_1, \ldots, T_1S_1M_n, \ldots, T_1S_nM_1, \ldots, T_1S_nM_n, T_2S_1M_1, \ldots, T_2S_1M_n, \ldots, T_2S_nM_1, \ldots, T_2S_nM_n\}
\]

where T represents the original terms, S represents their semantical equivalents, and M represents their morphological forms.

6. **Searching:** Finally, the appropriate search queries are executed for relevant resources looping through all terms existing in the vector space T.

![Diagram](image.png)

**Figure 7.4 - Illustration of search approach of the InnoLab_Net**

7.3.2 **Text matching approach**

For computing the similarity between two texts \{T1, T2\} for the sake of different purposes such as generating the content oriented metadata against given categories, matching the variable profile fields of two members, and filtering the search results, the system applies a Vector Space Model (VSM) approach using the cosine similarity measure. The cosine similarity is the most common measure used for determining text
similarities (Huang, 2008) and is the baseline for most of the similarity studies (e.g. Shrestha, 2011; Xie & Liu, 2008). Since the text matching in InnoLab_Net is mostly used for tagging and classifying the text according to predefined categories, the text matching is considered as classification task where one-to-one text similarity decision is made. Therefore, the VSM approach with cosine similarity is considered suitable as the task is to determine the presence of T1 in T2 where T1 is usually consisted of few words with no or minimal dependence on each other and all the words are equally important. For example, if the T1 is ‘service engineering’, the words ‘service’ and ‘engineering’ both are equally important to be present in T2 in any of their semantic or morphological form. Accordingly, the text matching task is achieved in following steps (cf. Listing 7.1):

1. **Pre-processing and expansion of target text:** The target text T1 designating the phrase whose occurrence is to be determined in destination text T2, is initially normalized, tokenized, parsed, and stop words are removed. Now, depending on the context if any or all of the tokens should match with destination text T2, the tokens one by one or all together are aggregated with their semantical equivalents S, and finally lemmatized and enriched with morphological features L by applying similar techniques as in the searching approach given in the preceding section. This step results in an expanded form of T1 comprising the original keyword(s), the semantical equivalents, and the morphological forms:

   \[ T_1 = \{T_1L_1, \ldots, T_1L_n, T_1S_1L_1, \ldots, T_1S_1L_n, \ldots, T_nS_nL_1, \ldots, T_nS_nL_n\} \]

2. **Measuring similarity:** As the next step, the cosine similarity of T1 and the destination text T2 is calculated. The basic idea behind cosine similarity is to transform each text string into a vector in some high dimensional space such that similar strings are close to each other. The cosine of the angle between two vectors is a measure of how “similar” they are, which in turn, is a measure of the similarity of these strings. Accordingly, at first, a high dimensional space V is created where each term in texts T1 and T2 defines an independent dimension, such that

   \[ V = (T_1, \ldots, T_n) + (T_2, \ldots, T_2n) \]

   Then, the texts (T1 and T2) are transformed into their respective binary vectors (V1 and V2) in this high dimensional space. Operating in the positive quadrant of the Euclidean space (i.e. no term is assigned a negative value), vectors represent the presence and absence of a particular term in each text string by a non-negative value (1 or 0) along the dimension corresponding to the term. Finally, the cosine of the angle between V1 and V2 is computed which is identical to their normalized inner product, such that

   \[ \text{Sim}_{\text{cos}}(T1, T2) = \frac{V_1 \cdot V_2}{\sqrt{V_1^2} \sqrt{V_2^2}} \]

   Since, non-negative values are used in the vectors, the cosine measure returns positive numerical value in the range of 0 (for the orthogonal vectors) and 1 (for the identical vectors).
Algorithm: Computes similarity of two text strings

**Input:** text strings Text1 and Text2, list of stop words Stop_words

**Output:** Cosine measure Cos_sim

```plaintext
1   Array T1, T2, V, V1, V2;
2   Variable Dot_product = 0; norm1 = 0; norm2 = 0; Cos_sim = 0;
3   Text1 = Normalize Text1; // preprocess the target text Text1
4   T = Tokenize Text1;
5   n = length of T;
6   for i = 1 to n do // parse Text1
7      if T[i] is not in Stop_words and T[i] is not in T1 then
8         add T[i] to T1;
9     end
10   end
11   foreach term t in T1 do // Add semantics
12      Array S = semantically similar words of t;
13      foreach word w in S do
14         if w is not in Stop_words and w is not in T1 then
15            add w to T1;
16         end
17      end
18   end
19   foreach term t in T1 do // Add morphological features
20      Array M = morphological forms of t;
21      foreach word w in M do
22         if w is not in Stop_words and w is not in T1 then
23            add w to T1;
24        end
25     end
26     end
27   Text2 = Normalize Text2; // preprocess the destination text Text2
28   T2 = Tokenize Text2;
29   V = merge unique items of T1 and T2; // compute cosine
30   n = length of V;
31   for i = 1 to n do
32      if V[i] is in T1 then
33         V1[i] = 1;
34      end
35   else
36      V1[i] = 0;
37   end
38   if V[i] is in T2 then
39      V2[i] = 1;
40   end
41   else
42      V2[i] = 0;
43   end
44   end
45   for i = 1 to n do
46      Dot_product = Dot_product + V1[i] * V2[i];
47      norm1 = norm1 + V1[i];
48      norm2 = norm2 + V2[i];
49     end
50   Cos_sim = Dot_product / square root of (norm1 * norm2);
51   return Cos_sim;
```

Listing 7.1 - Text matching algorithm of the InnoLab_Net
7.3.3 Workflow of domain specific registration and SNS integration

The InnoLab_Net platform is designed as a registration based system facilitating the InnoLabs to describe their corporate profile in terms of domain specific features that are not possible to list on existing SNSs, and simultaneously integrate their social networking steam from four SNSs: Facebook, LinkedIn, Google +, and Xing for seamless exchange of customer oriented information already available there. The domain specific registration and SNSs integration is achieved in five steps (cf. Figure 7.5).

1. **User account:** User sets the ‘Name of the InnoLab’, ‘Username’, and ‘Password’, and selects the registration method. The system facilitates three registration methods: manual registration, registration through Facebook, and registration through LinkedIn.

2. **Basic information:** While registering through Facebook or LinkedIn, the user is redirected to the OAuth page of a particular platform. Subsequently, once the user is authenticated, the system automatically retrieves the list of company pages that the authenticated user manages on the given platform. As the second step, after the user selects a page that he wants to connect, the system fetches the necessary information from the selected page and records it in the local database. The information fields stored by the InnoLab_Net platform includes the business description, founding year, contact details (address, phone, fax, email), and URL. In the case of manual registration, the user is presented with a specific form to put in the required information. During this step, the location information of the user is also geocoded using the Google Maps geocode service and the geographic coordinates are stored in the database.

3. **InnoLab specific information:** Once the user is registered, a form designated to capture domain related profile is presented that enables the user to describe the InnoLab in terms of InnoLab category, innovation object, innovation focus, supported stages of innovation process, type of innovation resources, offered innovation services, innovation tools, customer locus, thematic focus, and the business model of the InnoLab (for a description of the attributes see Section 4.3). For the varying types of information such as offered innovation services and facilitated innovation tools, the system presents the list of entries available in the database and additionally enables the user to insert any new item.

4. **Privacy settings:** The user sets the privacy for viewing detailed profile and network of the InnoLab. The profile and network privacy is supported at three levels: public, private, and network.

5. **SNS integration:** The user interconnects the SNS business pages in two steps. 1) The user authenticates him/herself on a particular platform. 2) The user selects the company page that he/she wants to connect with the account. In connecting the Facebook and Linked accounts, the list of company pages is retrieved automatically; while for connecting Google+ and Xing accounts the user is asked to manually enter the page name and page ID as the APIs of these platforms currently do not support retrieving user pages automatically. This step also allows the user to add Skype ID and the InnoLab URL.
Figure 7.5 - Process flow of domain specific registration and SNS integration of the InnoLab_Net
7.3.4 InnoLab_Net functional modules

This section describes the design and purpose of nine functional modules of the InnoLab_Net platform that collectively facilitate the necessary functionality for supporting the inter-InnoLab collaboration throughout the collaboration process.

7.3.4.1 Module 1: Company discovery tool for integrated business page search over Facebook and LinkedIn platforms

The first module of the InnoLab_Net platform is the ‘Company Discovery Tool (abr. CoDiT)’ which is designed to facilitate the discovery and awareness of businesses and InnoLabs through the aggregation of business information available on SNSs. The CoDiT module currently interconnects two SNSs: Facebook and LinkedIn. However, the module can easily be extended to interconnect other SNSs provided that they open up their data along with the support for required functionalities. The underlying rationale for the development of the CoDiT is to address the issues of isolated platform boundaries, platform dependencies in data representation, and the lack of business specific features of SNSs identified in Section 6.2. Accordingly, the CoDiT module supports three key features:

- Integrated search for business pages hosted on multiple SNSs in a business specific manner and thereby eliminates the need for visiting several SNSs in order to perform similar searches individually.

- The consistent view of data together with a uniform nomenclature for the data fields, additional content-oriented metadata, a business specific faceted filtering, and an integrated geographic map.

- The ability to manage the search results, and interact with the retrieved business pages.

CoDiT user interface: The CoDiT UI is very intuitive that initially presents a menu of six items for searching and retrieving the business pages. The first three menu items enable to retrieve the list of business pages that the logged-in user has previously bookmarked, networked, or liked (on Facebook) and followed (on LinkedIn), respectively. The next three menu items enable to search for business pages in three different ways. 1) Keyword search enabling to search with one or more keywords with a possible field restriction (name, location, industry or service of the business). The search box enables the auto-completion feature at the individual word level through the corpus-based suggestions retrieved from the LCC web services seamlessly by an AJAX call. 2) Advanced search enabling to search with one or more field - value pairs corresponding to the keyword, location, industry, and service of the business. 3) Navigational search enabling to search with a single field - value pair corresponding to the alphabet, country, industry, or service of the business. The values are browsed through the given list of values for a particular field available in the local database.

After retrieving the list of business pages according to the given search request, CoDiT UI lists the retrieved business pages, geocodes the location information and successively
InnoLab_Net draws an integrated map of the retrieved business pages using Google Maps JavaScript API, generates the business specific faceted (flat and multivalued) filters, and displays the details of the first business of the resultant dataset in the ‘business details’ section (right column of the screen). Selecting a business in the result set displays its detailed information in ‘business details’ section together with an action pane (on the top) which facilitates the user to commit several actions on the selected business page. The actions include the search management functionalities such as bookmarking and adding the selected business page to the network of logged-in user, and the page interaction functionalities including the reading the page stream, liking the page on Facebook, following the page on LinkedIn, and reading and writing the comments on any of the post on the selected business page. A snapshot of CoDiT UI after committing a basic search with keyword ‘scanning’ is given in Figure 7.6.

![Figure 7.6 - An aggregated screenshot of the CoDiT user interface. 1) CoDiT menu 2) Search interface 3) Faceted filtering 4) Integrated geographic map 5) Business page list 6) Selected business details 7) Page actions 8) Page stream](image)

**Technical implementation:** On receiving a search request from the UI, the server executes the integrated semantic search over Facebook and LinkedIn platforms in following steps (cf. Figure 7.8). It is noted that the user is required to have an active account on these platforms and connect them with the InnoLab_Net user profile so that the authorized API calls can be executed.

1. **Pre-processing and preparing semantic search:** The server after receiving the search parameters (search phrase and field restrictions), at first, prepares the semantic search following the search strategy described in Section 7.4.1. This results in an array of
search terms consisting of the original search terms, their corpus-based semantically similar words, and their different morphological forms.

2. **Fetching**: As the next step, the server iterates through the array of search terms, and issues appropriate API calls for searching the business pages on each of the connected platforms. Pertaining to the partial responses returned by SNSs, the system makes repetitive API calls for each word. This increases the recall (response rate), however, proportionally raises the response time as well. To make a trade-off between response rate and response time, a threshold of 2 Facebook graph API calls (returning around 50 pages) and 1 LinkedIn API call with a limit of 50 pages is set for each search term.

3. **Mapping data fields and generating additional metadata**: As the next step, the information for every retrieved business page is mapped to a uniform data structure. The native data scheme of the module with field mapping from interconnected platforms is shown in Figure 7.7.

![Figure 7.7 - Mapping of Facebook and LinkedIn data fields to the CoDiT native data structure](image)
Subsequently, the module generates additional pieces of business information including the page source (set with platform name), determination of the inclusion of a particular business page in the list of bookmarked, networked, and liked or followed business pages of the logged-in user, and generation of the business category and service tags. The business category and service tags are generated semi-automatically through the semantic analysis of free text fields available in business profile. The module uses a pre-defined list of business categories and business services stored in the local database for the identification of category tags and service tags, respectively. The corresponding algorithm for generating category and service tags is given in Listing 7.2.

<table>
<thead>
<tr>
<th>Algorithm: Identifies business category and services of businesses based on their textual data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input:</strong> List of business services or categories List, description text of business Description</td>
</tr>
<tr>
<td><strong>Output:</strong> List of category / service tags Tags</td>
</tr>
</tbody>
</table>

```plaintext
Variable n = 0; Sim = 0;
foreach item Item in List do
    Array Item_terms = tokenize Item;
    n = length of Item_terms;
    for i = 1 to n do
        Sim = match Item_terms[i] and Description; //Match texts according to algorithm 7.1
        if Sim > 0 then
            continue;
        end
        else
            break;
        end
        if i = n and Sim > 0 then
            add Item in Tags;
        end
    end
end
return Tags
```

Listing 7.2 - Algorithm for generating category and service tags for business pages

4. **Filtering:** As the next step, the retrieved business pages are filtered with respect to field restriction given in search request to discard any irrelevant pages. The Facebook response is additionally filtered to discard any non-business pages. This is achieved through matching the given page category with a list of valid business page categories that are possible on the Facebook platform.

5. **Merging the responses:** Finally, the individual responses from the given platforms are merged while discarding any duplicates. The duplicates are identified and removed by matching the business name and location information of business pages.
Figure 7.8 - The search procedure of the CoDiT module
7.3.4.2 Module 2: Social networks integrated directory and look up service for InnoLabs

The second module of the InnoLab_Net platform is the ‘Social networks Integrated Directory of InnoLabs (abr. SIDIL)’. The module is intended to facilitate a directory and lookup service for the InnoLabs in terms of their general as well as domain specific attributes, and simultaneously disseminate the awareness of InnoLabs by the aggregation of their information available on their SNS business pages. Besides the support for the interaction over the SNS pages, the SIDIL module also facilitates real-time textual, audio and video communication by the integration of Skype functionality.

Another key feature of the SIDIL module is to support the identification of the goals and thereby the discovery of homogeneous and heterogeneous InnoLabs in order to identify the opportunities and suitable partners for the horizontal and vertical collaborations, respectively. The dissimilarity indexing may also disseminate the information about different types of innovation support that are not included in the current portfolio of a certain InnoLab. This will, in turn, outline the new opportunities for collaboration and the integration of promising tools within the current service portfolios of InnoLabs.

**SIDIL user interface:** The SIDIL UI, initially presents a menu of eight items. The first menu item enables to load a complete directory of InnoLabs registered on the InnoLab_Net. The second and third menu items, respectively, enable the retrieval of a list of InnoLabs that the logged-in user has previously bookmarked or added to his/her network. The next three menu items enable the searching of InnoLabs in three different ways: keyword search (with a possible restriction to a particular field), advanced search, and a navigational search. Search functionality is implemented with auto completion feature in a similar way as in the CoDiT module (cf. Section 7.3.4.1) with an only difference in that the SIDIL module supports the field restriction in terms of general as well as InnoLab specific attributes such as the name, location, category, and innovation object, phase of the innovation process, innovation service, innovation tool, and industry. The last two menu items enable to search for homogeneous and heterogeneous InnoLabs with respect to the profile of the logged-in user. The user specifies the matching criteria (one or more attributes) and the matching level indicating that if any or all of the values for a multivalued data field should match or differ in order to qualify for the similarity or dissimilarity, respectively.

On the receipt of the response from the server, UI lists the retrieved InnoLabs, draws an integrated map of the retrieved InnoLabs using Google Maps JavaScript API, generates the InnoLab specific faceted (flat and multivalued) filters, and displays the details of the first InnoLab of the resultant dataset in the ‘InnoLab details’ section (right side of the screen). Selecting an InnoLab in the result set displays its detailed profile in ‘InnoLab details’ section together with an action pane (on the top), provided that the logged-in user is allowed to view the details of selected InnoLab. The action pane offers the search management functionalities, Skype interaction, and the retrieval of the connected SNS business pages of the selected InnoLab. When the user selects a particular SNS, the selected page is retrieved and displayed in a similar manner as in CoDiT module with a
sub action pane enabling the page interaction functionalities. A snapshot of SIDIL UI with the directory of InnoLabs is given in Figure 7.9.

![Figure 7.9 - An aggregated screenshot of SIDIL user interface. 1) SIDIL menu 2) Faceted filtering 3) Integrated geographic map 4) List of retrieved InnoLabs 5) Detailed profile of the selected InnoLab 6) Action pane 7) SNS page action pane 8) SNS page information 9) SNS page stream](image)

**Technical implementation:** The InnoLab fetching functionality of SIDIL is implemented in a typical three-tier application style. Once the fetch function is committed by the user, the UI formulates the fetch request and retrieves a list of relevant InnoLabs from the server via an AJAX call. The overall fetching functionality on the server side can be decomposed into several tasks. The execution of particular tasks depends on the type of fetch request as shown in the Figure 7.10. The essential tasks include:

1. **Preparing semantic search for InnoLabs:** For executing the search request, the server initially prepares the semantic search following the search approach specified in Section 7.3.1. Successively, the server iterates through the list of search terms and performs a full-text search over the complete (basic and the InnoLab specific) profile of all registered InnoLabs.

2. **Filtering and matching the InnoLabs:** The filtering of the search results with respect to any field restriction given by the user, and matching of the InnoLabs while searching for the homogeneous and heterogeneous InnoLabs is done in two ways. For the fixed value attributes such as InnoLab category, the similarity is determined by matching the absolute values of data fields. While for the varying value fields such as offered services, the similarity is determined according to the text matching approach specified in Section 7.4.2.
3. **Generating additional metadata:** The additional pieces of metadata generated for the retrieved InnoLabs include the determination of the inclusion in the list of bookmarked or networked InnoLabs of the logged-in user, and the permissions for the logged-in user for viewing the profile of a particular InnoLab. The former is done for easy visualization on the map and management of connected and non-connected InnoLabs, while the latter is necessary to maintain the privacy of the InnoLabs.

4. **Fetching the InnoLab information from SNS:** The connected SNS pages of the InnoLabs are identified by the combination of the page source (name of the SNS) and page ID (retrieved while connecting the particular page). The corresponding page is retrieved and data fields are mapped to the native data format following the same procedure as in CoDiT module.

---

**Figure 7.10 - The fetch procedure of the SIDIL module**
7.3.4.3 Module 3: Network mapping and network metrics

The third module of the InnoLab_Net platform is the ‘Network Map (abr. Net_Map)’. The module visualizes the first degree and second degree network connections of the InnoLab_Net members. The goal is to support the network management and the possible network expansion by the recognition of interlinking nodes between two members, and thereby identification of the opportunities for reaching out to each other without being directly connected. When two members are directly connected, the network visualization indicates that how they are interconnected and how strong their ties are in terms of their mutual connections.

Another key feature of the Net_Map is the computation of network composition and relevant metrics in terms of InnoLab specific attributes. Accordingly, the module is capable of answering the questions like ‘how many other InnoLabs in my network offer the similar services as to me?’ and ‘how many other InnoLabs in my network target the similar type of innovations or the business sector that I target?’ As a result, it indicates the level of network diversity of a particular InnoLab and thereby outlines the distributed resources that the InnoLab has access in the network.

Network map: The main menu of the Net_Map allows to view the network map and network metrics of the logged-in user as well as of any other InnoLab_Net member. In the latter case, the display depends on the set privacy of the selected member for viewing its network. The network map represents two types of edges for the selected InnoLab. 1) The pink coloured edges indicating the direct connections which are represented by green coloured pin points. 2) The blue coloured edges indicating the second degree connections which are represented by yellow coloured pin points. The mutual connections meaning the InnoLabs that are connected with the selected InnoLab and any of its first degree connections are represented by the pin point of a combination of yellow and green colours. The information window attached to every pin point indicates the network connections of the particular InnoLab. There is also a filtering functionality for filtering out the second degree connections and visualizing the sub networks. For the logged-in user, the module also displays the network suggestions that comprise the InnoLabs who have connected the logged-in user in their network but the logged-in user has not connected them yet.

Network metrics: The network metrics represent the similarity of the selected InnoLab with its networked InnoLabs in terms of InnoLab specific features. The similarity is calculated as the percentage of total networked InnoLabs matching a particular profile field to the selected InnoLab. For the multivalued attributes, the similarity is counted if any of the values match in the profiles of both parties. For example, if an InnoLab offers three services and any of its services matches with any of the services of other connected InnoLabs then the two are considered similar in the provision of a particular service. The field values are matched semantically according to the text matching approach given in Section 7.4.2. The various metrics computed by the Net_Map include the categorical similarity, innovation service similarity, innovation resource similarity, innovation type similarity, the similarity in coverage of innovation process, geographic proximity,
thematic similarity, and similarity in the business model. The similarity is indexed according to the matching value and the matching members of the network.

Figure 7.11 - A screenshot of the Net_Map module showing the network map and network metrics of the logged-in user. 1) Main menu 2) Network filter 3) Network map 4) Information window 5) Network suggestions 6) Network metrics

7.3.4.4 Module 4-6: Protected spaces for interaction activities - discussions, polling, and file sharing

The next three modules of the InnoLab.Net platform namely ‘Discussion Space’, ‘Polling Board’, and ‘File Library’ facilitate the protected spaces for interacting with each other in or out of the context of any particular project. The modules support two key features in general:

1. The resources (discussions, polls, and files) can be linked to any project and thereby the modules have the capability to support the formal and project-based interaction. The permission of the logged-in user to add a resource to any project depends on the set privacy of the particular project (cf. Section 7.3.4.5).

2. The creator of the resource explicitly controls the access rights for various tasks concerning the particular resource with 5 level privacy controls. The tasks include the reading the resource, closing the resource (in the case of discussion or poll), participating (in the case of discussion or poll), and deleting the resource. The privacy values include the public, private, network, project collaborators, and password. Setting the privacy to project collaborators for the project-linked resources makes the resource an internal resource of the project team. While setting the privacy to password allows to interact with an ad hoc group of diverse participants with complete user authorization.
**User interfaces:** The UIs of these modules initially present a menu of 4 items: the retrieval of all resources, the retrieval of the resources created by the logged-in user, searching through the resources, and adding a new resource of a particular type. Once the resources are retrieved from the server, the UI lists the resources together with the faceted filters that are generated on the basis of meta information of the resources such as creator of the resource (creator name), status of the resource (open/close), project association (yes/no), linked project (project name), and folksonomy based file tags (in the case of file library). Selecting a resource in the list displays the resource in the right column of the screen with an action page on the top enabling to commit several actions on the particular resource. When the user selects any of these actions, the user’s permissions are initially checked. If the user has been granted the appropriate rights, the selected action is committed. Figure 7.12, Figure 7.13, and Figure 7.14, respectively show the aggregated view of discussion space, polling board, and file library modules.

**Technical implementation:** All the resources are stored in the local database of the platform and accessed via SQL queries. For searching the resources, full-text searches are performed for appropriate resources. This is achieved in two steps. 1) The search phrase is translated into an array of search terms according to the semantic search approach given in the Section 7.3.1. The textual data from the relevant fields of each resource are retrieved, aggregated, and successively compared with the search phrase for computing their similarity according to the text matching approach given in Section 7.3.2.

![Figure 7.12 - An aggregated screenshot of the Discussion Space module. 1) Main menu 2) Discussion list 3) Faceted filtering 4) Action pane 5) Discussion 6) Adding a discussion 9) Linking the discussion with a project 9) Discussion privacy controls](image)
Figure 7.13 - An aggregated screenshot of the Polling Board module. 1) Main menu 2) Poll list 3) Faceted filtering 4) Action pane 5) Poll and ongoing results 6) Adding a poll 9) Linking the poll with a project 9) Poll privacy controls.

Figure 7.14 - An aggregated screenshot of the File Library module. 1) Main menu 2) File list 3) Faceted filtering 4) Action pane 5) File 6) Adding a file 9) Linking the file with a project 9) File privacy controls.
Module 7: Project portal for managing project information and related resources, and self-assessing the collaboration maturity level

The seventh module of the InnoLab.Net is the ‘Project Portal’ that facilitates the InnoLab.Net members towards achieving two tasks: 1) management of project information and related resources, and 2) self-assessment of inter-InnoLab collaboration maturity.

**Project and resource management:** The first functionality of the module is a portal for recording and managing the information and other related resources (discussion polls, and files) of the InnoLab projects in a centralized space. The key features of this functionality are:

- Recording the information of collaborative as well as non-collaborative projects undertaken by the InnoLabs.

- Categorization of the projects into three categories: research projects, third party projects, and customer projects.

- Specification of the role of InnoLab and all other collaborating InnoLabs (in the case of collaborative projects) involved in a particular project according to the network model of inter-InnoLab collaboration proposed in Section 5.3. Accordingly, the role of an InnoLab can be specified as mentoring, conceptualization, actualization, commercialization, resource provision, and networking.

- Support for project based interaction among the project partners and the public through the integration of discussion space, polling board, and file sharing modules in a centralized space. In addition, the module provides a mechanism for reviewing and commenting on the projects.

- Facilitation of a mechanism for the project teams to evaluate/rate the performance of each other in the course of a certain project. Only the team members are allowed to evaluate the team and the evaluation can only be submitted once the project is declared as a closed project. Each team member is allowed to submit a single evaluation on a scale of 0 (lowest) to 4 (highest) for all other team members.

- User authorized control over the different tasks (reading the project details, closing the project, deleting the project, adding the comments / review to the project, adding the resources including the discussions, polls or files to the project) regarding the particular project with 5 level privacy control (public, private, network, project collaborators, password). Setting the project privacy to project collaborators for all the tasks makes the project and all of its related resources internal to the project team. This enables to achieve the data transparency and alleviate the reluctance of participating InnoLabs for sharing their technical information.

- Searching the projects according to the semantic search approach presented in Section 7.3.1. The search is performed over the descriptions of all the projects and their linked resources in an aggregated manner.
Filtering of the projects on the basis of meta-information such as the project initiator (member name), project type (research, third-party, customer project), project status (open/close), collaborative project (yes/no), and project collaborators (InnoLab names).

**Self-assessment of inter-InnoLab collaboration maturity:** The second functionality of the project portal module is the facility for the logged-in user to self-assess the collaboration maturity by the computation of several inter-InnoLab collaboration metrics which are computed as percentages on the basis of the information of previous projects undertaken by the user. The metrics include:

- Counts and categorical distribution (research, third-party or customer projects) for all projects wherein the user has been involved
- Counts and categorical distribution (research, third-party or customer projects) for non-collaborative and collaborative projects individually
- Statistics of supported innovation tasks (mentoring, conceptualization, actualization, commercialization, resource provision, and networking) in non-collaborative as well as collaborative projects
- List of collaborators and number of projects undertaken with each collaborator
- Statistics of open and closed projects at the time
- Geographic proximity with the collaborators
- Thematic similarity with the collaborators
- Average performance rating received for the collaborative projects.
Figure 7.15 - An aggregated screenshot of the Project Portal module. 1) Main menu 2) Project list 3) Project filters 4) Project action pane 5) Project information 6) Project resource view 7) Team evaluation 8) Adding a new project 9) Collaboration metrics of logged-in user
7.3.4.6 Module 8: Partner search for inter-InnoLab collaboration with respect to the stages of the innovation process

The eighth module of the InnoLab_Net is the ‘Partner Search’ module that supports the discovery of potential business partners for the inter-InnoLab collaboration with respect to the different stages of the innovation process. The module analyses the record of previous projects and supported innovation tasks of the InnoLab_Net members and determines who can support a certain stage of innovation process or provide a certain functionality. Besides the discovery of potential partners, the module also supports the selection of the most appropriate partner among the potential partners on the basis of their collaboration metrics, the mutual collaboration index, and the cross profile matching of the logged-in user and the potential partners in terms of their InnoLab specific attributes.

User interface: The UI initially presents the network model for inter-InnoLab collaboration proposed in Section 5.3 allowing the user to select the particular role for which the assistance is sought. Once the user selects a certain role, the system retrieves and lists the InnoLabs that have been previously supporting the chosen task. When a potential partner is selected, the system displays its profile, collaboration metrics (similar to the project portal module discussed in Section 7.3.4.5), and a comparison of its profile with the logged-in user.

Figure 7.16 - An aggregated screenshot of the Partner Search module. 1) Network model of inter-InnoLab collaboration 2) List of potential partners 3) Domain-specific profile of the selected potential partner 4) Collaboration metrics of the selected potential partner 6) Mutual metrics and similarity index of the selected potential partner and the logged-in user
7.3.4.7 Module 9: Information search over native platform resources and SNS data

The last module of the InnoLab_Net platform is the ‘Information Search’. The module facilitates an aggregated search over the native information resources of the InnoLab_Net platform (discussions, files, and project descriptions) and the data hosted on SNS business pages of the registered InnoLabs. The module adopts a novel approach for supporting the user in building search query, and categorizing and filtering the information resources (cf. Figure 7.17). The module supports the user in building a well-defined query by suggesting the semantically similar and neighbouring words of the given keywords. The categorization and filtering of retrieved information sources is supported through a concept map consisting of the 2 and 3 worded concepts corresponding to the given keywords.

![Diagram](image)

**Figure 7.17 - Concept-based information retrieval methodology**

**Support for query building:** Currently, the open search systems facilitate the user in writing the query by presenting auto-completion suggestions from the large indices or a log of previous and popular searches containing the given keyword(s). This approach suggests the more common queries but does not depict what could actually be found in underlying data. In this regard, the information search module takes a bottom-up approach and supports the user in writing well-defined query by suggesting the semantically similar and neighbouring words of given keyword(s) generated from the
actual resources available in the repository. The semantically similar words assist the user to select any of the alternate terms that might describe the user query more appropriately as compared to the given keyword. While the left and right neighbouring words of the given keyword assist the user in refining the query. For example, if the given keyword is ‘innovation’, the user may select the ‘service’ or ‘product’ from its left neighbours to refine the query to either ‘service innovation’ or ‘product innovation’. Similarly, the user may select the ‘policy’ or ‘management’ from its right neighbours to refine the query as ‘innovation policy’ or ‘innovation management’. Since the left and right neighbours are generated on the basis of underlying data, it is assured that at least one resource could be found with the selected combination of words.

Concept mapping: Generally, once a search query is executed, the keyword based searching systems either do not support further query refinement or the results are categorized according to a well-established taxonomy or the metadata of the results. In the case of full-text search systems where capturing a complete picture of information beforehand is impossible and/or specific taxonomy is not available, the systems rely on simple keyword queries and any refined query requires a separate query resulting in an overload on the server side. To this end, the information search module provides a concept map comprised of two and three worded concepts with their frequency of occurrence across the retrieved resources. The concepts are generated by the aggregation of given query words with their respective left, right, and both neighbouring terms. A concept map for keyword ‘Innovation’ generated through the LCC by referencing the English corpus (eng_news_2013_3M) is given in Figure 7.18.
Accordingly, if a word has L left neighbours and R right neighbours, the total no. of concepts (N) generated for this word equals to:

\[ N = 1 + L + R + LR \]

After the generation of concepts, all the retrieved (matching) resources are tagged with relevant concepts through the text matching approach given in Section 7.3.2. Resources are assigned a concept only if all the individual terms of certain concept in any of their morphological form can be found in the resource. The algorithm for concept generation and resource tagging is given in Listing 7.3. The resources are presented along with the concept map for further navigation and filtering based on their concept tags, and therefore expansion or refinement in the original keywords does not necessarily instantiate a new search. Figure 7.19 presents a screenshot of the information search module.

![Figure 7.19 - A screenshot of the Information search module. 1) Query interface 2) Concept map 3) Resource list 4) Selected resource view](image-url)
Algorithm: Generates concepts on the basis of co-occurrences and successively tags the resources with relevant concepts

Input: list of keywords Keywords, list of retrieved resources Resources, list of stop words Stop_words
Output: List of concepts Concepts, list of tagged resources Resources

/* Generate Concepts */
foreach word W in Keywords do
  Array Semantical_equivalents = retrieve semantically similar words of W;
  foreach semantical equivalent S in Semantical_equivalents do
    if S is not in Keywords then
      add S in Keywords
    end
  end
end

foreach word W in Keywords do
  Array Left_neighbours = get left neighbouring terms of W;
  Array Right_neighbours = get right neighbouring terms of W;
  l = length of Left_neighbours;
  for i = 1 to l do
    if Left_neighbours[i] is not in Stop_words then
      add Left_neighbours[i] + W in Concepts;
    end
  end
  r = length of right_neighbours;
  for j = 1 to r do
    if Right_neighbours[i] is not in Stop_words then
      add W + Right_neighbours[j] in Concepts;
    end
  end
end

end

/* Add concept tags to resources */
foreach resource Resource in Resources do
  Array Concept_tags;
  foreach concepts Concept in Concepts do
    Concept_terms = tokenize Concept;
    n = length of Concept_terms;
    for i = 1 to n do
      Sim = match Concept_terms [i] and Resource;
      if Sim > 0 then
        continue;
      else
        break;
      end
    end
  end
end

end

/* Add concept tags to resources */
foreach concept Resource in Resources do
  Array Concept_tags;
  foreach concepts Concept in Concepts do
    Concept_terms = tokenize Concept;
    n = length of Concept_terms;
    for i = 1 to n do
      Sim = match Concept_terms [i] and Resource;
      if Sim > 0 then
        continue;
      else
        break;
      end
    end
end

end

end

return Concepts, Resources;
In this section, the evaluation of the InnoLab_Net in achieving its desired goals in a real world context is described. The evaluation strategy (approach, criteria, and method) is described. Next, the evaluation results of the InnoLab_Net in terms of its effectiveness, usability, and completeness are presented and discussed.

### 7.4.1 Evaluation strategy

For the evaluation of the InnoLab_Net, a summative and qualitative evaluation was conducted by the intended audience of the platform (i.e. InnoLab facilitators) through a questionnaire comprising of a combination of objective and open-ended questions.

#### 7.4.1.1 Evaluation approach

For the proper evaluation of DSR artifacts, Cleven, Gubler, and Hüner (2009) emphasize to design a structured evaluation strategy alongside the fundamental characteristics, and thereby present 12 morphological fields (Ritchey, 2006, p. 794) that can be configured and used during the artifact evaluation process. The field configuration of the InnoLab_Net evaluation is given in Figure 7.20 in terms of the proposed morphological fields of DSR evaluation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>Quantitative</td>
</tr>
<tr>
<td>Artefact focus</td>
<td>Technical</td>
</tr>
<tr>
<td></td>
<td>Organizational</td>
</tr>
<tr>
<td></td>
<td>Strategic</td>
</tr>
<tr>
<td>Artefact type</td>
<td>Construct</td>
</tr>
<tr>
<td></td>
<td>Model</td>
</tr>
<tr>
<td></td>
<td>Method</td>
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<tr>
<td></td>
<td>Instantiation</td>
</tr>
<tr>
<td></td>
<td>Theory</td>
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<tr>
<td>Epistemology</td>
<td>Positivism</td>
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<tr>
<td></td>
<td>Interpretivism</td>
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<tr>
<td>Function</td>
<td>Knowledge function</td>
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<td></td>
<td>Control function</td>
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<td></td>
<td>Development function</td>
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<td></td>
<td>Legitimization function</td>
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<tr>
<td>Method</td>
<td>Action research</td>
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<td></td>
<td>Case study</td>
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<td></td>
<td>Field experiment</td>
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<tr>
<td></td>
<td>Formal proofs</td>
</tr>
<tr>
<td>Object</td>
<td>Controlled experiment</td>
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<tr>
<td></td>
<td>Prototype</td>
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<td></td>
<td>Survey</td>
</tr>
<tr>
<td>Ontology</td>
<td>Artefact</td>
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<tr>
<td></td>
<td>Artefact construction</td>
</tr>
<tr>
<td>Perspective</td>
<td>Economic</td>
</tr>
<tr>
<td></td>
<td>Deployment</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
</tr>
<tr>
<td></td>
<td>Epistemological</td>
</tr>
<tr>
<td>Position</td>
<td>Externally</td>
</tr>
<tr>
<td></td>
<td>Internally</td>
</tr>
<tr>
<td>Reference point</td>
<td>Artefact against research gap</td>
</tr>
<tr>
<td></td>
<td>Artefact against real world</td>
</tr>
<tr>
<td></td>
<td>Research gap against real world</td>
</tr>
<tr>
<td>time</td>
<td>Ex ante</td>
</tr>
<tr>
<td></td>
<td>Ex post</td>
</tr>
</tbody>
</table>

Figure 7.20 - Field configuration for the evaluation of the InnoLab_Net with respect to the fundamental characteristics of DSR evaluation identified in Cleven et al. (2009)

Increasingly, an ex-post (after construction) evaluation of the InnoLab_Net was conducted externally (with InnoLab facilitators) for measuring its usefulness relative to the absence of any similar artifact with regard to its goals. The evaluation was conducted
with a deployment perspective (focusing on the comprehensibility and acceptance aspects) with a positivist epistemological attitude (implying that the evaluation leads to identical objective results regardless of individual characteristics of the evaluating persons). This is in alignment with the goal of the InnoLab_Net which is to connect the different types of InnoLabs in one network and thereby overrule the individual differences among their structure and practices.

7.4.1.2 Evaluation method

In the DSR literature, several evaluation methods have been used depending on the artifact type and evaluation objectives. Peffers et al. (2012) have classified the identified methods into two broad classes: technical experiments as a means to evaluate the performance of an artifact without the involvement of research subjects, and subject-based experiments that use research subjects to assess the validity of the assertions that motivated the development of the artifact. Venable (2006a) has also identified similar classes referring them as artificial and naturalistic evaluation methods, respectively. Artificial evaluation includes evaluating the artifact in a contrived, non-realistic and pre-designated manner by employing research methods such as laboratory experiments, field experiments, and simulations. Naturalistic evaluation involves exploring the artifact performance in real environment by involving its real users by employing research methods such as field studies, surveys, ethnography, and action research (Venable, 2006a). While the artificial (technical) evaluation is best suited for pure technological artifacts, the naturalistic (subject-based) evaluation brings real proof of the pudding for socio-technical artifacts as it incorporates all human complexities that may affect the usefulness and acceptance of the artifact.

Accordingly, for the evaluation of the InnoLab_Net, a naturalistic evaluation was conducted with InnoLab facilitators by employing the survey methodology. In doing so, InnoLab facilitators who had been interviewed in the empirical phase of the study were invited for the participation. Successively, the functionality of the InnoLab_Net was demonstrated to them on a one-to-one basis, either in a face-to-face meeting or through a live demonstration video. Afterward the experts were asked to record their opinions on a questionnaire given in Appendix D-1 comprising of 5-point ordinal and open-ended questions.

7.4.1.3 Evaluation criteria

The InnoLab_Net has been evaluated with respect to three aspects:

1. **Effectiveness** - the extent to which it achieves the targets set out, and is perceived useful in addressing its broader goals. This includes both the effectiveness in achieving overall high-level goal and individual low-level objectives.

2. **Usability** - the extent to which it is easy and pleasant to use, and can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. The usability measure includes the ease
of use, interface design, clarity of information, understandability and ease of learning, consistency, accuracy of the output, performance / efficiency, and suitability (fit) with organization and people.

3. **Completeness** - the extent to which it is perceived complete in terms of the offered functionality by its targeted audience. The measurement of completeness was achieved through comprehensibility of offered functionalities, the positive and negative aspects, and the efficacy with individual modules incorporated in the InnoLab_Net.

Figure 7.21 lists the criteria and sub-criteria of the InnoLab_Net evaluation together with the number and type of questions measuring each criterion included in the questionnaire.

![Figure 7.21 - Evaluation criteria and sub-criteria of the InnoLab_Net evaluation](image)
7.4.2 Evaluation results

This section discusses the results of the subject-based evaluation of the InnoLab_Net undertaken by the InnoLab facilitators.

7.4.2.1 Results of effectiveness

The effectiveness of the InnoLab_Net was evaluated on a five-level Likert scale ranging from 1 (very ineffective) to 5 (very effective) in terms of the overall effectiveness in supporting the inter-InnoLab collaborations, effectiveness in motivating the InnoLabs towards collaborative networking, and the individual effectiveness in supporting the particular tasks of different stages of the collaboration process. The results of the effectiveness study are given in Figure 7.22.

As depicted in the above figure, on average the effectiveness of the InnoLab_Net has been rated positively in every aspect. Specifically, all the evaluators found the InnoLab_Net either effective (score 4) or very effective (score 5) with respect to its broader goals as well as low-level objectives. Referring to the individual responses, only one evaluator marked the effectiveness as neutral (score 3) regarding three of its low-level objectives which are the facilitation of protected spaces for interaction, support for self-assessment of collaboration maturity, and support for project management. Accordingly, while some of the InnoLab_Net features (i.e. the ‘provision of protected interaction spaces’ and ‘support for self-assessment of collaboration maturity’) are at the borderline of effectiveness, some others (i.e. the ‘SNS data integration’ and ‘support for
network discovery and management’) are perceived very effective by every respondent. Interestingly, no one showed a negative response concerning any of its offered functionalities.

The positive scores for all the features of the InnoLab_Net suggest that it is perceived useful by its intended audience in achieving its set objectives. Furthermore, while indicating the most positive aspect of the InnoLab_Net, the evaluators have mentioned two aspects. One, support for whole/more collaboration process in one tool (mentioned by 67% of the evaluators). Two, social networking aspect of understanding the InnoLabs (mentioned by 33% of the evaluators). The indicated two aspects reflect back to the main goals of the InnoLab_Net design, and therefore, lead to the conclusion that it is capable of achieving its intended goals.

7.4.2.2 Results of usability

The usability of the InnoLab_Net was evaluated on a five-level Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied) in terms of several usability criteria as specified in Figure 7.21. The results of the usability study are given in Figure 7.23.

As depicted in the above figure, on average the usability of the InnoLab_Net with regard to all of the included usability criteria is rated positively with scores in the range of neutral (score 3) and satisfied (score 4). Furthermore, all the evaluators showed their willingness to join the InnoLab_Net which testifies its usability as well as suitability with its intended audience. Referring to the individual responses, one of the evaluators showed the negative response concerning the interface design noting that some of the textual elements can be better displayed with visualization (i.e. graphics and charts) in order to improve the readability and usefulness of the given information. Since during the prototyping stage, interface design has not been an important concern of the InnoLab_Net
development, there is a room for improvement and such valuable suggestions definitely need to be followed before that the InnoLab_Net is deployed in real settings.

7.4.2.3 Results of completeness

As depicted in the Figure 7.24, the InnoLab_Net is perceived complete in terms of the necessary functionality required for supporting inter-InnoLab collaboration. Specifically, 33% of the evaluators were very satisfied with its offerings and do not mention any missing functionality. The other 67% of the evaluators were satisfied with its completeness, however, they mentioned some additional features that should also be integrated. It is particularly interesting that the missing functionalities indicated by the respondents include the common supplementary features that the existing networking platforms provide such as ‘sending invites to others’, ‘mailing service and mail notifications’, and ‘sharing of different data formats’. As a result, it can be concluded that the InnoLab_Net is complete in terms of the dedicated functionalities that it sought to facilitate. However, such additional features need to be taken into consideration for further implementation.

Another desirable functionality mentioned by a respondent is the backward integration within SNSs. It is important to note here that the aim of the InnoLab_Net was to pull the relevant data from multiple SNSs aggregately for the business-specific purposes. Therefore, while facilitating the dedicated and domain-specific functionalities within SNSs is possible as the SNSs support the hosting of embedded applications, such artifacts could only leverage the data of the particular SNS that hosts them unless the SNSs allow fetching their data within the other SNSs. Moreover, such applications could only serve the audience of that particular platform and therefore could not address the issue of isolated platform boundaries of SNSs.

In order to measure the efficacy with the individual functional modules of the InnoLab_Net described in Section 7.3.4, the respondents were asked to select the
modules that they find most useful and interesting. The results of module efficacy are given in Figure 7.25. It is interesting to note that the functional modules enabling the dedicated functionalities for inter-InnoLab collaboration and the modules leveraging the SNS data are perceived more useful than the modules that facilitate the interaction among participants; i.e. the discussion space, polling board, and file library. One reason for this is that almost every existing web-based collaboration tool supports the information exchange and interaction of its participants, but lacks the dedicated functionalities which are the distinct features of the InnoLab_Net.

Figure 7.25 - Rate of the individual modules of the InnoLab_Net perceived most useful by the evaluation sample (N=3)

7.5 Chapter summary

In this chapter, the prototype of the InnoLab_Net platform developed as part of this thesis was introduced. The platform has been designed in order to address the lack of dedicated collaboration tools for InnoLabs. The unique features of the InnoLab_Net include the support for whole inter-InnoLab collaboration process, domain specificity, and integration of the data from existing SNSs. The results of its subject based evaluation undertaken by the InnoLab facilitators indicate that it is effective in addressing its set goal of assisting the InnoLabs in attaining higher levels of inter-InnoLab collaboration.
Chapter 8

Conclusions and Outlook

“This is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning”

— Winston Churchill

This final chapter summarizes the thesis. The chapter begins with a review of the major findings in line with the set research objectives (Section 8.1) and successively recapitulates the theoretical and practical contributions of the thesis (Section 8.2). The next part of the chapter elucidates the limitations of the study (Section 8.3) and gives an outlook to the interesting future work (Section 8.4).

8.1 Review of findings

The central problem addressed by this thesis is ‘how we can connect the geographically apart and diverse InnoLabs in a collaborative network’ in order to centralize their mediating services for the successful innovation of business products and services. In this esteem, at the outset, this work aimed to facilitate a dedicated and domain-specific web-based collaboration platform for InnoLabs. Nevertheless, given the limited and inconclusive prior research on the paradigm of InnoLabs, initially, an empirical investigation of the InnoLabs in field settings was conducted in order to ascertain the research hypothesis that the inter-InnoLab collaboration is both valuable and crucial for enhancing the potential of InnoLabs in supporting sustainable innovations. The empirical inquiry was also essential to draw the necessities and opportunities of supporting inter-InnoLab collaboration in an online space. Accordingly, the overall goal of supporting inter-InnoLab collaboration has been decomposed into three research objectives defined in Section 1.3. The relevant findings in line with each research objective have been discussed coherently in separate chapters of this thesis and are summarized in this section.

Research objective 1: A comprehensive study of the phenomenon of InnoLabs

The first research objective of this research work was to explore the overall concept of InnoLabs in field settings and answer the question: “What are the InnoLabs and how they support successful innovation management of products and/or services of business organizations?” This objective has been achieved by employing a triangulation of online survey and a series of in-depth expert interviews with the InnoLab facilitators. The relevant findings have been discussed in Chapter 4 of the thesis.

To this end, the foremost finding of the thesis is that the physical infrastructure (space and tools) that previously has been identified as an essential component of the InnoLab structure (cf. Table 2.1) is actually not an integral part. It has been observed that many of the existing InnoLabs are oriented around the groups of people who facilitate innovation
process out of the specific physical boundaries. With this viewpoint, a conclusive
definition of an InnoLab reflecting real field settings has been framed in Section 4.1. Moreover, the study has revealed that the term ‘Innovation Laboratory’ is used as a hypernym where the underlying structures differ in terms of both, structure and functioning. Accordingly, they can be differentiated with respect to the types of innovations they support, phases of innovation process they cover, types of resources they provide, scope of innovations they focus, maturity of methodological approaches they apply, thematic orientation, regional orientation, business model, and their management structure (cf. Section 4.3 for the field configurations). Furthermore, the existing InnoLabs are aiming at achieving different innovation related goals and in doing so they offer varying innovation services to their clients. As a result, the mediating services that can be solicited at these facilities range from the basic services such as the provision of shared space to the very sophisticated services such as modelling and simulation. Accordingly, on the basis of their offered services, existing InnoLabs can be classified into 9 categories: service InnoLabs, product InnoLabs, co-working spaces, business incubators, network coordinators, consulting firms, research and development labs, fab labs, and living labs (cf. Section 4.2).

Increasingly, the detailed analysis of the offered services of InnoLabs elucidates that besides the previously identified functionality of stimulating creative behaviour of the participants, they also undertake many other functionalities that add substantial value in maximizing the effectiveness and success of innovation process. These functionalities include the knowledge dissemination, business incubation, resource provision, process intermediation, research and development, network formation, and market research (cf. Section 4.4). However, pertaining to the differences in their motives and offered service portfolios, not every InnoLab contribute similar propositions. While some of them are oriented around mentoring services, others support the conceptualization, actualization, and/or commercialization of the innovative products and services. Consequently, the necessary support that might be needed in the course of an innovation process remains scattered among different InnoLabs and thereby a business organization using InnoLab services may need to consult more than one InnoLab in the course of a single innovation project. This, besides requiring an increased amount of efforts at the client side, also brings difficulties for the InnoLabs in tracking their ideas and measuring the success.

**Research objective 2: An investigation of the inter-InnoLab collaboration**

The second research objective of this research work was to formulate the concept of inter-InnoLab collaboration and answer the question: “Why InnoLabs should exercise inter-InnoLab collaboration and what is the current extent of interconnection among InnoLabs?” This question has been answered in Chapter 5 of the thesis.

Pertaining to the service diversity and fragmentation of innovation support among InnoLabs, inter-InnoLab collaboration is beneficial for the InnoLabs, their customers, and innovation environment as a whole (cf. Section 5.2.2). Aligning in a collaborative network with a combination of horizontal and vertical collaborations (cf. Figure 5.5), InnoLabs may access diverse skills, competencies, and resources of each other and thereby enhance their potential for supporting whole innovation process and improve
their quality of service. This besides increasing their capabilities, will also facilitate their customers in receiving all the required support of at one place with improved levels of quality. Furthermore, the extended innovation support will result in more fruition of ideas and thereby satisfy more market demands.

InnoLabs may collaborate with each other in the context of research, customer, or third-party projects maturing through different degrees of interconnection (cf. Section 5.4). However, the current extent of interconnection among InnoLabs is sparse. Most of the InnoLabs included in this study are aware of only a few other InnoLabs with whom they are either in business competition (such as InnoLabs residing very nearby or working for the same business sector) or an inherent relationship (such as InnoLabs owned by same organization). Furthermore, their interaction with each other is limited to only the information exchange in sporadic meetings (cf. Section 5.5).

The major obstruction curtailing the InnoLabs from engaging in collaborative activities in the course of customer projects is the business competition that result in their limited openness to share detailed information publicly. This, in turn, hampers the awareness of the competencies of each other and the knowledge of other types of innovation support offered at such facilities. As a result, the potential incentives and possibilities of inter-InnoLab collaboration are largely left unidentified and thus unavailed among InnoLabs.

**Research objective 3: Technological support for inter-InnoLab collaboration with integration of SNS data**

The third research objective of this work was to facilitate a technological supportive artifact for the inter-InnoLab collaboration. The fundamental question that was to be answered in this regard was: “How can we support the diverging InnoLabs in attaining the higher levels of inter-InnoLab collaboration?” Specifically, the aim was to envisage the design and successively develop a dedicated web-based collaboration platform for InnoLabs. Accordingly, the conceptual framework for such a platform was developed in Chapter 6 and the developed platform was introduced in Chapter 7 of the thesis.

A platform for supporting inter-InnoLab collaboration throughout the collaboration process must facilitate the participating InnoLabs towards four activities: 1) defining own competencies and discovering others’ competencies, 2) identifying the common goals and interacting with each other, 3) selecting the potential partners and collaborating with the selected ones, and 4) managing and evolving the long-term relations. In this esteem, the existing collaboration tools are inadequate in that they all support collaboration process only in part and most of them are targeted to support the communication and exchange of information providing a very little support for further stages of the collaboration process. Increasingly, SNS integrate a number of necessary services at one place and are gaining rapid popularity among businesses as an efficient means of promotion and interaction with customers. However, their application in inter-organizational context is under the challenges of isolated platform boundaries, platform dependencies, varying focus and services, lack of interoperability and data integration, lack of support for domain specificity, and privacy concerns. This elucidates the need for dedicated inter-InnoLab collaboration platforms supporting dedicated functionalities.
with enhanced data transparency and domain specific features. Nevertheless, offering another platform will require the InnoLabs to regenerate the customer-oriented information already available and being shared on SNSs in order to disseminate it with other businesses within new dedicated platforms. In such circumstances, any new web-based platform aiming at supporting inter-organizational collaboration among InnoLabs as well as any other business domain must integrate with existing SNSs so that the relevant information that the participants share on SNSs can be fetched into the new platform automatically.

Accordingly, the InnoLab_Net platform designed as part of this research work supports dedicated functionalities for whole inter-InnoLab collaboration process with seamless integration of SNS data in nine functional modules (cf. Section 7.3.4). The subject based evaluation of the InnoLab_Net undertaken by the InnoLab facilitators has shown positive results in terms of its effectiveness, usability, and completeness towards supporting InnoLabs in achieving higher levels of inter-InnoLab collaboration (cf. Section 7.4).

8.2 Summary of contributions and their implications

This work described in this thesis included both the research and engineering parts. As a result, it makes a number of contributions to the knowledge that have academic as well as practical implications to the fields of InnoLabs, and the development of web-based inter-organizational collaboration platforms.

First, the previous literature on InnoLabs as summarized in Section 2.1.4 indicated the inconclusiveness and insufficiency of knowledge in describing the structural and functional manifestation of InnoLabs. The current study has sufficiently addressed this research gap with an inclusive explanation of the construct and current practices of InnoLabs in a broader and general context with a large-scale empirical evidence from field settings. The conclusions drawn in this esteem, besides their contributions to scientific knowledge, also have implications for the innovation managers and InnoLab facilitators. Innovation managers may exploit the given description of the functional capabilities of InnoLabs to inform themselves on the benefits that an InnoLab may bring to them in addressing their individual innovation challenges and enhancing their innovation capabilities. This, in turn, will encourage them to utilize such facilities and result in an increased application of the InnoLab services. On the other hand, the InnoLab facilitators may leverage the given information in envisaging different types of innovation assistance that is currently being offered at other InnoLabs. This will help them to assess their capabilities (strengths and weaknesses) and determine what they can focus in addition while looking over the edge of their current service portfolios.

Second, the study adds a foundational study on the topic of inter-InnoLab collaboration to the scientific literature. It is, particularly, first of its kind on the topics like the necessity, benefits, assessment, and implications of interconnection among InnoLabs. In that, it would extend the scientific discussion on InnoLabs in a new direction. Furthermore, the postulation of the possibilities and incentives of inter-InnoLab collaboration carried out in this study provides a motivation for the InnoLab facilitators towards opening up their services and resources for external utilization and
simultaneously leveraging upon others’ capabilities. In this regard, the ‘inter-InnoLab collaboration network model’ framed in this study (cf. Section 5.3) could serve as a guideline for them in determining that how and with whom they can collaborate according to their offered services. In a nutshell, the study could initiate and encourage the nurturing of a collaborative ecosystem of InnoLabs.

Third, the study contributes a conceptual framework for designing dedicated and domain-specific inter-organizational collaboration platforms with seamless integration of the SNSs. Although in the course of the present study, the proposed framework has been explicitly put in the context of InnoLabs, it is equally applicable to any other business domain. The framework would guide the web developers interested in facilitating inter-organizational collaboration in two ways. One, it advocates the necessary activities that must be facilitated in order to support the participants throughout the collaboration process (cf. Section 6.1). Two, it suggests what could be an acceptable design of such platforms in the current era of extensive utilization of the SNSs (cf. Section 6.3). Furthermore, it could also serve as a reference for evaluating the potential of the web-based collaboration tools with respect to their offered functionalities.

Fourth, the study contributes the InnoLab_Net platform which besides supporting InnoLab interactions with necessary functionalities, also provides some reusable components (cf. Section 7.3.4). Aligning with the proposed conceptual framework, the platform sets an example for designing dedicated and domain-specific collaboration platforms with seamless integration of the SNS data. As a result, it could initiate and encourage a paradigm shift to the integrated collaboration platforms for inter-organizational connectivity.

8.3 Limitations of the study

As in any research, this study also has some limitations which are discussed below:

1. In essence, the sample size is small for representing the whole population of 190 identified InnoLabs. However, since the main objective of the empirical investigation was to qualitatively explore the diversity among InnoLabs rather than establishing a statistical evidence, maximum variation sampling was used to ensure that all the participants who are likely to generate varying information are included. At a later point in the interview process, the new participants started to produce considerably similar views on particular topics which indicate that the sample was sufficient to achieve theoretical saturation.

2. Due to the financial constraints, the participants of study are recruited only from two regions: North America and Central Europe. Therefore, although few of the participants also operate in other parts of the world such as Asia, the empirical findings mainly represent a North America and Europe-centric view. Henceforth, further investigation of the InnoLabs operating in other regions of the world is necessary in order to claim the comprehensiveness of the identified diversity and established categories at a global level.
3. The findings rely on respondents’ self-reported data concerning their services and undertakings, rather than the independent assessment of their actions. This might have influenced the participants’ responses for the business related questions such as the questions relating to the funding sources, turnover, and success rate. Nevertheless, it is unlikely to influence their descriptions of service offerings, focus, and methodological approaches which have been the important aspects for this research.

4. The functionality and effectiveness of the InnoLab_Net platform have been verified by the InnoLab facilitators individually in disconnected settings only. Further work including its deployment and subsequently the monitoring of interactions and measuring of impacts in real settings is still to be done.

5. For the functionalities offered in conjunctions with SNS data, the InnoLab_Net platform relies on their APIs. As a result, it is susceptible to the changes in the policy, offerings, and openness of respective APIs.

While acknowledging such limitations, this research exhibits a sufficient comprehension of the diverse features of existing InnoLabs, benefits and possibilities of inter-InnoLab collaboration, and the technological support for inter-InnoLab collaboration. Accordingly, this study constitutes an important step towards nurturing a collaborative culture among InnoLabs in an international context.

8.4 Future research agenda

Although this study has yielded significant results concerning the diversity and interconnections among InnoLabs, there are still some avenues of research that are worthy of further pursuit. In particular, three research areas deserve close attention: the comparative investigation of the InnoLabs, application and evaluation of the InnoLab_Net in real settings, and impact analysis of inter-InnoLab collaborations.

1. Comparative studies of the InnoLabs

First, in the contextual terms, this research has investigated the InnoLabs and their interconnection in an aggregated and broader sense while not considering the regional or sectorial particularities. Therefore, it would be interesting to undertake a comparative analysis of the InnoLabs operating in different regions and/or serving different business sectors with a quest to identify the synergies and complementarities in term of their focus and offerings. The resulting cross-regional and cross-sectorial elucidations will, on one hand serve the unpacking of the innovation support that can be solicited locally by the business organization of a particular region/sector. On the other hand, they will unfold the regions’ strengths, needs, challenges, and opportunities of collaboration and thereby outline that how the InnoLabs may benefit from participating in specific regional and inter-regional collaborative networks.
2. Application and evaluation of the InnoLab_Net in real settings

As indicated in preceding section, the InnoLab_Net platform has yet not been applied in real settings. Therefore, a promising next step would be to deploy it and successively refine and improve it based on the participants’ observations and feedback. While it is currently perceived useful by the InnoLab facilitators in isolated settings, its application in real collaboration settings would help to better understand and recognize the scenarios where it is not effective and uncover the additional functionalities that still need to be integrated. Another important direction of further work on the InnoLab_Net would be to maintain its compatibility with the SNS APIs and simultaneously scale it up with new features leveraging the new opportunities that the APIs offer in future.

3. Impact analysis of inter-InnoLab collaboration

The work discussed in this thesis has set the foundation for the research and practice of inter-InnoLab collaboration by providing an inclusive description of its incentives and opportunities. As the inter-InnoLab collaborations increasingly develop in practice, future research could be directed towards measuring their actual impacts on the InnoLabs and their customers. In particular, it would be interesting to see if and to what extent the extended service portfolio and improved quality of service offered by the InnoLabs as a result of inter-InnoLab collaborations elevate their business and success rate. Furthermore, it would be interesting to measure the benefits that the InnoLab_Net platform brings to such collaborations.

8.5 Closing remarks

Pertaining to the growing business competition and recent technological advancements, the amount of complexities and challenges of innovation process continues to increase at a rapid pace. InnoLabs as mediators are a means of dealing with these challenges and bring successful innovations to the market. Nevertheless, they individually are not capable of facilitating all the innovation support that might be needed in the course of an innovation process. Therefore, they need to align in joint actions, share diverse competencies, and work together in order to support the development of innovative products and services throughout the innovation process. By undertaking the conceptualization and assessment of InnoLab interactions, and successively the development of a technological supportive artifact, this thesis aims to motivate and simultaneously facilitate the InnoLab facilitators towards engaging in collaborative activities. To put it in other way, this thesis constitute one early step into the promising future of collaborative InnoLabs offering the inclusive mediating support for the innovation process.
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References


Appendix A

Web-based collaboration tools

A-1: Web-based inter-organizational collaboration tools

1. Communication tools

Website refers to a collection of interrelated web pages usually served from a single web domain. Website is the foremost communication channel adapted by business organizations for establishing an online presence and sharing their information with a wider audience. Generally, websites support the sharing of static and unidirectional information, however, the ecommerce websites may also include a shopping cart facility and online transactions support and thus alleviate the geographical restrictions of a brick-and-mortar business (Getting, 2007).

Email (short for electronic mail) is the best known asynchronous communication tool for exchanging digital messages from one-to-one or one-to-many recipients. It offers intuitive features for forwarding messages, creating mailing groups, attaching documents, and sorting messages automatically in a chronologically order.

Weblog (shortened as blog) is a simple content management tool enabling the people to build easily updatable web diaries or online journals (Kamel Boulos, Maged N & Wheeler, 2007). The weblog entries (aka weblog posts) are made in journal style and are usually displayed in reverse chronological order (Razmerita et al., 2009). Weblogs range from personal diaries meant for family and friends to personal knowledge repositories maintained by professionals, learning journals or networking instruments (Avram, 2005). The organizational weblogs can be private (internal to an organization) or publicly accessible containing the text, photographs, videos, or audio clips (Aghaei et al., 2012; Patel, 2013). Weblogs offer two interesting features. One, a weblog post can be linked to other weblog posts, so interesting posts travel from site to site and through these linked weblogs, people with similar interests can build relationships and form communities. Second, the weblog readers can syndicate (subscribe to) a weblog using the RSS (Really Simple Syndication or Rich Site Summary) technology that automatically checks for weblog feeds for updates represented in XML based web feed format (Kamel Boulos, Maged N & Wheeler, 2007) summarizing the information items and links to the information sources (Murugesan, 2007).

2. Conversation tools

Instant messaging or chat software allows the users to share short messages (usually text messages) in an asynchronous mode. Such tools usually use split screens for displaying the user messages and the conversation history is always stored unless the user deliberately deletes it. Besides the support for text chat, some services also extend to the higher fidelity experiences including the sharing of video links between users. Instant messaging services may also be structured within the chat rooms which support multicasting and show usernames, number of people, location, and discussion topic.
Discussion forums (aka as the bulletin boards, discussion boards, and discussion groups) allow people with common interests to debate and share certain information, questions, comments and opinions. The discussion posts are stored and sorted chronologically to form a discussion thread or topic. From a technological standpoint, forums or boards can be regarded as web applications managing user-generated content. They differ from chat rooms in that messages are often longer than one line of text, and are at least temporarily archived.

Web conferencing tools facilitate real-time conversation involving text-based messages, voice and video among geographically dispersed participants. Such services may allow real-time point to point communications as well as multicast communications from one sender to many receivers. Applications for web conferencing include peer-level online meetings, web seminars (webinars), and webcasts from a web-connected computer to other web-connected computers.

3. Coordination tools

Wiki (derived from the Hawaiian word wikiwiki meaning fast or quick) is a simple yet powerful web-based collaborative authoring tool (Murugesan, 2007). The wiki process of co-construction of content is best known through the public collaborative encyclopaedia - Wikipedia. Wiki applications facilitate collaborative creation and editing of documents in real-time along with the revision mechanisms that support the monitoring (Razmerita et al., 2009) and rolling back of the changes (Patel, 2013). Business organizations use wiki applications to keep track of internal procedures and knowledge by storing documents in a centralized knowledge repository and thus enabling the asynchronous contribution by a group of people, information annotation, efficient communication and productivity, harnessing of the power of diverse individuals to create collaborative works, and support for the content to evolve, expand, and improve incrementally over time (Murugesan, 2007).

Collaborative document editing tools allow users to create and edit documents online while collaborating with other users in real-time. Documents can be shared, opened, and edited by multiple users simultaneously and users are able to see the changes that other collaborators make. The application may include a notification functionality prompting the users when a comment is made or replied to, a chat functionality allowing the collaborators to discuss the edits in real-time, and a revision history allowing the users to archive the additions made to the document.

Project management tools facilitate the users to collaborate over a certain project covering all aspects of managing project from its genesis to its completion. Project management tools help to track complex projects distributed in many geographical areas and/or managed by a number of project managers. Typical task supported by such tools include project planning (mapping of project tasks and task interactions), task management (assignment, deadlines and status reports of tasks), document sharing and collaboration (central document repository accessible to project stakeholders), calendar and contact sharing (scheduled meetings, activity dates and automatically updating
contacts), bug and error management (error reporting, viewing, notifying and updating for stakeholders), and time tracking (ability to track time for all tasks).

4. Content sharing tools:

*Cloud based file or document sharing services* refers to the shared repositories hosted on cloud servers where the users can store the electronic documents and anyone with appropriate permissions can access them. With nearly ubiquitous internet connectivity these days, storing files remotely rather than locally boasts an array of advantages for the users including the wider accessibility, lower costs, improved security, easy syncing, sharing and collaboration, and more protection. Business organization build on cloud based file sharing in order to give their employees flexibility in file accessibility and reducing the costs of setting up virtual private networks and in-premise fileservers.

*Media sharing platforms* refers to the social forums or communities whereby the users interact with each other by sharing a variety of different types of user generated content (often referred as media object) via digital channels. Such platforms enable the users to upload the media to a central webserver that can be accessed from anywhere and are often equipped with a comment function, which allows the discussion of shared content. The users are usually allowed to control the access rights of the media. Another key feature of such platforms is the technique called ‘embedding’, that facilitates the cross platform sharing or interlinking of the shared media by placing a short HTML snippet on the destination platform.

5. Community platforms:

*General social networking sites* (abr. SNSs), which arrived commercially about a decade ago, has rapidly gained momentum and currently there are tons of different social networks available for individual as well as professional purposes. SNSs offer great ways of making and managing the connections with people based on similar interests or professions by constructing a public or semi-private profile within a bounded system (boyd & Ellison, 2007). Increasingly, the paradigm has provided many opportunities for intra- and inter-organizational connectivity that were either unavailable or very difficult to obtain for most of the organizations on their own (Jefferson III, Carl E & Traughber, 2012). For example, leading SNSs offer the creation and hosting of the business pages (aka company pages) that enable the business organizations to introduce themselves, list and promote their products and/or services, post updates, advertise their events, solicit product review, interact directly with customers, and engage user community in co-creation of innovative products and services.

*Business-specific networking platforms* allow business organizations to create business networks over the internet and thereby facilitate the sharing of business-specific content with business professionals. Such platforms support business identity meaning the profiles are created with respect to business specific information rather than the biographical information of users. The business-specific networking platforms may be oriented around a single business domain, or may support more than one business sector. In the latter case, they usually enable the creation of thematic smaller networks.
Appendix B
Online survey

B-1: Survey questionnaire

<table>
<thead>
<tr>
<th>SURVEY QUESTIONNAIRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INNOVATION LABORATORIES</td>
</tr>
<tr>
<td>Construct, functioning, and practices</td>
</tr>
</tbody>
</table>

1 of 7 - General information

1 [1.1] What is the name and location (city and country) of the innovation laboratory?
______________________________________________________________________

2 [1.2] Could you please provide us with your contact email address in case of further questions?
______________________________________________________________________

3 [1.3] How many people work for the Innovation Laboratory approximately?

☐ 1 - 5 |
☐ 11 - 15 |
☐ 21 - 50 |
☐ 6 - 10 |
☐ 16 - 20 |
☐ >50 |

Make a comment on your choice here: ______________________________________

4 [1.4] In which year was the Innovation Laboratory founded?

______________________________________________________________________

2 of 7 - Innovation Laboratory information

5 [2.1] In which areas of knowledge can the Innovation Laboratory provide innovation support? Please choose all that apply:

☐ IT and software development |
☐ Electric and mechanical engineering |
☐ Finance |
☐ Social services |
☐ Business processes |
☐ Services engineering |
☐ Healthcare |
☐ Other areas: ______________________

6 [2.2] Which type of services does the Innovation Laboratory offer? Please choose all that apply:

☐ Consulting service |
☐ Engineering tools |
☐ Rapid prototyping tools |
☐ Linking up with experts
Appendix B-1

☐ Moderated innovation sessions   ☐ Funding brokerage
☐ Start-up mentoring              ☐ Office workspace
☐ Open meeting place             ☐ Contacts to normal citizens
☐ Other services: ________________

7 [2.3] Who can use the Innovation Laboratory and do customers have to pay a fee? Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Service Type</th>
<th>No access</th>
<th>Paid access</th>
<th>Mixed access</th>
<th>Free access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal citizen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any company</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SME</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner company</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic users / Scientists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employees of the lab owner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8 [2.4] How many persons can use the Innovation Laboratory at the same time? What is the recommended capacity? ________________________________

9 [2.5] Do you have further comments to the access rules for the Innovation Laboratory?
__________________________________________________________________________

3 of 7 - Typical process of innovation

10 [3.1] What is the typical time interval between start and end of the whole typical innovation lab process?

☐ Several hours   ☐ 1 day
☐ Several days    ☐ 1 month
☐ Several months  ☐ 1 year or longer

Make a comment on your choice here: ________________________________

11[3.2] What is the typical accumulated Innovation Laboratory time spent together with a customer for the whole typical innovation lab process?

☐ Same as above   ☐ Several hours
☐ 1 day          ☐ Several days
☐ 1 month        ☐ Several months
☐ 1 year or longer

__________________________________________________________________________

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Appendix B-1

Make a comment on your choice here: _______________________________________

12 [3.3] How many Innovation Laboratory processes do you start per year? ________________

13 [3.4] How many people (employees, partner and customers) are involved in a typical innovation lab process? ________________

14 [3.5] How many employees (of any kind) of the Innovation Laboratory are involved in the typical innovation lab process? ________________

4 of 7 - Methods and tools

15 [4.1] Which methods are used in the Innovation Laboratory to facilitate innovation in the session? ____________________________

16 [4.2] Which tools are used in the Innovation Laboratory? ____________________________

17 [4.3] Please rate the following statements: Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Statement</th>
<th>agree</th>
<th>neutral</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The Innovation Laboratory utilizes methods and tools to support innovation.</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. Loops or iterations are used in a typical innovation process</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. A good methodology is important for the success of the Innovation Laboratory.</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

18 [4.4] Please outline the typical innovation lab process in no more than 3 sentences. ____________________________

5 of 7 – Facilities

19 [5.1] How many employees of which type work for the Innovation Laboratory? Please choose the appropriate response for each item:

<table>
<thead>
<tr>
<th>Type of Employee</th>
<th>0</th>
<th>1</th>
<th>2-5</th>
<th>6-10</th>
<th>&gt;10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderators</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Experts</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Scientist</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Social worker</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Manager or administrators</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

xxxii
20 [5.2] What is the motivation for the room design in the Innovation Laboratory? Please summarize the idea with no more than 3 sentences.

21 [5.3] Which special facilities and tools does the Innovation Laboratory offer? What does the lab provide in addition to the normal meeting room standard?

6 of 7 – Statistics

22 [6.1] For how many projects uses a typical customer the Innovation Laboratory?

23 [6.2] What is the maximum count of projects for which one customer uses the Innovation Laboratory?

24 [6.3] Who is the typical consumer or customer of the Innovation Laboratory? Please choose all that apply:

- Normal citizen
- Big companies (>250 employees)
- Students
- Other: _______________________________________________________

25 [6.4] How much utilizes the Innovation Laboratory public funding? Please choose only one of the following:

- 100% public financing
- More public than private financing
- About 50/50% public & private financing
- More private than public financing
- 100% private financing

Make a comment on your choice here: _______________________________________

26 [6.5] How strong is the connection of the Innovation Laboratory to a research institution like a university for example? Please choose only one of the following:

- The lab is managed by a research institution
- The laboratory has research institutions as partner
- There is no connection to a research institution

Make a comment on your choice here: _______________________________________
27 [7.1] Please describe the Innovation Laboratory in one short sentence.

28 [7.2] Could you please name other innovation laboratories, possibly together with contact emails?

29 [7.3] We want to stress again that we will not publish individual data provided by you in this survey. But would you be interested to be contacted separately to collect data for a public directory of innovation laboratories? Please choose only one of the following:

- Yes, please contact us
- No, we are not interested

Make a comment on your choice here: ________________________________

30 [7.4] Please provide us with an email address, so that we can contact you for a public directory of innovation laboratories. ________________________________

31 [7.5] Are you interested in an email with a preliminary version of our web research based study? Please choose only one of the following:

- Yes
- No

32 [7.6] If you want to provide us with further comments about the Innovation Laboratory or about this questionnaire, here is a place to do it.

______________________________________________________________________
## B-2: Descriptions of the survey participants

<table>
<thead>
<tr>
<th>Lab code</th>
<th>Year of Foundation</th>
<th>Location</th>
<th>Lab size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab # 1</td>
<td>2006</td>
<td>Germany</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 2</td>
<td>2007</td>
<td>Ireland</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 3</td>
<td>2009</td>
<td>Germany</td>
<td>11-15</td>
</tr>
<tr>
<td>Lab # 4</td>
<td>2010</td>
<td>USA</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 5</td>
<td>1995</td>
<td>Netherlands</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 6</td>
<td>2012</td>
<td>Iran</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 7</td>
<td>2011</td>
<td>Ethiopia</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 8</td>
<td>2003</td>
<td>Philippines</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 9</td>
<td>2009</td>
<td>Germany</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 10</td>
<td>2009</td>
<td>Hong Kong</td>
<td>16-20</td>
</tr>
<tr>
<td>Lab # 11</td>
<td>2007</td>
<td>Spain</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 12</td>
<td>2011</td>
<td>Nigeria</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 13</td>
<td>2008</td>
<td>Germany</td>
<td>21-50</td>
</tr>
<tr>
<td>Lab # 14</td>
<td>2010</td>
<td>Germany</td>
<td>11-15</td>
</tr>
<tr>
<td>Lab # 15</td>
<td>2005</td>
<td>South Africa</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 16</td>
<td>2011</td>
<td>Zambia</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 17</td>
<td>1986</td>
<td>United kingdom</td>
<td>21-50</td>
</tr>
<tr>
<td>Lab # 18</td>
<td>2012</td>
<td>Egypt</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 19</td>
<td>2010</td>
<td>Greece</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 20</td>
<td>2007</td>
<td>UK</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 21</td>
<td>2011</td>
<td>Nigeria</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 22</td>
<td>2010</td>
<td>USA</td>
<td>21-50</td>
</tr>
<tr>
<td>Lab # 23</td>
<td>2011</td>
<td>Madagascar</td>
<td>16-20</td>
</tr>
<tr>
<td>Lab code</td>
<td>Year of Foundation</td>
<td>Location</td>
<td>Lab size</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(No. of people working for the lab according to the given ranges)</td>
<td></td>
</tr>
<tr>
<td>Lab # 24</td>
<td>2010</td>
<td>Cameroon</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 25</td>
<td>2010</td>
<td>Africa</td>
<td>21-50</td>
</tr>
<tr>
<td>Lab # 26</td>
<td>2005</td>
<td>UK</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 27</td>
<td>2007</td>
<td>Victoria</td>
<td>11-15</td>
</tr>
<tr>
<td>Lab # 28</td>
<td>2011</td>
<td>Kenya</td>
<td>&gt;51</td>
</tr>
<tr>
<td>Lab # 29</td>
<td>2007</td>
<td>Hungary</td>
<td>21-50</td>
</tr>
<tr>
<td>Lab # 30</td>
<td>2011</td>
<td>Madagascar</td>
<td>6-10</td>
</tr>
<tr>
<td>Lab # 31</td>
<td>2002</td>
<td>Australia</td>
<td>21-50</td>
</tr>
<tr>
<td>Lab # 32</td>
<td>2008</td>
<td>Sweden</td>
<td>&gt;51</td>
</tr>
<tr>
<td>Lab # 33</td>
<td>2001</td>
<td>USA</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 34</td>
<td>1995</td>
<td>France</td>
<td>1-5</td>
</tr>
<tr>
<td>Lab # 35</td>
<td>2013</td>
<td>Germany</td>
<td>6-10</td>
</tr>
</tbody>
</table>
B-3: Statistical analysis of the survey data

1. Areas of knowledge for innovation support

- IT and software development are the top prioritized areas for innovation support.
- More than half of the labs support innovative business processes and service engineering.
- Other areas as mentioned by the respondent labs include innovation studies, architecture, logistics, community participation, etc.

2. Types of offered services of the InnoLab

- Most of the labs support the provision of experts’ knowledge through the linking services with the experts, and the moderated innovation sessions.
- Few of the labs provide rapid prototyping tools (44%) and engineering tools (22%).
- Other services as mentioned by the respondent labs include social innovation methodologies, sustainability vision and research, technical tools for animal tracking, etc.
3. The access criteria for different users of the lab

- Business organizations (SMEs and big companies) get paid access to more number of labs.
- More number of labs do not allow normal citizens to access the lab.
- Academic users, students and employees of lab get more free access to the labs.
- Partner companies of the lab mostly get mixed access.

4. The InnoLab employees statistics

- All the labs have at least 1 expert
- Social workers are either absent in most of the labs or only up to 5
- Moderators and administrators are usually less than 5.
- More number of the labs have employees less than 10, out of which many have only 1-5 employees.
5. Innovation process time intervals

- Most of the labs take several months for a typical InnoLab process.
- About 13% of the labs even take 1 year or longer.
- Only few of the labs complete a process within several days.

- Customers are engaged in InnoLab process for only fraction of the total time of whole InnoLab process.
- Most of the labs indulge customer in the process for only several days.
- About 33% of the labs spend several months with the customer.

6. Sources of financing

- More number of labs run on private financing.
- About 19% respondent labs use equal share of public and private financing.
- Only few labs have acquired more public financing than private financing.
7. Connection of InnoLab with research institute

- Higher number of labs are working in association with some research institute.
- Research institutes either manage the labs (44%) or are partners of the labs (40%).
- Only few labs work in isolation from the research institutes.

8. Typical customer or user of the InnoLab

- Main customer/user group of most of the labs is the SMEs.
- The second largest groups using the labs’ services are the big companies and the students.

9. Recommended participant capacity in the sessions of the InnoLab

- More than one third of the labs can only accommodate up to 20 participants at a time.
- Some labs can accommodate up to 40 or even up to 60 participants.
- Labs able to accommodate more participants than 60 are very few in number.

<table>
<thead>
<tr>
<th>Count (Processes/people/employees/projects)</th>
<th>Processes started per year (%)</th>
<th>People per process (%)</th>
<th>Employees per process (%)</th>
<th>Projects per typical customer (%)</th>
<th>Maximum projects per customer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–5</td>
<td>33.3</td>
<td>20.7</td>
<td>69</td>
<td>82.4</td>
<td>70</td>
</tr>
<tr>
<td>6–10</td>
<td>29.6</td>
<td>34.5</td>
<td>24.1</td>
<td>11.8</td>
<td>10</td>
</tr>
<tr>
<td>11–15</td>
<td>11.1</td>
<td>20.7</td>
<td>–</td>
<td>–</td>
<td>10</td>
</tr>
<tr>
<td>16–20</td>
<td>3.7</td>
<td>3.4</td>
<td>–</td>
<td>5.9</td>
<td>5</td>
</tr>
<tr>
<td>21–35</td>
<td>–</td>
<td>6.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>26–30</td>
<td>7.4</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>31–35</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>36–40</td>
<td>7.4</td>
<td>6.9</td>
<td>3.4</td>
<td>–</td>
<td>5</td>
</tr>
<tr>
<td>41–45</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>46–50</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>7.4</td>
<td>6.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

- One third of the labs start only up to 5 projects per year.
- More than one third of the labs involve 6 to 10 people in innovation process.
- More than two third of the labs involve only up to 5 employees in an innovation process.
- The number of projects taken by any customer with most of the labs is up to 5.

11. Use of methods and tools in the innovation process

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Agree (%)</th>
<th>Neutral (%)</th>
<th>Disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The innovation laboratory utilizes methods and tools to support innovation. (N=27)</td>
<td>92.6</td>
<td>7.4</td>
<td>–</td>
</tr>
<tr>
<td>Loops or iterations are used in a typical innovation process (N=26)</td>
<td>73.1</td>
<td>26.9</td>
<td>–</td>
</tr>
<tr>
<td>A good methodology is important for the success of the innovation laboratory (N=27)</td>
<td>88.9</td>
<td>11.1</td>
<td>–</td>
</tr>
</tbody>
</table>

- A higher number of labs perceived a good methodology important for the success of innovation laboratory and thereby utilizes methods and tools to support innovation employing iterations in innovation process. Interestingly, no lab denied from any of the statements.
Appendix C
In-depth expert interviews

C-1: Interview guide

INTERVIEW GUIDE
INNOVATION LABORATORIES
Construct, Collaboration and Need for Support

❖ Interview information
   Name of the interviewee: ________________________________
   Name of the innovation lab: ________________________________
   Place of the interview: ____________________________________
   Date of the interview: ____________________________________

❖ General conditions, focus and business models
   ▪ Please characterize in short your innovation lab.
   ▪ Which goals are you trying to achieve within the lab?
   ▪ Which thematic areas do you cover with the innovation lab?
     o Is there an explicit focus on services?
   ▪ What is the share of public and private funding for the innovation lab?
   ▪ What size and which service area are you covering?
     o How many employees?
     o How many persons can use the lab simultaneously?
     o How much turnover do you generate?
     o Where is your site located?
   ▪ Which qualifications do your employees have? What competences do they contribute into the innovation projects?
   ▪ Who can use the lab and under what conditions can they use it?
     o Who is the main user/customer? (type and location)
     o How do you establish the first contact with the user/customer?
   ▪ Which organizations do you cooperate with?

❖ Procedure models and service portfolio
   ▪ Do you use specific procedure models for the innovation projects?
   ▪ What project specific or general models do you apply?
   ▪ Which areas of the innovation management do you cover?
     o Generation of ideas?
     o Evaluation of ideas?
     o Implementation?
     o Market launch?
Which services do you offer?
  o How do you bill these services?
What information material do you provide regarding procedure and techniques?
How do you motivate and integrate different stakeholders into the innovation process?
How do you reduce innovation barriers?
Which equipment (space, technologies) do you offer (to your employees, to your customers)?

Application of methods and tools
Which specific methods for the different stages of innovation process do you provide?
  o Generation of ideas?
  o Evaluation of ideas?
  o Implementation?
  o Market launch?
  o Which IT-tools do you apply?
  o Is there a shortage/lack of methods?
Do you use description or formal modeling of ideas, products, services or processes?
  o Which methods or concepts are you applying (e.g. process models, resource models etc.)?
  o Which IT-tools do you apply for this task?
  o Is there a shortage/lack of tools? What IT-tools would you need for this task?
How do you simulate or test the ideas or innovations before the market launch?
  o Which IT-tools do you apply for this task?
  o Is there a shortage/lack of tools? What IT-tools would you need for this task?
What procedures or processes do you apply for the implementation, the transfer of the model into reality? (Forward Engineering)
  o Which IT-tools do you apply for this task?
  o Is there a shortage/lack of tools? What IT-tools would you need for this task?
How do you adjust or synchronize changes from the implementation back into the theoretical model? (Reverse Engineering)
  o Which IT-tools do you apply for this task?
  o Is there a shortage/lack of tools? What IT-tools would you need for this task?

Success factors and statistics
How many innovation projects have been accompanied with your lab in the past?
  o How many during the last year?
How do you assess these projects?
  o What has to be achieved to consider a project as successful?
- What is the rate of successful and failed projects?
- What is the size of an average innovation project regarding costs, users, effort and time?
- How often do customers return to your lab?
- What factors for success and failure do you observe?

❖ **Connection with other innovation labs**
- Are you aware of other innovation labs?
- Are you connected with other innovation laboratories?
  - How many you are connected with?
  - How often do you come in contact with them?
  - What are the means of the contact? Is it face to face meeting or some other means of contact?
  - How many of them you interact on regular basis? How periodically these meetings occur?
  - What is the purpose of being connected with other labs?
  - Is there anything that encourages / limits you to connect to the specified labs only? Why not the others?
  - How you establish the first contact with other labs, especially the new ones? Do you find them or they approach you to get connected?
- What type of activity you perform in connection with other innovation labs?
  - Do you share physical resources and innovative ideas as well? Which resources are shared?
  - What type of information is shared most of the time?
- Have you ever collaborated with any of other labs on a project? Or have ever tried to solve some innovation challenge collectively?
  - How many projects and which ones?
  - With whom you have taken these collaborative projects?
  - Is the connection established only for the specific project or you have long term relations with these labs (partnership)?
  - What was the main role of your lab in these projects?
  - What is the success rate of these collaborative projects?
- Do you organize some events to bring the innovation labs at one place?
  - What type of events?
  - How many of them you organize in collaboration with other labs?
  - How many events you have collaborated with other labs in their events?
  - Do you organize some trainings/workshops to let others learn of your experiences?
- How much do you think collaboration is important for the success of innovation/innovative ideas?
  - Do you feel any information gap between you and other labs?
Online collaboration with other innovation labs

- Have you ever communicated with other innovation labs over the web?
  - In what manner? Which tools are used for?
  - How often do you use this method?

- Do you think that there should be some online collaboration among the Innovation labs?
  - If yes, why? What benefits do you think online collaboration can bring for innovation labs in terms of:
    - Functional benefits
    - Social benefits
    - Economic benefits

- Are you aware of some existing online collaboration platforms for innovation laboratories?
  - Which ones?
  - Have you joined any of them? Which one and how would you describe it?
  - What is your motivation for joining this platform?
  - Are you fully satisfied with this platform or some other functions are still required?

- What type of support/features an online collaboration environment for innovation labs should offer?
  - Which ones you need at most?
  - Which one is most essential/useful?

- Would you prefer to share and discuss the ideas in an open environment with different stakeholders or only with the innovation laboratories?
### C-2: Descriptions of the interview participants

<table>
<thead>
<tr>
<th>Lab</th>
<th>Year</th>
<th>Location</th>
<th>Size(^{32})</th>
<th>Business model</th>
<th>Management structure</th>
<th>Interview mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab1</td>
<td>2006</td>
<td>USA</td>
<td>Medium</td>
<td>Profit oriented</td>
<td>Private</td>
<td>On-location</td>
</tr>
<tr>
<td>Lab2</td>
<td>2008</td>
<td>Germany</td>
<td>Small</td>
<td>Profit oriented</td>
<td>Company owned</td>
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<tr>
<td>Lab3</td>
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<td>USA</td>
<td>Small</td>
<td>Not for profit with public finance</td>
<td>University hosted</td>
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</tr>
<tr>
<td>Lab4</td>
<td>2007</td>
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<td>Big</td>
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<td>Private</td>
<td>On-location</td>
</tr>
<tr>
<td>Lab5</td>
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<td>Big</td>
<td>Profit oriented</td>
<td>Company owned</td>
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</tr>
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</tr>
<tr>
<td>Lab7</td>
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<td>Small</td>
<td>Not for profit with public finance</td>
<td>University hosted</td>
<td>On-location</td>
</tr>
<tr>
<td>Lab8</td>
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<td>Germany</td>
<td>Small</td>
<td>Profit oriented</td>
<td>Private</td>
<td>On-location</td>
</tr>
<tr>
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<td>Not for profit with public finance</td>
<td>University hosted</td>
<td>On-location</td>
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<tr>
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<td>2002</td>
<td>Denmark</td>
<td>Big</td>
<td>Not for profit with private finance</td>
<td>Private</td>
<td>Online</td>
</tr>
<tr>
<td>Lab11</td>
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<td>Profit oriented</td>
<td>Company owned</td>
<td>Online</td>
</tr>
<tr>
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<td>USA</td>
<td>Small</td>
<td>Profit oriented</td>
<td>Private</td>
<td>Online</td>
</tr>
<tr>
<td>Lab13</td>
<td>2004</td>
<td>Canada</td>
<td>Big</td>
<td>Profit oriented</td>
<td>Private</td>
<td>On-location</td>
</tr>
<tr>
<td>Lab14</td>
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<td>USA</td>
<td>Medium</td>
<td>Not for profit with private finance</td>
<td>Private</td>
<td>On-location</td>
</tr>
<tr>
<td>Lab15</td>
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<tr>
<td>Lab17</td>
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<td>USA</td>
<td>Big</td>
<td>Not for profit with private finance</td>
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<tr>
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<td>Profit oriented</td>
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<tr>
<td>Lab21</td>
<td>2002</td>
<td>Germany</td>
<td>Big</td>
<td>Profit oriented</td>
<td>Private</td>
<td>On-location</td>
</tr>
</tbody>
</table>

\(^{32}\) Number of lab personnel facilitating lab activities. Small = 1-5, Medium = 6-10, and Big >=10
Appendix D

InnoLab_Net evaluation

D-1: InnoLab_Net subject evaluation questionnaire

Dear evaluator,

We would like to thank you for taking the time to evaluate the InnoLab_Net platform. The questionnaire seeks the qualitative evaluation of the InnoLab_Net platform from the subjects of the study (the InnoLab facilitators) from a strategic point of view. This means that we attempt to measure the degree of effectiveness of the InnoLab_Net platform in achieving its targeted goals and the operational feasibility and completeness of the system. The main purpose of developing the InnoLab_Net platform is to support and foster the inter-InnoLab collaboration. The conceptual framework of InnoLab_Net is based on the information gathered from InnoLab facilitators through in-depth expert interviews. Accordingly, one of the intentions of this survey is to confirm that the InnoLab_Net platform fulfils user acceptance criteria and is perceived useful by the targeted audience of the system. The questionnaire is arranged in three sections measuring the effectiveness, usability and completeness of the InnoLab_Net platform respectively.

Taking out this survey would take approximately 10-15 minutes. Please feel free to skip any question that you feel you cannot answer based on the given description and your understanding of the system.

Evaluation information:

Name of the InnoLab:

Name and designation of the evaluator:

Date of evaluation:
1. **Effectiveness**


1. How will you rate the overall effectiveness of InnoLab_Net in assisting the InnoLabs in attaining higher levels of inter-InnoLab collaboration?

2. How will you rate the effectiveness of InnoLab_Net in:
   a. Enabling the InnoLabs to describe themselves according to domain specific features?
   b. Supporting the discovery of InnoLabs and exploration of their competencies?
   c. Disseminating the awareness of different types of innovation support offered at different InnoLabs?
   d. Assisting InnoLabs in developing the acquaintance and expressing the affinity with each other?
   e. Assisting the InnoLabs in identifying the similar goals and thereby establishing the grounds for collaboration?
   f. Helping the InnoLabs in managing their network, identifying interlinking nodes and determining overall networking metrics?
   g. Integrating social networks data to the business oriented / domain specific information of InnoLabs?
   h. Facilitating the protected space for interconnecting activities (discussions, polls, file sharing) in or out of the context of a particular project?
   i. Maintaining data transparency and thereby addressing the reluctance and limited openness of InnoLabs?
   j. Assisting the InnoLabs in the search and selection of right business partners for inter-InnoLab collaborative projects?
   k. Facilitating the self-assessment of collaboration maturity levels for the InnoLabs?
1. Helping the InnoLabs in managing project related information and evaluating the team performance?

3. How will you rate the usefulness of InnoLab_Net platform in initiating the collaborative networking among InnoLabs and thereby cultivating a culture of inter-InnoLab collaboration on a broader scale?

### 2. Usability

<table>
<thead>
<tr>
<th>1 – Strongly disagree</th>
<th>2 – Disagree</th>
<th>3 – Neutral</th>
<th>4 – Agree</th>
<th>5 – Strongly agree</th>
</tr>
</thead>
</table>

1. Please indicate your level of agreement with the following statements:

   a. The InnoLab_Net platform is easy to use.

   b. The interface of InnoLab_Net platform is pleasant and attractive.

   c. The information displayed by the InnoLab_Net platform such as on-screen messages, menus, and other textual information is clear, understandable and self-explanatory.

   d. The tools and functionalities embedded into the InnoLab_Net platform are understandable and easy to learn.

   e. The InnoLab_Net platform is technically and economically feasible to be operated in real InnoLab environment.

2. How are you satisfied with the consistency of the interfaces (menus, on-screen messages, etc.) of the InnoLab_Net platform?

   - Very dissatisfied
   - Dissatisfied
   - Neutral
   - Satisfied
   - Very satisfied

3. How are you satisfied with the accuracy of the output generated by the InnoLab_Net platform?

   - Very dissatisfied
   - Dissatisfied
   - Neutral
   - Satisfied
   - Very satisfied

4. How will you rate the performance (loading time of web pages, running time of queries and other tasks) of the InnoLab_Net platform?

   - Unsatisfactory
   - Sometimes unsatisfactory
   - Neutral
   - Good
   - Excellent
Appendix D-1

5. How much it is likely that once the InnoLab_Net platform is made available, you as an InnoLab facilitator will participate in the community?

☐ Very unlikely  ☐ Unlikely  ☐ Neutral  ☐ Likely  ☐ Very likely

A. Completeness

1. How are you satisfied with the completeness of the InnoLab_Net platform in terms of necessary functionality that is integrated into the platform?

☐ Very dissatisfied  ☐ Dissatisfied  ☐ Neutral  ☐ Satisfied  ☐ Very satisfied

2. Is there any other functionality that you would like to have embedded in InnoLab_Net platform?

3. Please indicate the most negative aspect of InnoLab_Net platform.

4. Please indicate the most positive aspect of InnoLab_Net platform.

5. Which of the following tools you find the most interesting and useful?

☐ CoDiT  ☐ SIDIL  ☐ Net_Map  ☐ Discussion space

☐ Polling Board  ☐ File Library  ☐ Project Portal  ☐ Partner search

6. Please provide any other remarks or extend your previous answers here:

Thank you for your efforts for evaluating the InnoLab_Net
Selbständigkeitserklärung

Hiermit erkläre ich, die vorliegende Dissertation selbständig und ohne unzulässige fremde Hilfe angefertigt zu haben. Ich habe keine anderen als die angeführten Quellen und Hilfsmittel benutzt und sämtliche Textstellen, die wörtlich oder sinngemäß aus veröffentlichten oder unveröffentlichten Schriften entnommen wurden, und alle Angaben, die auf mündlichen Auskünften beruhen, als solche kenntlich gemacht. Ebenfalls sind alle von anderen Personen bereitgestellten Materialien oder erbrachten Dienstleistungen als solche gekennzeichnet.

Atia Bano Memon

Leipzig, den 15.10.2016