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Fablabs to transform the Italian Industry: The Case of the Fablabs Community

By

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Abstract

This research studies the case of Fablabs community helping the Italian industry in the process of innovation and growth. This case is representative of how entrepreneurs engage in Fablab digital fabrication technologies which allow to make almost anything and optimizing time and production cost. The number of entrepreneurs in Italy using Fablab services is exploding. However, while entrepreneurs in the main centers of innovation, such as Silicon Valley, have crucial social, cultural, economic, and material resources to build high-impact companies, these resources are often not present in moderate innovators countries. Those resources are defined as innovation infrastructures, stable and dependable resources necessary to systematically conduct technology innovation activities. Entrepreneurs in moderate innovators countries have a double challenge of excelling at their company, and using innovation infrastructures such as Fablabs. This research analyzes how Fablabs can facilitate the innovation activities of the Italian industries, reviewing the case of Fablabs who experience success in providing services to companies. To obtain useful data that match the research objectives, this study use a Focus group interview method. The questions are open-ended, which means that during the interviews, the actual questions may change according to the responses of the interviewees. I depended on triangulation as a means of ensuring construct validity. Data triangulation involves collecting data from interviews, observations, and document analysis. The findings will contribute to understanding the role that Fablabs play for the Italian industry, explaining how digital fabrication technologies can help Italian companies to be more competitive.

Keywords: Fablab, Italian industry, MIT, Digital Fabrication, Neil Gershenfeld, case study, Silicon Valley.

Dedication

I dedicate this paper to my family. There is an old adage that states “Behind every great man is a great woman” and my mother Albina is a living testament to the truth of this statement. Since I was child and throughout all my life, she has continued to support and guide me as I progressed in my career. Her willingness to provide me the time to pursue my masters and doctoral degree by giving up her personal time to assisting me could not have been easy yet she never, ever complained. My mother was particularly instrumental in my life as he taught me the value of hard work, character, and integrity. During the times when I was most stressed out and feeling overwhelmed, she knew just what to say to get me refocused or what to do to help me realize that I have what it takes to complete the dissertation. I am who am I today because of my mother support and guidance. To the rest of my family, I say your support and encouragement throughout my entire life led me to believe that I could accomplish anything and that boundaries were only temporary.

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List of Abbreviations

CADCAM Computer Aided Design/Computer Aided Manufacturing

CBA Center for Bits and Atoms CBA

CEPEJ Council of Europe‘s European Commission for the Efficiency of Justice

CNC Computer Numerical Control

CNEL Consiglio Nazionale dell'Economia e del Lavoro

DIY Do It Yourself

EPO European Patent Office

EU European Union

FDI Foreign Direct Investment

GDP Gross Domestic Product

ICT Information and Communication technology

ICTD Information and Communication technology for Development

IMF International Monetary Fund

IUS Innovation Union Scoreboard

MIT Massachusetts Institute of Technology

NSF National Strategic Framework

OECD Organisation for Economic Cooperation and Development

R&D Research & Development

SME Small Medium Enterprise

STEM Science, Technology, Engineering and Mathematics

TiE Indus Entrepreneurs

USFLN United States Fablab Network

WIP World Development Report

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CHAPTER 1 INTRODUCTION

1.1 Research Background

According to Innovation Union Scoreboard 2014[1], Italy is a moderate innovator. Its innovation performance has been increasing steadily until 2012 and experienced a small decline in 2013. Italy has been increasing its innovation performance relative to the EU which reached 80% in 2013. Italy performs below the average of the EU for most indicators. Relative weaknesses are in Non-EU doctorate students and Innovative SMEs collaborating with others. Relative strengths are in International scientific co-publications and community designs. Growth declines are observed in Venture capital investments, Non-R&D innovation expenditures, Community designs and Employment in knowledge intensive activities. Many people are seeking to transform this situation, especially new entrepreneurs who aspire to create cutting-edge products such as those built in Silicon Valley. Entrepreneurs' aspiration in Italy are fed by vivid stories of Silicon Valley companies and startups. They read about innovative startups in blog such as TechCrunch. However, there is an unstated backdrop for these Silicon Valley success stories. Entrepreneurs in Silicon Valley rely on the many resources available to them, including personal social networks, technical and entrepreneurship communities, technology innovation events, and venture capital financing (Saxenian, 1996). However, in view of the current economic conditions and the rather uncertain outlook, it is likely that in most southern (Italy) and eastern European countries, most strongly affected by the crisis growth in business R&D expenditure will be quite sluggish in the foreseeable future. In 2009, the initial shock affected all categories of firms, but while the innovative activities of large multinationals, especially those in high-technology sectors, were back on track in 2010, innovative entrepreneurship has not yet returned to pre-crisis levels. In 2011, both enterprise creation and venture capital investment were still well below pre-crisis levels. Following the dramatic rise in firm failures during the crisis, the renewal of industry and the corresponding reallocation of resources have yet to make significant progress toward enhancing overall economic performance (OECD, 2012). This lack of resources makes technology innovation in southern and eastern European countries very difficult.

I selected the Italian case because it is representative of all southern European countries and it shows how people are building innovation-based industries without direct access to Silicon Valley's

[1] The Innovation Union Scoreboard provides a comparative assessment of the research and innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems.

resources, and in the midst of profound global transformation of innovation activities. The practices of Italian entrepreneurs are radically different from those of other entrepreneurs, because manufacturing sector is well known to be the most important in Italy, and also the most appreciated abroad with the famous brand "Made in Italy". The study selects entrepreneurs who first worked or had some experience in Silicon Valley or other center of innovations and then migrated back to Italy, bringing with them the practices and connections required for innovation activities. Of course, the Italian entrepreneurs had little firsthand experience in Silicon Valley. Usually, young Italian entrepreneurs combined new global and local resources, including social media applications, cloud technologies, new organizational forms, and low-cost travel, to learn innovation practices and connect to the global innovation networks.

Thus, it is evident that entrepreneurs in southern European countries face a double challenge in realizing their aspirations: they must design and market innovative products, and they must create and utilize "innovation infrastructures" that support their practice. Innovation infrastructures are defined as a set of stable and dependable social, cultural, technical, informational, economic, and material resources that afford systematic, effective, and efficient innovation. These infrastructures aid entrepreneurs in learning new innovation practices. Entrepreneurs leverage these infrastructures to connect with mentors, clients, and investors. They also use them to find potential cofounders, employees, and business partners. This definition is based on Star and Ruhleder's (1996) work on infrastructures. In their work, infrastructures are resources that undergird the shared practices of a certain group. Infrastructures must persist beyond a single event, standardizing practices across time and space (Star & Ruhleder, 1996) Thus, innovation infrastructures must give continuity and stability to innovation practices, so entrepreneurs can rely on these practices to innovate systematically. The Indian and Chinese entrepreneurs who returned from Silicon Valley brought key resources to create the infrastructures necessary for innovation (Saxenian, 2006). Saxenian explained how in those cases, Chinese and Indian entrepreneurs introduced into their companies innovation practices they learned in Silicon Valley to create products for global markets. As they introduced these practices, they started to change the business attitudes and expectations towards technology innovation of their employees, investors, and other local entrepreneurs. Saxenian found that Chinese and Indian entrepreneurs used their Silicon Valley connections to access venture capital, mentors, and business partners. These global resources allowed the companies to accelerate their growth and consolidate their participation in global markets. Saxenian also found that these entrepreneurs started to create personal networks in their locality, following social practices they learned in Silicon Valley, to access local resources such as business partners, potential cofounders, and employees. The formation of the startup industries in China and India in the 1990s and early 2000s were fundamentally tied to the migration patterns of

Indian and Chinese professionals, who for decades migrated to Silicon Valley, and then returned to their home countries to create startups (Saxenian, 2006). Saxenian demonstrated that those migration patterns were crucial for India and China to develop deep connections within the global networks of innovation, especially with Silicon Valley. The strong personal networks between entrepreneurs in those Asian countries and their compatriots in Silicon Valley, were fundamental for Indian and Chinese startups to find investors, business partners, and clients (Saxenian, 2006). Chinese and Indian professionals institutionalized those Silicon Valley ties, creating powerful entrepreneurship associations that have been key for the development of strong startup communities in their home countries (Saxenian, 2006). In contrast, most southern European countries do not have an established community of professionals working in Silicon Valley, and consequently lack direct connections with the main centers of innovation. This is the case for Italy. While there are hundreds of Italians working in Silicon Valley and in some other technology parks in USA, much more still prefer to remain in Italy and accept a low wage rather than earning more abroad. Fortunately, Italian young entrepreneurs tend to be fluent English speakers compared to the previous generation, making it easier for them to find opportunities in the US. Despite a recent increase in the number of Italian professionals migrating to the US the total number is still low when compared with the number of other European citizens working in the United States. However, it seems clear that new resources to innovate and political reforms in Italy and EU open new possibilities to create innovation-based industries in southern European countries, even if these countries lack professionals who have returned home after migrating to Silicon Valley. These new resources to innovate include social media, internet technologies, cloud computing, low-cost travel, and new methodologies and practices for product development. An example of working out these new possibilities is the case of Italian entrepreneurs, who have combined new resources to create innovation infrastructures that allow them to engage in technology innovation. These innovation infrastructures helped them to find alternative ways to learn innovation practices, as there were few people in their context from whom they could learn how to innovate. With these infrastructures they started to create alternative pathways to connect with foreigners' business partners, clients, investors, and mentors. Using those infrastructures Italian entrepreneurs can create networks to tap into the talent and resources of their own location. The case I present here shows that while migration to and from centers of innovation will continue to be a fundamental force to create industries in new locations, those entrepreneurs who decide to stay in their home country now have a greater chance to succeed at creating products and companies with global potential if they start to use new innovation infrastructure, such as Fablabs. Fablabs are digital fabrication laboratories , set up to inspire people and entrepreneurs to turn their ideas into new products and prototypes by giving them access to a range of advanced digital manufacturing

technology. Italian entrepreneurs created innovation infrastructures to bootstrap an innovation-based industry in their country. The term bootstrap is used to emphasize that they are in an environment with scant innovation infrastructures, and little precedent and support for innovation activities. Bootstrapping is a term commonly used by Silicon Valley entrepreneurs to denote startup companies that initiate operations without external funding (Bhide, 1992, 2000.) Bootstrapping entrepreneurs must launch their startups with their own financial resources. The usage of bootstrapping is extended to denote how Italian entrepreneurs must create their startups in an environment where they must build their own innovation infrastructures.

Italian entrepreneurs are looking to fill their innovation and competitive gap. They seek to develop innovation infrastructures that assist their companies or startups to create the business connections they need for growth, and empower aspiring entrepreneurs to learn new innovation practices. The members of this community are continuously building innovation infrastructures. They have created diverse online spaces, such as forums and social news sites, to discuss how to create startups or more innovative companies in Italy. They have founded hackerspaces, makerspaces, Fablabs and co-working spaces, which are low-cost locations where entrepreneurs work and the community meets. In particular, I will focus in my dissertation on fabrication laboratories (Fablabs). A Fablab is a technical prototyping platform for innovation and invention, providing stimulus for local entrepreneurship. A Fablab is also a platform for learning and innovation: a place to play, to create, to learn, to mentor, and to invent. To be a Fablab means connecting to a global community of learners, educators, technologists, researchers, makers and innovators, a knowledge sharing network that spans 30 countries and 24 time zones. Because all Fablabs share common tools and processes, the program is building a global network, a distributed laboratory for research and invention (Fablab chart, 2014). A Fablab is a fully kitted fabrication workshop which gives everyone in the community, from small children through to entrepreneurs and businesses, the capability to turn their ideas and concepts into reality (Neil Gershenfeld, MIT). A Fablab is a community inventors' workshop offering digital fabrication on a personal scale, in which new products can be built by both businesses and individuals. In addition, Fablabs hosts learning events that support entrepreneurs to learn new innovation practices from Silicon Valley, Boston MIT and main center of innovation. They have held formal events to increase the recognition of their community both within and outside Italy. They have organized networking trips and events to amplify their connections with American entrepreneurs, Fablab community and investors.

One of the main activity of the Fablab community seeking to effectively bootstrap innovation in Italy is to transform the business culture and practices of their industry so it is conducive for technological innovation. They need to transform the negative disposition towards innovation of the mainstream

small entrepreneurs and family-business culture in Italy, where many historical, economic, and social situations have created an environment with few incentives for innovators, aimed just to maintain the acquired "status-quo". They needed to change the perception among Italians that technology innovation is too risky, and that there are not sufficient resources for it. They need to overcome the mistrust that hinders cooperation among businesses in Italy, a country where the historical formation of privileged groups and oligopolies has made business people reluctant to cooperate. Italian government are seeking to create and expand a startup and entrepreneurial culture in Italy. In fact, with the law October 18, 2012, n. 179 coordinated with the conversion L. December 17, 2012, n. 221, has been introduced a legislative framework which favors the birth and growth of innovative enterprises (innovative startups[2]) with the aim contribute to the development of a new entrepreneurial culture, creating an environment more conducive to innovation, promote greater social mobility, attract talent and capital from abroad in Italy. The government want a large number of people in Italy to embrace the culture of startups, which prizes the creation of innovative products that give great value to the user, puts emphasis on efficient and flexible organizations to create these products, and is ready to constantly learn and adapt. In this culture it is normal to collaborate within and across companies to create the greatest value for everyone. The effort of this community to transform the culture and practices of their industry is very deliberate. Entrepreneurs reflect about specific needs and actions to change the aspirations, attitudes, values, and practices of people in their industry. They seek to enable an increasingly larger number of people to learn these practices and culture, to apply them, and to create new companies.

Italian entrepreneurs have been trying to combine the innovation infrastructures they are building and the new resources available such as Fablabs to facilitate that learning process. The community's efforts to create an innovation culture are often inspired by Silicon Valley's practices and culture. However, while they admire Silicon Valley, they understand it is not possible to simply transplant its culture to Italy. Rather, they leverage these foreign inspired innovation practices to transform the people in their local context regarding attitudes, expectations, and disposition to innovate. They seek to create the conditions for Italian entrepreneurs to work in new schemes of collaboration, continuous learning, and innovation. A growing number of entrepreneurs are experiencing this new culture in the events and spaces the community is creating. Yet, to create an Italian industry with a global impact, necessary is the engagement of many more entrepreneurs and investors, and connect more deeply with global networks of innovation. In this view, Fablabs play a critical role for the possible

[2] The Law Decree refers to "innovative
s" to make it clear that it is not dealing with any new company but only with companies whose business is clearly linked to innovation and technology.

development of the Italian industry. All Fablabs are part of a larger, global Fablab network, that is, you can't isolate yourself. This is about being part of a global, knowledge-sharing community. The public videoconference is one way to do connect. Attending the annual Fablab meeting is another. Collaborating and partnering with other labs in the network on workshops, challenges or projects is another way.

Thus, a strong community of innovators is key to foster efficient, effective, and systematic technology innovation (Ahuja, 2000; Florin, Lubatkin, & Schulze, 2003; Saxenian, 1996; Shan, Walker, & Kogut, 1994; Tuomi, 2006). The emergence of the Fablab community indicates that the process to bootstrap innovation in Italy is underway. This community is building and knowing new infrastructures that will accelerate the creation of new companies and startups. Upcoming entrepreneurs can adapt these infrastructures to meet their particular needs. More importantly, the Italian Fablab community is learning how to offer new efficient innovation infrastructures. This community is experimenting with many different approaches to creating spaces, events, networks, and organizations. While only some of these efforts are successful, the Fablab community is generating and sharing knowledge of what works, and what does not work, in the Italian context.

In this dissertation I will explain how entrepreneurs are using Fablabs and face-to-face events to gain know-how and access to new technology. These new resources and Fablab services are enabling the Italian Industry to learn innovation practices and being more competitive becoming creators of technological innovations, not just users of technology.

Italian entrepreneurs are using social media to familiarize themselves with Silicon Valley's innovation practices, and to organize their community. They regularly read internet industry blogs and social news sites. From these sources they learn about methods and techniques used to create innovative products and startup companies. Social media has been crucial for strengthening the local community. Italian entrepreneurs use Facebook groups and mailing lists to efficiently organize events and meet-ups. They discuss how to use and access to new technologies in specialized forums. Many Italian entrepreneurs use Twitter to initiate new business connections, and maintain current relationships in lively conversations. Thanks to social media, entrepreneurs are discovering Fablabs in Italy. In other part of the world such as USA and Asia, Fablabs have already contributed to the process of the growth of small-companies and startups. Even if Italian young entrepreneurs are advanced users of internet technologies, they find that face-to-face interaction is irreplaceable to create learning experiences and meaningful connections. For instance, in the "Startup Weekend[3]"

[3] Startup Weekend is a global grassroots movement of active and empowered entrepreneurs who are learning the basics of founding startups and launching successful ventures. It is the largest community of passionate entrepreneurs with over 1800 past events in 120 countries around the world in 2014.

innovation events and several Fablabs workshops entrepreneurs learn through practice important techniques for creating a startup. These events are powerful learning experiences where participants work on real projects and collaborate intensely in a highly collocated environment. Italian entrepreneurs travel to networking events in Silicon Valley to expand their global business connections. At these events, Italian entrepreneurs can initiate relationships with potential business partners and investors.

The recent emergence and growth of Fablabs both in the world and in Italy seems to imply that the development of companies may be a better way to achieve innovation and new forms of manufacturing through this new form of cooperation. Is it really the case? Can the Italian industry use this new innovation infrastructure of developing a more sustainable and comprehensive form of innovation, production and new expertise? How? These questions stimulate this study.

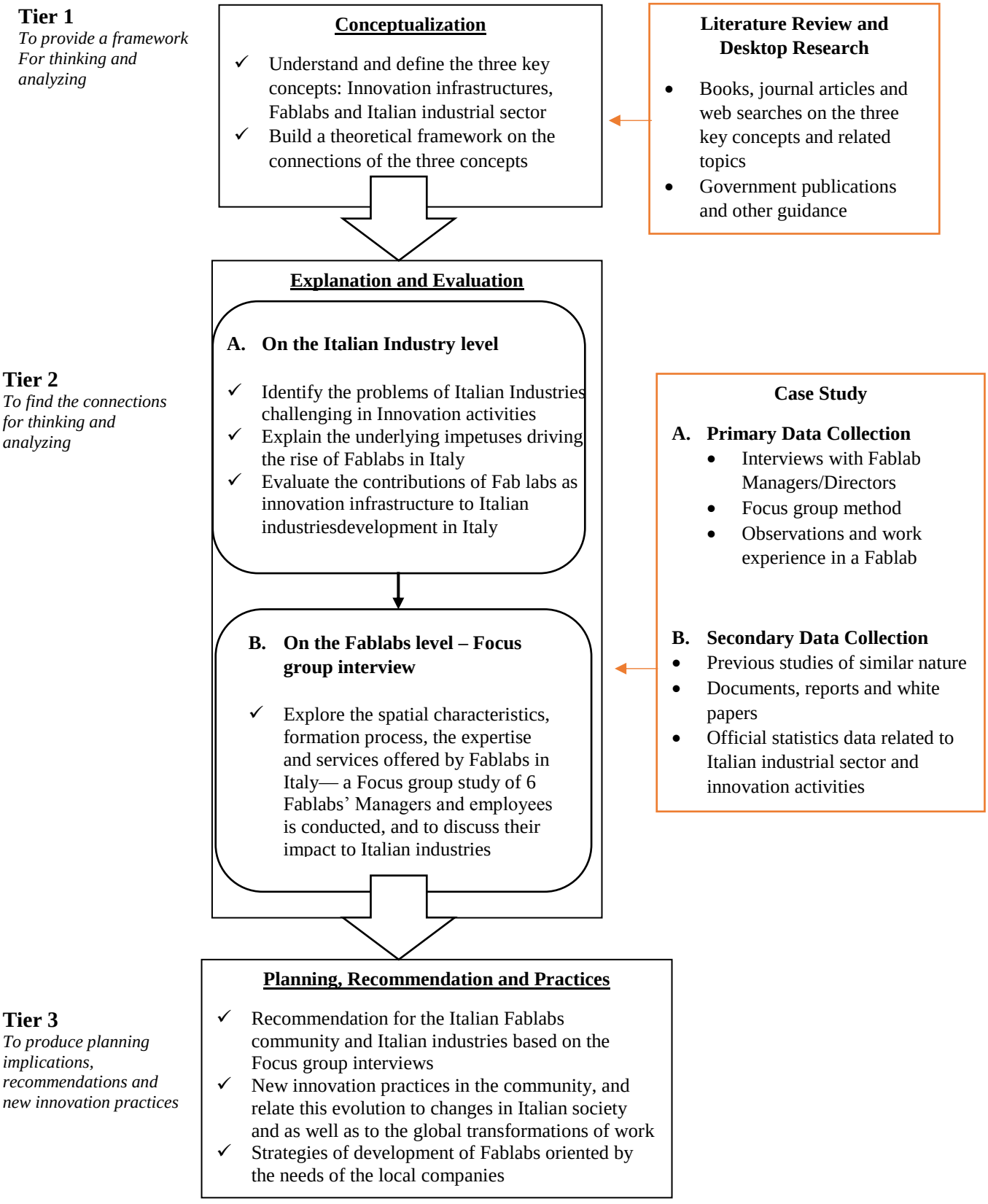
1.2 Research Objectives

This study aims to explore the relationships between Innovation infrastructures, Fablabs and the Italian industrial sector and how people outside of Silicon Valley and main center of innovations create technology innovation in practice and why they should use Fablabs tools for accelerating those processes. To this end, I will conduct an explanatory, multiply-case, used to explain causal relationships between Fablabs and the Italian Industry and to develop theory regarding this new field of research. In detail, the key objectives of this study include:

1. To interpret the meanings of three key concepts—innovation infrastructures, Fablabs and how can improve the innovation process in the Italian industry ;
2. To take the Italian Fablabs community as the case study, to examine their major problems, the major strategies and practices of innovation and company development, and to identify the visions in future;
3. To explain the underlying impetuses driving the rise of Fablabs in Italy, and to evaluate the major contributions of Fablabs as innovation infrastructure for the Italian Industry;
4. To analyze the spatial characteristics, the formation process, the expertise and services offered by Fablabs in Italy, a case study of Italian Fablabs community is conducted, and to discuss their impact to Italian Industry.

1.3 Research Methodology

Figure 1.1. Three-tier Research Framework



Source: Author (2015)

Around these research objectives, this study adopts a three-tier research framework (Figure 1.1).The first tier involves the process of conceptualizing innovation infrastructures, Fablabs, and Italian Industry, and of developing the analytical framework through the review of related theoretical and empirical studies. Based on the analytical framework, the second tier aims to conduct the case study in Italy for finding the relationships between Fablabs and Italian Industry and explaining the underlying developmental mechanism of Fablabs as innovation and expertise tool for Italian Industry. The explanation and evaluation in this tier is divided into two levels. The first-level analysis is on the Italian Industry level, around the research objectives 2-3 as mentioned in previous section; the second level analysis is on the Fablabs dimension, taking three Fablabs as the case to explore how a real Fablab works and which is the impact on the Italian Industry. The analysis in this tier is conducted mainly by the qualitative methods based on the primary data collected from the site visits, deep interviews and Focus Group interview method and supplemented by the secondary data from the web search, related empirical studies, statistical yearbooks and other sources. The detailed discussion of methodology is given in Chapter Three. Based on the findings in the previous tier, the third tier is to produce planning implications, recommendations and new innovation practices.

1.4 Structure of the Dissertation

This study has been organized into five chapters.

Chapter 1 is a brief introduction of the whole study, including the research background, research objectives, research methodology, and the structure of the study.

Chapter 2 reviews the theoretical and empirical studies on innovation infrastructure, Fablabs, and Italian Industry situation to understand the meaning of the three key concepts and their connections.

Chapter 3 contains the research methodology. Topics include an overview of the methods, research design, setting and participant selection process, data collection procedures, data quality and data analysis procedures, and a summary of the methodology.

Chapter 4 presents the findings of the study and **Chapter 5** presents a summary of the findings as well as the conclusion and recommendations for further study.

CHAPTER 2 LITERATURE REVIEW

This chapter reviews the theoretical and empirical studies related to Innovation infrastructure, Fablabs, and Italian Industry current situation to understand the meaning of the three key concepts and to identify existing research gaps. Finally, a summary is presented, and the research gaps for which this study is undertaken are highlighted.

2.1 Building Innovation Infrastructures to Bootstrap an Innovation Culture

One of the main objective of my analysis is to understand how the Italian Industrial sector has been collaborating and approaching the Italian Fablabs community. I will argue that one way to bootstrap an innovation culture, entrepreneurs need to use existing innovation infrastructures. Innovation infrastructures were constructed using technical and material resources, concepts, and social relationships. Technical and material resources comprise social media technologies, internet and cloud computing technologies, physical meeting spaces, and the financial and funding resources necessary to conduct innovation activities. Conceptual resources include aspirations, visions, narratives, practices, models, methodologies, rules, and habits of mind necessary to guide people when realizing innovation activities. Social relationships are comprised of business and personal relationships between entrepreneurs, developers, designers, engineers and other technically oriented people, investors, and officials of various institutions who support each other in their innovation activities. Throughout this dissertation I will analyze how entrepreneurs combined in practice all of these resources to form innovation infrastructures. To exemplify how the definition of innovation infrastructures becomes operational, I briefly explain how Fablabs can become an innovation infrastructure. Fablabs become an innovation infrastructure when technical, social, and conceptual resources all converge to create a stable place where entrepreneurs can routinely get useful feedback and create their products. Building and sustaining this vision of Fablabs that support innovation activities is a long process requiring strong collaboration and commitment. To transform the Italian Industry, entrepreneurs need to commit in the long term to build, use and maintain the concept of Fablab as tool of innovation infrastructure. I observed that in Italy often the responsibility of creating innovation infrastructures relied on the enthusiasm of a small number of members. The challenge for the community is to develop mechanisms to motivate and empower more participants to enter the activities of the community. The community needs to grow and diversify its membership to ensure its long-term development.

2.1.1 The Urgent Need for Further Research in Technology Innovation in Southern European countries

We need research to design policies, institutions, and technologies that can catalyze the positive social and economic outcomes of Fablabs in Italy, and minimize the potential negative consequences. This research must come from a variety of perspectives to have a broad, holistic understanding of the economic, social, and cultural implications of building innovation-based industries in Italy. My work contributes towards this end, analyzing the processes required to build an innovation culture in Italy, at a time when entrepreneurs have new resources to create companies, and the emergence of new industries is less dependent on migration patterns. Having a greater diversity and number of people involved in technology innovation would yield more, and better, solutions for many of the problems of humanity (Tuomi, 2006). For example, Startup communities are now rapidly emerging all over the world. The Startup Genome project recently issued the results of a global survey of internet entrepreneurs (Herrmann L., Marmer, Dogrultan, & Holtschke, 2012) to determine the maturity of startup communities across the world. The report showed an explosion of startup communities in many middle-income countries including Latin America, the Middle East, South East and South Asia, and some African countries including South Africa, Kenya, and Ghana. The report found consolidated startup communities in only three middle-income countries: Bangalore in India, Santiago in Chile, and Sao Paulo in Brazil. Those three centers are special cases: Sao Paulo and Santiago have had unique governmental support for decades (Lacy, 2011), and Bangalore has strong ongoing connections with Silicon Valley (Saxenian, 2006). I infer that the greatest challenge to consolidating the technology innovation in Italy is for entrepreneurs to transform their business culture and practices to allow greater innovation. Many of the problems that Italian innovators faced with their local business culture, include a generalized risk aversion and perception of innovation as being too difficult, as well as a lack of trust which impeded cooperation in business. An economic approach can provide only limited data for this phenomenon, as emergent startup communities are still learning how to participate in the global system of innovation, and their economic impact is often not yet visible. Much more research is needed to identify the processes behind the formation of these emergent startup communities, and ways in which their development can be supported.

2.1.2 Technology Innovation in High-Income Countries

In high-income countries, studies have estimated that innovation accounts for as much as 80 percent of economy-wide growth in productivity. Most R&D spending still takes place in high-income

countries, around 70 percent of the world total. They spend around 2.5 percent of their GDP on R&D – more than double the rate of middle-income economies (WIP report, 2011). At the firm-level, there is emerging but increasingly solid evidence that demonstrates the positive links between R&D, innovation and productivity in high-income countries. Specifically, these studies imply a positive relationship between innovative activity by firms and their sales, employment and productivity. In the last few years, technology innovation get enriched of new resources which include social media and internet informational sites, greater global mobility of people, new tools and techniques for development and production of new technology, and scalable production and distribution platforms. These new resources have made the process of developing technology more affordable and practical both in high and middle-income countries. Students, skilled workers, scientists, and entrepreneurs have upgraded their expertise and connections to participate in innovation activities.

The historical, social, cultural, and economic context encourages or inhibits entrepreneurs to use these new resources for innovation. Context is the fulcrum on which the effectiveness of these new resources teeters. For instance, social media can enhance entrepreneurs' ability to discover new contacts such as potential business partners and mentors. Knowing in advance whom to contact, entrepreneurs take full advantage of networking events and mutual acquaintances. Yet, the ability to leverage these opportunities to connect is determined by the local social and cultural rules. At the same time, entrepreneurs are catalyzing changes in their local context using new information and social media resources. Previously, learning innovation practices and creating global connections was facilitated only by migration flows. Now entrepreneurs regularly learn about new techniques and methodologies using information resources on the internet. Social media help entrepreneurs understand how to access global innovation networks that previously were opaque to them. Gradually, entrepreneurs transform their local business culture by using these resources to change their practices. Saxenian (2006) found that the Indian, Chinese, Israeli, and Taiwanese immigrant communities in Silicon Valley were crucial for the emergence of those nations' high-tech industries. For several decades, large numbers of engineers and managers from those countries migrated to Silicon Valley for work. During the 1980s the emigration of these workers to the US was seen as a pernicious brain drain," depleting Asian countries of valuable human resources (Todaro, 1981). These immigrants created strong formal and informal organizations that enabled their compatriots to swiftly connect to innovation networks in Silicon Valley. During the 1990s and the 2000s large numbers of skilled workers returned home as high-tech entrepreneurs. Saxenian (2006) named this pattern "brain circulation," highlighting the positive effect that these migrants' return had on the development of their nations. The historic, cultural, social, and political context of the countries Saxenian (2006) studied facilitated brain circulation. For instance, migrants of Indian origin have historically learned

to maintain strong family and friendship ties while away from their motherland (Xiang, 2006). Strong ties helped Indian entrepreneurs who returned home after many years to set up companies taking full advantage of the local resources, while also having access to the resources of Silicon Valley. The stable political environment of India allowed entrepreneurs to continue their relationship with their home country. This contrasts with other immigrant communities in Silicon Valley such as Iranians, who have not been able to create innovation-based industries in their country due to the economic and political embargoes imposed by the West. Saxenian (2006) explained that the Indian startup community began to flourish when software export to the US became practical in the 1990s. At this point their migratory context converged with a high demand for software in the US, along with availability of high-speed internet connections and a business-friendly regulatory framework in India. The returned entrepreneurs continued to work with their Silicon Valley partners and investors using e-mail, phone, and low-cost travel. In fact, they traveled so frequently to the US that the flight almost felt like a commute. Their capacity to make valuable business connections was amplified by the strong professional networks of Indians in Silicon Valley. While informational resources and social media are important levers to initiate connections with Silicon Valley, face-to-face contact is still essential to solidify effective business connections. Diverse studies have shown that face-to-face, collocated interactions are the most effective means to create the shared context and trust necessary for a productive business relationship (Mark, 2002; Nardi, 2005; Olson & Olson, 2000; Venolia et al., 2010; Whittaker et al., 1994). During their long-term presence in Silicon Valley, Indians developed strong, trusted contacts that helped them to secure funding, sign partnerships, and acquire customers systematically. With far less presence in Silicon Valley, Italian startups or small companies have been at a disadvantage to engage more deeply with Americans. The process involved in bootstrapping innovation varies according to the context. Takhteyev (2012) studied the coding practices of Brazilian software developers. He observed how developers learned about novel techniques and software from Silicon Valley thanks to the internet. Yet, sometimes the local infrastructures did not support the use of global resources. For instance, the rigid organizational culture of some companies, reinforced by local social and cultural practices, was incompatible with new software methodologies that required a less hierarchical organization. My aim in this chapter is to locate the case of the Italian Fablabs community in the larger landscape of technology innovation. I describe how the context of high-income countries interacts with global resources when creating technology innovation. I present the concepts and prior work that will guide my analysis in later chapters, characterizing universal patterns as well as context-specific contingencies of technology innovation activities.

2.1.3 Social and Technical Resources for Innovation

A high-income economy is defined by the World Bank as a country with a gross national income per capita above US $12,746 in 2013, calculated using the Atlas method. The means of production in innovation-based industries are fundamentally different from those of the industrial era (Engeström, 2008). Industrial-era companies use efficient, but often rigid, mass production methods supported by assembly lines, mechanization and automation, mass distribution, and a steady supply of low-cost labour. Innovation-based companies, by contrast, must collaborate with partners and consumers to create value, using flexible production processes and new organizational patterns (Engeström, 2008). The internet and software industries are the foremost example of innovation-based companies. They create products that are highly malleable to user needs, and do not require intensive capital investment, especially when compared to manufacturing industries. Innovation-based companies often design their offerings as platforms that can be directly consumed or customized to create new products that cater to the needs of specific niche markets (Gawer, 2009). Designing platforms allows multiple parties to collaborate in a process of continuous innovation, creating greater value for all. For instance, internet product companies release an early version of their platform to get customer feedback. The user feedback is quickly integrated into new versions of the platform. Frequent updates constantly evolve the platform. Independent developers and startups create extensions of the platform or combine multiple platforms to create new products. The production process that brings together companies, partners, and customers has been studied under the rubrics of "user innovations" (Von Hippel, 2005), "open innovation" (Chesbrough, 2006), and "co-configuration work" (Victor & Boynton, 1998). Information and communication technologies (ICTs) are crucial for this new production practice as they enable multiple parties to coordinate and exchange information efficiently and at low cost (Hagel et al., 2010). As innovation-based industries continue to experiment with new production processes, they will continue to push forward the development of new technologies and methodologies. I distinguish three main kinds of resources revolutionizing internet entrepreneurship. First, the new technical platforms, techniques, and methodologies simplify and lower the cost of creating and distributing software products. Second, social media and information resources have streamlined the capacity of entrepreneurs to collaborate and learn from people within their organization and outside of it. Third, new kinds of social spaces, events, and organizations leverage the power of face-to-face interactions for entrepreneurs to nurture their communities and innovation networks.

2.1.4 New Organizational Resources for Innovation

Entrepreneurs around the globe are hosting new kinds of events and social spaces to create stronger business connections and promote the adoption of new innovation practices (Lacy, 2011; Saxenian, 2006). When they design these face-to-face interactions they seek to induce peer-to-peer learning exchanges and open-ended conversations. Meeting face to face is ideal for these interactions as it facilitates creating affinity and building commitment between parties (Nardi, 2005). In informal technical "meet-ups" developers create groups that help each other deepen their knowledge, legitimize their practice in the eyes of other local organizations and companies, and build an individual reputation. Fablabs and coworking locations serve as meeting points for companies, promoting formal and informal collaborations among entrepreneurs. Formal events such as Fablab workshops give companies a greater global visibility and help individual entrepreneurs to make key connections. Formal organizations that promote entrepreneurship and business growth are fundamental for creating stronger innovation networks (Lacy, 2011; Saxenian, 2006). Such organizations, which include non-profits, formal networks, Fablabs, makerspaces, hackerspaces, business accelerators, seed-stage funds, venture capital, and investor clubs, allow entrepreneurs to access key resources including capital, connections, and mentorship. One of these worthy to mention are makerspaces. Makerspaces are places where like-minded persons gather to work on personal projects, share tools and expertise as well as learn from each other (Tweney, 2009). The driving principle of makerspaces is that users enjoy sharing tools, equipment, expertise and ideas rather than working by themselves in the garage or basement (Roush, 2009). The past ten years have been about discovering new ways to create, invent, and work together on the Web. The next ten years will be about applying those lessons to the real world (Anderson, 2012). Thanks to makerspaces, would- be entrepreneurs and inventors are no longer at the mercy of large companies to manufacture their ideas. Recognizing the power of this movement, in early 2012 the Obama administration launched a program to bring makerspaces into one thousand American schools over the next four years, complete with digital fabrication Tools such as 3-D printers and laser cutters. In a sense, this is the return of the school workshop class, but now upgraded for the Web age for forming the new stream of entrepreneurs. This program funded by US government is for advanced manufacturing initiative aimed at creating a new generation of systems designers and production innovators.

Originally, some of these organizations were created by Silicon Valley immigrants. For instance, The Indus Entrepreneurs (TiE) and Mount Jade Science and Technology Association promote ties between that center of innovation and India and China respectively (Saxenian, 2006). Other organizations have been created by entrepreneurs seeking to create global networks, with no

particular ethnic group in mind. Financial organizations including banks, venture capital, and seed funds are also playing a fundamental role in the creation of global networks of innovation. For instance, the Silicon Valley Bank, which has branches in India and China, enabled companies in those countries to consolidate their financial operations. Appadurai (1996) studied how migration and media enable resources and practices to travel across a globalized world. In Appadurai's formulation, flows of people and information unintentionally transform culture. However, I argue that entrepreneurs skillfully design interactions that combine different kinds of resources to facilitate powerful learning and networking experiences. Their intention is to enable more people to experience new ways of working and behaving. As a result, they are able to collectively create new concepts that make it possible to transform their current practices (Engeström, 2001) to be more conducive for technology innovation.

2.1.5 Studying Innovation Infrastructures

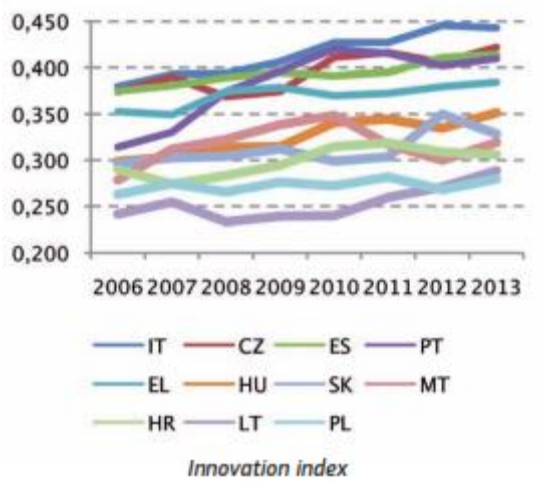
To study innovation infrastructures it is crucial to understand the context in which they are created. Innovation is fundamentally a social achievement (Tuomi, 2006). While the personal effort and talent is necessary, it is the social context that provides the necessary resources for innovation. Every inventor, even a genius, is always the outgrowth of his time and environment. His creativity stems from those needs that were created before him, and rests upon those possibilities that, again, exist outside him. No invention or scientific discovery appears before the material and psychological conditions that are necessary for its emergence are created (Vygostky, 1930; cited in Van der Veer & Valsiner, 1993). Innovations become useful only when they address the needs of social practices in a specific context. Innovators' work is supported by technologies, methodologies, and material means that were created by others before them, and their creativity is nourished by the experiences they have had in the environment they live in. I follow the suggestion of Star and Ruhleder (1996) to study infrastructures as relational entities, embedded in a social context. For these authors the appropriate question to ask is not what resources are infrastructures, but rather, when do resources become infrastructures. For an entrepreneur who is seeking funding, venture capital is an infrastructure that allows him to obtain financial resources, but for the manager of that venture capital, the fund is her object of work rather than an infrastructure. Depending on the context, a resource can be enabled as an infrastructure or not. The contact networks in Silicon Valley are an infrastructure for entrepreneurs to obtain resources for their company, as the cultural norms allow sharing contacts. In more secretive business cultures contact networks are not an infrastructure as the norms do not encourage sharing. In my research I seek to understand the process by which people use a collection of resources to

transform them into infrastructures that support innovation practices. Two important analytical distinctions stem from the fact that infrastructures are relational and embedded in a social context. First, infrastructures are inseparably related to the history of the communities they support (Bowker & Star, 2000; Engeström & Ahonen, 2002; Star & Ruhleder, 1996). Engeström and Ahonen (2002) explained that "communities need infrastructures to exist," because infrastructures give communities the material basis on which they can act together. The evolution of the community is reflected in the development of infrastructures. An established, vibrant community will have solid infrastructures; an emerging community will have less reliable infrastructures because they are still being built. Communities must cooperate intensely to build and maintain their infrastructures, continuously negotiating how to serve a variety of users (Bowker & Star, 2000; Engeström & Ahonen, 2002). Thus, the empirical data where I observe how successful companies emerge are the observations of how entrepreneurs use innovation infrastructures. The entrepreneurs who collectively design and negotiate innovation infrastructures gain access to new innovation practices. The second distinction is that infrastructures are embedded in "other structures, social arrangements and technologies" (Star & Ruhleder, 1996). Innovation infrastructures interact with the larger cultural, social, economic, and material conditions in which they are embedded. A community creating new infrastructures must take into account the possibilities and deficiencies of existing infrastructures. Entrepreneurs in middle-income countries must work around or transform infrastructures that are ill suited for innovation-based industries, such as the educational system and the financial system.

2.1.6 Comparing Innovation in Different Contexts

IUS 2014 analysed innovation performance over an eight-year period within EU members. This longer time frame allowed to compare performance changes before and during the crisis. Performance has improved strongest for Germany. The German innovation index has grown at an average annual rate of 1.3% (Figure 2.1), followed by Finland (1.2%), Denmark (0.9%) and Sweden (0.3%). Within the Moderate innovators Innovation performance has been improving for all Moderate innovators. Italy has consistently been the best performing country within this group. Both Portugal and Malta experienced rapid increases between 2006 and 2010.

Figure 2.1. Moderate Innovators



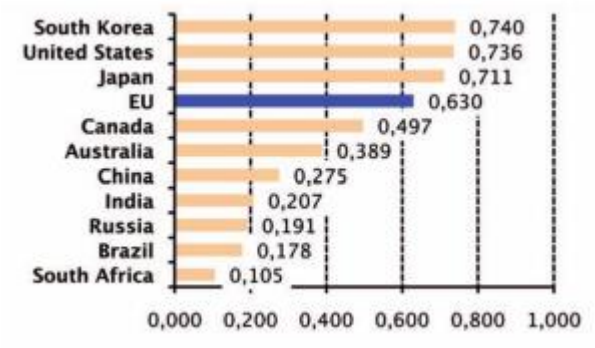
Source: IUS (2014)

For the EU innovation performance has been increasing at an average annual rate of 1.7% between 2006 and 2013. But growth has not been equally strong across all dimensions and indicators. In particular in Open, excellent and attractive research systems (4.5%) growth has been very strong. Also in Human resources (2.3%) and Intellectual assets (2.1%) growth has been relatively strong. Growth in Linkages & entrepreneurship (1.7%), Economic effects (1.2%) and Innovators (0.7%) has been positive but below average. Strong performance increases are observed for Innovative SMEs collaborating with others (3.8%) and License and patent revenues from abroad (3.7%). For Finance and support (-0.5%) and Firm investments (-1.4%) growth has even been negative, in particular due to a strong decline in Venture capital investments (-2.8%) and Non-R&D innovation expenditures (-4.7%).

When looking at a wider European comparison, Switzerland is the overall innovation leader in Europe, outperforming all EU Member States.

South Korea, the US and Japan have a performance lead over the EU (Figure 2.2). The performance lead has been increasing for South Korea as its growth over 2006-2013 has been more than double that of the EU. The EU continues to have a performance lead over Australia, Canada and all BRICS countries (Brazil, Russia, India, China and South Africa). Of these countries only China has managed to grow at a higher rate than the EU, albeit from a relatively low level.

Figure 2.2 Global Innovation Performance



Source: IUS (2014)

The relevant literature analyse innovation in different context in several ways. Nardi, Vatrapu, and Clemmensen (2011) advocated for comparing how ICTs are used in practice across different social, cultural, and economic contexts. Those authors argued that such comparisons would enable us to "generate nuanced, critical understandings of technology in human life in the world we inhabit together." Due to the social and economic importance of technology innovation, we must analyze it from multiple disciplines and in multiple contexts. Comparing how this activity happens in practice will allow us to design better technologies and policies that potentiate the benefits of innovation around the globe. Saxenian's (2006) landmark study on startups in India, China, Taiwan, and Israel is a major point of comparison and inspiration for my dissertation. With this perspective, during the 1990s and early 2000s a series of workplace studies were conducted in the US and Western Europe (Bowker & Star, 2000; Heath & Luff, 2000; Nardi & O'Day, 2000; Orr, 1996). Those studies became ingrained as basic assumptions of CSCW and HCI, often treated as universal, despite being based only in observations in high-income countries. The emergent body of literature on middle-income countries challenges those assumptions, investigating the differences, commonalities, and relationships between knowledge work across cultures. Takhteyev (2012) showed how context variations often make it difficult to adapt resources created in high-income countries into middle-income realities. Irani et al. (2010) highlighted the difficulties that workers in middle-income countries face when accommodating collaborations with clients in high-income countries. Kow and Nardi (2011) studied Chinese developers producing mods (software extensions) for a popular multiplayer online game. They found that Chinese developers were culturally and socially tied to teamwork configurations fundamentally different from those assumed to be optimal in high-income countries. Tang et al. (2009) conducted a cross-cultural study comparing email usage across a global organization, sampling branches across seven geographical regions. They found statistically

significant differences in email use between regions, showing how local culture affects ICT-based work practices, even in a global organization. Another strand of pertinent literature for my analysis is the subset of the ICT for Development (ICTD) literature that analyzes the IT and software industries in developing countries (Carmel, 2003; D'Costa, 2011; Nicholson & Sahay, 2007; Parayil & D'Costa, 2009; B. Parthasarathy & Aoyama, 2006). Avgerou (2010) argued that researchers must warn against the "falsity of widely held technology-deterministic expectations that ICTs, by virtue of its technical properties, will have this or that development effect." Many ill-informed public policies have been implemented on the assumption that IT industries will automatically bring comprehensive development for a country (D'Costa, 2011). For instance, the Indian IT industry despite having generated great wealth still provides uneven development opportunities. There are large sections of the population lacking access to the educational system that would allow them to enter into this industry (D'Costa, 2011).

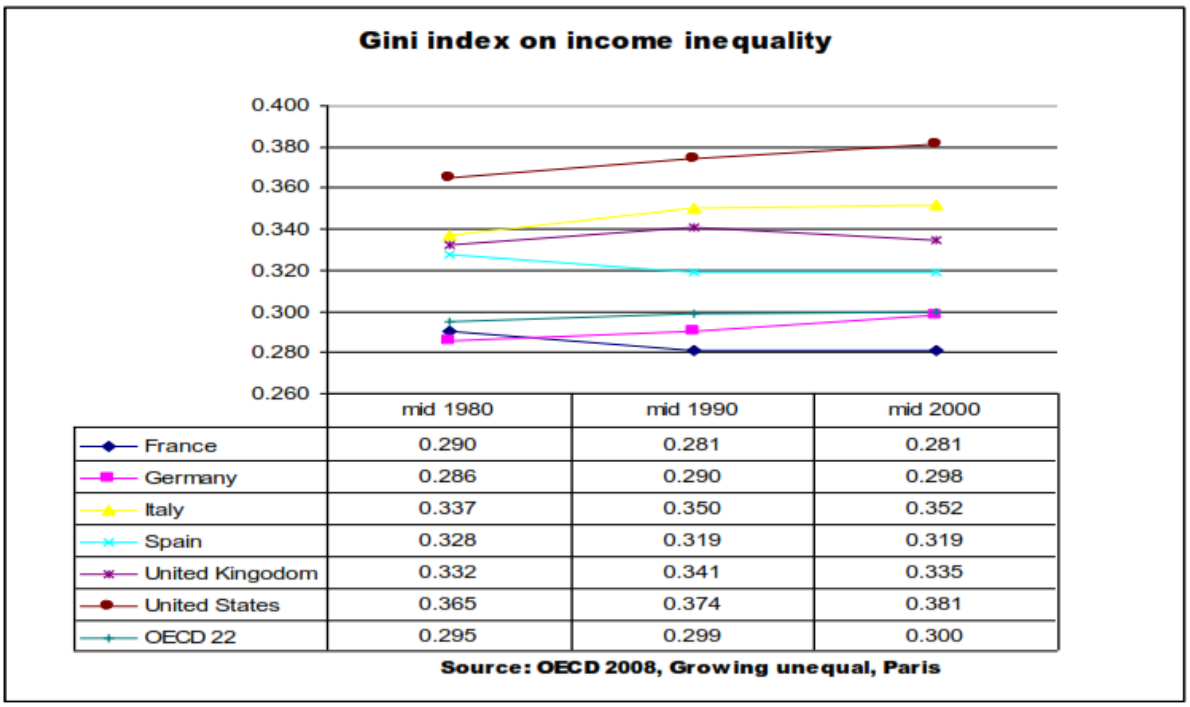
2.1.7 Discussion

In the 1990s and early 2000s migration back from Silicon Valley was a major factor in the growth of technology companies in India and China. Such was not the case for Italy and many other countries without skilled migrants. Now Fablabs and other formal organization are accelerating the entry to networks of innovation of people in countries that previously had little access to these networks. These new resources are fundamentally transforming how technology innovation happens. The revolutionary possibilities that Fablabs and cloud technologies are creating for entrepreneurs to engage in technology innovation, echo the profound social and economic transformations facilitated by the adoption of personal computers at home and in small businesses in the last two decades of the twentieth century (Venkatesh, 1996). Yet, when personal computers arrived at the home and the office, people required magazines, online publications, user groups and local experts to harness the full potential of these devices to transform their work activities (Nardi & O'Day, 2000; Venkatesh, 1996). Similarly, entrepreneurs must work to create the appropriate social context to take advantage of these new resources, building innovation infrastructures they need to facilitate the emergence of innovation-based industries. Bolstering the growth of innovation-based infrastructures can leverage the development of the entire nation. However, countries like Italy must transform their social and institutional structures, otherwise the benefits of innovation-based industries will remain marginal. Face-to-face events and workshops provide an important perspective to understand technology innovation practices. My analysis can be used to inform the design of environments and policies for expanding innovation-based industries in Italy.

2.2 Challenges to Technology Innovation in Italy

Historically, the Italian Industry had overcame many challenges to bootstrap innovation. Italy has been an economy with few incentives for technology innovation, due also to the social, cultural, and economic consequences of a society that is based on privilege rather than merit. Many scholars assess the emergence of the Italian "Fablab movement" as an asset for the transformation of the culture and practices of the entire country and fundamental tool for the Italian Industry. Italy's socioeconomic development has been challenged by aspects of its historic, cultural, social, political, and economic situation. The country suffers from an income inequality, with powerful special interest groups such as monopolies and privileged unions that have slowed down many necessary reforms. The weakness of the state is a major reason to explain the relatively high level of inequality observed in contemporary Italy. The weakness of the state indirectly increases social inequality, as it is complemented by individualistic, market-based mobilization (Pizzorno,1993) and by the strength of particular social groups. Among the latter, the most important is surely *the family*: the classic concept of "amoral familism", developed by Banfield (1956) on the basis of his fieldwork in Southern Italy, is still useful to express how Italian families act for their own particular interests, without taking into account the welfare of society at large. When compared to other OECD countries Italy appears as one of the most unequal countries in terms of income distribution. The Gini index of income inequality stand at 0.34 and rising, very similar to the UK value. This is rather striking when considering that this country is characterized by educational institutions and labour market institutions that are typical of social economies.

Figure 2.3. Inequality indices – main OECD countries



	mid 1980	mid 1990	mid 2000
France	0.290	0.281	0.281
Germany	0.286	0.290	0.298
Italy	0.337	0.350	0.352
Spain	0.328	0.319	0.319
United Kingodom	0.332	0.341	0.335
United States	0.365	0.374	0.381
OECD 22	0.295	0.299	0.300

Source: OECD (2008)

More recently, despite an inflow of young cohort who attain levels of education in line with the Lisbon 2020 target (at least 85% of the population with a secondary school degree), there is still almost half of the population in working age missing this target. Clearly Europe remains a two-speeds continent, with Mediterranean countries lagging behind continental ones in terms of socio-economic development. The lack of a robust industrial structure, the presence of powerful family firm that have long controlled large parts of Italy's industry, a large share of small firms and self-employment, a large share of employment in the service sector (exceeding 50%) are all underlying forces that tend to create inequality and scant infrastructure to support innovation-based industries.

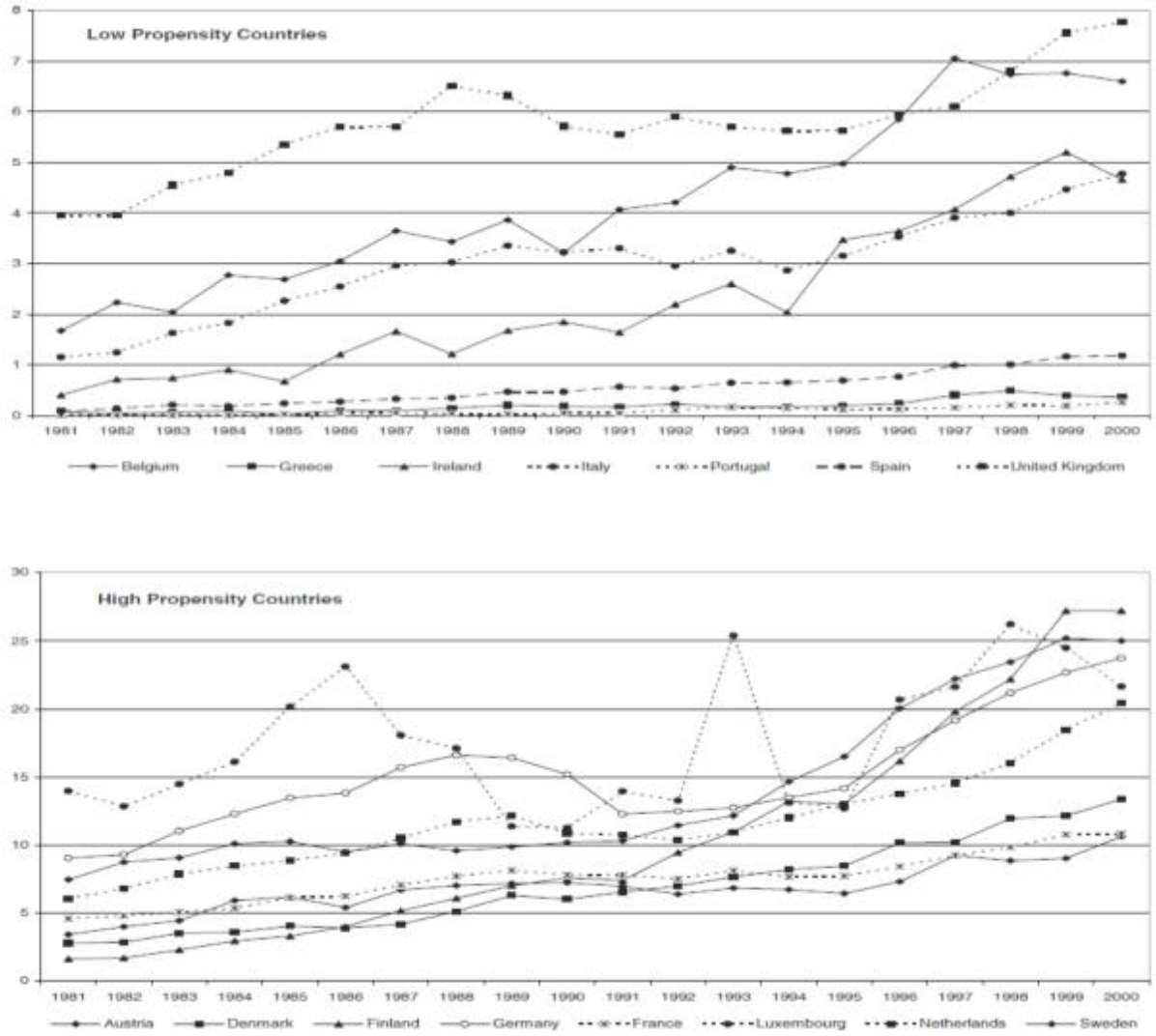
2.2.1 An Economy with Little Incentive for Innovation

The lag in innovation in Italy vis-à-vis the other main industrial countries is one of the effects of the fragmentation of the production system into many small firms that have trouble bearing the high cost of R&D and taking the related risks. Such other causes as shortages in human capital for management and R&D and excessive labour flexibility, undermining the incentive to invest in training, also play a role. Lack of financial sources is a further hurdle; equity, more suitable than debt for financing innovation, is less common than in other countries. Public incentives for firms have had modest

results. To enhance the capacity for innovation some actions should be taken to help firms grow, adopt a more managerial approach, and increase their equity. It is important to support the venture capital market, which is less developed than in other countries. The design and management of public funding for innovation need improvement (Bugamelli et al., 2012).

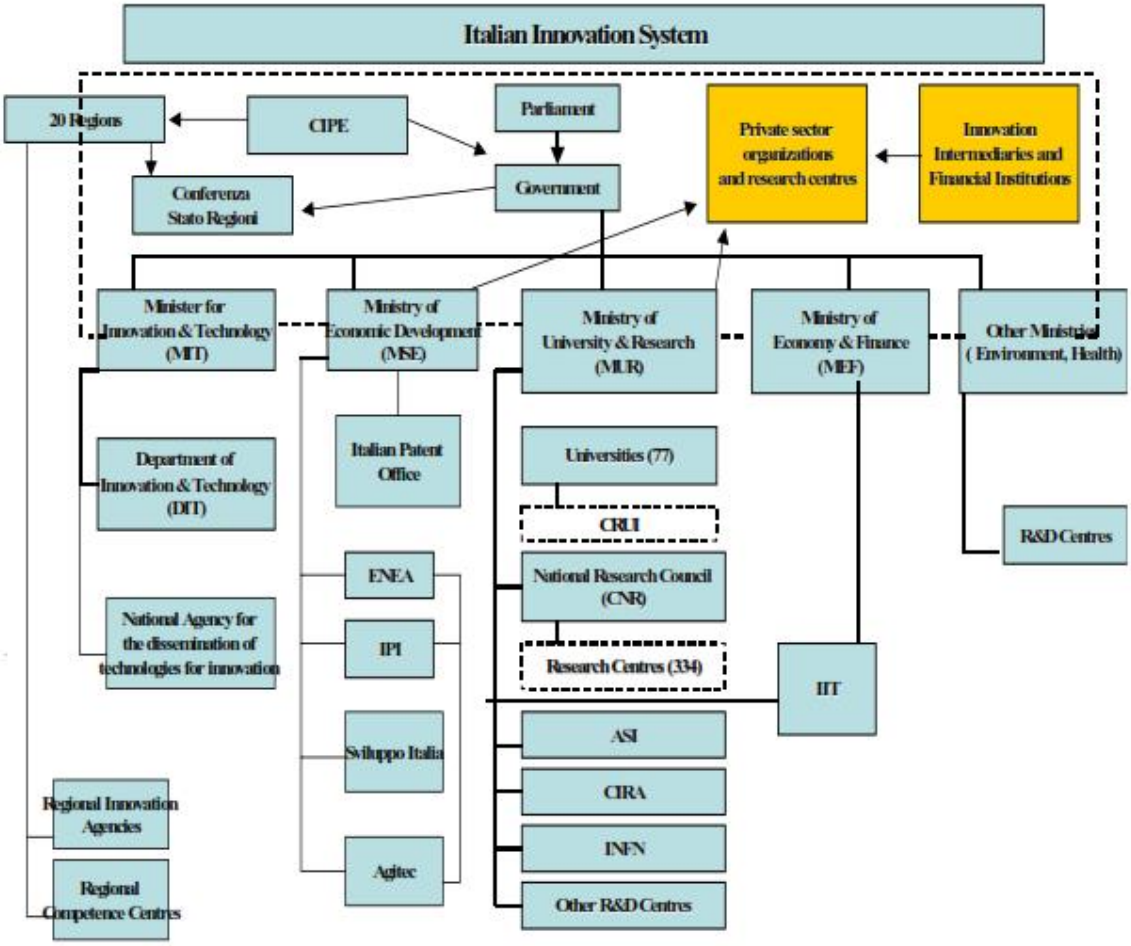
The European Commission – Directorate General Regional Policy stated that "in 2005, Italy's innovation performance was in 12th position out of the 25 EU Member States. Its main strength is the public funding of innovation; its main weaknesses are the lack of venture capital, the low level of cooperation between firms and the low level of business RTD. In addition, there is a predominance of SMEs (98% have less than 20 employees) specializing in low and medium technology sectors." (Directorate-General Regional Policy, Innovation in the National Strategic Reference Frameworks, 2006, p.2). In the National Strategic Framework (NSF) 2007-2013, the poor innovation capacity of the private and public sectors is identified as the principal source of competitive lag in the country. The systemic weakness of Italy is linked to the modest amount of private research conducted even in very large firms, the insufficient capacity to institute relationship mechanisms between the latter and SMEs, the limited aptitude of SMEs to dialogue with the research supply system, the inadequate level of training of entrepreneurs and the poor involvement of workers in the innovation process both in businesses and in the public administration (Coletti, 2007). Indicators of innovative output such as patents filed at the European Patent Office (EPO) confirm the Italian delay in innovation (Lotti & Schivardi, 2005). Of the total number of patents filed at the EPO in 2001 Italy had a share (7.8%) is significantly lower than one of the main European countries. The relationship between the number of patents and population puts Italy in the group of countries with a low propensity to patent (which also includes Belgium, Greece, Ireland, Portugal, United Kingdom) set against Austria, Denmark, Finland, France, Germany, Luxembourg, Netherlands, Sweden (Fig. 4). Since 1980, Italy has the propensity to patent a flat profile until the mid-nineties, followed by a phase of growth. Overall, at the European level there is no weak signs of convergence between countries, more visible when comparing countries with low than high propensity to patent; signals are almost absent within each group.

Figure 2.4. Evolution of the propensity to patent by country



Source: Bank of Italy (2012)

Figure 2.5. Italian Innovation system mechanism



Source: Coletti (2007)

2.2.2 Special Privileges Disincentivize Cooperation and Innovation

Privileged and interest groups such as de-facto monopolies and oligopolies, corrupt political cliques, and dishonest sectors of workers' unions have been a constant burden for Italy´s development. Their presence engenders systemic corruption, deters cooperation in business, and discourages technology innovation. The problem with this explanation is that a number of different metrics suggest that interest groups in Italy grew weaker, rather than stronger, in the period between the early 1990s and the late 2000s. In the early 1990s, trade unions commanded around 40% of the labour force in the private sector. In 2007, this figure had declined to a mere 19% (Baccaro & Pulignano 2009). This data is mirrored by decline in company-level wage bargaining. During the 2000s, 30.6% of firms with more than 20 employees have reached a company agreement, down from 43.4% in the 1990s

(CNEL - CESOS 2009). From an Olsonian viewpoint this decrease should have had beneficial effects because unions in Italy have not historically been an "encompassing" group that internalizes the systemic consequences of its strategies. Italian unions have been characterized for their factionalism and militancy, which followed national political cleavages (Olson 1982; Golden 1988; Baccaro 2003).

The most notable interest group in Italy are the Italian political parties. It is precisely because Italian parties collude to protect/promote their collective interests that the Italian party system should be viewed as a cartel party system rather than as an instance of consociationalism (Bogaards, 2005). Historically privileged and lobby groups have made Italy a very conservative society. To avoid losing their position, the privileged have held back many reforms and slowed the transformation of institutions that could make the country more competitive. The assurance, pharmaceutical and banking sectors are prominent examples. Due to lack of competition among assurance companies, the cost of insurance own vehicle in Italy remains high in comparison with many other European countries. The banking system has been slow in giving credit to small businesses. Until very recently, it has not participated in the creation of solutions for online payments, hindering the ability of internet entrepreneurs to create new products. These privileged groups, formed by specific business people, politicians, bureaucrats, and union members, have historically supported corrupt governments and companies in exchange for special favors. The history of a privilege-based society can be traced back to the Spanish Colonial period, when the government favored some groups to increase the incipient state power. In a privilege-based society most people have little incentive to create innovative companies, as they perceive that those with privileges have an unfair business advantage (Elizondo Mayer-Serra, 2011). While in every country connections are important, in Italy there is a generalized perception that only the privileged can enter the most profitable industries such as banking, pharmaceutical and companies serving the public sector. These special privileges are linked to a high degree of corruption in the public and private sectors. Business people in Italy feel that they will have to bribe someone or ask a special favor at some point, if they want to be successful. In this environment many Italians are wary to cooperate with each other. Their lack of cooperativeness created a system characterized by many small companies. The behavior of business people is perceived to be similar to that of crabs trapped in a bucket, pulling each other down instead of cooperating to get out of the trap. Several indicators show that the lack of trust in collective endeavors goes beyond a mere perception. In fact, counter-intuitive findings about cooperation, that theoretically is a tool to overcome internal barriers to innovation, can be explained taking into account the less propensity to cooperate by Italian firms that means a too low experience of Italian firms in cooperative agreements and consequently the ineffectiveness of cooperation and the inability to access to

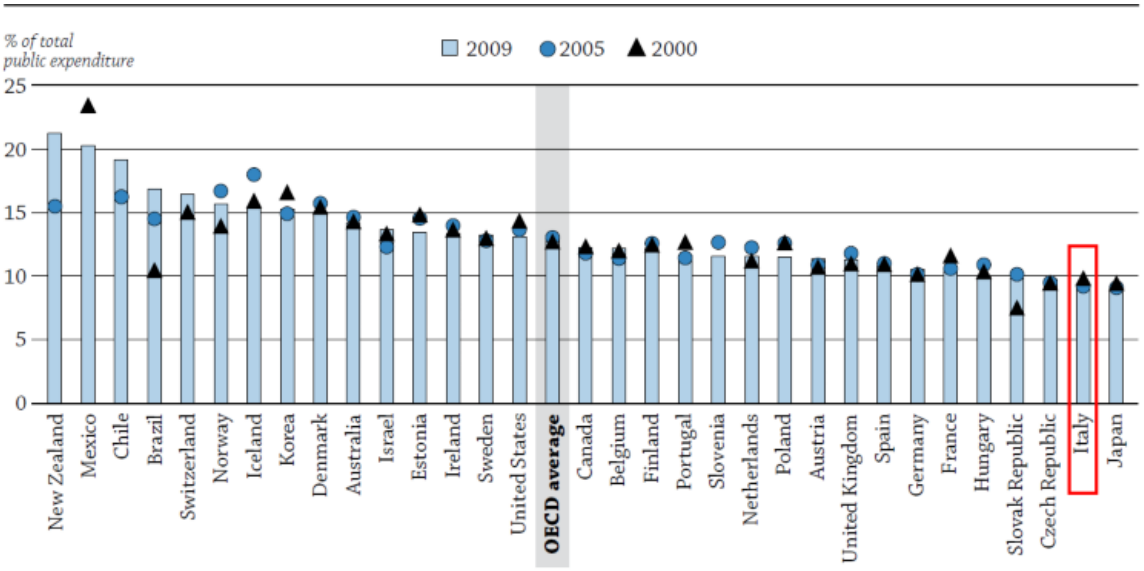
partners‟ resources or to exploit the synergies among partners‟ human resources (Galia et al., 2012). For example, by comparing Italian and French SMEs, results that French SMEs are more prone to enjoy R&D cooperative agreements (11.5% of French SMEs are engaged in R&D cooperation compared to only 4.3% of Italian SMEs). Early stage venture capital in France is 0.03% of GDP whilst in Italy is 0.002%.

2.2.3 Lack of Support to Achievers, Lack of Support to Innovation

In times of economic crisis, higher education often becomes a central part of the political discussions. On the one hand, there seems to be agreement that higher education is a key factor in finding a way out of the crisis, and in creating a stable and competitive knowledge economy that would be able to better absorb potential future economic downturns. However, the role and value of higher education in society and the economy, vary from country to country. Indeed, in the European context, it is clear that while certain countries have provided new investment to fund higher education since the start of the crisis (Germany, France and Portugal), others have decided to renege on previous commitments to increase funding (Hungary, Flemish Community in Belgium, Spain and Austria) or to introduce budget cuts varying from minor (less that 5% in the Czech Republic, Poland, Croatia, Serbia and Macedonia) to major up to 20% such asItaly (Garben, 2012).

In 2009, public expenditure on education in Italy represented an amount equal to 4.7% of GDP, well below the OECD average of 5.8%. As a percentage of total public expenditure, public expenditure on education in Italy (9.0%) was the second lowest after that in Japan (Figure 2.6). Between 2000 and 2009, public expenditure on education as a percentage of total public expenditure decreased from 9.8% to 9.0% and increased by only 4% in real terms (the OECD average increase in real terms was 33%). Between 2000 and 2009, funding for educational institutions from private sources increased in real terms by 77%. In particular, funding for higher education shifted more markedly from public to private sources than on average in OECD countries. Whereas public sources accounted for 82.9% of funding in 1995 (above the OECD average of 78.9% that year), they accounted for 68.6% in 2009 (below the OECD average of 70.0%). The increase in public spending on tertiary educational institutions, equaling 4% in real terms between 2000 and 2009, is the lowest among OECD countries.

Figure 2.6. Total public expenditure on education as a percentage of total public expenditure (2000, 2005, 2009)



Countries are ranked in descending order of total public expenditure on education at all levels as a percentage of total public expenditure in 2009.
Source: OECD. Table B4.3. See Annex 3 for notes (*www.oecd.org/edu/eag2012*).

Source: OECD. Table B4.3 (2012)

Today's graduates need to combine transversal, multidisciplinary and innovation skills and competences with up-to-date subject-specific knowledge so as to be able to contribute to the wider needs of society and the labour market, but in Italy, according to the last figures, this is not possible. It is clear that educational system in Italy has produced uneven results in educating people for innovation-based industries. The root causes of this deficient system are the lack of a merit-based educational system that would encourage students to give their best effort, along with the historical lack of access by unprivileged groups. In Italy, most private universities are open to anyone who can afford them. There is likely to be a significant difference in terms of resources between public and private institutions, one should note that in contrast to the USA, the proportion of students enrolled at private universities in Italy is extremely low (Di Pietro & Cutillo, 2006). In Italy in 2002 the proportion of students enrolled at private universities was 6.5%, significantly lower than the OECD average of 11.4 % (OECD, 2004). Second, in contrast to other countries, in Italy (with the exception of some private universities) there are no selective barriers to entry to university. All the individuals successfully completing high school are free to enroll at the institution they prefer. In addition, choice is unlikely to be affected by the direct cost of university education as Italian tuition fees are significantly lower than in other countries (e.g. the USA), and do not significantly vary across

institutions. This general openness to education, testify that education system in Italy is not meritocratic based. Generally, in a non-meritocratic system there are limited economic resources to support elite institutions that produce world-class research. The lack of tuition fees at University in Italy, decrease the resources available for research and investment in innovation.

In contrast, India has invested heavily in its higher education and research systems since its independence in the 1950s, creating a series of world-class, elite scientific, engineering, and management institutes, colleges, and universities, including the prestigious Indian Institute of Technology. These public institutions are reserved for the best students in the country. The privileged groups and the State failed to support an Italian research and innovation system. During many years there was no support for the highest achievers in science, technology, and innovation. This systemic absence of support for the highest achievers is one reason why Italy lacks a tradition of world-class research programs.

Many Italians practice "clientelism," seeking to obtain short-term benefits from populist governments including special privileges, however small, in exchange for their vote. It will be very difficult to change these practices, and make the entire society demand their rights using democratic participation.

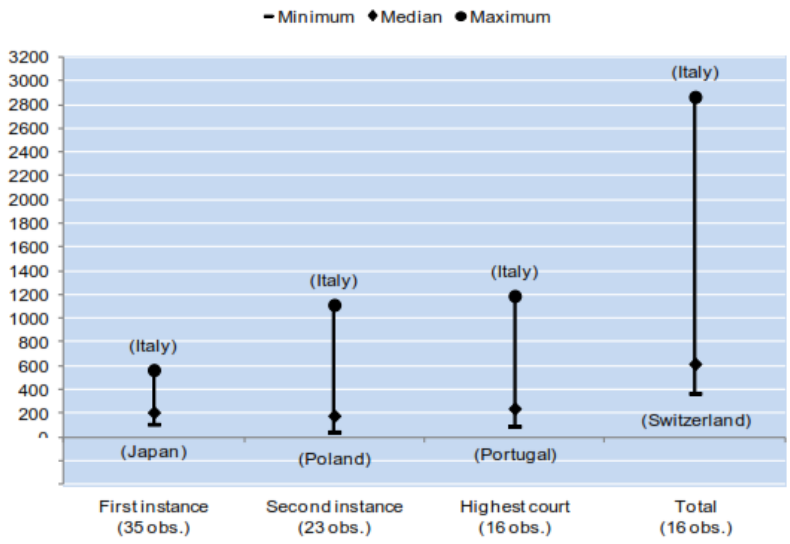
2.2.4 The Italian Justice System—A Contributor to a Difficult Environment for innovation

Some Italians perceive that the lack of technical innovation can be explained by an inefficient justice system. Judicial systems serve important purposes in up-holding social values but also in determining economic performance. Well-functioning judiciaries guarantee security of property rights and enforcement of contracts. Security of property rights strengthens incentives to save and invest, by protecting returns from these activities. A good enforcement of contracts stimulates agents to enter into economic relationships, by dissuading opportunistic behavior and reducing transaction costs. This has a positive impact on growth through various channels: it promotes competition, fosters specialization in more innovative industries, contributes to the development of financial and credit markets and facilitates firm growth. A well-functioning, independent and efficient justice system is one where decisions Are taken within a reasonable time, are predictable and effectively enforced, and where individual rights, including property rights, are properly protected. As further, improving the efficiency of the judicial system can help improve the business climate, foster innovation, attract FDI, secure tax revenues and support economic growth (IMF, 2013). The performance of the Italian justice system is well below European and OECD averages. Of note, it takes an average of 1,200 days to

enforce a contract in Italy, more than twice the OECD high-income country average (OECD, 2013, and Council of Europe‘s European Commission for the Efficiency of Justice (CEPEJ), 2012).

The regulatory and legal environment is commonly held to be an important factor in determining a country’s economic performance. Trials length and the costs of accessing the judicial system (court fees, expert fees, lawyers ‘fees) are very important for enterprises that invest in innovative activities. With some exceptions (Slovenia), systems characterized by lengthy trials tend to be more costly, discourage the creation of new businesses, foreign direct investment and investment in innovation. Thus, lengthy trials undermine certainty of transactions and investment returns, and impose heavy costs on firms.

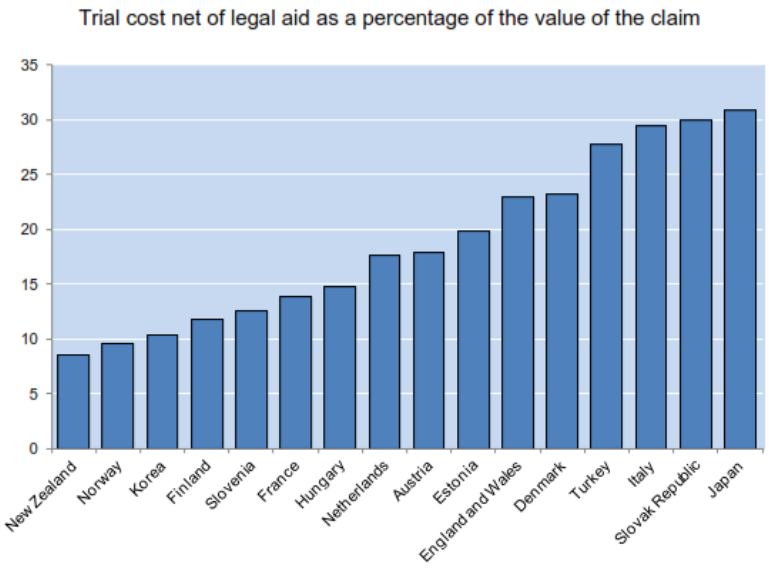
Figure 2.7. Distribution of trial length (in days) across countries by tipe of instance



Note: Trial length is estimated with a formula commonly used in the literature based on incoming, pending and resolved civil justice cases: $[(Pending_{t-1}+Pending_t)/(Incoming_t+Resolved_t)]*365$. Each of the bars illustrates the main summary statistics of the sampled data. The diamond represents the median. The end points of the whiskers represent the minimum and the maximum values in the sample. The spacing between the main parts of the bars illustrates the degree of dispersion and skewness in the data.

Source: OECD and CEPEJ (2013)

Figure 2.8. Trial costs vary widely across countries



Note: The indicator is constructed as the total private cost of trial discounted by the expected probability of receiving legal aid, which is assumed to reset trial costs to zero. The cost of trial (as a percentage of the value of the claim, which is assumed to be equivalent to 200% of income per capita in the country) is taken from the World Bank Doing Business database and encompasses three different types of costs necessary to resolve a specific commercial dispute: court fees, enforcement costs and average lawyers' fees. The reduced number of observations is due to data availability.

Source: OECD and CEPEJ (2013)

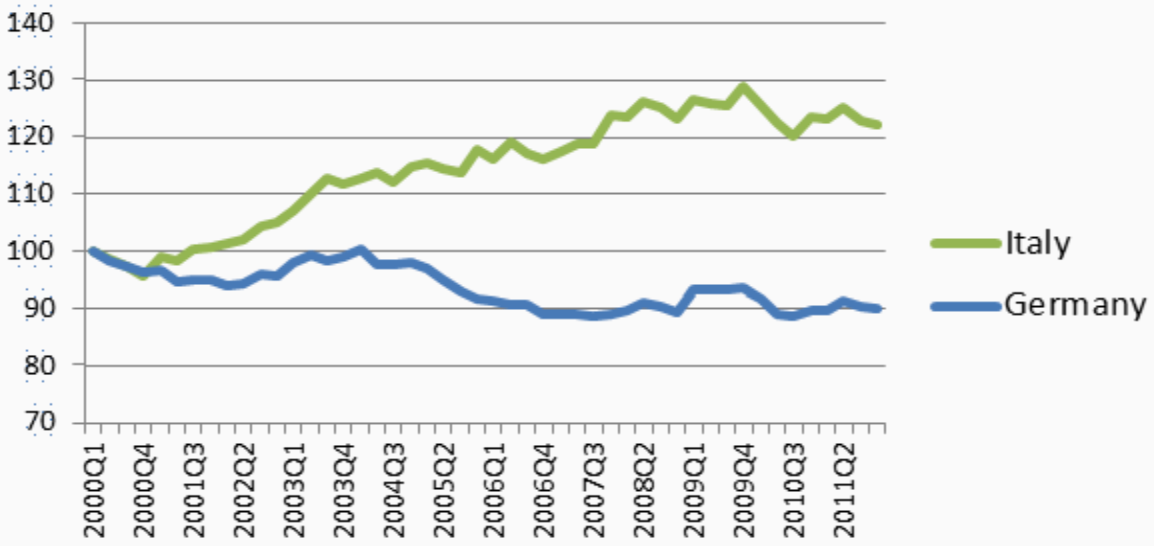
Further, very important for companies is the enforcement of contracts. According to Doing Business, in Seoul resolving a standard contract enforcement dispute takes 230 days, while in Italy 1185 days (Doing Business, 2014). In fact, small and medium-size enterprises usually try to avoid going to trial, effective contract enforcement systems matter for them. Efficient courts and enforcement reduce informality, improve access to credit and increase trade. Dabla-Norris and Inchauste Comboni (2008); Safavian and Sharma (2007), in a study on Eastern Europe, found that in economies with slower courts, firms tend to have less bank financing for new investments. Yann and Utoktham (2009) found that simplifying contract enforcement procedures increases bilateral trade.

2.2.5 High recruiting costs weakens the incentive to innovate

High recruiting costs associated to scarcity of skilled labour weakens the incentive to innovate, on the other and, lower innovation and less productive technology reduce the economic return to human capital (Colonna, 2014).Taxes on labour, such as social security contributions and taxes on personal income, tend to discourage the labour supply, while, on the demand side, increase labour costs and depress the labour demand. In the ranking of the level of the tax wedge on the labour, Italy lies in an intermediate position. In Italy, the amount of social contributions amounts to 32.2%

of the average wage level, compared to 31.0% for the average of the 15 EU countries. Income tax is 14.2%, compared to 14.1% for the EU average (Dell'Arringa, 2003). "When an investor asks about severance costs, all the other countries can provide an answer," says Pietro Ichino, an Italian senator and professor of labour law at the University of Milan. "Italy can't." Duccio Astaldi, president of Condotte, one of Italy's largest construction companies, says the difficulty of firing often prevents him from hiring when times are good. "It's easier for me to get rid of my wife than to fire an employee," he says. The result is crippling. The World Economic Forum ranks Italy 123rd out of 142 countries in the efficiency of its labour market. Employers are robbed of their ability to innovate, from experimenting with hours of operations to introducing new forms of wage structures. Meanwhile, national strikes roll around like federal holidays—one every month or so and almost always on a Monday or Friday to guarantee participants a three-day weekend. On average, Italian workers spend almost six times as many hours on strike as their German counterparts, according to the European Industrial Relations Observatory. In the past decade productivity has remained flat, even as its neighbours to the north have continued to work more efficiently. Comparing Italy and Germany, the unit labour costs-based indexes for Italy (green line) and Germany (blue) are shown in Figure 2.9. Between the first quarter of 2001 and the last of 2011, unit labour cost in Italy rose by 23% points more than in its trading partners (a real appreciation), while unit labour costs in Germany declined by 9.7 percentage points (a real depreciation). What explains the huge rise in the Italian relative unit labour costs?

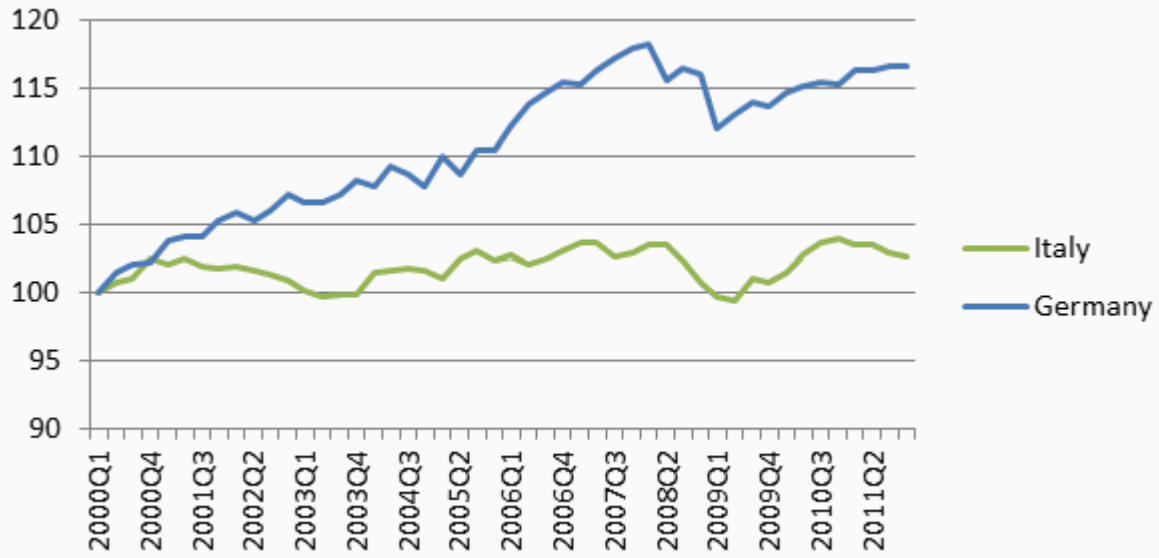
Figure 2.9. Unit labour cost-based real effective exchange rates



Source: Darvas (2012)

Labour productivity, however, did not follow wages. Figure 2.10 shows that labour productivity completely stagnated in Italy (+2.7% in the entire period) while it rose considerably Germany (+16.7%). As a result, net of taxes, unit labour costs in Italy rose about 32.5% more rapidly than in Germany.

Figure 2.10. Hourly labour productivity



Source*:* Darvas (2012)

These figures show that a country becomes more competitive if the domestic relative (to foreign) average wage per hour falls, if the domestic relative average labour productivity rises, if the relative social security tax rate paid by domestic employers falls, if the domestic relative sales tax rate rises, and if the (trade weighted) nominal exchange rate depreciates (Manasse, 2013).

Italy's unit labour costs grew by nearly 28% cumulatively during 1995-2007, compared to a European average of just over 20 percent during the same time period (Schindler, 2009). The high cost of labour is the reason why Italian companies have a specialization toward unskilled labour intensive sectors. Lack of skilled labour might reduce firms' incentive to innovate; on the other hand, low technological growth can curb economic returns to human capital. Colonna (2013) finds that multiple equilibrium and "low skill-low innovation" traps can arise when the matching process between labour demand and supply is very. In particular, Italy differs significantly from the others countries in two dimensions. First Italian labour market is characterized by a more costly matching process: a 1% increase of the labour supply reduces the associate recruiting cost by around 2% against 1% in Spain and 0.2% in France and Germany. Second, Italian system exhibits a bias toward sectors with a relatively low skilled labour productivity. These two factors can explain respectively almost 50% and

30% of the Italian gap in graduation and innovation rate. Thus, a large part of the innovation between Italy and other leading European countries can be explained by labour market frictions. Colonna's estimates (2008) show for Italy a higher elasticity of skilled labour demand to skilled labour supply. This finding can justify 1) bias toward labour intense technology; 2) low R&D investment, 3) smaller firm's size.

Thus labour cost and high recruitment cost can play a pivotal role in shaping firms' innovation activity. In Italy, labour markets, suffocated innovation and productivity growth, and resulted in wage dynamics that were completely decoupled from labour productivity and demand conditions.

2.2.6 Discussion

Italy is still at a crossroads in building an innovation-based industry. The new local and global resources can help the country overcome the challenges from old institutions and practices. The economic crisis and the awareness that political reforms are needed society can create a culture emphasizing education and merit. While the Italian Industry is having initial experiences that are foundational towards creating an entire industry based on innovation, there is a long road to create a full transformation. Italian entrepreneurs must create collective aspirations to build strong innovation-based industry that benefits all, beyond the mistrust of cooperation amongst SMEs." In the coming years we will be able to determine how initial experiences of new ways of working translate into the required large-scale transformation. For this colossal transformation, entrepreneurs must not only create new innovation infrastructures, they must transform the entire business context. They must transform the network of pernicious institutions that perpetuate the lack of a meritocracy, as well as the corruption that hinders the development of Italy. I am hopeful that the great rewards of creating these new industries in Italy will continue motivating entrepreneurs to achieve a full transformation of their industry and of the old family business concept. Younger generations must have opportunities to develop their ambitions in positive and constructive activities. D'Costa (2011) cautioned against being naively optimistic about innovation-based industries: the socioeconomic differences between those who are qualified for the new economy and those who are not are widening rapidly. Thus, it is urgent to create mechanisms to ensure equal access to a better education for all members of society in order for everyone to benefit from innovation-based industries. Enabling more members of society to participate in these industries will contribute to overcoming the existing innovation gap in Italy. Scholars and practitioners should look into potential structural and cultural changes that can enable the overall development of society. These reflections can be used in turn to design public policies and socio-technical infrastructures that enable or modify this social development.

2.3 The Fablab Revolution

A new digital revolution is coming, this time in fabrication. It draws on the same insights that led to the earlier digitization of communication and computation, but now what is being programmed is the physical world rather than the virtual one. Digital fabrication will allow individuals to design and produce tangible objects on demand, wherever and whenever they need them. Widespread access to these technologies will challenge traditional models of business, foreign aid, and education (Gershenfeld, 2005). All started in 2001, when Prof. Neil Gershenfeld taught a class called "How to Make (almost) Anything" at MIT's Center for Bits and Atoms (CBA) Boston. The class was developed to study the boundary hypothesis between computer science and physical science. The class was designed to teach a small group of research students how to use CBA's tools but were overwhelmed by the demand from students who just wanted to make things. Thus, following this request, in 2003 CBA began an outreach project with support from the National Science Foundation. CBA started to purchase the needed tools.
They assembled a kit of about $50,000 worth of equipment (including a computer-controlled laser, a 3-d printer, and large and small computer-controlled milling machines) and about $20,000 worth of materials (including components for molding and casting parts and producing electronics). All the tools were connected by custom software. These became known as "Fablabs" (for "fabrication labs" or "fabulous labs"). Their cost is comparable to that of a minicomputer, and they have found that they are used in the same way: to develop new uses and new users for the machines. *Thus, a* Fablab (fabrication laboratory) is a fully kitted fabrication workshop which gives everyone in the community, from small children through to entrepreneurs and businesses, the capability to turn their ideas and concepts into reality. A Fablab is a community inventors' workshop offering digital fabrication on a personal scale, in which new products can be built by both businesses and individuals (Neil Gershenfeld, MIT). Digital fabrication, in turn, can create highly customized products, as a handicraft method, with the advantages of the industrial system because it optimizes time and cost. In this sense, Gershenfeld showed in his MIT classes "that the ultimate app for personal fabrication in the developed world is the technology for a market of one."

Gershenfeld calls it the "third digital revolution." The first was communication, the second was computation and the third is fabrication, making things. It will seriously disrupt, but not destroy traditional manufacturing, Gershenfeld said. "Mass manufacturing will still stay, but it will by definition make the boring stuff because everyone gets the same thing," he said. "This is like the birth of the Internet, but it's literally an internet of things. It's an internet where data becomes things and

things become data. And we're seeing the births of entirely new businesses where you go to market by shipping data and you produce on-demand where you consume." As Tanaka[4] claims, the trend is now "from Personal Computers to Personal Fabricators" or "from Web Society to Fab Society" that is going to revolutionize the way people make things, and eventually use things for their own life, beyond the conventional business systems. The raise of commons-based peer production, individuals collaborating in producing cultural content, knowledge, and other information and indeed physical goods, is commonly attributed to this "digital revolutions", the broad availability of new information technologies (Benkler & Nissenbaum, 2006).

Since then, the Fablab concept quickly became popular among users outside the research domain, and an international network of similar Fablabs came into being that were all active in the areas of research, education and application of personal digital fabrication. These Fablabs cooperate with local communities, universities and (international) governments. There are currently already over 200 Fablabs worldwide and they are becoming ever more important as interdisciplinary research and development facilities. The development and rapid dissemination of digital fabrication technologies is comparable with that of personal computers in the 1970s (Stelzer & Jafarmadar, 2012). At the beginning of 2014, the international Fablab network consisted of 474 Fablabs in 71 countries, made possible by hundreds of staff members (paid and volunteers). This phenomenon is caused by the continued cost reduction of the machines, the growth of open source software and hardware (Troxler & Wolf, 2010, Troxler, 2013), and because the cost of a part or component "is based on the machine's time, not shape or variety of parts, so there is no surcharge for complexity or difference" (SHoP, 2012, 251). The trend was evident in conferences such as Non Standard Praxis (MIT, Cambridge, 2004), ACADIA Fabrication (Toronto, 2004), through exhibitions like Scriptingbypurpose (Philadelphia, 2007), Home Delivery: Fabricating the Modern Dwelling (MoMA, New York, 2008), the Architectural Biennial Beijing on emerging technologies (Beijing, 2004-2010) curated by Neil Leach and Xu Wei-Guo, including events on fabrication organized by the Center for Bits and Atoms since 2001.

Fablabs use the same tools and processes and an international infrastructure for co-operation in digital design and fabrication. A Fablab has these main characteristics:

- is free and open to the public, although direct expenses like materials used maybe charged;
- subscribes to the Fab Charter and has its text on display on site and web site;
- disposes of a common set of core tools and processes (and maybe even more);

[4]Professor Hiroya Tanaka of Keio University. Founder of FabLab Japan and FabLab Kamakura.

- contributes to and/or cooperates with many other Fablabs and takes part in or leads network initiatives.

Thanks to digital fabrication today are all potentially designers and manufacturers and this technological revolution, which some call the third industrial revolution, rewards a historical characteristics of an Italian creativity. The Italian Industry should bet on the value of the network and digital culture, to revive all its main sectors, especially the manufacturing, the most important sector of the Made in Italy. In the last two years, are springing up everywhere Fablabs in Italy. The makers of the movement is spreading across all regions, driven also by the passion of those who believe that the future is in their hands, in the things that they can build. To strengthen this movement to grow this network was formed on the Italian Fablab and Makers Foundation. The foundation starts from a new Made in Italy, namely the Italian talent, combining know-how with the wonders of digital fabrication. Helping those who have no means to express their talent, to support the dreams and needs of innovators best, and most work on digital skills of the Italians, from children to seniors, because only then, only with a large investment in training Italian Industry can really have a future . Useful to those who want to open a Fablab and useful to those who want it to grow by finding a business model, useful to those who want to become makers and does not know how to do it, and useful to those seeking to entrust one for a project.

Personalized design and manufacturing machines will be an emancipating technology, creating freedom for people to work and play independently in ways that were previously restricted to an elite few (Burns, 1995). An industrial technology becomes “personalized” when it becomes cheap, small, and easy enough for mainstream consumers to use without extensive training. A virtuous cycle ensues as an industrial technology creeps into homes and offices, catalyzing new markets for companies that create applications, thereby attracting yet more consumers, and an even bigger market for applications. When enough applications exist that the formerly industrial technology becomes an affordable and essential tool for everyday use, the technology has become personalized.

Table 2.1. Converging forces that are personalizing manufacturing technologies

	Personal fabricators	Industrial-scale manufacturing machines
Machine size	Fit on a desktop or kitchen table	Are the size of a cargo van or much, much larger
User safety	Use built in filters and sensors to provide non-expert users with safety mechanisms	Require monitoring and careful configuration to ensure they meet OSHA requirements
	Use modular raw ingredients that are packaged to be "plug and play," and do not require processing or special handling.	Need raw material that comes from a number of suppliers and is potentially toxic and requires special handling
	Are precise, therefore create very little left over waste, offering a cleaner and more eco-friendly manufacturing process	Use wasteful, mass production techniques that create large amounts of toxic waste and unusable scrap materials
Cost	Cost about $1000 for the cheapest, low end 3D printers, lasers cutters and automated sewing and embroidery machines	Cost up to tens or thousands of dollars for a basic mill or laser cutter; some mass production injection molding machines cost hundreds of thousands of dollars
	Are greener and use less power than their industrial strength counterparts	Consume enormous amounts of power
	Create a low-cost prototypes enabling designers to experiment with different materials and designs at a very low cost	Do not offer cheap prototyping or low-cost, small-scale production of custom objects, since machine set up costs must be amortized by making and selling large volumes

Ease of use	Require very little user training	Require specialized training and certification for machine operators
	Are supported by online communities	Make it costly for regular people to become people operators due to proprietary machine technology and costly, required certification
	Benefit from internet retail and online storefronts that sell custom blueprint designs and offer a ready-made marketplace to sell custom objects	Rely on massive supply chains and large distributors or retail chains
Universality	Run of customizable electronic blueprints that can be downloaded from the internet from anywhere in the world	Use proprietary, complicated and expensive design software and machine automation
	Can be made from low cost kits by moderately skilled users	Can be purchased only by those who can afford large and costly machines that require a lot of expensive upkeep and maintenance
Software availability	Use machine parts are based on open source hardware designs, meaning anybody can use and customize their fabber without worrying about patents or IP issues	Rely on expensive, specialized, patented parts that can't be duplicated and are expensive to purchase.
	CAD software is growing more sophisticated and easier to use and cheaper	Work only with expensive, proprietary CAD software that requires a lot of user training

	Growing number of design blueprints available online for sale and swap	Eletronic blueprints are not freely available for mass produced products and machine parts; many products are protected by copyrights and patents, therefore usable only for a fee

Source: Hod Lipson & Melba Kurman, Factory@home (2010)

2.3.1 Fablabs Ecosystem

The Fab ecosystem is an ever changing and adapting and not always clear complexity of people, local, regional and global organizations.

People

People are the most important drivers of the Fab ecosystem. They run the Fablabs, the regional and the worldwide organizations. Some of them are paid, others are volunteering. For all of them Fablabs are important, although the reasons why might differ. To mention just a few: digital fabrication, the triumph of technology, tools to the people, empowerment, open design now, community development, inventing new products to solve global problems, connecting scholars, promoting standardization, hands-on learning and raising interest for STEM[5] education. Some people focus on their own Fablab only, many take part in cooperation between Fablabs and/or the activities at a regional or worldwide level.

Labs

The core processes of the Fab ecosystem take place in the Fablabs and in the local organizations with which they directly interact, both their "clients" and their "suppliers". The clients are organizations like community centers, schools, local associations of crafters, local guild of inventors etc. They, as well as individuals, use the services from the Fablabs. The suppliers are organizations like the municipality, Chamber of Commerce, a museum, etc. who help the Fablabs and/or their services up

[5] STEM stands for Science, Technology, Engineering and Mathematics

and running. Note, that some suppliers (a school with an embedded Fablab), could be a client as well, e.g. by sending its pupils to the Lab.

Regions

There exist a range of organizations supporting Fablabs at regional levels. These organizations might be formal, like USFLN, the United States Fablab Network, or informal, like the Group of Spanish Speaking Fablabs. They can exist for years or for a short period only, e.g. to organize an event.

World

Organizations supporting Fablabs at a global level might have a permanent or a temporary character. An example of the former is CBA, an example of the latter the annual Fab conference.

2.3.2 Other examples of commons-based peer production

Around the world, diverse groups of people are making things together in community-based workshops and their networks. Equipped with versatile digital design and manufacturing technologies, global networks of workshops, like Hackerspaces, Fablabs and Makerspaces, provide facilities for exploring "commons-based, peer-production" in practice; and they are spreading rapidly. Emphasis rests in bringing people into collaborative DIY projects where they innovate and learn together - from making toys and jewelry to solar panels and eco-houses and use on-line social media to connect to open-source designs, tutorials, and workshops globally. The raise of commons-based peer production, individuals collaborating in producing cultural content, knowledge, and other information and indeed physical goods, is commonly attributed to 'digital revolutions', the broad availability of new information technologies (Benkler, 2006). There are other initiatives of commons-based peer production other than Fablabs that could be summarized under the heading of 'shared machine shops' (Hess, 1979).

Makerspaces are places where like-minded persons gather to work on personal projects, share tools and expertise as well as learn from each other (Tweney, 2009). The driving principle of makerspaces is that users enjoy sharing tools, equipment, expertise and ideas rather than working by themselves in the garage or basement (Roush, 2009). Maker Media defines makerspaces as: Learning environments rich with possibilities, Makerspaces serve as gathering points where communities of new and experienced makers connect to work on real and personally meaningful projects, informed by helpful mentors and expertise, using new technologies and traditional tools.

A Hackerspace or a hack space is a membership-based location featuring workshops, tools, and people; it is a location where people with common interests, usually in computers, technology, science, digital and electronic art can meet, socialize and/or collaborate. Many Hackerspaces participate in the use and development of free software and alternative media. Hackerspaces have been a self-forming organic concept. European Hackerspaces are places where local programmers meet and collectively work (Borland, 2007). Emerging from the counter culture movement (Grenzfurthner & Schneider, 2009), they are 'places where people can learn about technology and science outside the confines of work or school' (Farr, 2009). Activities in hacker spaces evolve around computers and technology, and digital or electronic art. Hackerspaces are founded as local initiatives following a common pattern, becoming a hacker space is predominantly self-declaratory.

A TechShop is a commercial venture that combines the concepts of Hackerspace, Fablab, prototyping studio and learning center. The TechShop provides member access to a significant list of equipment and software, in general over $1 million worth of professional equipment and software (Torrone, 2011). TechShop organizes a number of experience-driven corporate events developed specifically to bring teams together and engage them in the act of making.

100k-Garages is 'is a community of workshops with digital fabrication tools for precisely cutting, machining, drilling, or sculpting the parts for your project or product, in all kinds of materials, in a shop or garage near you' (100kGarages, 2010), supported by machine manufacturer ShopBot and the design sharing platform Ponoko. Most of these workshops are located in the U.S.A. and Canada (about 180), with five shops in Europe and two in Australia. As opposed to the other examples, 100k-Garages are providing a professional manufacturing service, rather than offering shop access to makers.

Hackerspaces and Makerspaces, per their name and definition, build on commons-based principles. 100k-Garages and TechShops use dedicated platforms to share (final) designs, yet their commitment to a commons-based peer production philosophy seems to be somewhat weaker. Fablabs' commitment to some kind of commons is more explicit. Economic growth requires continued entrepreneurial innovation and expansion (Kauffman Foundation, 2013; Schwab, 2012). Knowledge, research, innovation, learning and entrepreneurial spirit are crucial to long-term economic growth (Eaton & Kortum, 1996; Romer 1986). These commons-based peer production places that foster innovation and creativity can adapt faster to the new economy and sustain economic growth.

2.3.3 Impetuses that drive and strengthen Fablabs as Innovation Infrastructures for companies

Personal manufacturing technologies will profoundly impact how we design, make, transport, and consume physical products. As manufacturing technologies follow the path from factory to home use, like personal computers, "personalized" manufacturing tools will enable consumers, schools and businesses to work and play in new ways.

"The digital culture's dynamics have led to a general acknowledgment of data production as the most important future option. However, the production of things seems to be outdated: Factories are not sexy!" (Boeing, 2010) At the same time, there are developments and hints suggesting the digital future "lies outside the box, in making the box" (Gershenfeld, 2005). One will not be limited to making boxes, though. Since new technologies and machines enable people to easily produce chess pieces, jewelry, computers, batteries, teeth, yet action figures that look exactly like oneself (like proclaimed in the TV series Big Bang Theory) and all the other things one can imagine. The concept of turning ideas into things is probably as old as mankind. For a long time, one has been able to read and hear about enchanted lamps, mysterious stones and unknown cases that can make wishes come true and turn words into real objects. In the present digital culture, digital data can transform into material objects and the formerly fictional idea of such a 'magic machine' has been turned into reality, namely by the further dissemination of small, digitally controlled production machines in Fablabs, so-called "labs for fabrication" (Gershenfeld, 2005), that are accessible for a broad public. These machines "are the pint-sized, low-cost descendants of factory-scale, mass manufacturing machines" (Lipson & Kurman, 2010), for example 3D printers, laser cutters or CNC machines that produce objects on the basis of rapid prototyping, tooling and manufacturing (Chua et al., 2010). Such production machines are able to print, cut or mill objects from data files without any human intervention.

Fablabs are neither chambers of magic nor mere accumulations of 3D printers nor other fabrication devices. Fablabs are places where digital culture and material production merge and enter a new stage: There, one can find "collections of commercially available machines and parts lined by software and processes developed for making things" (Gershenfeld, 2005). These machines are based on digital technologies and operated with computers. In these facilities, people can create material objects that can be beautiful or practical, complex or simple, intelligent or not. Fablabs are open for interested individuals, such as artists, hobbyists and students, but also for entrepreneurs who want to "move more quickly from an idea or concept to a physical object or prototype, or […] want to experiment with and enhance their practical knowledge of electronics, CADCAM , design, 21st century DIY" (Eychenne, 2012).

Transformative change happens when industries democratize, when they're ripped from the sole domain of companies, governments, and other institutions and handed over to regular folks. The Internet democratized publishing, broadcasting, and communications, and the consequence was a massive increase in the range of both participation and participants in everything digital, the long tail of bits. Now the same is happening to manufacturing, the long tail of things." (Anderson, 2006). Personal manufacturing will transform the world of physical objects from a mass production-based, bricks and mortar model, to a long tail model made up of infinite shelf space, large numbers of custom products and global niche consumer markets. The power of a manufacturing facility contained within a small affordable device is an exciting prospect for industrial design. It changes the very nature of product development as it is done today. Manufacturers are increasingly shifting away from product design and focusing on producing product designs first developed and tested by user innovation communities (Von Hippel, 2005).Eric Von Hippel describes user-centered innovation as the converse of the traditional top-down product design and product manufacturing model in which companies conduct market research in order to design products and goods based on what they think users will buy. Wise companies will learn from their customers. Products designed by consumers may be more profitable than products conceived and designed using traditional market research and in-house engineering departments.

A major research study at 3M Corporation indicates that consumer-designed product improvements were more novel than the incremental product improvements dreamed up by in-house design teams and market researchers. In the same study, researchers predicted that new products created by passionate leading-edge consumers would end up with higher market share, and be more likely to evolve into an entirely new product lines that would earn an estimated five times as much as products dreamed up using traditional methods. (Lilien et al., 2002).

Several studies of the probability of success for new products, both consumer and industrial, show that despite the type of product, only about one quarter of newly introduced products survive their introduction to the commercial marketplace. Today, good companies keep their fingers to the pulse of their users' desires using market research, but even precise and diligent market research may not give companies an accurate picture of consumer needs. Most new products will fail shortly after they reach the market mostly because manufacturers failed to understand what users needed. (Henkel and Von Hippel, 2005). Why not give customers their own set of tools and ask them to design the product they would prefer to buy? A new type of innovation service provider could play a leading role in the front lines of toolkit programs for product design and manufacturing companies, creating and issuing targeted toolkits based on personal fabrication technologies, providing customer support, collecting kit feedback and organizing and making sense of user design prototypes and suggestions.

Bringing digital manufacturing capacity to the level of the individual is regarded by some as potentially disruptive (Lipson & Kurman, 2010). Disruptive technologies combined with practices and values aligned with empowerment and peer learning means the Fablab model could well be a stepping stone to more widespread implementations of distributed production – as an alternative to, or alternate form of, mass production. The Fablab community workspace removes barriers such as access to equipment and access to expertise. The Fablab's grassroots environment serves as an incubator for creative endeavors, job creation, economic development and research. Individuals applying scientific and mathematical principles to the practical design, manufacturing and operation of products (engineer, 2011) engage in engineering activities. Some individuals become entrepreneurs (entrepreneur, 2011) as they create businesses related to marketing and selling their newly engineered creations. Thus Fablabs help create "entrepreneurs" -individuals who design as well as market their own creations. Fablabs serve as "social engineering" agents that encourage systemic change in education and entrepreneurial environments (Gershenfeld, 2007).

Many authors have invoked the next or Third Industrial Revolution, not only Neil Gershenfeld (2005) wrote about "Fab The Coming Revolution on Your Desktop", Chris Anderson (2012) claimed that "In the Next Industrial Revolution, Atoms Are the New Bits" and added that 'Makers are "The New Industrial Revolution". Moreover, Jeremy Rifkin (2011) described 'The Third Industrial Revolution – How Lateral Power is Transforming Energy, the Economy, and the World'. According to Gershenfeld (2005), "possession of the means for industrial production has long been the dividing line between workers and owners. But if those means are easily acquired, and designs freely shared, then hardware is likely to follow the evolution of software. Like its software counterpart, Open Source hardware is starting with simple fabrication functions, while nipping at the heels of complacent companies that don't believe that personal fabrication 'toys' can do the work of their 'real' machines" (Gershenfeld, 2005). For Anderson, "the Third Industrial Revolution is best seen as the combination of digital manufacturing and personal manufacturing: the industrialization of the Maker Movement" (Anderson, 2012). This evidently has two aspects to it. First, digital tools and equipment are becoming widely used by makers both for designing and for manufacturing products, which makes sharing of and collaborating on designs over time and distances easier. Second, as files can be directly sent to machines for production (direct digital manufacturing), makers are able to use pooled manufacturing resources that are larger in scale than what any single maker possibly could afford.

The cost and complexity of digital fabrication are coming down very quickly, bringing the tools and capabilities for invention and innovation within the reach of almost anyone, almost anywhere in the world. That kind of democratic, distributed capability is revolutionary. It promises to change everything, the way we design, manufacture, finance, communicate and market for business, supply

chains, the platforms upon which we build businesses, the way we educate and conduct research. And a pioneering group of Fab individuals is constructing foundations to leverage and support the digital revolution in fabrication, foundations that merge design, Open Source collaboration, social networking, entrepreneurship and digital fabrication into something new and electric.

For Anderson, "the Third Industrial Revolution is best seen as the combination of digital manufacturing and personal manufacturing: the industrialization of the Maker Movement" (Anderson, 2012). This evidently has two aspects to it. First, digital tools and equipment are becoming widely used by makers both for designing and for manufacturing products, which makes sharing of and collaborating on designs over time and distances easier. Second, as files can be directly sent to machines for production (direct digital manufacturing), makers are able to use pooled manufacturing resources that are larger in scale than what any single maker possibly could afford. We are in the midst of a profound shift in the very way society is structured, away from hierarchical power and toward lateral power" (Rifkin 2011). Furthermore, for Rifkin, the Third Industrial Revolution includes a shift to green buildings, electric cars and distributed manufacturing: "a new digital manufacturing revolution now opens up the possibility of following suit in the production of durable goods. In the new era, everyone can potentially be their own manufacturer as well as their own power company. Welcome to the world of distributed manufacturing" (Rifkin 2011).

Table 2.2. Industrial revolutions and their drivers: communication and energy sources

1st revolution	**2nd revolution**	**3rd revolution**
19th century	20th century	21st century
Printing press	Radio, TV	Internet
Coal and Steam	Oil and Electricity	Renewable Energies

Source: Rifkin (2011)

Similar to Open Source software, this emerging ecosystem of Open Source hardware can be seen as a peer-produced commons, "thousands of volunteers collaborating on a complex economic project" (Benkler, 2002). Open Source hardware as a peer-produced commons might at least initially take different shapes in different economic contexts: "The killer app for personal fabrication in the developed world is technology for a market of one, personal expression in technology and the killer app for the rest of the planet is to overcome the instrumentation and the fabrication divide, people locally developing solutions to local problems" (Gershenfeld 2006). Such peer-production communities, including the Fablab community, are challenging some foundational assumptions about

the free market. “What was formerly taken for granted or minimized in free-market theory – the role of social and civic factors in economic production, is becoming a powerful variable in its own right” (Bollier, 2012), as David Bollier states. Christian Siefkes (2008) seeks to generalize peer production “into the physical world” and draws a picture of a society where peer production is the primary mode of production.

Neil Gershenfeld points out that the power of the Fablab community is the bottom-up application of technology outside traditional institutions: “The message coming from the Fablab is that the other five billion people on the planet aren’t just technical sinks, they are sources. The real opportunity is to harness the inventive power of the world to locally design and produce solutions to local problems. I thought that’s a projection twenty years hence into the future, but it’s where we are today. It breaks every organizational boundary we can think of. The hardest thing at this point is the social engineering and the organizational engineering, but it’s here today” (Gershenfeld 2006).

Communities, movements and collective action have been of research interest in social movement theory and the topic has recently gained interest in organizational analysis and design (Evans & Davis, 2005). Siobhán O’Mahoney and Karim R. Lakhani (2011) discuss the impact of communities on organizations, concluding the following four key points:

- Communities help organizations emerge.
- Communities mediate the performance and growth of organizations.
- Communities can pose competitive threats to organizations.
- Communities outlive organizations.

In this sense, the Fablab community today is both threatening pre-existing organizations built around the provision of and education about technology and possibly helping new organizations emerge. As Jeremy Rifkin points out, the Third Industrial Revolution will require “a wholesale reconfiguration of the economic infrastructure” (Rifkin, 2012) and “a massive retraining of workers on a scale matching the vocational and professional training at the onset of the First and Second Industrial Revolutions” (Rifkin, 2012). Fablabs can contribute to both the reconfiguration of the economic infrastructure and the re-training of workers.

According to Katzmair (2008), who analyzed the Austrian network of centers for technology, ideal networks follow a “center-periphery model” (Katzmair,2008). This model is a combination of the “single peaked network” (Katzmair,2008) that relies on one strong actor in the center, which attracts further actors, and the “multi peaked network” (Katzmair, 2008) that consists of many connected, equally strong actors. Referring to Schumpeter (1912), Katzmair argues that these centers are

important ‘hubs’ that stabilize an innovation landscape. We argue that Fablabs have a strong potential to serve as hubs in these networks of innovation (following the center-periphery model), and to support local embedded economies because of the following reasons:

- Fablabs are globally connected and also serve as a local hub at the same time, where actors meet, connect, and exchange knowledge and ideas.
- Fablabs provide access to tools for digital fabrication beyond production for personal needs. Fabrication in Fablabs has a professional character.
- The actors involved in Fablabs are committed to an Open Source and Open Design mindset and are driven by the awareness of global economical and ecological problems.

With Fablabs, new ways of manufacturing come to the people. On the one hand, some machines may make certain arts and crafts skills obsolete. On the other hand, it opens up new ways of production to the individual, opening up novel opportunities for DIY.

Fablabs do not offer just a low threshold, but also wide walls and high ceiling (Schelhowe, 2012). To illustrate this with an example: One can start by downloading a digital model from the web, then open the file with a tool to print it, or send it over to a 3D printing organization or someone at the Fablab who can print it. This is a low threshold. But one could then continue using digital crafting tools, like 3D programs, to customize that model one wants to print, to create new models, and so on, hence exploring a range of possibilities like moving along on wide walls. At a later point, one might wish to improve the printing output and thus get involved in the printing process, and eventually assemble or even develop one’s own 3D printer, and thereby – literally speaking – climb up the ceiling.

Being accessible for everyone, Fablabs can open a real avenue for insights into how post-modern production works. They are environments for “Building” in the sense that individuals cannot only develop their personality but also their relation to the world and to society. In combining a very practical approach with complex theoretical insights, Fablabs incarnate accesses to understand the today’s world. This is what Ann and Mike Eisenberg called “tangible expressions of important ideas” (Eisenberg & Eisenberg, 1999, when they spoke about using robots in education, or when Murray (2003) said about digital media, “the digital medium is as much a pattern of thinking and perceiving as it is a pattern of making things. We are drawn to this medium because we need it to understand the world and our place in it” (Murray, 2003).

In Fablabs, learners meet communities of creative people with very different backgrounds and knowledge who help and inspire each other, and where learners can integrate. Fablabs also connect to network communities, where Jenkins locates the dawn of a new “participatory culture” (Jenkins,

2006) that characterizes, in his point of view, the young generation. “Play, Performance, Simulation, Appropriation, Multitasking, Distributed Cognition, Collective Intelligence, Judgment, Transmedia Navigation, Networking, Negotiation” (Jenkins, 2006) are characteristics that Fablabs connect to the interests and needs of youth in a digital culture.

2.3.4 Discussion

Globally, Fablabs are emerging. What are the impetuses that drive the expansion of these industries? We have just seen many related studies on Fablabs that attempt to answer this question from a broad perspective, situating this new industrial revolution and a new way of manufacturing in the changing socioeconomic context as it instills some of the key changes in the modern economy. These changes or development trends drive the rapid expansion of the digital manufacturing and new benefits for companies, especially SMEs.

The literature review in this chapter shows that Fablabs have many positive effects on innovation, companies, civil society and individuals. The various contributions of Fablabs apparently show that the emerging Fablabs can help the Italian Industry achieve comprehensive innovation and economic development and growth. Therefore, this study attempts to integrate the theories of Fablabs and innovation infrastructure to find an effective approach to achieve comprehensive development for the Italian Industry.

CHAPTER 3 METHODOLOGY

Chapter 3 contains a description of the methodology used to conduct a qualitative case study of the Italian Fablabs community. Specifically, the purpose of this research study was to determine the causal relationships between Fablabs and the Italian Industry and to develop theory regarding this new field of research. The seven major components of this chapter include the assumptions and rationale for a qualitative study, setting and participant selection procedures, informed consent and permission procedures, data collection procedures, data quality procedures, data analysis procedures, and a brief summary. In addition, subheadings within each section provide detailed descriptions which include the role of the researcher, assurance of confidentiality, focus group protocols, and the credibility and dependability of study results.

3.1 Research Questions

Four specific questions guided this study: (1) How effective have Fablabs been in attracting, diffuse knowledge, give access to technology and fasten time-to-market to companies?, (2) Have companies which use Fablabs services stopped making prototypes in their home locations or are they referring to external companies and preferring Fablabs prototyping services?, (3) How effective and important Fablabs can be for Italian companies?, and (4) Do the physical infrastructures and human resources inside Fablabs (buildings, layout, facilities) help facilitate collaboration and accelerate idea generation and innovation?

3.2 Assumptions and Rationale for a Qualitative Design

3.2.1 Type of Design

A qualitative design was selected to conduct a case study of the Italian Fablabs community. Creswell (1998) defines qualitative research as "…an inquiry process of understanding based on methodological traditions of inquiry that explores a social or human problem". Qualitative research is conducted in a natural setting and seeks to explore human behavior within the context of a bounded program. The qualitative researcher wants to answer the "what" and the "how" questions. The "what" question may involve a phenomenon, a person, or a program; whereas, the "how" question looks at the effects of the study focus on all stakeholders within a bounded system (Hatch, 2002). A case study approach was selected based on its usefulness and appropriateness for this particular study. According to Yin (1994), a case study is a special kind of qualitative work that investigates a contextualized, contemporary phenomenon within a specified boundary. Merriam (1988) presented examples of a

bounded phenomenon in education as "…a program, an event, a person, a process, an institution, or a social group". Case study characteristics include examining a particular subject bounded in time and space, providing a detailed description of contextual material about the case setting, gathering extensive material from multiple sources to provide an in-depth picture of the case, and using the researcher as an instrument of data collection (Creswell, 1998). This qualitative case study was conducted using the philosophical assumptions of Epistemology and Methodology. The Epistemology research paradigm examines the relationship of the researcher to the research and involves the researcher as a data collection instrument. The goal is for the researcher to get close to the subject being researched. The researcher is able to meet this goal due to his position in the field of study as he is considered an "insider" by the participants. The Methodology research paradigm involves the rich descriptions of the case and its setting as well as the use of an inductive data analysis approach. Methodology also requires a study to be conducted within its context using an emerging design. The researcher followed this process in data collection and analysis (Creswell, 1998; Hatch, 2002). In summary, the researcher's selection of a qualitative case study provides the best method to study a school division's leadership academy for the following reasons. First, the system to be studied is a bounded system unique to this particular school division. Second, a case study approach allows the researcher to serve as a data collection instrument when conducting interviews or observations. Third, the program under review is described in great detail by the researcher. Fourth, the researcher organized and analyzed the data according to general themes first before honing in on the most salient themes. Finally, the results are presented in such a manner to benefit the school division as they continue to modify the leadership academy program to meet the needs of all stakeholders. Role of the Researcher Creswell (1998) defined the role of the researcher in qualitative research: "The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting" (p. 15). Merriam (1988), Yin (1994), Patton (1990), and Hatch (2002) cite the role of the researcher in qualitative research as a data collection instrument. Data collected by the researcher in this study includes interviews, observations, field notes, and document reviews. The researcher in this case study not only works in the school division but also has participated in and graduated from the leadership academy under review. Thus, the researcher considered the concept of Reflexivity as an essential component to ensure the integrity of the study. Hatch (2002) defined reflexivity as the researcher's ability "to keep track of one's influence on a setting, to bracket one's biases, and to monitor one's emotional responses". Therefore, it was imperative for this study to admit my positive attitude about my work experiences in working in a Fablab. My personal experiences inside one Fablab included two distinct components of the Fablab community. The first involved my internship inside one Fablab and occurred during my second year as PhD candidate. This experience

helped me to complete more effectively the daily responsibilities of my position and at the same time exposed me to specific aspects of the role of working as a "Fabber" and at the same time as researcher. My second encounter with the Fablabs community was during the second and third year as a PhD candidate. I participated in seminars and activities designed to help companies to get know the Fablabs community and all the services and tools offered. In addition, during my internship in the lab, I was assigned several undergraduate students to serve as their mentor during their semester. The practical internship held provided me with the ability to handle a myriad of responsibilities on a daily basis. These responsibilities included budget, working with all the digital fabrication tools, knowing the software for rapid prototyping, supervision of undergraduates students, and community relations. At the beginning, the anxiety level with some of these tasks was enormous and I was grateful to my University for allowing me to have this practical internship and at the same time conducting my academic job. The opportunity to participate in such internship designed to teach "real" tasks associated with the principalship was of great value to me as PhD researcher. To control for any bias, Epoche will be employed. Patton (1990) discussed epoche in terms of the researcher's need to become completely aware of personal bias and to control this bias to gain clarity or eliminate preconceptions. This clarity of awareness is necessary for the researcher to bracket or separate any preconceptions about the effectiveness or importance of the leadership academy (Moustakas, 1994).

3.3 Setting and Participant Selection Procedures

3.3.1 Selection Process

The study selection process emerged from the research documented in the review of literature as well as my work experience as PhD researcher. The literature illustrated the need to investigate this new phenomena that it is changing and introducing new opportunities in the businesses landscape by offering alternative pathways for pursuing innovation and technology advancement for interested companies that do not have the requisite knowledge, availability of funds and technologies degree for realizing what a Fablab allow them to do. I was fortunate enough to work in a Fablab while I was conducting my study. The combination of the review of literature and my work experience framed the selection of the Fablabs in Italy and the program for review in this study.

3.3.2 Setting Participants

This study was conducted taking in consideration several Fablabs (hereafter referred to as in alphabetic letters) in all Italy.

The researcher selected a purposeful sampling method in conjunction with criterion and stratified sampling to select study participants. Purposeful sampling is a logical and powerful sampling method that allows for relatively small samples to be selected purposefully. Purposefully means the selection of information-rich cases that are subjected to in-depth study (Patton, 1990). Patton noted that information-rich cases are cases where the researcher "…can learn a great deal about issues of central importance to the purpose of the research". The researcher included criterion sampling as the method to select a purposeful sample of information-rich cases. Patton (1990) found that utilizing more than one sampling method, or mixed method, would further contribute to sample reliability. Criterion sampling is a quality assurance approach that allows the researcher to study cases that meet certain predetermined criterion of importance. The researcher has established specific criterion, **Figure 3.1**, for participation in the study. First, study participants must have been employees of Fablabs and must have served in an administrative capacity at some time. Second, the managers/directors were separated into groups based on their position, level of administration, and their tasks. From this group I selected the members of the two managerial focus groups using stratified random sampling. Third, the four administrative personnel who work with Fablabsmanagers were selected to participate.

Figure 3.1. Criterion Sample Selection Matrix

Case Study Focus Group Participants
Fablabs Managers
Assistant Fablab Managers
Administrative Personnel and other workforce

Source: Author (2016)

Study participants were selected from a population of 52 Fablabs in all Italy. I assigned each prospective participant from each of the stratified groups a number beginning with one and continuing sequentially until all potential participants had been assigned a number. A random number generator was then used to select the random sample for inclusion into focus group one and focus group two.

Focus Group Three consisted of the five administrative personnel who complete the Fablabs workforce.

3.3 Informed Consent and Permission Procedures

Prior to conducting the study, I reviewed the ethics and procedures for conducting research presented by Patton (1990) and Lock et al. (2000). Full and complete disclosure to all participants at all times during the study was followed. I strictly adhered to all procedures and regulations prescribed by my university. Specifically, I completed the necessary paperwork to gain the approval of the several Fablab' Managers to conduct research within their lab as well as to complete all requirements set forth by my university. With the approval of both parties, then I selected participants for the study and sought their permission using all prescribed procedures. Participants were given an informed consent form to sign that follows Creswell's (1998) model for gaining consent approval. Components of this approval include: (a) participation in the study is voluntary, (b) the participants right to withdraw at any time from the study, (c) the purpose of the study and the data collection procedures to be used, (d) an assurance of confidentiality statement, (e) a statement listing any risks to the participants, (f) any expected benefits to the participants, and (g) a signature and date line giving permission to participate in the study. The final stage in the informed consent process involved me providing all consent form signed documents to all participants prior to the interview. I instructed the participants to review the documents carefully and to ask questions if they did not understand any part of the documents. On the day of the interview, I again reviewed the documents and provided an opportunity for questions prior to beginning the formal interview.

3.3.4 Assurance of Confidentiality

I took every precaution to ensure the confidentiality of participants. Interviews were audio-taped and transcribed verbatim; however, I used a coded system when presenting interview question responses to protect the identity of participants. No information was released to any party listing the actual name of the respondent without the express written consent of said respondent. Finally, the audiotapes were destroyed at the completion of the study.

3.4 Data Collection Procedures

3.4.1 Focus Groups

Focus group research involves an organized group interview that allows the researcher to obtain several perspectives on the same topic in a relatively small amount of time (Patton, 1990). Powell et al (1996) defines a focus group as "A group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research". Focus groups are generally comprised of a homogenous group, with regard to specific characteristics, of six to ten people (Powell & Single, 1996; Patton, 1990). The researcher will follow focus group protocols when selecting participants for this study. Focus group research has both benefits and limitations to be considered by the researcher. The benefits of focus groups to the researcher include the opportunity to conduct multiple interviews at the same time as well as to gain the insight and data produced by the interaction between participants. Limitations to be considered are the difficulty in keeping participants focused on the topic, ensuring that all group members have the opportunity to provide input, and outcomes which cannot be easily predetermined (Gibbs, 1997). Patton (1990) concludes that focus group interviews are indeed interviews and therefore require the same quality controls as a one-on-one interview. Conducting a focus group interview requires the researcher to carefully plan for a structured approach in five areas: (a) preparing for the session, (b) developing the questions, (c) planning the session, (d) facilitating the session, and (e) ending the session (McNamara, 1999). Preparing for the session involves identifying the major objectives of the meeting, notifying participants of the exact time and location of the interview, and gathering all needed materials for recording the interview session. Developing the questions involves a careful review of the topic and literature to create questions that are clear, concise, and designed to gather the necessary data for the study. Planning the session involves several items which include: (a) scheduling a one to two hour time period to conduct the interviews at a convenient time for all participants, (b) selecting a comfortable location with preferably a large circular table, (c) providing name tags and refreshments for the participants upon arrival, (d) establishing the ground rules in advance, (e) developing and sharing a comprehensive agenda, and (f) securing all equipment needed to audiotape the interview (McNamara, 1999).

Facilitating the session involves a general introduction of participants and an ice-breaker activity. This is followed by a detailed explanation of interview protocols, agenda review, and answering any questions which the participants may have. Next, the question and answer period begins and the researcher, referred to as a moderator in focus group research, is tasked with ensuring that each question is accurately presented and that even participation of group members exists. Finally, the

researcher closes the session by reviewing the occurrences of the meeting, thanking the participants for attending, and adjourning the meeting (McNamara, 1999). Immediately after the session the researcher must complete several tasks. These tasks include verifying the tape recorder captured the entire interview, clarifying any notes made during the session, and noting any unusual occurrences or comments from the interview.

3.4.2 Focus Group Interview Protocol

In a focus group setting the researcher serves as the facilitator or moderator. Gibbs (1997) discussed the important role the moderator plays in focus groups, "The role of the moderator is a demanding and challenging one, and moderators will need to possess good interpersonal skills and personal qualities, be good listeners, non-judgmental and adaptable". Hatch (2002) and Patton (1990) presented the role of the moderator as the group facilitator who encourages participants to engage in high quality dialogue centered on the topic of interest. The use of a field test provided the researcher the opportunity to practice his group interview skills.

Interview procedures that are research based were used and all protocols were strictly followed. The researcher followed Creswell's (1998) model for an interview protocol.

Components of the interview protocol include the title of the project; the date, time and place of the interview; the name of the interviewer and the interviewee; a brief description of the project; the interview questions; and a closing remark thanking participants for their time.

3.4.3 Focus Group Interview Questions

I used open-ended questions to solicit the opinions of participants. Patton (1990) noted "the purpose of open-ended questions is not to put things in someone's mind, but to access the perspectives of the person being interviewed". Research questions were correlated with interview questions to ensure that data from the interviews would yield findings that corresponded with the research questions. **Table 3.1** presents a matrix illustrating this correlation. Content validity for the interview instrument was reached through the consultation with other PhD candidate and University professors both in USA during my internship and in Italy at my University, followed by a field test of the instrument with a select group of scholars. Results of the field test allowed me to assess the clarity, readability, and reliability of all questions. Field test results yielded the required 80% benchmark for clarity, readability, and reliability thus, no changes were made to the questions.

Table 3.1. Chain of evidence matrix

Research Question	**Focus Groups**
1. How effective have Fablabs been in attracting, diffuse knowledge, give access to technology and fasten time-to-market to companies?	1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why? 2. What benefit in terms of R&D and manufacturing time and costs did the Fablab provide for Italian companies?
3. Have companies which use Fablabs services stopped making prototypes in their home locations or are they referring to external companies and preferring Fablabs prototyping services?	3. What do you see as the strengths of your prototyping service? 4. Do you feel that Fablab's services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?
5. How effective Fablabs can be for italian companies?	5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why? 6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?
7. Do the physical infrastructures and human resources inside Fablabs (buildings, layout, facilities) help facilitate collaboration and accelerate idea generation and innovation?	7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?

	8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking? 9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?

Source: Author (2015)

Open-Ended Interview Questions (Focus Groups)

1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?
2. What benefit in terms of R&D and manufacturing time and costs did the Fablab provide for Italian companies?
3. What do you see as the strengths of your prototyping service?
4. Do you feel that Fablab's services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?
5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why?
6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?
7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?
8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?
9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?

3.4.4 Field Test

The interview instrument used in the three focus groups was field tested by a select group of Fablab Managers, their assistants and Administrative Personnel and other workforce. The field test group

included two Fablab manager assistants and four administrative personnel. Field test group responses were used to assess the clarity and reliability of questions in measuring the respondent's level of preparation for the interview. Feedback from the field test group required me to edit some interview questions.

3.4.5 Data Quality Procedures

I used prescribed data quality procedures to ensure that the study was credible and valid, the results are transferable, and the methods are dependable. The combination of the three lends rigor to the study and provides support to the results (Creswell, 1998; Patton, 1990; Miles & Huberman, 1984). This section details the procedures used to ensure credibility and validity in conducting the study and presenting results.

3.4.6 Credibility

The goal of qualitative inquiry is to provide high quality data that are credible, accurate, and true to the subject under study. In qualitative inquiry, the researcher serves as the data collection instrument and requires that he/she carefully reflect on, deal with, and report potential sources of bias and error. Credible research requires that the researcher remain neutral at all times with regard to the subject under study. In this study I entered data collection with no predetermined outcome theory. Further, I was committed to reporting results accurately with the sole purpose of fully understanding the study under review. I added to the validity of this study through data triangulation. Patton(1990) notes that triangulation is an important way to strengthen a study design. Data triangulation involves collecting data from a variety of sources. Patton concludes,

"Combinations of interviewing, observation, and document analysis are expected in much social science fieldwork". I triangulated his data by conducting interviews in focus groups, completing observations of the academy program, and reviewing appropriate academy program documents to add to the validity of this study. Results were reported in a thorough manner noting all processes for gathering, analyzing, interpreting, and reporting data.

3.4.7 Data Analysis Procedures

Miles and Huberman (1984) list three concurrent flows of activity in data analysis: data reduction, data display, and conclusion drawing/verification. The researcher's challenge is to make sense out of

a massive amount of data, to organize the data by patterns or themes, and to communicate the essence of what the data reveals (Patton, 1990; Hatch, 2002). The researcher used three areas to present his plan for data analysis. They are data management, data analysis, and data representation. This section details the methods used to organize and reduce raw data into meaningful pieces, and to transform the meaningful pieces into results.

3.4.8 Data Management

In this case study, I collected data from three sources that included focus group interviews, document analysis, and observations. Creswell (1998) suggests that the researcher decide early on how he or she will store data in a structured, organized format, and in a safe location to ensure its protection from damage. The researcher exercised care to accurately and systematically collect and protect data throughout the duration of the study.

My purpose in the focus group interviews was to investigate whether Italian Fablabs under the point of view of their managers can play an important role for Italian companies. To collect focus group interview data, I used two tape recorders to record the interview session and had a secretary take anecdotal notes. I made this decision based on the nature of conducting focus group interviews. In focus group interviews, the researcher acts as a moderator or facilitator who has specific responsibilities to follow (Patton, 1990; Hatch, 2002; Gibbs, 1997). I did not feel comfortable taking notes and moderating the interview session at the same time. Therefore, I enlisted the assistance of a secretary to take notes during the interviews to add to the richness of data collection.

At the conclusion of the focus group interviews, I had the secretary type her notes and transcribe verbatim the audio-taped interviews. Focus group participants were coded according to a number (1-18) and a letter (A-C) given by me prior to the start of the interview. The number sequence represents the 18 participants in the three focus groups. The letter designation represents each of the three focus groups. The participant referred to himself as “1A” or “2C” depending on the number and group they are in. My primary purpose in reviewing documents was to investigate whether Fablabs in Italy can be really useful for Italian economy and companies and if so far this goal has been reached. To gather the necessary information, I extensively reviewed all documents with regards to the Fablabs, Fablabs in Italy, Italian economy structure and Italian companies. My purpose in conducting observation was to provide a third data source to add to the depth, richness, and validity of study results. Observations included a review of my anecdotal notes from my experience as intern in one Fablab as well as a visit by me to several Fablabs in Italy and other makers events. At the conclusion of the observation, I organized my notes according to prescribed data collection methods. I followed Creswell’s (1998)

suggestion to use an initial sorting process of field notes into some means that allow the researcher to recognize recurring patterns or themes from the data.

3.4.9 Data Analysis

Data analysis in a qualitative case study consists of a detailed description of the case and the setting (Creswell, 1998) in conjunction with a structured approach at analyzing results. The researcher used the constant comparative method of data collection to identify general themes first followed by a detailed discussion of the most salient themes. The constant comparative method is a detailed organizational data analysis process where the researcher follows a prescribed format. This format, endorsed by Maykut and Morehouse (1994), includes: (a) reading and coding each data piece carefully, (b) organizing each data piece into categories, (c) comparing each new data piece to existing categories to determine whether the new data fit an existing category or falls into a new category, (d) looking for emerging themes within each category, and (e) repeating the process for finding the most salient themes. Patton (1990) refers to this type of analysis as inductive. Inductive analysis allows categories "…to emerge from patterns found in the case under study". The researcher used the constant comparative analysis with the focus group interviews, document reviews, and observations. Data collected from each focus group was first organized by group. Within each group, the researcher looked for categories to emerge that help determine if really Fablabs in Italy can play a critical role for Italian companies. Next, I compared the categories from each focus group to identify recurring themes that help illustrate the level of preparedness of academy program graduates. These themes were then compared to find the most salient themes affecting principal preparation.

Data collected from document reviews and observations were used to supplement the focus group interviews. Specifically, the researcher reviewed each of the documents and observations to determine where they fit into the emerging themes found in the focus groups. The triangulation of data allowed the researcher to present a rich, detailed description of the academy program as well as add support to study conclusions.

3.4.10 Data Representation

The final piece of data analysis involves representing and reporting results. Creswell (1998) refers to this phase of data analysis as the "…packaging of what was found in text, tabular, or figure form". Merriam (1988) noted that "There is no standard format for reporting case study research". The real issue is to accurately portray the results in such a form to thoroughly educate the reader on the subject

under study (Patton, 1990). The researcher used a combination of methods to represent and report findings in this study. A narrative format was used to provide the reader with detailed descriptions of the Fablabs reality and ecosystem as well as direct quotations to provide the reader access to the thoughts of the participants. Tables and figures were used to enlighten the reader to contextual data and to illustrate theme development. The goal was to present a report that is both readable and understandable.

3.5 Discussion

This chapter began with an overview of the methods and a list of questions that led me to my research question. I presented my rationale for selecting a qualitative inquiry using a case study approach to conduct my study followed by my philosophical assumptions, Epistemology and Methodology, and how they fit into the case study method. Next, my role was presented with a discussion of how reflexivity and epoch will impact this role. The setting and participation selection process detailed my decision to select several Fablabs in Italy as the subject of study.

Purposeful sampling using a specific criterion to select participants was chosen to provide me with an information-rich group from whom to collect data. Further, a detailed description of the Fablabs in Italy and Italian economic system was provided to give the reader a sense of the significance of this study. The procedures used in the research to gain access and entry from Fablabs, approval from Fablabs Managers, and informed consent from participants followed. A description of focus groups and interview protocols were then presented. In addition, I presented the interview questions and the methods for validating the interview instrument. Data were collected from focus group interviews, documents, and observations. The subsequent data were then gathered and reported in a truthful fashion using prescribed research-based methods to add credibility and validity to results. Next, data were coded and organized in a systematic fashion to help the research reveal the most salient themes. Finally, a narrative approach in conjunction with tables and figures was used by me to present findings.

CHAPTER 4 DATA

The purpose of this study was to understand the role that Fablabs play for the Italian industry, explaining how digital fabrication technologies can help Italian companies to be more competitive. Based on the literature review, an analytical framework that links the concepts of Innovation, Fablabs, and Italian Industry was built to address the four key research questions. This possible relationship between Fablabs and Italian companies. Data were gathered in the form of focus group interviews, document reviews, and observations. Three focus groups were formed from a sample (N = 18) of Fablab' Managers, Assistants Fablab Managers and Administrative Fablabs Personnel. Documents for review included the Fablabs charts, mission statement**,** budget, design, methodology, staff characteristics, and Fablabs statistics. Observations included a review of my anecdotal notes from my internship experience in one Fablab as well as a visits by me to several Fablabs in Italy. The sample for focus group one (N = 6) was drawn from a population of 52 Fablabs in Italy by taking in consideration just the main manager/director of the lab. Each of the managers was assigned a number between 1 and 6. I contacted as many Fablabs as possible and first six that accepted to join to the study were invited to participate. Once, selected the sixth participant who agreed to participate, I obtained the sample of six for focus group one. The sample for focus group two (N = 6) was always drawn from a population of 52 Fablabs with more than 200 Assistants Fablab Managers. However, the assistant Fablabs Managers were selected within the six original Fablabs who accepted to take part in the study. Each of the assistants Fablab Managers was assigned a number between 1 and 6. In this way, I obtained my sample of six for focus group two. Focus group three was comprised of the complete population of administrative Fablabs personnel (N = 6). The 6 administrative Fablabs personnel were selected based on their job and task within their Fablab and especially if they executed jobs for companies.

For all focus groups, participants were provided a copy of their own transcribed comments to review and edit for accuracy. This provided the research with content validity in reporting participant responses. Results reported in chapter 4 are in both a narrative and tabular form. The findings section includes a narrative presenting the results from each focus group interview, followed by a report by question according to common themes. From the list of common themes, I present the emerging themes. Data from reviewed documents and observations are included where applicable in the results. Finally, the summary section concludes the report of findings and previews Chapter 5.

4.1 Findings

4.1.1 Focus Group One A

Focus group one was comprised of six Fablab Managers/directors. The results for each question are reported in a narrative format.

1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?

All six participants noted how their Fablabs and all the services offered were a benefit for each company that start dealing with the lab. Participant 3A stated, "We offer to companies the possibility to take advantage of increasing accessibility to versatile and powerful digital design and fabrication tools. I think that we were effective because Fablabs worldwide created a maker community that shares knowledge on a widely distributed basis. Entrepreneurs don't often get the opportunity to network with their counterparts because they are so isolated in their companies." In addition, all six noted the overall professional experience in the Fablabs as either beneficial or very beneficial for companies. Comments included, "I found entrepreneurs very satisfied," "Fablabs often provided knowledge of technology no previously known by companies", "It was very beneficial for SMEs and startups to have access to information and knowledge fundamental for their development" and finally "Several entrepreneurs stated that being inside a Fablab was a very rewarding experience and enriched their point of views." Four of six noted how exposure of a company to a Fablab, was a benefit for the company in terms of facilitation exchange of knowledge, ideas and resources. Participant 5A stated, "Fablabs strive to achieve more equal participation and inclusion of entrepreneurs in knowledge transformation processes for a future society by establishing integrative public spaces where citizens and entrepreneurs are provided with open access to information and knowledge." Participant 4A noted, "They are supposed to share new information and knowledge back that will be useful for their production activity." Finally, all six noted how Fablabs were a very powerful tool for diffusing knowledge to companies thanks to a well organized international and regional Fablab network. Participant 1A cited some of this platforms, "FabConnections is a web-based platform for linking business ideas incubated in Fablabs to development services including crowd-funding, enterprise advice, and attaining sponsorship." Participant 2A stated, "The main international network is the Fab Foundation. The Foundation helps in diffusing knowledge, as well as providing support for those Fablabs that wish to take part. Recent supportive platforms include a

FabEconomy initiative which connect Fablabs with companies, which seeks to network and promote a new economic paradigm based on globally distributed peer design with customization and production locally." Participant 6A concurred, "I think that thanks to Fablabs and the several Fablab platforms, companies are supposed to share new information and knowledge back into their daily activities, receive training on the usage and further development of digital technologies gain affordable or free access to the technologies and/or methodologies for the production of their products."

2. What benefit in terms of R&D and manufacturing time and costs did Fablabs provide for Italian companies?

Five of six noted how a Fablab is a place for small and medium size companies to have a place to do R&D in the market and give companies access to technology they would not ordinarily have. Participant 5A stated, "A Fablab has quite some potential when it comes to knowledge and technology transfer." Participant 1A concurred, "Fablabs promise a degree of productivity, which is highly relevant for competitiveness and wealth of almost any company, helping those without technical skills or availability of technology to get products to market." and 2A noted, "In a traditional world, innovative products are developed on the basis of rapid prototyping at R&D departments of privately owned companies or at laboratories of universities and research institutes. Instead, in a Fablab small group of experts has the possibility to produce prototypes in short time and using simple means." Four of six noted how Fablab tools and machines could cut the cost of market entry for new companies. Participant 3A noted, "The use of Fablabs technology to lower tooling costs makes it cheaper to begin manufacturing, even at low volumes, or to serve niche segments." Participant 5A concurred, "The direct manufacturing of end products greatly simplifies and reduces the work for a SME who would only have to take products from its computer screen to the Fablab." In addition, all six noted how Fablabs can effectively save weeks off the development cycle and dramatically accelerate time-to-market of new products. Participant 2A stated, "Just-in-time manufacturing is a feature of Fablabs and it is the opposite of what architects and contractors usually anticipate. Often, the schedule for a large new building hinges entirely on whatever specified product has the longest lead-time for production. So if the means for producing a building product is located right on the job site, the cost of scheduling and transporting is neutralized. And a Fablab does not care if the building product is a one-of-a-kind shape or a recurring one. After all, we're printing it and cutting it right now, made to order, so, it is faster and cheaper." Participant 3A noted, "Usually, when you go to an external company that offer services similar to Fablabs, you think that turnaround time with outsourcing only takes 2-3 days to get models back. This is rarely the case. In fact, it takes around a

week. So, when taking into account internal design review meetings, order placement, approval processes, and other procedures, the total design delay time can be five or 10 times the actual turnaround time when outsourcing. In many cases, this process may be repeated two or three times before a product design is finalized for production, compounding the time-to-market delays. Delayed time-to-market is not the only cost. Even though some things can be done in parallel, it is estimated that a significant amount of time spent waiting for models to return from an outsource provider is wasted design time. In comparison, in a Fablab a prototype model can be produced within hours, rather than days. Not to mention additional time saved by printing during the night or over the weekend when no one is at the office." Participant 6A concurred, "Today, time-to-market is critical, but not if it means sacrificing quality and performance. Testing, early and often, is the key to keeping a project on schedule and the product on target, and the ability to turn CAD models directly into prototypes has made that testing possible. Fablabs own this ability."

3. What do you see as the strengths of your prototyping service?

All six noted that Fablab rapid prototyping helps companies turn great ideas into successful products faster than ever before. Participants 1A, 3A, and 5A made a similar statement, "3D printing your prototypes directly from CAD data enables fast, frequent revisions based on real-world testing and feedback." 2A noted stated "The rigorous testing, evaluation and refinement inside the lab are the best means to assess what works and what doesn't. Through this approach rapid prototyping with 3D printing provides the flexibility required to make this crucial trial and error process possible for physical products." Participant 6A noted, "Prototyping in a Fablab can cut costs and make your development cycle quicker and more effective. Our 3D printing services gives to a company the ability to test out prototypes on customers or people in your organization. Testing and getting feedback along with iterations help eliminate mistakes further along." Participant 5A supported this**,** "Test in the real world is so important for a company, know exactly how your products will look and perform before investing in tooling. A company can 3D print in a Fablab short-run tooling to prove out your products and manufacturing processes before making big investments." Four of six noted how prototyping in Fablabs can reduce scrap and rework and communicate better ideas about the prototype to be realized. Participant 4A supported this, "In general, the later a problem is discovered, the more costly it will be to correct. Finding and fixing problems early in the design cycle is essential to preventing scrap, rework and retooling. Rapid prototyping with Fablabs 3D printing allows industrial designers and engineers more revisions in less time, so they can test thoroughly while still reducing time-to-market." Participant 2A noted, "Physical models convey ideas to collaborators,

clients and marketers in ways computer models can't. Fablabs rapid prototyping facilitates the clear, detailed feedback essential to product success, and lets entrepreneurs quickly respond to input."

4. Do you feel that Fablabs' services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?

All of six noted how beneficial the Fablabs for the sector of prototyping services are. Participant 2A stated, "Fablab services and especially the use of 3D printing has grown in Italy and this technology is being adopted by more and more small and medium enterprises around the country allowing businesses to get customized products and services." Participant 6A concurred, "Three-dimensional (3D) technologies and services for rapid prototyping have become more affordable in Italy over the last decade thanks to the born of Fablabs. Any companies can take advantage of them during the packaging design process and the realization of prototypes is now possible in a cost-effective and timely manner with these technologies." 1A noted, "One of the biggest benefits of working with Fablabs, is the personal service. Fablabs not only provide companies with expert advice and guidance often for free, but also connected SMEs with funders, other entrepreneurs and outside support. This generated referrals to new projects and clients who were not aware of what they do, and helped them and us almost double our work annually."

Four of six noted how the traditional actors of prototyping services are losing markets and always more and more companies are coming to their Fablabs. Participant 5A stated, "The main PROs for companies to come to Fablabs rather than referring to an external business are the affordability of service, companies pay for only what they need and one-stop shop feature, Fablabs offer a range of capabilities, from designing an initial concept to printing it." 4A presented these benefits, "We offer an external perspective, a fresh set of eyes on your ideas can be helpful. You can forge valuable partnerships with different companies and Fablab personnel professionals and tap into a greater range of capabilities and expertise. We have always new materials, companies can try new technologies and different materials without committing to only one." Participant 3A stated, "SMEs that are now our clients referring us that prototyping companies were more expensive, referring to specialized companies can be costly depending on what you buy and the services you choose. You need always an investment in resources, even if you do go completely outside, you still need someone in-house to manage the process on your end. In addition, there is a greater risk that you could lose intellectual proprietary info if the other part don't maintain confidentiality."

5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why?

All six noted how beneficial and important Fablabs are for the competitiveness and growth of Italian companies. Participant 4A stated, "I think of the ABC's of Fablabs: A stands for academics, B for business and C for community. Fablabs can be a new free network for Italian companies. We can be a network where small businesses needing assistance developing products into saleable products." Participant 3A noted, "The big opportunity that we offer to Italian companies that mostly have really small size with often a low power of spending is the opportunity to cost-effectively prototype a variety of new products and business applications." Finally, 1A stated, "Fablabs provide to SMEs access to the tools needed to conceptualize, design, develop, and test new products. All what they need to compete with foreign companies." Four of six noted that Fablabs are particularly beneficial for SMEs which made up the 99% of Italian economy. Participant 6A stated, "We empower SMEs to realize their ideas and to engage in a global community of technology and makers, providing them new digital machines." Participant 5A supported this benefit, "we help those without technical skills or availability of technology to get products to market, an opportunity for SMEs to have access to technology they would not ordinarily have." Participant 2A stated, "Through the use of Fablabs' tools also SMEs can now generate fast paced electronics, come up with a way to build quickly and to replicate the fast production process."

6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?

All of six noted the value of this question because it is one of the main goal of all Fablabs worldwide. Participant 2A stated, "Once people learn the basics of the Fablabs' computers and manufacturing equipment, they can start developing their own solutions to local problems. A great and famous example, was in rural India, where inventors at the local Fablab were developing a machine to measure the fat content of milk and to sound an alarm when that milk is about to turn sour, and this was important for local dairy farmers." Participant 3A concurred, "Unemployment is high in South of Italy. The presence of Fablabs in the south can educate young people, getting kids to come into the Fablab and come up with ideas that can sustain their lives. Meanwhile, dozens of children are getting their first taste of technology, one day they will be the future workforce." Participant 6A stated, "So, Fablabs are likely to become still more popular in developing and underdeveloped regions, where Fablabs can empower individuals, developing skills, furthering innovation, educating children and prototyping new product ideas." Participant 1A supported, "Fablabs bring people together to work,

to learn from each other, to share knowledge with the global community, and to develop into a highly-skilled local workforce. Local problems can be solved and living standards increased." Finally 4A stated, "Meanwhile, the labs can help excite a new generation of Italians about manufacturing, an underdeveloped economic sector in the south of Italy. Fablabs might also spark new businesses, even industries, by allowing inventors of all backgrounds to use equipment and design prototypes for free."

7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?

Four of six noted how Fablabs helped Italian companies by providing valuable human resources. Participant 2A stated, "In my Fablab we brought unique groups of people together coming from several communities, academic, business, community at large, all can be included. People who are thinking about innovation in a different way with different resources capability and not just engineers and scientists." Participant 1A concurred, "Fablabs are integrative, put specialties of several people into broader context; cross pollination of disciplines. Transcends age, gender, socioeconomic, educational backgrounds, is a technological playground for all. So many people together across age, class, language, discipline, culture, artists working with scientists." Participant 6A noted, "Inside Fablabs is important the human element, it is not like a business. People are willing to help each other, like a different culture, amazing to look at people finding out they can do what they never thought they could do." Finally 5A stated, "The Human resources that run the lab are like consultants for the outside world. Fablabs have an enviable storehouse of intellectual and creative resources, so companies can collaborate with innovators and their creative economy communities, and enhance their chances for growth."

8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?

Five of six Managers were agree on this statement. Participant 1A stated, "The Fablab environment is the cultural hot-bed for the "Maker Movement" which advocates for knowledge sharing, experimentation with new technologies, and the exploration of cross-disciplinary projects motivated by enjoyment and personal achievement. The environment inside Fablab seem to provide fertile ground for entrepreneurship and could significantly reduce the barriers for the individuals who, under the correct circumstances, might decide to become entrepreneurs." Participant 3A concurred, "The collaborative and open-source ethos of Fablabs is meant to ensure that while creators can retain rights to the inventions, as much of the process as possible is shared so that others can build on and learn

from the work." Participant 6A noted, "By sharing information across the network, Italian companies can take and adapt these innovations to their own local circumstances. Synergy among players in the network will create products and opportunities for innovation and new ways of thinking." Finally 2A stated, "Projects initiated at one Fablab can be adopted, modified for local conditions and improved upon by other nodes in the network. Sometimes the adaptation to local needs happens through collaborations between different Fablabs, each seeking to solve a local problem, but sharing experiences and thus contributing to the solving of problems around the globe. One example of a project that several Fablabs have undertaken collectively is the search for low-cost Internet and Wi-Fi infrastructure."

9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?

Four of six think about fabrication tools more as tools that inspire creativity. Participant 1A stated, "When people come together in a Fablab, their wheels start spinning with creativity. Fablab is a place that is an invention playground, an incubator of design ideas, a maker of possibilities, a creative ecosystem, and a place that gives anyone and everyone the technology to power their ideas." Participant 5A stated, "Probably, the most disruptive element of this technology are not the tools themselves, but the maker culture, the community of people who sell, use, and adapt the tools of digital fabrication. For sure, Fablabs is a place that enhance creativity, because the idea is that with a Fablab you can make practically anything." Participant 3A concurred, "When you combine innovations in energy production with the open source hardware movement you create very low cost and high value technologies. We are building a creative space to stimulate local innovation." Finally, participant 2A stated, "A Fablab stimulates your creativity, you can also produce a gun, a pizza or anything else. I can declare that it is useful both for companies and both for individuals that can use their creativity and fantasy to make almost anything."

4.1.2 Focus Group Two B

Focus group two was comprised of six assistant Fablabs managers. The results for each question are reported in a narrative format.

1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?

All six participants from their perspective of Assistant Fablab Manager noted provided new knowledge to the companies that came inside their labs. Participant 2B stated, "All the small Italian

companies that used our services had access to new tools and technology previously not known by them. Once, inside the lab entrepreneurs or innovators can get in contacts with the other people working in the lab or they can also attend to the several workshop that we periodically held. Especially, SMEs and their owners often are isolated within their own walls, but coming to the labs they have the opportunity to enlarge their network and get new knowledge for free." Participant 3B noted, "The overall professional experience of a company in a Fablab was most of the time very beneficial. Usually, a lot of entrepreneurs that come to the Fablab for the first time and do not know the Fablab reality remained very impressed, because they receive knowledge of technology no previously known by companies and this is beneficial in particular for startups in their growth stage." Participant 6B concurred, "Fablabs are a public space where innovators and entrepreneurs are provided with open access to information, technology and knowledge. Companies receive new information and knowledge that will be useful for their production activity." Participant 5B stated, "I have to underline the importance of the international Fablab network that is a very powerful tool for diffusing knowledge to companies. There are several international platforms that are used for linking business ideas incubated in Fablabs to development services including crowd-funding, enterprise advice, and attaining sponsorship." Finally, Participant 1B stated, "Fablabs and companies started to collaborate each other, this new relation allowed companies to receive training on the usage and development of digital technologies and to gain free access to the technologies or methodologies for the production of their products."

2. What benefit in terms of R&D and manufacturing time and costs did Fablabs provide for Italian companies?

All six noted the fundamental role that Fablabs can play for small and medium size companies that usually cannot invest a great budget on R&D activities and for this reason always have one step back compared to their foreigner counterparts and competition. Participant 4B stated, "A Fablab is often a place with the latest technology and machines when one basic principal is the sharing of knowledge and transfer of technology." Participant 2B concurred, "Fablabs can enhance the productivity of Italian companies, which is highly relevant for being competitive in the domestic and foreign market and growth of almost any company, helping those without a big budget for innovation, qualified human resources and technical skills to get products to market." and 1B noted, "In Italy, SMEs before launching a product on the market have to test this product at rapid prototyping department of privately owned companies or at private laboratories. Instead, in a Fablab small group of experts has the possibility to produce prototypes in short time and using simple means." Five of six noted how Fablab tools and resources could cut the cost of market entry for new companies. Participant 3B

noted, “Manufacturing a new product by using Fablabs technology makes it cheaper to begin manufacturing, even at low volumes, or to serve niche segments. This is especially worthy for small Italian companies can often are focused on the quality and luxury products and serve niche segments of clients” Participant 5B concurred, “Fablabs allow companies to save weeks off of the development cycle and dramatically accelerate time-to-market of new products.” Participant 6B stated, “Just-in-time manufacturing and time-to-market are some of main concerns of almost any companies, but not if it means sacrificing quality and performance. Delayed time-to-market is not the only cost, waiting for models to return from an outsource provider is wasted design time. In comparison, in a Fablab a prototype model can be produced within hours, rather than days. On average, if the entrepreneur come with the model already done on CAD takes just 1-2 days to get models back.

3. What do you see as the strengths of your prototyping service?

Five of six noted that Fablab rapid prototyping helps companies turn great ideas into successful products faster than ever before. Participant 5Bstated, “Rapid prototyping in our Fablab can help verify a design, communicate an idea and fix design issues early in the development process preventing costly changes to the hard tool once the product is in full production.” 2B noted, “The 3D printers that we use can reduce the construction of complex objects to a manageable, straightforward, and relatively fast process. Today's rapid prototyping is heavily used by companies to better understand and communicate their product designs as well as to make rapid tooling to manufacture those products.” Participant 6B noted, “One main benefit is the Design freedom. Thanks to these new technologies, it’s quick and efficient to create multiple iterations of a project, sketch or rendering. Another benefit is that you can maintain your intellectual property if you aren't ready to share your designs with the world yet.” Participant 1B noted, “In our Fablab we help you to build your Imagination. In Fablabs we see a boom of digital art and design, and the possibilities are not only accelerating but limitless. One can now 3D print almost anything they imagine after drawing it up virtually. In a relatively short time, an idea, concept, dream or invention can go from a simple thought to a produced part that you can hold.”

4. Do you feel that Fablabs’ services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?

Five of six noted how beneficial Fablabs are for the sector of prototyping services. Participant 2B stated, “In the last years, Fablab services and especially the use of 3D printing has grown in Italy. This technology is now affordable also for SMEs that can get customized products and services.” Participant 6B concurred, “Prototyping services in traditional specialized companies are expensive

and SMEs often cannot afford this investment. 3D printing in a Fablab allows the creation of parts and/or tools through additive manufacturing at rates much lower than traditional companies." Participant 1B stated, "Any companies can take advantage of the technologies inside the Fablab either small or big it can save time and money, the packaging design process and the realization of prototypes is now possible in a cost-effective and timely manner with these technologies." 3B noted, "An Entrepreneur coming to the lab will receive attention and the personal service is one of our feature. However, we not only provide companies with expert advice and guidance often for free and helping them with the initial design, but also help SMEs connecting with other entrepreneurs and outside professionals. This implicit referrals to new projects and clients who were not aware of what they do, and helped them to almost double their business." Finally participant 5B stated, "Some benefits for companies to use Fablabs services are the affordability of service, companies pay for only what they need and one-stop shop feature, Fablabs offer a range of capabilities, from designing an initial concept to printing it, companies can try new technologies and different materials without committing to only one."

5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why?

Five of six noted how beneficial and important Fablabs are for the competitiveness and growth of Italian companies. Participant 2B stated, "Italy's companies could be the ones to profit most from embracing 3D printing in their manufacturing processes. The main advantage could come from rapid prototyping, which would allow companies to experiment and try new products at much cheaper costs than was possible before. This would be a boon for Italy's SME sector, which is dominated by 3.4 million small businesses which employ under 10 people and have little money to invest in R&D." Participant 4B stated, "Another opportunity that Fablabs could offer to Italian companies is the ability to produce small batches of high-quality goods, personalized according to the customers' requests, in a more cost-effective way than before." Participant 5B concurred, "Fablabs give to Italian SMEs more scope to experiment with prototypes, limited production runs and personalised products. Coming to Fablabs companies do not have to sustain set-up costs, but only material costs, meaning that you don't have to spend hundreds or thousands on set-up." Finally 1B concluded, "It is also not surprising that the most frequent barrier for SMEs is lack of resources, because of which SMEs cannot take on Rapid Prototyping technology due to the current internal and external financial constraints. We believe that our Rapid Prototyping service is evidently seen as an appropriate process when related to the crucial

dynamics on which the SMEs strategically perform. Our better technology, better tools may help SMEs and at the same time we should not miss the real opportunity of creating a new generation of SMEs with a strategic mindset."

6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?

Four six noted the value of this question because it is one of the main goal of all Fablabs worldwide. Participant 2B stated, "Fablabs are emerging not only in developed Western world, but also in Africa, South America and Asia. Especially for underdeveloped areas, additive manufacturing (3D printing) made accessible via Fablabs, holds a high potential to overcome the poor availability of spare parts, high-tech and customised objects. Thus the Fablab movement affects one of the main ideas of sustainable development: balancing human welfare, fairness and participation on a global scale. Participant 3B concurred, "Although South of Italy is characterized of unemployment and lack of companies, many Italians of that area are still struggling to build their businesses. We have met many community members with wonderful, inspiring ideas and talents but because they lack the space, tools, training, resources and other support, they have no ability to realize them. Our Fablab provided them a place where entrepreneurs with ideas can gather and find support for their projects. It is our goal to give anyone in the local community the resources they need and to connect them with various networks to help them establish or expand their business." Participant 1B supported, "At the moment we're in talks with a large number of educational institutions, from primary schools to university level, to realize workshops on digital fabrication and learning courses based on the aforementioned themes. This should result in a high potential of skilled young talents for local companies, which will benefit the local economy in the underdeveloped areas that is currently lacking in qualified staff." Finally 6B stated, "Furthermore, we are collaborating with local companies in challenges: students find solutions for their company-defined problems and try to solve them using open design principles. This is especially useful for companies in underdeveloped areas because in the long run, they can expect to find talented, motivated young people who are interested and qualified to work for them. Finding the connection with the already present local economic infrastructure and stimulating bottom-up innovation is one of our key proposition."

7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?

Five of six noted how Fablabs helped Italian companies by providing valuable human resources. Participant 2B stated, "In any Fablab there are unique groups of people together coming from several

communities, academic, business, community at large, all can be included. People with different experience, background and skills that work under the same roof with the capacity to combine all their knowledge." Participant 1B concurred, "Valuable and rare characteristics of our human resources can provide above normal saves and profits for the firm in the short term and improve their innovation performance.. Big companies started a recruiting competition and organizations put further emphasis on acquiring and retaining top talent, so find valuable human resources for SMEs get always more expensive and difficult, instead we can provide it."

Participant 6B noted, "For a SME working with a Fablab, along with an incrementally established network of specialized Fablabs located throughout Italy, could have a catalytic impact on the company development by spurring innovation and creating synergies among innovators. Moreover, the kind of innovation infrastructure provided by the Fablab could amplify the impact of the SME in the market by generating spillover effects for other parts of the innovation ecosystem, especially if operated in tandem with other innovation instruments. With Fablab support, in terms of human resources and infrastructure a SME could compete on global standards."

8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?

All of six Managers were agree on this statement. Participant 1B stated, "The open Fablab environment removes barriers, such as access to equipment and technology, while serving as an incubator for applied research, innovation, job creation and economic development." Participant 3B concurred, "A Fablab provides to a broad public an accessible environment (industry-grade technologies, facilities, education, mentorship) for prototyping and digital fabrication of innovative ideas and products. It thus can be a catalytic stimulus for knowledge sharing, entrepreneurship, and research. Fablabs also mitigate the risks associated with launching new products and ideas by eliminating failures when products are launched in real life. Fablabs today are also seen as an interconnected global community of learners, educators, technologists, researchers, makers and innovators, who have collectively created a knowledge-sharing network. Finally 2B stated, "Fundamentally, for a company going to a Fablab in Italy would overcome systemic inefficiencies by providing broad access to high-tech equipment, expertise and mentorship; thereby, creating a conductive enabling environment for incubating research and entrepreneurial ventures."

9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?

Five of six think about fabrication tools more as tools that inspire creativity. Participant 1B stated, "Fablab is a community maker space that encourages creativity and innovation. The new technologies, products and services that stem from the creativity of individuals and companies will benefit all of Italian companies and contribute to economic development. Such increase in the value of Italian intellectual capital might help establish Italy's image and reputation as a source of cutting-edge innovation and can serve to attract innovators and investors." Participant 5B stated, "Fablabs located in Italy will contribute to accelerating the dynamics of Italian companies' innovation by providing access to the latest technologies for prototyping tangible products and services, advanced 3D printing tools and a whole new environment for creativity and entrepreneurship." Participant 3B concurred, "The Creative and Social use of Fablabs is available for everybody, In this sense, Fablabs seek to amplify human potential while providing people with the necessary supporting tools to stimulate creation and invention but also to spread their ideas, building up markets, communities and even movements. Such practices and values promote alternative ways of creating physical goods and innovation systems focusing mainly on learning-by-doing approaches, shared information on technologies and tools, peer-to-peer design or social product development."

4.1.3 Focus Group Three C

Focus group two was comprised of six Administrative Fablabs personnel. The results for each question are reported in a narrative format.

1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?

All six participants from their perspective of Fablab personnel noted that their Fablab provided new knowledge to the companies that came inside their labs. Participant 1C stated, "I think that Fablabs are of fundamental importance for companies and their innovation process. For the SMEs coming to our lab, knowledge itself can be embodied in the products that we help them to create. What I know, is that technological knowledge is often not transferred as itself, but instead within our technologies. Thus if we talk about our effectiveness in diffusing knowledge, it is either a direct transfer in the sense of human capital transfer or more indirectly linked with the use of the Fablab technologies. Participant 4C noted, "Our ability to understand and apply complex technical knowledge is recognized from all the companies served so far. A SME because of its limited budget and resources always face a high degree of uncertainty about an innovation and knowledge necessary for the time of adoption. While a SME often cannot get these knowledge, the Fablab plays an important role in

the diffusion of these knowledge. Thus, the Fablab plays a gate keeping role in the flow of new knowledge into the company." Finally 6C noted, "We also diffuse knowledge to companies through intensive training course or workshops held in our Fablab. Because of the cheap training cost, many entrepreneurs can attend and get knowledge almost for free."

2. What benefit in terms of R&D and manufacturing time and costs did Fablabs provide for Italian companies?

Five of six noted the fundamental role that Fablabs can play for small and medium size companies that usually cannot invest a great budget on R&D activities and for this reason always have one step back compared to their foreigners counterparts and competition. Participant 3C stated, "The current market forces companies to produce low-cost and high-quality products in order to maintain their competitiveness at the highest possible level. There is no doubt that, a Fablab can help the company to reduce the cost of a product starting from the design stage to the manufacturing stage." Participant 5C concurred, "Fablabs have a "just-in-time" manufacturing philosophy which calls for reducing setup times and costs. I point out that the reduced setup costs with the accompanying smaller lot sizes have numerous benefits for a SME including, reduced manufacturing lead times, improved quality due to the early detection of defects, reduced work-in-process, easier sched- uling and sequencing, increased production capacity, increased operational flexibility, reduced storage space, and lower investment in inventory." Participant 6C stated, "Nowadays, Italian SMEs suffer more than the past due to the traditional disadvantages of their size limitations, more to the new demand for multiple technological competences and by increased competition. Fablabs can help to resolve these issues, thanks to its technologies, flexibility and rapid response."

3. What do you see as the strengths of your prototyping service?

Five of six noted that Fablab rapid prototyping helps companies turn great ideas into successful products faster than ever before. Participant 4Cstated, "Our Fablab thrives from the creative process and personal growth through providing a workshop space where entrepreneurs and professionals can learn how to rapid prototype in various fields such as electronics, robotics, software, wood or metal working, art, video, or photography can expand their skills, invent, and build new products in a collaborative environment. Our Fablab is place where entrepreneurs gather to work on their company projects, share tools and expertise as well as learn from each other." Participant 1C noted, "The Fablab helps entrepreneurs to start and develop their prototype ideas by providing space, business development services and networking opportunities for the business tenants. Small entrepreneurs have a place to test their product before launching it to the market." Participant 2B noted, "Our Fablab offer numerous classes to entrepreneurs depending on their expertise and interest. Members and non-

members teach workshops classes for a wide variety of machines and practices, needed for entrepreneurs. We don't only provide a service but also we teach how to do it and how to transform ideas in realities. These outreach events are important to attract companies, funding and donations in addition to developing community knowledge with private and institutional partners, such as public schools, museums or public libraries.

4. Do you feel that Fablabs' services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?

All six noted how beneficial Fablabs are for the sector of prototyping services. Participant 5C stated, "Business owners who need an easy, inexpensive way to prototype new products will want to check out their local Fablabs. Fablabs usually offer resources for technological experimentation, hardware development, and prototyping your ideas. Low-tech supplies like cardboard, wood, plastic pieces, metal doodads, and batteries are likely to be readily available in the space, as are tools for tasks such as sawing, welding, and laser-cutting. The higher-tech offerings include micro-controllers and 3-D printers." Participant 3C noted, "Our 3D printers are especially useful for fast and low-commitment prototyping of new products compared the ones of traditional companies offering the same service. The Fablab movement is taking the market and the traditional competition, allowing people from all walks of life to start inventing innovative new tools and products. A culture of technology-oriented DIY that has grown up around the areas of engineering, computer science, and graphic design encourages anyone with a great idea and the desire to start a creative business from scratch." Finally 6C stated, "Until very recently, industrial design often had to be done in the context of a large company, because the tools to do it were exclusively the territory of big companies. But that's not the way it works any more. People can go right into creating an enterprise or product, all by themselves. This thanks to the availability of Fablabs."

5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why?

All six noted how beneficial and important Fablabs are for the competitiveness and growth of Italian companies. Participant 4C stated, "Fablabs can boost the development of Italian SMEs and startups. We provide service platforms for entrepreneurship where innovators gather to create by sharing resources and knowledge, to nurture an environment for entrepreneurship and innovation as well as to allow people to realize their full potential." Participant 2C stated, "Our goal include building our Fablab to meet the demands of startup entrepreneurs and to deliver professional services, to cultivate

a group of angel investors and venture capital institutions to offer convenient financial support. It also highlights the key goal of incubating a large number of small and micro-businesses in emerging industries to boost economic growth." Participant 6C concurred, "With low-cost digital design and fabrication tools such as 3D printing and the ability to digitize almost any object companies can boost their growth, bold new innovations become apparent. Very young entrepreneurs get to "touch and feel" the results, and can experiment to their heart's content. These ideas can grow quickly into real products. In addition, we help to meet the new consumer demand for customization. Customers today increasingly demand solutions that are customized just for them. Fablab tools are changing these economies of scale."

6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?

Five of six noted the value of this question because it is one of the main goal of all Fablabs worldwide. Participant 4C stated, "Fablabs have the potential to act as centers to promote creativity and innovation, and to bring about long-term social innovation in disadvantaged and rural communities. In essence, Fablabs can become the delivery vehicles for a range of national policies designed to redress inequalities and for the benefit of developing countries." Participant 2C concurred, "Underdeveloped areas often suffer abuses motivated by engineering consultancies and large corporations' financial interests. Fablabs can arise as an alternative to these structures, turning into local, non-profit consultants of sorts. We can meet some of the rural area's needs, particularly digital de-isolation, by creating independent Internet networks that work in mountainous or isolated areas, setting up local, democratic servers, regional Internet radios, etc. In our open space, everyone is welcomed with no prejudice, in the spirit of working together." Participant 5C supported, "As entrepreneurs in underdeveloped areas we all asked ourselves how digital technologies could be merged with nature, heritage and agriculture. Our Fablab, including our philosophy and practices, can be seamlessly transposed onto rural areas. We open up areas struck by digital exclusion. We can develop autonomous Internet networks in mountainous areas, install organic solar panels, and let local Internet radio emerge. We can even transform abandoned water troughs into eco-jacuzzis. Thus, our Fablab user-friendly space is a place that can boost the disadvantaged areas and spreading throughout the local companies."

7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?

Four of six noted how Fablabs helped Italian companies by providing valuable human resources. Participant 1C stated, "Fablabs provided to Italian companies new spaces for individual creation, fabrication and artistic expression. We enable individual production by providing both the physical tools, such as 3D printers and laser cutters as well as a network of members who are willing to share their knowledge to help others through a collective effort. These spaces have emerged through the convergence of a number of phenomena such as the availability of affordable digital manufacturing technologies, ubiquitous computing and network technologies." Participant 4C noted, "Our space represent a real opportunity to empower Italian entrepreneurship. The collective nature of our Fablab allows entrepreneurs to realize projects that they would otherwise have not been able to alone. It is like a cooperative systems where members are motivated to contribute to the collective effort instead of pursuing their own interests at the group's expense." Participant 2C concurred, "We gave a technological advantage to Italian companies, pioneering access to information and communication technologies and innovative solutions in an era where SMEs were suffering for the economic crisis in Europe."

8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?

Five of six Managers were agree on this statement. Participant 5C stated, "If a company is satisfied of our service, the same company can be an instrument of networking for other companies. In fact, local industry clusters can promote the Fablab to its members and incubators can encourage start-ups to use the Fablab facilities and network for prototyping. The Fablab's response to attract professional users has been to segment its activity around three identified user groups, the general public, companies and research bodies." Participant 2C concurred, "This global and informal network is identified by a set of shared technologies, procedures, and values, which relate to the idea of open source software, hardware and data, rather than to any formal governance structure. The global Fablab network is simply a platform that enables Fablab users and companies worldwide to share best practices concerning how to manage independent spaces based on open access, open source software and hardware ideals, while working on their individual and collective prototypes." Finally 4C stated, "Inside our Fablab the design of new products and tools becomes a community building effort, creating new networks between multiple actors and stakeholders. Monitoring, sharing and making sense of various "objective" and "scientific" data and protocols or creating DIY kits. In this sense,

Fablabs embody new networks and alliances between various human and non-human actors that extend the notion of political and social participation."

9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?

All of six think about fabrication tools more as tools that inspire creativity. Participant 3C stated, "When the philosophy of open source goes from the hard disk to the material world and combined with imagination, collaboration, interaction and appetite for creation then comes to the Fablab to make it happen. Against a background of consumerism , we learn to create our own (DIY), reusing what society considers garbage and we can freely use our creativity." Participant 4C stated, "While it may seem counterintuitive as an economic strategy, the main way that Fablabs are teaching creativity is by pushing participants to stop thinking about "making" as work. Most Italian entrepreneurs, if they do something, are always thinking, How do I turn this into a product and make money? They are not thinking, I am just doing this for fun." Participant 2C concurred, "Fablabs foster innovation and creativity so they can adapt faster to the new economy and sustain company growth. In order for companies to remain competitive in the global economy, technological improvements require an increased knowledge base for industrial innovation. In this regard, I think that Fablab technology and services is a central component of the strategy of any community, regardless of the existing growth patterns. Companies need to invest in creative products and foster a talented workforce in order to stay competitive in the global economy."

4.2 Common Themes

Table 4.1 presents common themes that emerged from the focus group responses to the interview questions. Two or more responses to an interview question identified a common theme. The table contains four columns. Column one presents the question, which is further identified by focus group and common themes. Further, the themes include the number of times (n) each response was listed.

Table 4.1. Common themes by question

Question	Focus group one (N=6)	Focus group two (N=6)	Focus group three (N=6)
1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?	1. Knowledge to companies and entrepreneurs (n=13) 2. Diffusing and sharing Knowledge (n=10) 3. Access to new information (n=4)	1. Knowledge to companies and entrepreneurs (n=11) 2. Diffusing and sharing Knowledge (n=6) 3. Access to technology (n=3)	1. Diffusing and sharing Knowledge (n=11) 2. Knowledge to companies and entrepreneurs (n=7) 3. Access to innovation and technology (n=4)
2. What benefit in terms of R&D and manufacturing time and costs did the Fablab provide for Italian companies?	1. Accelerate the time-to-market for products (n=13) 2. Lower the cost and improving of manufacturing process (n=6) 3. Improvement of the product design and manufacturing time (n=4)	1. Accelerate the time-to-market for products (n=6) 2. Lower the cost and improving of manufacturing process (n=5)	1. Lower the cost and improving of manufacturing process (n=7) 2. Allow companies to be competitive in the market (n=3) 3. Accelerate the time-to-market for products (n=3)

3. What do you see as the strengths of your prototyping service?	1. The 3D printing services give to companies more opportunities and flexibility (n=5) 2. Testing the prototypes before launching it in the market (n=6) 3. Turn great ideas into successful products faster (n=3)	1. Improvement of the product design (n=6) 2. Turn great ideas into successful products faster (n=3)	1. Entrepreneurs start and develop their prototypes (n=6) 2. Entrepreneurs learn new expertise and how to rapid prototyping (n=4) 3. Space to develop own ideas (n=3)
4. Do you feel that Fablab's services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?	1. Fablabs provide affordable rapid prototyping and customized services (n=8) 2. Fablabs offer new resources, customized services and technologies to companies (n=4)	1. Fablabs provide affordable rapid prototyping and customized services (n=7) 2. Fablabs offer new resources, customized services and technologies to companies (n=4) 3. Fablabs help companies with the design process (n=3)	1. Companies have the possibility to prototype new products and ideas (n=4) 2. High-tech tools are now available also for small companies (n=3) 3. Fablabs offer new resources, customized services and technologies to companies (n=3)

5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market?	1. Fablabs allow SMEs to have access to technology and new digital machine (n=5) 2. Fablabs provide to SMEs assistance in developing products and to fast their production process (n=6)	1. Fablabs help Italian SMEs to overcome the current internal and external financial constraints (n=7) 2. Fablabs offer to Italian companies the ability to produce high-quality goods, personalized, in a more cost-effective way than before (n=4)	1. Fablabs provide professional services for entrepreneurs (n=4) 2. Fablabs boost growth of Italian companies
6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?	1. Fablabs can develop their own solutions to local problems and living standards can be increased (n=5) 2. Fablabs bring people together to work and can develop a highly-skilled local workforce (n=3)	1. Fablabs provide local companies in underdeveloped areas, with additive manufacturing (3D printing) and especially skilled qualified staff (n=4) 2. Fablab in underdeveloped area are places where entrepreneurs with ideas can gather and find	1. Fablabs meet some of the rural area's needs, particularly digital de-isolation and need to provide a specialized workforce (n=8) 2. Fablabs can create Internet networks that work in mountains or isolated areas, and regional Internet radios (n=4)

		support from other people for their projects (n=3)	
7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?	1. Fablabs brought unique groups of people together. People who are thinking about innovation in a different way (n=6) 2. Fablabs have a storehouse of intellectual and creative resources (n=4)	1. Fablabs could have a catalytic impact on the company development by spurring innovation and creating synergies among innovators (n=6) 2. The Fablabs' human resources can provide above normal saves and profits for firms in the short term (n=4)	1. Fablabs gave a technological advantage to Italian companies, pioneering access to information and and innovative solutions (n=4) 2. Fablabs are cooperative systems where members are motivated to contribute to the collective effort instead of pursuing their own interests at the group's expense (n=3)
8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?	1. Fablab share information across the network, Italian companies can take and adapt these innovations to their own local circumstances (n=4)	1. Fablabs create a conductive enabling environment for incubating research and entrepreneurial ventures (n=4) 2. Fablabs provide through their international	1. Fablab network is a platform that enables users worldwide to share best practices, new knowledge about open source software and hardware ideas(n=6)

	2. Users using the Fablabs network can share experiences and contribute to the solving of problems around the globe (n=4)	network an accessible environment for prototyping and digital fabrication. It can be a catalytic stimulus for knowledge sharing, entrepreneurship, and research (n=3)	2. A company using in a satisfactory way Fablabs' tools can be an instrument of networking for other companies (n=5)
9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?	1. Fablabs is a place that enhance creativity, because the idea is that with a Fablab you can make practically anything (n=5) 2. Fablab is a place that is an invention playground, an incubator of design ideas, and a creative ecosystem (n=3)	1. Fablabs have tools that inspire creativity. Fablab is a community maker space that encourages creativity and innovation (n=5) 2. The Fablabs technologies, products and services stem from the creativity of individuals and companies (n=4)	1. Fablabs foster innovation and creativity so they can adapt faster to the new economy and sustain company growth (n=4) 2. Companies need to invest in creative products and foster a talented workforce in order to stay competitive in the global economy (n=3)

Source: Author (2015)

4.3 Emerging Themes

For the purposes of this study, I have defined emerging themes as those common themes which are mentioned by greater than or equal to 50% of the respondents in at least two of the three focus groups. The emerging themes include knowledge, rapid prototyping, time-to-market, innovative tools and services, human resources, and network. Each emerging theme is presented to include the focus group/question, total number of questions, total number of focus groups, and the number of questions by focus group containing a reference to the theme as well as participant comments supporting the theme.

Knowledge, was discussed explicitly in questions 1 and 8 for all the three focus groups. All three focus groups referenced knowledge: focus group one, two times; focus group two, three times; and, focus group three, three times. Participant comments supporting knowledge included: (a) new knowledge for companies and entrepreneurs; (b) diffusing and sharing of knowledge; and (c) new knowledge about open source software and hardware ideas. An observation conducted during my work experience in the Fablab on 2015, supported the development of an increasing development of knowledge sharing through the creation of the many makers community borned around the Fablabs. In addition, Fablabs and makers communities in Italy often organize events about the digital fabrication services that are an important moment of acquiring and sharing new knowledge. Rapid Prototyping was discussed in questions 3 and 4 for all the three focus groups. All three focus groups referenced on rapid prototyping: focus group one, two times; and focus group two, onetime; and, focus group three, three times. Participant comments supporting on rapid prototyping included: (a) Fablabs allow to test the prototypes before launching the final product in the market; (b) entrepreneurs can create and develop their prototypes (c) entrepreneurs learn new expertise and how to rapid prototyping; (d) Fablabs provide affordable rapid prototyping and customized services; and, (e) companies have the possibility to prototype new products and ideas.

Time-to-market was discussed in question 2 for all the three focus groups. All three focus groups referenced on time-to-market: focus group one, two times; and focus group two, one time; and focus group three, one time. Participant comments supporting time-to-market included: (a) accelerate the time-to-market for products; and (b) improvement of the product design and manufacturing time.

Innovative tools and services was discussed in questions 4 and 7 for all the three focus groups. All three focus groups referenced on innovative tools and services: focus group one, three times; focus group two, three times; and, focus group three, three times. Participant comments supporting Innovative tools and services included: (a) Fablabs offer new resources, customized services and technologies to companies; (b) Fablabs brought unique groups of people together. People who are

thinking about innovation in a different way; and (c) Fablabs gave a technological advantage to Italian companies, pioneering access to information and innovative solutions.

Human resources was discussed in questions 6 and 7 for all the three focus groups. All three groups referenced on human resources: focus group one, two times; focus group two, three times; and, focus group three, two times. Participant comments supporting human resources: (a) Fablabs bring people together to work and can develop a highly-skilled local workforce; (b) Fablabs provide local companies in underdeveloped areas, with skilled qualified staff; (c) Fablab are places where entrepreneurs can find support from other people for their projects; (d) Fablabs meet some of the rural area's needs, particularly digital de-isolation and need to provide a specialized workforce; and (e) The Fablabs' human resources can provide above normal saves and profits for firms in the short term.

Network was discussed in question 8 for all the three focus groups. All three focus groups referenced on network: focus group one, two times; focus group two, one time; and, focus group three, two times. Participant comments supporting human resources included: (a) Fablab share information across the network, Italian companies can take and adapt these innovations to their own local circumstances; (b) users using the Fablabs network can share experiences and contribute to the solving of problems around the globe; (c) Fablabs through their international network provide an accessible environment for prototyping and digital fabrication; (d) Fablab network is a platform that enables users worldwide to share best practices, new knowledge about open source software and hardware ideas; and (e) a company using in a satisfactory way Fablabs' tools can be an instrument of networking for other companies.

4.4 Discussion

Chapter 4 presented the results of the three focus group interviews in a narrative format by focus group for each question. This was followed by the presentation of common themes in tabular form by question and by focus group. Finally, the emerging themes from the focus group interviews were presented in narrative form. Additional data from documents and observations were included to support the common and emerging themes. Chapter 5 will include a summary of the study as well as the study conclusions, recommendations, and reflections. The conclusion section will present an analysis of the findings presented in Chapter 4 as they relate to answering the four research questions followed by the researcher's recommendations and reflections.

CHAPTER 5 SUMMARY, FINDINGS, RECOMMENDATIONS, FUTURE STUDIES, AND REFLECTIONS

Chapter 5 presents a summary of the study followed by the findings and the recommendations drawn from an analysis of the data detailed in Chapter 4. The summary, findings, and recommendations are followed by my recommendations for future study and my personal reflections.

5.1 Summary

The purpose of this study was to analyze the case of Fablabs community helping the Italian industry in the process of innovation and growth. This case is representative of how entrepreneurs engage in Fablab digital fabrication technologies which allow to make almost anything and optimizing time and production cost. In fact, the number of entrepreneurs in Italy using Fablab services is exploding. A qualitative case study design was selected to gather data through focus group interviews, document reviews, and an observation of a current academy session. Focus group interviews included assistant principals and principals (N = 18), purposefully selected to include an equal number of Fablabs Managers, Assistant Fablab Managers and Administrative Personnel and other workforce. In addition, the focus group interview with the Administrative Personnel, provided me with a comprehensive and exhaustive data source. Data were also collected from academy documents as well as from my personal observation during my experience inside a Fablab. The collection of data provided additional information that contributed to the research reaching saturation. Findings have been presented as they relate to each of the four research questions in order of significance. The research questions that guided this study include: (1) How effective have Fablabs been in attracting, diffuse knowledge, give access to technology and fasten time-to-market to companies?, (2) Have companies which use Fablabs services stopped making prototypes in their home locations or are they referring to external companies and preferring Fablabs prototyping services?, (3) How effective and important Fablabs can be for Italian companies?, and (4) Do the physical infrastructures and human resources inside Fablabs (buildings, layout, facilities) help facilitate collaboration and accelerate idea generation and innovation?

These research questions were based on the construct “better prepared,” defined as the principles covered in seminar topics in Fablabs and makers community events. They include a Fablab Manager knowledge of vision, the current economic situation of the Italian companies, the technological needs

of Italian companies, management of human resources, my work experience inside a Fablab, and the awareness of the innovative technologies and services offered by a Fablab.

5.2 Findings

Finding 1: A core component of Fablabs community is the idea of sharing knowledge. Generally, Fablabs rely on community members and their human resources acting as mentors and sharing their knowledge in particular fields to other community members. For instance, individuals who have skills in electronics or programming are tapped into teaching hands-on workshops to entrepreneurs and other people of the local community. Fablabs seek to encourage in their local environment innovation, collaboration and learning, enabling more companies to cultivate an interest in the several digital fabrication fields. Fablabs develop creative ways to encourage local entrepreneurs to actively learn, create, innovate and share knowledge. As one Fablab Manager notes, "Instead of trying to interest companies in science as received knowledge, it's possible to equip them to do science, giving them both the knowledge and the tools to discover it."Further, Fablabs local events facilitated networking and knowledge sharing as well as allowed community members and entrepreneurs to create their own base of knowledge. Fablabs workshops are taught by local experts who share their knowledge and physical resources. Knowledge, research, innovation, learning and entrepreneurial spirit are crucial to long-term economic growth (Eaton & Kortum, 1996; Romer, 1986). Places such as Fablabs that foster innovation and creativity can adapt faster to the new economy and sustain economic growth. In order for communities to remain competitive in the global economy, technological improvements require an increased knowledge base for industrial innovation. In this regard, nurturing innovation and entrepreneurship is a central component of the strategy of any community, regardless of the existing growth patterns. Communities need to invest and foster a talented workforce in order to stay competitive in the global economy but often for small companies could be expensive so Fablabs tend to resolve this problem. In many cases, individuals will propose a project, mention an idea or begin to tackle a complicated problem. Other members would share ideas, knowledge, tools, and expertise (Kalish, 2010; Levin, 2011). Within this Fablab creative and learning environment, free exchange of ideas, skills, and knowledge are encouraged and open house events continue to attract new members and entrepreneurs.

Secondly, the existence of an Italian Fablabs community makes it easier for entrepreneurs to exploit knowledge-based business ideas, thus lowering the barriers that inhibit direct commercial application and increasing the possibility of competition in foreign markets. Furthermore, Italian companies can benefit from their proximity to Fablabs, due to the fact that numerous Fablabs are clustered in a

relatively small area, especially if they operate in the same sector (or in closely connected sectors). Thus, the knowledge sharing opportunities of companies are also widened, basically for the same reason. I can define a "Fablab" as a property-based initiative which has formal operational links with centers of knowledge creation, such as universities, (public and/or private) research centers and companies, it is designed to encourage the formation and growth of innovative businesses, and it has a management function which is actively engaged in the transfer of technology and business skills to companies organizations.

Finding 2: An insured feature of Fablabs is to significantly speed time-to-market. By combining the several Fablab technologies (3D printers, laser cutters, milling machines etc.) prototypes can be created in few hours or in case of complex one just in some days. One Fablab Manager said, "With this new disruptive technologies and process, users can now go directly from machine to molding, expediting the time it takes to go to market."

Fablabs prototyping services, of course, is essential to the growth of any company involved in manufacturing their branded products, and a key step in the process of creating new products. Companies in a wide range of industries have turned to the practice of rapid prototyping to speed their time to market. Whenever time-to-market is critical, Fablabs rapid prototyping can produce a "first draft" of a new product that allows testing, evaluation, and further refinement of the product idea, which helps a company more quickly and cost-effectively transform early concepts into marketable products. At the same time, for concepts that may not make practical products, rapid prototyping can spare a company further investment time and expenses by revealing the product's flaws at an early stage of the development process. This technology has also been referred to as layer manufacturing, solid free-form fabrication, material addition manufacturing and three-dimensional printing. Fablab technology is a means of compressing the time-to-market of products and, as such, is a competitiveness enhancing technology.

In the old days, before the coming of Fablabs and makerspaces on the scene, time-to-market was clearly a lengthy cycle in any industry because getting a product from concept stage to being available for purchase took time. Product development often had a difficult time making it out of the engineering department, based on such variables as initial approval, testing phases, budgeting, staffing allocations, manufacturing, shipping etc.. But today, that's all different. Thanks to an innovative process known as 3D rapid prototyping, time-to-market can be greatly reduced. And the strange thing is: the technology is nothing new. It has been around for nearly three decades. Known as "additive manufacturing," 3D printing is used to fabricate models, prototypes and parts out of resin material. Using a CAD drawing, a part can be printed in a matter of hours. Today's high-end 3D rapid-prototype printers have improved exponentially over the last decade. There are machines with

better print quality and resolution, significantly higher run speeds, more material choices, properties and shades of color, and less of a footprint. It's possible to buy a 3D printer to sit on your desk, similar in size to a laser printer, for printing convenience at your fingertips.

However, these technologies for small companies are still expensive but through Fablabs they can accede to these new technologies and speed the time-to-market for their products.

Finding 3: Fablabs usually have the most advanced 3D printers and digital fabrication tools and most of the time these 3D printers can print in over one-hundred different materials. The possibilities with this emerging technology are mind-boggling, from printed prosthetic limbs to printer replication. Some of the world's largest companies such as Coca-Cola, Nokia and eBay are all currently utilising 3D printing technologies. The possibilities of 3D printing are captivating, but it does not come without costs. For this reason, Fablabs are fundamental for offering 3D printing technology to small companies at a low cost. Fablabs make the costs for this technology to go down and drive more demand for 3D printer services. Although small companies have been struggling with innovating 3D printers, the concept of 3D printing is logical and easy to understand. The 3D printing technology made its way to the technological world in 1986, but didn't gain traction until the 1990's. It was not that popular outside the world of engineering, architecture and manufacturing until the last few years. 3D printing is now one of the hottest and most interesting advancements in the design and marketing world today. This type of printing make it possible to create a part from scratch in just hours. It allows designers and developers to go from flat screen to an exact physical part. 3D printing, also called additive manufacturing, is the process of creating 3D (three-dimensional) objects from a digital model. Entrepreneurs with 3D printer can create many complex figures, being confined only by a person's imagination. This method can give to small companies higher structural integrity and more durability. Sometimes, the finished product of 3D printing can be up to 60 percent lighter than the machined part but still sturdy. Large cost savings can be attained in this way and a smaller amount of waste also means a lesser effect on the environment. Cheap Manufacturing 3D printing helps companies save up to 70 percent of their manufacturing cost. This is attained through lower packaging and shipping costs related to more reliable and cheaper raw materials and lesser workforce needed, as well as overseas parts suppliers. In the end, this technology makes small companies more profitable. The possibilities of using this type of production are endless. With so many potential benefits of 3D printing, there's no surprise that this method is making its way through a diverse number of industries and quickly becoming a favorite tool of progressive marketers.

Finding 4: For small businesses that make things and for entrepreneurs who dream of doing the same, the greatest challenge is almost always the cost of technology for turning an idea into a tangible product. Often, the chore of even creating a prototype is so daunting, great ideas are simply left on

the table. This problem is very common amongst Italian companies due to the fact that 99% of them are of small and medium sizes. That common obstacle is exactly why Fablab technology is a potential game changer for small Italian companies. While manufacturing was once a big money, big business proposition, digital fabrication technologies can put the power of prototyping and one-off manufacturing into the hands of local entrepreneurs. With one machine and a digital design, in Fablabs companies can build a three-dimensional object of virtually anything right on the spot. The advent of affordability is one of the most surprising things about Fablabs, besides what they can do is that the technology isn't actually new; it's just newly affordable. Fablabs services are now relatively inexpensive for companies and they can expand capability for small companies that will be only limited by the imagination of their owners. Any time a company places an order to a Fablab, it can print that item on demand and ship it directly to the company. With the power of manufacturing transferring from the factories to Fablabs located inside the cities, there's no telling how dramatically digital fabrication tools and 3D printing could change the world economy, but one thing is for sure: small businesses and entrepreneurs will be at the helm of the transformation.

Most of all, small business startups are looking at Fablabs digital fabrication tools for the possibilities they offer to create prototypes, artistic renderings and promotional materials. Digital fabrication technologies are becoming much more common among small companies, as opposed to being relevant in only certain industries such as medical device production. Fablabs are part of a dynamic industry in which the possibilities continue to grow. Chances are, there could be something in it for your business if there isn't already. Digital fabrication services and 3D printing can be more affordable, and also quicker than testing out your product design using the actual parts you intend to use. With 3D printing, you'll get a prototype that allows you to determine if the look and feel of your design is right before creating the real thing. You can also correct mistakes before actually making them, and experiment more than you would have otherwise. Today, as technology improves and 3D printing gets more affordable, it's becoming useful for small companies in additional ways. 3D printing is more and more common among small companies that offer highly customized products. Being able to create an exact reproduction of something that took a great deal of time to invent and design is a boon for entrepreneurs, because it can help save lots of time and allow more production volume. But now the doors to Fablabs and digital fabrication technologies are opening up in new industries. The opportunity to harness this technology gives entrepreneurs who are creative and innovative a method of bringing their ideas to life that is entirely unprecedented.

Finding 5: Fablabs could actually be most useful in some of the world's most undeveloped and impoverished places. Fablabs are now running everywhere in the world from South Boston, Ghana, Costa Rica, India, Norway to South Africa. In underdeveloped areas there are people in demand and

companies with compelling technologies problems that they're desperate to solve. These places are very different from each other, and people and companies have unique problems. Some areas of South of Italy have the same problems of some rural areas in India and so in some ways, entrepreneurs remarkably face similar issues. Small companies in underdeveloped areas lack technologies and qualified human resources so they have this tremendous sense of opportunity for technology. Fablabs deliver high-tech tools and fabrication laboratories aim to help developing small companies communities find innovative solutions to local needs.

Fablabs work to introduce technology to disadvantaged communities. Entrepreneurs in underdeveloped areas could learn to create technology, as well as use it. Fablabs try to give them access to the knowledge and the tools. Fablabs are filled with modern manufacturing equipment, laser cutters that can make two and three-dimensional structures; copper cutters that make circuit boards and antennas; plasma cutters to model steel and aluminum. They have open-source computer codes for new inventors to design their projects; and various print and online manuals for newcomers to teach themselves how to create. The Fablabs also show how personal fabrication can empower local communities. Once entrepreneurs learn the basics of the Fablabs' computers and manufacturing equipment, they can start developing their own solutions to local problems. In rural India, for instance, inventors at a Fablab are developing a machine to measure the fat content of milk and to sound an alarm when that milk is about to turn sour, important for local dairy farmers. In the mountains of Norway, the local Fablab inventors are developing a monitoring device for herders to put on sheep, which would give the animals' location, body temperature, and other statistics. Fablabs in underdeveloped area might also spark new businesses, even industries, by allowing inventors of all backgrounds to use equipment and design prototypes for free. They can help solving the issue of unemployment which high there, so is poverty.

Finding 6: Fablabs can provide Italian companies very qualified human resources. Fablabs are part of a new model of organization experimenting with people’s willingness to volunteer their time and relinquish traditional property rights over some portion of the fruits of their labor. This does not mean that standard forms of compensation are becoming obsolete. Particularly among extremely highly skilled individuals, however, additional forms of motivation, such as the chance to work on personally meaningful projects, and the opportunity to display ingenuity in the company of respected peers, are proving capable of accomplishing more than was traditionally thought possible. Indeed, it is these use the whole range of human motivations to harness talent and a diverse motivations that make the Fablab network a growing force in solving global problems and provide services for companies. In fact, the human resource that use and run the lab become consultants for the outside world. With classes and products moving through the Fablabs, there should be an abundance of both funding and

human resources to tackle community and companies projects. The purpose of doing community projects includes simply improving the life of the people directly around the Fablab as well as to justify the existence of the Fablab within the community in the first place. Community projects can include setting up local mesh communication networks, alternative power grids, automation, sensors, and equipment for agriculture, and even automation and other technological solutions for small companies. Fablabs through their technologies and human resources can work also as a local small business incubator where the Fablabs serves as a springboard for aspiring entrepreneurs to develop their ideas and implement them, or take their existing business and improve upon it. The idea of an entire community engaged in business with each other and with neighboring communities or like-minded people around the globe is particularly appealing in a time when consumerism has particularly begun to chaff at even ordinary people socially and economically. Rather than complaining about it, we can take what we find as unpleasant and use it as positive motivation to create more appealing alternatives. The Italian Fablab community in and of itself could be considered to have stemmed from dissatisfaction of what was available to buy, spurring many to simply make it themselves.

Finding 7: Fablabs are organized in a global network of local labs, enabling invention by providing access to tools for rapid digital fabrication. Fablabs have the most regulated requirements and the closest connection to the universities and research centers. This renders the global Fablab network a very suitable platform for technology transfer options and STEM entrepreneurship and for regulated digital fabrication performed in a sustainable way. In fact, Fablabs can open new niches for sustainable innovation in society and allow companies to find new partners all around the world. All over this study was evident that in order to develop entrepreneurs and entrepreneurial communities, a strong support network as well as a community that is ready for change and seeks innovation is critical. Innovation needs to be enabled and supported at all age groups. The goal of any Fablab in Italy should be to help Italian companies in collaborating each other in order to share best practices that allow for the creation of programs and networks. These programs are intended to foster an entrepreneurial ecosystem, resulting in more opportunities for talented people to innovate and create competitive products and companies that contribute to the local economy. Generating effective strategies to support entrepreneurs through the local Fablab ecosystems is critical in cultivating a digital fabrication culture in Italy, especially in the places struggling with unemployment, poverty and lack of private investment.

5.3 Recommendations

Recommendation 1: The Italian Fablabs community should continue as a professional development opportunity specifically designed to help Italian companies in having access to digital fabrication tools. The bottom-line of all Fablabs should be help companies in their process of growth and support entrepreneurs who have the will to learn using these new innovative technologies. Some Fablab Managers during the interviews suggested that in the process of teaching entrepreneurs in using Fablab services very important are the workshops designed to build a strong knowledge base with the challenge to apply that knowledge in the context of the company. Over the last years, some Fablabs in Italy has been highly effective in preparing entrepreneurs for the use of digital fabrication technologies by continuing to evolve based on the entrepreneurs feedback and companies needs.

Recommendation 2: The Italian Fablabs community should continue as a mechanism to attract and train Italian companies to fill their technology gap. It is well known that Italian companies do not have access to the latest technologies in the market and cannot make high investment in R&D or hire qualified human resources because it is too expensive. The benefits of using Fablabs services for a company can be seen by the opportunity to have access to the latest technology even without counting on a big budget.

Recommendation 3: The Fablabs community should continue as a professional development opportunity for entrepreneurs to develop needed skills in the area of digital fabrication tools, 3D printing, rapid prototyping, and human resources.

Recommendation 4: The Italian Fablabs community should continue as a professional development opportunity designed to meet the needs of Italian companies at any level of technological progress.

Recommendation 5: The Italian Fablabs community should expand training in the areas of 3D printing and rapid prototyping. Entrepreneurs asked for additional training in these areas in order to compete on the international markets.

Recommendation 6: The Italian Fablabs community should continue to evolve based on feedback from Italian companies and on needs identified by the Fablabs Managers. A key strength of the Italian Fablabs is the willingness of the Fablab staff to accept feedback from entrepreneurs and other Fablab users, and to make adjustments to the Fablabs services as necessary.

Recommendation 7: All Italian Fablabs should offer professional development opportunities to all people working inside the lab focusing on the roles and responsibilities of assisting companies.

Recommendation 8: The Italian Fablabs community should require all new lab human resources, users and entrepreneurs who have not had experience in the digital fabrication field, to participate in the Fablab workshops and events.

5.4 Future Studies

Recommendation 1: Conduct a mixed-method study in three to five years to measure the effectiveness of the Italian Fablabs community in providing and assisting italian companies in the use of the digital fabrication tools.

Recommendation 2: Conduct a quantitative study in three to five years to examine Italian companies that used Fablabs services compared to Italian companies that did not used Fablab services.

Recommendation 3: Conduct a longitudinal study in five to ten years to examine the retention rates of Italian companies who went through the Italian Fablab community and those who did not.

5.5 Reflections

My internship in a Fablab provided an invaluable experience to me in preparing and conducting this work and made my choice of investigating the Italian Fablab community. My experiences offered me an array of benefits to learn about Fablabs and Fablabs community and served to help me develop the necessary skills to understand how the Fablabs community can help the Italian entrepreneurial system. As a result of my positive feelings towards the Italian Fablabs community, it was necessary for me to control for my bias when collecting data and conducting interviews. Nonetheless, the results of this study confirmed my intuition that companies that utilize Fablabs services obtain better results in terms of business results than companies that do not utilize Fablabs services. This conclusion is based not only on the data herein but also through my research and interactions with Fablabs Managers, assistants and stuff during the study. From the onset of this study, Fablabs Managers, Assistant Fablab Managers and Administrative Personnel in their responses did not distinguish themselves in a marked manner. As a moderator of focus groups, it was evident and well appreciated that all participants engage in high quality dialogue centered on the question. The several responses rarely deviated amongst the different focus groups, and showed very good knowledge on the issue. Fablabs personnel, themselves, were aware of the small demarcation from their peers who were Managers or assistants. Clearly, Fablab personnel learned from experience and unfortunately, in some instances, from their mistakes when left to their own devices. When interviewed, Fablabs Managers and assitants, on the other hand, showed an in-depth knowledge of each issue and merely enhanced responses by bundling Fablab knowledge with personal experiences. In addition, Fablabs Managers and assistants answered questions in a detailed and succinct manner. They were able to provide concrete examples and could verbalize in such a way to confirm their knowledge of the subject at hand. Fablabs assistants noted that Fablabs Managers “hit the ground running” in so many ways when

placed in a leadership role. Unwittingly, responses of the assistants indicated that companies having experience in using Fablab services required less supervision than companies who do not have. Italian companies perhaps unwittingly also recognize the value of the Fablabs community when prior to using Fablab services. This is due to information gained through informal conversations and word of mouth with other companies that had already experience in using Fablabs services. The data from this study leads me to conclude that companies who use Fablabs services are better prepared, have more business opportunities, are more confident in competing in the market, are more knowledgeable and gain access to new technologies compared to companies who do not use Fablabs services.

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Appendix A
University of Pavia
Informed Consent Protocol

Title of Project: Fablabs to transform the Italian Industry: The Case of the Fablabs Community

I. Purpose of the Project

This research studies the case of Fablabs community helping the Italian industry in the process of innovation and growth. This case is representative of how entrepreneurs engage in Fablab digital fabrication technologies which allow to make almost anything and optimizing time and production cost.

II. Procedures

The procedures for this study include focus group interviews, observations, and collection of documents. Focus group interviews will be conducted with three different groups of Fablab Managers, assistant Managers and Fablabs administrative personnel. Each focus group interview will last approximately 90-120 minutes. The interviews will be audio-taped and transcribed verbatim by a secretary who will take notes during the interview sessions. Each participant will be provided the opportunity to review his transcribed statements for accuracy and make changes if necessary.

III. Risks

There are no risks to the participant in this study.

IV. Benefits of this Project

The benefits of this study include providing the Italian companies with qualitative data to assess the effectiveness of the Italian Fablabs community. The findings will contribute to understanding the role that Fablabs play for the Italian industry, explaining how digital fabrication technologies can help Italian companies to be more competitive.

V. Extent of Anonymity and Confidentiality

The identity of all participants in this study will be confidential. Each participant will be referred to using a combination of a number and letter. Only the researcher will be able to identify you individually after the data is collected. The audiotapes and subsequent transcriptions will remain in the researcher's position except during transcription by a secretary. All documents will then be stored in a safe location for two years.

VI. Compensation

The participants will not receive any monetary compensation in this study.

VII. Freedom to Withdraw

Participants are free to withdraw from this study at any point without penalty. Participants have the right to refuse to answer any question during the interview or to have their answers removed from the data after interviews have been completed.

VIII. Approval of Research

This research study has been approved by the Department of Business of University of Pavia.

IX. Participant's Responsibilities

I voluntarily agree to participate in this study. I understand that I will participate in a focus group interview, review my transcribed remarks after the interview, and be available for any follow-up questions from the researcher.

X. Participant's Permission

I have read and understand the conditions of this research study and my role in data collection. I have had the opportunity to ask questions and am satisfied with the answers. I hereby give my voluntary consent for participation in this study.

_____ _____

Signature Date

Appendix B
Raw Data Matrix: Focus Group One A

Interview Question	Response
1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?	1A: "I think so thanks to the several platform available also at international level such as FabConnections. It is a web-based platform for linking business ideas incubated in Fablabs to development services including crowd-funding, enterprise advice, and attaining sponsorship." 2A: "Knowledge are spreaded through the Fablab network. The main international network is the Fab Foundation. The Foundation helps in diffusing knowledge, as well as providing support for those Fablabs that wish to take part. Recent supportive platforms include a FabEconomy initiative which connect Fablabs with companies, which seeks to network and promote a new economic paradigm based on globally distributed peer design with customization and production locally." 3A: "We offer to companies the possibility to take advantage of increasing accessibility to versatile and powerful digital design and fabrication tools. I think that we were effective because Fablabs worldwide created a maker community that shares knowledge on a widely distributed basis. Entrepreneurs don't often get the opportunity to network with their counterparts because they are so isolated in their companies. The overall professional experience in the Fablabs as either beneficial or very beneficial for companies." 4A: "They are supposed to share new information and knowledge back that will be useful for their production activity. Fablabs are a very powerful tool for diffusing knowledge to companies thanks to a well organized international and regional Fablab network." 5A: "For a company, being inside a Fablab is a very rewarding experience and enrich their point of views. Exposure of a company to a Fablab, is a benefit for the company in terms of facilitation exchange of knowledge, ideas and resources. Fablabs strive to achieve more equal participation and inclusion of entrepreneurs in knowledge transformation processes for a future society by establishing integrative public

	spaces where citizens and entrepreneurs are provided with open access to information and knowledge." 6A: "I think that thanks to Fablabs and the several Fablab platforms, companies are supposed to share new information and knowledge back into their daily activities, receive training on the usage and further development of digital technologies gain affordable or free access to the technologies and/or methodologies for the production of their products."
2. What benefit in terms of R&D and manufacturing time and costs did the Fablab provide for Italian companies?	1A : "Fablabs promise a degree of productivity, which is highly relevant for competitiveness and wealth of almost any company, helping those without technical skills or availability of technology to get products to market." 2A : "In a traditional world, innovative products are developed on the basis of rapid prototyping at R&D departments of privately owned companies or at laboratories of universities and research institutes. Instead, in a Fablab small group of experts has the possibility to produce prototypes in short time and using simple means." "Just-in-time manufacturing is a feature of Fablabs and it is the opposite of what architects and contractors usually anticipate. Often, the schedule for a large new building hinges entirely on whatever specified product has the longest lead-time for production. So if the means for producing a building product is located right on the job site, the cost of scheduling and transporting is neutralized. And a Fablab does not care if the building product is a one-of-a-kind shape or a recurring one. After all, we're printing it and cutting it right now, made to order, so, it is faster and cheaper." 3A: "Usually, when you go to an external company that offer services similar to Fablabs, you think that turnaround time with outsourcing only takes 2-3 days to get models back. This is rarely the case. In fact, it takes around a week. So, when taking into account internal design review meetings, order placement, approval processes, and other procedures, the total design delay time can be five or 10 times the actual turnaround time when outsourcing. In many cases, this process may be repeated two or three times before a

	product design is finalized for production, compounding the time-to-market delays. Delayed time-to-market is not the only cost. Even though some things can be done in parallel, it is estimated that a significant amount of time spent waiting for models to return from an outsource provider is wasted design time.In comparison, in a Fablab a prototype model can be produced within hours, rather than days. Not to mention additional time saved by printing during the night or over the weekend when no one is at the office. 4A: "Thanks to Fablabs, R&D effectively moves out of the corporate environment into niche development by individual innovators and eventually works back into the core business. Fablabs will allow SMEs and new ecosystems to access the resources and tools that were historically available only to large enterprises, on a shared or rental basis. This opens up the potential for new types of business offerings, including the supply chains that will evolve around these ecosystems." 5A: "A Fablab has quite some potential when it comes to knowledge and technology transfer. The direct manufacturing of end products greatly simplifies and reduces the work for a SME who would only have to take products from its computer screen to the Fablab." 6A : "Today, time-to-market is critical, but not if it means sacrificing quality and performance. Testing, early and often, is the key to keeping a project on schedule and the product on target, and the ability to turn CAD models directly into prototypes has made that testing possible. Fablabs own this ability."
3. What do you see as the strengths of your prototyping service?	1A: "Our Fablab has developed the processes and capabilities to design for distributed manufacturing. For some industries, particularly those that are trending towards shorter product life-cycles, like consumer electronics and clothing, small-scale distributed manufacturing may be necessary to take advantage of the ability to learn from rapid prototyping and designing. Assembly functions would also move closer to the end consumers. This would change the economics that drive the current centralized manufacturing and assembly model and could compel restructuring for incumbent firms and

	workforces. We try and promote this transformation in product segments that are consumer-facing, demand more customization, and require lower investment in tools (apparel, home furnishing, jewelry, consumer electronics, etc.)." 2A: "The rigorous testing, evaluation and refinement inside the lab are the best means to assess what works and what doesn't. Through this approach rapid prototyping with 3D printing provides the flexibility required to make this crucial trial and error process possible for physical products." 3A: "As individuals gain expertise in the requirements to transition from Maker-to-Market, focused Fablabs as ours may help foster small businesses and lead to a virtuous cycle of more successful businesses being developed. Our Fablab functions as "prototypes-tanks" that help small businesses quickly prototype their hardware and business models. Codifying a playbook for Fablabs could help galvanize and grow the entire Italian Fablabs ecosystem." 4A: "In general, the later a problem is discovered, the more costly it will be to correct. Finding and fixing problems early in the design cycle is essential to preventing scrap, rework and retooling. Rapid prototyping with Fablabs 3D printing allows industrial designers and engineers more revisions in less time, so they can test thoroughly while still reducing time-to-market." 5A: "Test in the real world is so important for a company, know exactly how your products will look and perform before investing in tooling. A company can 3D print in a Fablab short-run tooling to prove out your products and manufacturing processes before making big investments." 6A: "Prototyping in a Fablab can cut costs and make your development cycle quicker and more effective. Our 3D printing services gives to a company the ability to test out prototypes on customers or people in your organization. Testing and getting feedback along with iterations help eliminate mistakes further along."
4. Do you feel that Fablab's services offer and quality has refined the sector of	1A: "One of the biggest benefits of

prototyping services? Do you think the traditional actors of this market are losing business?	working with Fablabs, is the personal service. Fablabs not only provide companies with expert advice and guidance often for free, but also connected SMEs with funders, other entrepreneurs and outside support. This generated referrals to new projects and clients who were not aware of what they do, and helped them and us almost double our work annually." 2A: "Physical models convey ideas to collaborators, clients and marketers in ways computer models cannot. Fablabs rapid prototyping facilitates the clear, detailed feedback essential to product success, and lets entrepreneurs quickly respond to input." 3A: "SMEs that are now our clients referring us that prototyping companies were more expensive, referring to specialized companies can be costly depending on what you buy and the services you choose. You need always an investment in resources, even if you do go completely outside, you still need someone in-house to manage the process on your end. In addition, there is a greater risk that you could lose intellectual proprietary info if the other part don't maintain confidentiality." 4A: "We offer an external perspective, a fresh set of eyes on your ideas can be helpful. You can forge valuable partnerships with different companies and Fablab personnel professionals and tap into a greater range of capabilities and expertise. We have always new materials, companies can try new technologies and different materials without committing to only one." 5A: "The main PROs for companies to come to Fablabs rather than referring to an external business are the affordability of service, companies pay for only what they need and one-stop shop feature, Fablabs offer a range of capabilities, from designing an initial concept to printing it." 6A: "Three dimensional (3D) technologies and services for rapid prototyping have become more affordable in Italy over the last decade thanks to the born of Fablabs. Any companies can take advantage of them during the packaging design process and the realization of prototypes is now possible in a cost effective and timely manner with these technologies."

5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why?	1A: "Fablabs provide to SMEs access to the tools needed to conceptualize, design, develop, and test new products. All what they need to compete with foreign companies." 2A: "Through the use of Fablabs' tools also SMEs can now generate fast paced electronics, come up with a way to build quickly and to replicate the fast production process." 3A: "The big opportunity that we offer to Italian companies that mostly have really small size with often a low power of spending is the opportunity to cost-effectively prototype a variety of new products and business applications." 4A: "I think of the ABC's of Fablabs: A stands for academics, B for business and C for community. Fablabs can be a new free network for Italian companies. We can be a network where small businesses needing assistance developing products into saleable products." 5A: "we help those without technical skills or availability of technology to get products to market, an opportunity for SMEs to have access to technology they would not ordinarily have." 6A: "We empower SMEs to realize their ideas and to engage in a global community of technology and makers, providing them new digital machines."
6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?	1A: "Fablabs bring people together to work, to learn from each other, to share knowledge with the global community, and to develop into a highly-skilled local workforce. Local problems can be solved and living standards increased." 2A: "Once people learn the basics of the Fablabs' computers and manufacturing equipment, they can start developing their own solutions to local problems. A great and famous example, was in rural India, where inventors at the local Fablab were developing a machine to measure the fat content of milk and to sound an alarm when that milk is about to turn sour, and this was important for local dairy farmers." 3A: "Unemployment is high in South of Italy. The presence of Fablabs in the south can educate young people, getting kids to come into the Fablab and come up with ideas that can sustain their lives. Meanwhile, dozens of children are getting their first taste of

	technology, one day they will be the future workforce." 4A: "Meanwhile, the labs can help excite a new generation of Italians about manufacturing, an underdeveloped economic sector in the south of Italy. Fablabs might also spark new businesses, even industries, by allowing inventors of all backgrounds to use equipment and design prototypes for free." 5A: "Fablabs, Individuals and small businesses will come together, both in urban and rural areas and in virtual communities, driven by a desire to learn faster by working together. Within these ecosystems, participants will combine and recombine as necessary to exchange skills, capital or learning, creating a resilient and agile network structure that supports the decentralization of some activities, including innovation and some types of production, currently done within large enterprises." 6A: "So, Fablabs are likely to become still more popular in developing and underdeveloped regions, where Fablabs can empower individuals, developing skills, furthering innovation, educating children and prototyping new product ideas."
7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?	1A: "Fablabs are integrative, put specialties of several people into broader context; cross pollination of disciplines. Transcends age, gender, socioeconomic, educational backgrounds, is a technological playground for all. So many people together across age, class, language, discipline, culture, artists working with scientists." 2A: "In my Fablab we brought unique groups of people together coming from several communities, academic, business, community at large, all can be included. People who are thinking about innovation in a different way with different resources capability and not just engineers and scientists." 3A: "Our Fablab is a key vehicle for pulling edge communities – artisans, disadvantaged groups, youth, industrial arts communities, temporary workers – into the core by providing them with access to more and more powerful tools of production through shared platforms and helping them to connect with individuals and resources that can amplify their efforts and

	build viable commercial enterprises. If our national government find ways to relax restrictions and create space, negatives like unregulated micro business activity can be seen as positive, early-stage entrepreneurial activity." 4A: "Our Fablab technology makes it easier and cheaper for individuals and small businesses to find resources, create products or services, and reach a large audience of customers and collaborators. Meanwhile, considering the large number of small businesses in Italy, the need for Fablabs services – for example, of logistics, design tools, digital infrastructure, financing platforms and marketplaces – to serve the fragmented businesses is very important. Individuals and small businesses rely on the existence and further development of Fablab services to continue to lower barriers to entry and make businesses viable at smaller scale." 5A: "The Human resources that run the lab are like consultants for the outside world. Fablabs have an enviable storehouse of intellectual and creative resources, so companies can collaborate with innovators and their creative economy communities, and enhance their chances for growth." 6A: "Inside Fablabs is important the human element, it is not like a business. People are willing to help each other, like a different culture, amazing to look at people finding out they can do what they never thought they could do."
8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?	1A: "The Fablab environment is the cultural hot-bed for the "Maker Movement" which advocates for knowledge sharing, experimentation with new technologies, and the exploration of cross-disciplinary projects motivated by enjoyment and personal achievement. The environment inside Fablab seem to provide fertile ground for entrepreneurship and could significantly reduce the barriers for the individuals who, under the correct circumstances, might decide to become entrepreneurs." 2A: "Projects initiated at one Fablab can be adopted, modified for local conditions and improved upon by other nodes in the network. Sometimes the adaptation to local needs

	happens through collaborations between different Fablabs, each seeking to solve a local problem, but sharing experiences and thus contributing to the solving of problems around the globe. One example of a project that several Fablabs have undertaken collectively is the search for low-cost Internet and Wi-Fi infrastructure." 3A: "The collaborative and open-source ethos of Fablabs is meant to ensure that while creators can retain rights to the inventions, as much of the process as possible is shared so that others can build on and learn from the work." 4A: "Our Fablab creates training tools and templates for Maker-to-Market. Document the lessons, pitfalls, and useful tools that Makers currently going through incubators and accelerators are discovering. Templates and guidance around bill of materials (BoM) and lead time planning, trade-offs in designing for manufacturing, basic set of financial templates, and guidance about unit economics could help fill the basic knowledge and expertise gaps that small enterprises encounter when trying to scale." 5A: "Making prototypes inside our Fablab develops a habit for experimenting and instills a culture of continuous and active learning. It encourages learning dispositions by nurturing the curiosity, exploration, and collaboration that comes with experimenting – values often undermined with traditional education. Collaboration relieves the learner from isolation, fostering a learning disposition that is also fueled by connectedness. Making creates an ecosystem for learners to find and explore their creative potential by celebrating collaboration and knowledge share." 6A: "By sharing information across the network, Italian companies can take and adapt these innovations to their own local circumstances. Synergy among players in the network will create products and opportunities for innovation and new ways of thinking."
9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?	1A: "When people come together in a Fablab, their wheels start spinning with creativity. Fablab is a place that is an invention playground, an incubator of design ideas, a maker of possibilities, a creative ecosystem,

	and a place that gives anyone and everyone the technology to power their ideas." 2A: "A Fablab stimulates your creativity, you can also produce a gun, a pizza or anything else. I can declare that it is useful both for companies and both for individuals that can use their creativity and fantasy to make almost anything." 3A: "When you combine innovations in energy production with the open source hardware movement you create very low cost and high value technologies. We are building a creative space to stimulate local innovation." 4A: "We are on the cusp of an opportunity to more fully tap into our creative potential, driven by significant Fablab technological innovation that is democratizing the means of production and enabling connections between resources and markets. Realizing this opportunity will require re-thinking and redesigning all of our major institutions, innovating the way we work, learn and consume. It will require developing ecosystems that can more effectively integrate distributed production by smaller entities with the scale and scope that can be provided by larger entities." 5A: "Probably, the most disruptive element of this technology are not the tools themselves, but the maker culture, the community of people who sell, use, and adapt the tools of digital fabrication. For sure, Fablabs is a place that enhance creativity, because the idea is that with a Fablab you can make practically anything." 6A: "Fablabs and short-run manufacturing is critical to revitalizing Italian manufacturing. Framing manufacturing as a design challenge and calling upon the public to address the problem creatively can attract the right talent and resources to make meaningful change. There may be a role for the Italian government to play in facilitating relationships between different players to help understand what constitutes an effective supply chain for small entrepreneurs and what the dynamics of creating one would be. We will for the first time be able to truly "race with the machine," harnessing the power of the machine to unleash and amplify our creative energies. More broadly, we will finally make learning a true lifetime journey, providing new sources of

	meaning, and develop ways to connect more richly in physical space so that we all benefit and prosper from the new opportunities that are now available through Fablabs."

Raw Data Matrix: Focus Group Two B

Interview Question	Response
1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?	1B: "Fablabs and companies started to collaborate each other, this new relation allowed companies to receive training on the usage and development of digital technologies and to gain free access to the technologies or methodologies for the production of their products." 2B: "All the small Italian companies that used our services had access to new tools and technology previously not known by them. Once, inside the lab entrepreneurs or innovators can get in contacts with the other people working in the lab or they can also attend to the several workshop that we periodically held. Especially, SMEs and their owners often are isolated within their own walls, but coming to the labs they have the opportunity to enlarge their network and get new knowledge for free." 3B: "The overall professional experience of a company in a Fablab was most of the time very beneficial. Usually, a lot of entrepreneurs that come to the Fablab for the first time and do not know the Fablab reality remained very impressed, because they receive knowledge of technology no previously known by companies and this is beneficial in particular for startups in their growth stage." 4B: "SMEs across Italy are home to numerous thinkers, inventors, and creative people with a wide range of skills and talent. Many of these SMEs work by themselves in their own factory, or at local level. A Fablab is a sort of new strong entrepreneurial ecosystem that supports these SMEs and its entrepreneurs and encourages them to develop new skills, innovate, and pursue their entrepreneurial ideas is important in furthering economic growth. The main objective of a Fablab plan is to review innovative practices in building an entrepreneurial ecosystem based on talent,

	innovation, and creativity that fosters a vibrant local economy, in addition to provide actionable recommendations for its local community. 5B: "I have to underline the importance of the international Fablab network that is a very powerful tool for diffusing knowledge to companies. There are several international platforms that are used for linking business ideas incubated in Fablabs to development services including crowd-funding, enterprise advice, and attaining sponsorship." 6B:"Fablabs are a public space where innovators and entrepreneurs are provided with open access to information, technology and knowledge. Companies receive new information and knowledge that will be useful for their production activity."
2. What benefit in terms of R&D and manufacturing time and costs did the Fablab provide for Italian companies?	1B: "In Italy, SMEs before launching a product on the market have to test this product at rapid prototyping department of privately owned companies or at private laboratories. Instead, in a Fablab small group of experts has the possibility to produce prototypes in short time and using simple means." Five of six noted how Fablab tools and resources could cut the cost of market entry for new companies. 2B: "Fablabs can enhance the productivity of Italian companies, which is highly relevant for being competitive in the domestic and foreign market and growth of almost any company, helping those without a big budget for innovation, qualified human resources and technical skills to get products to market." and 3B: "Manufacturing a new product by using Fablabs technology makes it cheaper to begin manufacturing, even at low volumes, or to serve niche segments. This is especially worthy for small Italian companies can often are focused on the quality and luxury products and serve niche segments of clients" Participant 5B concurred, "Fablabs allow companies to save weeks off of the development cycle and dramatically accelerate time-to-market of new products." 4B: "A Fablab is often a place with the latest technology and machines when one basic principal is the sharing of knowledge and transfer of technology."

	5B: "Fablab motto is, do-it-yourself. We have moved from financial sponsoring to active engagement through Fablabs. These are new and exciting times for us where we explore open source collaboration. It is still early days for Italian ecosystem, but we are committed to experiment with new forms of assay technology development in an open source space such as a Fablab. We are ready to share our knowledge and to learn from enthusiastic people in our new network. For us it is a paradigm shift because we are not aiming at creating and securing IP in our Fablab – it is exactly the opposite: We strive to learn and share with everybody. We hope to learn how we can accelerate R&D by employing smarter and lower cost approaches that we apply to all Fablab users." 6B: "Just-in-time manufacturing and time-to-market are some of main concerns of almost any companies, but not if it means sacrificing quality and performance. Delayed time-to-market is not the only cost, waiting for models to return from an outsource provider is wasted design time. In comparison, in a Fablab a prototype model can be produced within hours, rather than days. On average, if the entrepreneur come with the model already done on CAD takes just 1-2 days to get models back."
3. What do you see as the strengths of your prototyping service?	1B: "In our Fablab we help you to build your Imagination. In Fablabs we see a boom of digital art and design, and the possibilities are not only accelerating but limitless. One can now 3D print almost anything they imagine after drawing it up virtually. In a relatively short time, an idea, concept, dream or invention can go from a simple thought to a produced part that you can hold." 2B: "The 3D printers that we use can reduce the construction of complex objects to a manageable, straightforward, and relatively fast process. Today's rapid prototyping is heavily used by companies to better understand and communicate their product designs as well as to make rapid tooling to manufacture those products." 3B: "For some industries, particularly those that are trending towards shorter product life-cycles, like consumer electronics and clothing, small-scale distributed manufacturing may be

	necessary to take advantage of the ability to learn from rapid prototyping and designing. Our Fablab assembly functions also move closer to the end users. This actually change the economics that drive the current centralized manufacturing and assembly model and could compel restructuring for incumbent firms and workforces. 4B: "The relative ease of access to, and use of, these Fablab machines allows more people, in more places, to prototype new products. In our Fablab we have created a new networks of independent prototype shops, service bureaus, and small manufacturing and assembly firms will emerge as digital platforms, marketplaces and mobile make coordination of a supply chain of small suppliers easier. Moreover, through our services the assembly part locate closer to customers. Large manufacturing incumbents may mirror this ecosystem or tap into the new external prototyping infrastructure until a product requires larger-scale." 5B: "Rapid prototyping in our Fablab can help verify a design, communicate an idea and fix design issues early in the development process preventing costly changes to the hard tool once the product is in full production." 6B: "One main benefit is the Design freedom. Thanks to these new technologies, it's quick and efficient to create multiple iterations of a project, sketch or rendering. Another benefit is that you can maintain your intellectual property if you aren't ready to share your designs with the world yet."
4. Do you feel that Fablab's services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?	1B: "Any companies can take advantage of the technologies inside the Fablab either small or big it can save time and money, the packaging design process and the realization of prototypes is now possible in a cost-effective and timely manner with these technologies." 2B: "In the last years, Fablab services and especially the use of 3D printing has grown in Italy. This technology is now affordable also for SMEs that can get customized products and services." 3B: "An Entrepreneur coming to the lab will receive attention and the personal service is one of our feature. However, we not only provide companies with expert advice and guidance often for free and helping them with

	the initial design, but also help SMEs connecting with other entrepreneurs and outside professionals. This implicit referrals to new projects and clients who were not aware of what they do, and helped them to almost double their business." 4B: "I think so because generally speaking Fablabs empower their users to develop, build and test physical prototypes hands-on. Prototyping is a key process of product development, especially in technology driven industries and research and we offer this service. A prototype serves as a milestone and can be used in various stages of the development process to improve communication and learning within a group or organization. It is also an important part of project-centered education and relevant for engineering education. One good way to empower students and give them a space to build physical prototypes are makerspaces in the university. So, we have refined the sector of prototyping services, by allowing the use of these new technologies to SMEs but also the sector of education. 5B: "Some benefits for companies to use Fablabs services are the affordability of service, companies pay for only what they need and one-stop shop feature, Fablabs offer a range of capabilities, from designing an initial concept to printing it, companies can try new technologies and different materials without committing to only one." 6B: "Prototyping services in traditional specialized companies are expensive and SMEs often cannot afford this investment. 3D printing in a Fablab allows the creation of parts and/or tools through additive manufacturing at rates much lower than traditional companies."
5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian	1B: "It is also not surprising that the most frequent barrier for SMEs is lack of resources, because of which SMEs cannot take on Rapid Prototyping technology due to the current internal and external financial constraints. We believe that our Rapid Prototyping service is evidently seen as an appropriate process when related to the crucial dynamics on which the

companies in competing in the business market? If yes, how? If no, why?	SMEs strategically perform. Our better technology, better tools may help SMEs and at the same time we should not miss the real opportunity of creating a new generation of SMEs with a strategic mindset." 2B: "Italy's companies could be the ones to profit most from embracing 3D printing in their manufacturing processes. The main advantage could come from rapid prototyping, which would allow companies to experiment and try new products at much cheaper costs than was possible before. This would be a boon for Italy's SME sector, which is dominated by 3.4 million small businesses which employ under 10 people and have little money to invest in R&D." 3B: "Entrepreneurs in the Fablab can be simple users developing its own products, business ideas and get involved in a start-up with other Fablab users. Especially Italian SMEs and start-ups need support and funding in their early phase, as they can often not afford to buy expensive machines to build their first prototypes and develop a product. This is where our Fablab, empower entrepreneurs through access to space and equipment to build their first prototypes." 4B: "Another opportunity that Fablabs could offer to Italian companies is the ability to produce small batches of high-quality goods, personalized according to the customers' requests, in a more cost-effective way than before." 5B: "Fablabs give to Italian SMEs more scope to experiment with prototypes, limited production runs and personalised products. Coming to Fablabs companies do not have to sustain set-up costs, but only material costs, meaning that you don't have to spend hundreds or thousands on set-up." 6B: "Our Fablab often act as accelerators, allowing entrepreneurs to meet, form teams, and experiment with the idea of bringing technology from research laboratories to the market. Further, our Fablab effectively can offer an incubation period to spin-offs, in which entrepreneurs have the freedom to develop the technology and form their strategic plans, reducing the venture's market and technological risk.

	Additionally, our Fablab and its creative environment create a community for local SMEs, which serves as a creative breeding ground for ideas. This helps entrepreneurial students and alumni with team creation and networking."
6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?	1B: "At the moment we're in talks with a large number of educational institutions, from primary schools to university level, to realize workshops on digital fabrication and learning courses based on the aforementioned themes. This should result in a high potential of skilled young talents for local companies, which will benefit the local economy in the underdeveloped areas that is currently lacking in qualified staff." 2B: "Fablabs are emerging not only in developed Western world, but also in Africa, South America and Asia. Especially for underdeveloped areas, additive manufacturing (3D printing) made accessible via Fablabs, holds a high potential to overcome the poor availability of spare parts, high-tech and customised objects. Thus the Fablab movement affects one of the main ideas of sustainable development: balancing human welfare, fairness and participation on a global scale." 3B: "Although South of Italy is characterized of unemployment and lack of companies, many Italians of that area are still struggling to build their businesses. We have met many community members with wonderful, inspiring ideas and talents but because they lack the space, tools, training, resources and other support, they have no ability to realize them. Our Fablab provided them a place where entrepreneurs with ideas can gather and find support for their projects. It is our goal to give anyone in the local community the resources they need and to connect them with various networks to help them establish or expand their business." 4B: "Having an open space accessible to small entrepreneurs such as a Fablab foster personal drive and ambition. Fablabs are a good solution for hungry entrepreneurs in under developed areas for getting their startup going. Fablabs are no substitute for inquisitive hardware minds to experiment. Both require people driven towards a goal already, the space doesn't

	matter if the person isn't ready. Fablab can help accelerate entrepreneurs. So, Fablabs give driven people a chance to move further, faster. The basics of fast internet, space to work with like-minded people, access to tools, inroads to mentors and/or business contacts, and government or university connections are all things that a Fablab can provide. 5B: "Fablabs can be a tool to create enterprises and especially physical products have become accessible to just about anyone. For example, until very recently, industrial design often had to be done in the context of a large company, because the tools to do it were exclusively the territory of big companies and consequently in developed areas. But that's not the way it works any more. People can go right into a Fablab to create a model or product, all by themselves through 3-D printers, laser cutters, and computerized machine tools available to anyone." 6B: "Furthermore, we are collaborating with local companies in challenges: students find solutions for their company defined problems and try to solve them using open design principles. This is especially useful for companies in underdeveloped areas because in the long run, they can expect to find talented, motivated young people who are interested and qualified to work for them. Finding the connection with the already present local economic infrastructure and stimulating bottom-up innovation is one of our key proposition."
7. How successful do you feel your Fablab has been in providing companies with a high quality human resources and infrastructures?	1B: "Valuable and rare characteristics of our human resources can provide above normal saves and profits for the firm in the short term and improve their innovation performance.. Big companies started a recruiting competition and organizations put further emphasis on acquiring and retaining top talent, so find valuable human resources for SMEs get always more expensive and difficult, instead we can provide it." 2B: "In any Fablab there are unique groups of people together coming from several communities, academic, business, community at large, all can be included. People with different experience, background and skills that work under the same roof with the capacity to combine all their knowledge."

	3B: “We think that innovation needs to be enabled and supported at all age groups. In our entrepreneurial community we think that our Fablab can offer a supportive infrastructure that develops human capital and supports innovation, risk-taking and creativity. Talent is becoming increasingly relevant in determining the allocation of economic opportunities and to foster economic productivity and growth suggested that high-tech companies are attracted to places where a technology, research, invention and innovation base already exists such as Fablabs.” 4B: “Currently, Italian SME have been exploring the Fablab program for the potential this initiative has in growing the local innovation infrastructure, as well as business development and creativity support services. These economic development efforts require qualified human resources in order to integrate this new culture into the company. A Fablab program is a very effective way to introduce people, especially entrepreneurs, to creative and entrepreneurial concepts. Through encouraging participants to learn and develop new skills, including entrepreneurial skills, and digital fabrication skills.” 5B: “Fablabs are compatible with the infrastructure of universities, since similar setups exist in other university shops. The main difficulty, however, is that they are available in foreign universities but not in the Italian ones which have more a culture of closed shop-environments. Although the concept of a Fablabs is not too complex, the meaning and possibilities are currently not that well-known in Italy in comparison to the USA, where more examples of Fablabs exist. However, as the Fablan movement increase in Italy, more people will understand the concept and potential of a Fablab and all the qualified human resource and innovative infrastructure that we offer.” 6B: “For a SME working with a Fablab, along with an incrementally established network of specialized Fablabs located throughout Italy, could have a catalytic impact on the company development by spurring innovation and creating synergies among innovators. Moreover, the kind of innovation infrastructure provided by the Fablab could amplify the

	impact of the SME in the market by generating spillover effects for other parts of the innovation ecosystem, especially if operated in tandem with other innovation instruments. With Fablab support, in terms of human resources and infrastructure a SME could compete on global standards."
8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?	1B: "The open Fablab environment removes barriers, such as access to equipment and technology, while serving as an incubator for applied research, innovation, job creation and economic development." 2B: "Fundamentally, for a company going to a Fablab in Italy would overcome systemic inefficiencies by providing broad access to high-tech equipment, expertise and mentorship; thereby, creating a conductive enabling environment for incubating research and entrepreneurial ventures." 3B: "A Fablab provides to a broad public an accessible environment (industry-grade technologies, facilities, education, mentorship) for prototyping and digital fabrication of innovative ideas and products. It thus can be a catalytic stimulus for knowledge sharing, entrepreneurship, and research. Fablabs also mitigate the risks associated with launching new products and ideas by eliminating failures when products are launched in real life. Fablabs today are also seen as an interconnected global community of learners, educators, technologists, researchers, makers and innovators, who have collectively created a knowledge-sharing network. 4B: "The problems facing Italy are well known. Italy is lagging the nation in developing a knowledge-based economy and adapting to a rapidly changing global economy. Italian SMEs community needs to place technology, innovation, and entrepreneurship at the center of economic policymaking. In our local community we develop programs that support learning, innovation and entrepreneurial spirit. Economic gardening initiatives that seek to harness the inherent knowledge-base of the community and foster creativity, as well as the desire to learn and innovate in the community's youth are critical for local SMEs." 5B: "In our Fablab, members share their knowledge with other affiliates, including how

	to use specific tools and equipment. For dangerous or expensive equipment, prior knowledge or training within the Fablab is required. Projects in Fablab groups tend to develop organically. In many cases, individuals will propose a project, mention an idea or begin to tackle a complicated problem. Other members would share ideas, knowledge, tools, and expertise and some of the resulting projects led to successful start-ups." 6B: "A core component of Fablabs communities is the idea of sharing knowledge. Our Fablab relies on community members acting as mentors and sharing their knowledge in particular fields to other community members. For instance, individuals who have skills in electronics or programming are tapped into teaching hands-on workshops. Our Fablab develops creative ways to encourage entrepreneurs to actively learn, create and innovate."
9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?	1B: "Fablab is a community maker space that encourages creativity and innovation. The new technologies, products and services that stem from the creativity of individuals and companies will benefit all of Italian companies and contribute to economic development. Such increase in the value of Italian intellectual capital might help establish Italy's image and reputation as a source of cutting edge innovation and can serve to attract innovators and investors." 2B: "The benefits of Fablabs are tremendous in supporting an entrepreneurial ecosystem through, fostering innovation, creativity and making skills. Fablabs allow experimentation, learning, creation and invention through play. In addition, Fablabs have the potential to help communities to learn science, math, technology, and engineering through hands-on activity. These programs foster exploration and encourage entrepreneurs to be more entrepreneurial and creative as well as develop skills that would allow them to adapt to changes in the economy." 3B: "The Creative and Social use of Fablabs is available for everybody, In this sense, Fablabs seek to amplify human potential while providing people with the necessary supporting tools to stimulate creation and invention but also to spread their ideas, building up markets,

	communities and even movements. Such practices and values promote alternative ways of creating physical goods and innovation systems focusing mainly on learning-by-doing approaches, shared information on technologies and tools, peer-to-peer design or social product development." 4B: "Communities across Italy are home to numerous thinkers, inventors and creative people with a wide range of skills and talent. These communities should develop a local entrepreneurial ecosystem to support their innovators and encourage them to develop new skills, innovate and pursue their entrepreneurial ideas. Therefore, a Fablab program would be an appropriate direction in furthering the innovation ecosystem in a community. Fablab programs have the potential to nurture timeless skills such as curiosity, problem-solving, collaboration, creativity and the ability to learn on one's own that will help prepare our children for their future careers. Many entrepreneurs will develop practical skills that can be applied to their own creative and entrepreneurial ideas." 5B: "Fablabs located in Italy will contribute to accelerating the dynamics of Italian companies' innovation by providing access to the latest technologies for prototyping tangible products and services, advanced 3D printing tools and a whole new environment for creativity and entrepreneurship. 6B: "Since the Fablab is a place where innovations are created and the next generation of entrepreneurs who will design tomorrow's products come together, there exists a high demand in the community for a space to make ideas tangible. This can be realized in Fablabs. As the Fablab movement continues to grow internationally, it becomes important to build an understanding of the impact Fablabs have inside of companies. In recent years it has gone through improvements and changes, such as building a large entrepreneurial network inside Fablabs that inspire innovation.

Raw Data Matrix: Focus Group One C

Interview Question	Response
1. Do you think that Fablabs in Italy has been effective in diffusing new knowledge to companies? If yes, how? If no, why?	1C: "I think that Fablabs are of fundamental importance for companies and their innovation process. For the SMEs coming to our lab, knowledge itself can be embodied in the products that we help them to create. What I know, is that technological knowledge is often not transferred as itself, but instead within our technologies. Thus if we talk about our effectiveness in diffusing knowledge, it is either a direct transfer in the sense of human capital transfer or more indirectly linked with the use of the Fablab technologies." 2C: "I think that Fablabs are gathering points where communities of new and experienced makers connect to work on real and personally meaningful projects, informed by helpful mentors and expertise, using new technologies and traditional tools. Fablabs are physical location where people gather to share resources and knowledge, work on projects, network, and build. They are primarily places for technological experimentation, hardware development, and idea prototyping." 3C: "Entrepreneurs can apply their knowledge hands-on in Fablabs, which through their services has a positive effect on their learning. Within Fablab community, they can also develop soft skills, such as communication skills and team work. In Fablabs entrepreneurs see a purpose in applying their knowledge and engaging in personal projects. New inventions and innovations as a place of creative freedom, Fablabs are catalysts for new inventions and innovations. This has a positive impact on several areas, such as research and entrepreneurship." 4C: "Our ability to understand and apply complex technical knowledge is recognized from all the companies served so far. A SME because of its limited budget and resources always face a high degree of uncertainty about an innovation and knowledge necessary for the time of adoption. While a SME often cannot get these knowledge, the Fablab plays an important role in the diffusion of these knowledge. Thus, the Fablab plays a gate

	keeping role in the flow of new knowledge into the company." 5C: The Fablab movement in Italy is maturing and formalizes. It started few years ago with hackerspaces, where computer programmers could share knowledge infrastructure with each other. Besides programming and hacking they were also engaged in creating physical projects. In the last five years, Fablabs started becoming en vogue: spaces where from knowledge we obtain real objects which are made from digital designs." 6C: "We also diffuse knowledge to companies through intensive training course or workshops held in our Fablab. Because of the cheap training cost, many entrepreneurs can attend and get knowledge almost for free."
2. What benefit in terms of R&D and manufacturing time and costs did the Fablab provide for Italian companies?	1C: "Due to the inimitable manufacturing processes of 3D printing inside a Fablab, users now have the ability to innovate products from the inside out. The process cannot be mimicked using traditional manufacturing methods, since 3D printing is an additive process. This means that individuals and businesses alike can create internal skeletal structures and unique shapes within an object. This breakthrough opens the door to mass customization and on-demand manufacturing of industrial parts. Fablab machines permits a single part to be made with a variety of densities and material properties." 2C: "Because 3D printing inside a Fablab allows users to develop and revise products rapidly before undertaking the costly processes associated with traditional manufacturing, the applications for the technology are vast. The 3D printing industry is expected to change nearly every industry it touches, completely disrupting the traditional manufacturing process. As a result, the projected value of the industry is expected to explode in the near future." 3C: "The current market forces companies to produce low-cost and high-quality products in order to maintain their competitiveness at the highest possible level. There is no doubt that, a Fablab can help the company to reduce the cost of a product starting from the design stage to the manufacturing stage." 4C: "Yet, traditional manufacturing still holds an important place in the Italian economy. Once products are developed, it is challenging

	for a Fablab and its 3D printers to match the economies of scale available through traditional manufacturing. However, the main advantage of 3D printing is that a low number of goods can be produced at an inexpensive cost, as compared to traditional manufacturing, which typically requires higher volumes to lower costs. However, as those economies of scale come into play, traditional manufacturing can be more beneficial for producing larger quantities of products." 5C: "Fablabs have a "just-in-time" manufacturing philosophy which calls for reducing setup times and costs. I point out that the reduced setup costs with the accompanying smaller lot sizes have numerous benefits for a SME including, reduced manufacturing lead times, improved quality due to the early detection of defects, reduced work-in-process, easier scheduling and sequencing, increased production capacity, increased operational flexibility, reduced storage space, and lower investment in inventory." 6C: "Nowadays, Italian SMEs suffer more than the past due to the traditional disadvantages of their size limitations, more to the new demand for multiple technological competences and by increased competition. Fablabs can help to resolve these issues, thanks to its technologies, flexibility and rapid response."
3. What do you see as the strengths of your prototyping service?	1C: "The Fablab helps entrepreneurs to start and develop their prototype ideas by providing space, business development services and networking opportunities for the business tenants. Small entrepreneurs have a place to test their product before launching it to the market." 2C: "Our Fablab offer numerous classes to entrepreneurs depending on their expertise and interest. Members and non-members teach workshops classes for a wide variety of machines and practices, needed for entrepreneurs. We don't only provide a service but also we teach how to do it and how to transform ideas in realities. These outreach events are important to attract companies, funding and donations in addition to developing community knowledge with private and institutional partners, such as public schools, museums or public libraries."

	3C: "In our Fablab, single items can be produced inexpensively without incurring the mold and tooling costs of traditional manufacturing and new innovations can be created and revised quickly since 3D printing is an iterative process." 4C: "Our Fablab thrives from the creative process and personal growth through providing a workshop space where entrepreneurs and professionals can learn how to rapid prototype in various fields such as electronics, robotics, software, wood or metal working, art, video, or photography can expand their skills, invent, and build new products in a collaborative environment. Our Fablab is place where entrepreneurs gather to work on their company projects, share tools and expertise as well as learn from each other." 5C: "3D printing has developed significantly over the past 5 years and now allows consumers and businesses to conduct rapid prototyping and even produce individual items at a profit. As the costs for 3D printers decreased drastically in recent years, we have bought several 3D printers in our Fablab and our services and technology has become accessible to businesses across many industries. As a result, SMEs are using 3D printers to create unique items. In fact, consumers are even creating new innovations without financial, technological or human capital support from large organizations." 6C: "Our Fablab allows existing SMEs, startups, inventors, homemakers, and engineers to use an extensive array of digital fabrication and prototyping equipment. The purpose is to enable the users to create a rapid, proof-of-concept prototype to validate product design and assist in determining market viability. So, entrepreneurs can come to the lab and construct their own prototypes and engage in more hands-on creative activities."
4. Do you feel that Fablab's services offer and quality has refined the sector of prototyping services? Do you think the traditional actors of this market are losing business?	1C: "A Fablab would complement the services offered by other innovation type centers, foster innovation and creativity as well as further the local innovation ecosystem. A Fablab for its local community is an invaluable asset of knowledge. Our Fablab helps entrepreneurs to start and grow their business ideas by providing space, business development services and networking opportunities for the

	business tenants other than a private company that just offer a paid service." 2C: "The most used equipment in a Fablab are the rapid prototyping machines, such as the laser-cutter and 3D-printer. Entrepreneurs, who need to build physical prototypes in a Fablab find materials and sometimes a space for storage. In the case of a Fablab, many materials that users need to build their products can be bought at the location through a partnership with reseller. Additional services, such as storage or private rooms, are available for a fee that usually is always much cheaper than a private company offering a similar services." 3C: "Our 3D printers are especially useful for fast and low-commitment prototyping of new products compared the ones of traditional companies offering the same service. The Fablab movement is taking the market and the traditional competition, allowing people from all walks of life to start inventing innovative new tools and products. A culture of technology-oriented DIY that has grown up around the areas of engineering, computer science, and graphic design encourages anyone with a great idea and the desire to start a creative business from scratch." 4C: "Although traditional manufacturing will likely still hold a place in the competitive landscape in the years to come, the next 5 years promise to reveal a rapid increase in the innovations made possible by Fablabs and 3D printing. To fully capitalize on these opportunities, governments should encourage the use of the Fablabs to make 3D printing widely accessible within free public service locations. For its part, our Fablab will want to continue working towards embracing this technology as a platform to create new businesses, business models, products and services that push Italian SMEs forward by spurring the creation of new sources of profits, innovation and global wealth." 5C: "Business owners who need an easy, inexpensive way to prototype new products will want to check out their local Fablabs. Fablabs usually offer resources for technological experimentation, hardware development, and prototyping your ideas. Low-tech supplies like cardboard, wood, plastic pieces, metal doodads, and batteries are likely

	to be readily available in the space, as are tools for tasks such as sawing, welding, and laser-cutting. The higher-tech offerings include microcontrollers and 3-D printers." 6C: "Until very recently, industrial design often had to be done in the context of a large company, because the tools to do it were exclusively the territory of big companies. But that's not the way it works any more. People can go right into creating an enterprise or product, all by themselves. This thanks to the availability of Fablabs."
5. 99% of Italian companies are of a small size, which implies many difficulties in competing with the big actors in the domestic and foreign market. Do you think the Fablabs can help Italian companies in competing in the business market? If yes, how? If no, why?	1C: "In order to benefit from the applications and opportunities offered by Fablabs, companies in virtually every industry must be fast, flexible and capable to understand the implications that Fablabs and 3D printing will have on the nature of their businesses. Through Fablabs the use of 3D printing for companies becomes a more efficient and cost-effective way to produce goods, this will be an opportunity for entrepreneurs to create new innovations, disrupt industries, and potentially generate new sources of profits." 2C: "Our goal include building our Fablab to meet the demands of startup entrepreneurs and to deliver professional services, to cultivate a group of angel investors and venture capital institutions to offer convenient financial support. It also highlights the key goal of incubating a large number of small and microbusinesses in emerging industries to boost economic growth." 3C: "Italian SMEs do not know rapid manufacturing of end-use parts when they are approached by a Fablab with a novel idea. The idea is to use digital scanning and 3D printing services to dramatically change the use of these technology by SMEs. In Fablab, entrepreneurs can use digital technology to eliminate their reliance on private companies that offer similar services at higher prices." 4C:"Fablabs can boost the development of Italian SMEs and startups. We provide service platforms for entrepreneurship where innovators gather to create by sharing resources and knowledge, to nurture an environment for entrepreneurship and innovation as well as to allow people to realize their full potential." 5C: "Fablabs have been started by private companies, government entities, and nonprofits

	in pursuit of varying goals. These spaces have demonstrated the range of participants that can support a Fablab community and the ability to create a growing ecosystem to learn from. Fablabs can function as platforms for Italian SMEs, providing the physical space for entrepreneurs to meet learn, and organize around projects and initiatives, some of which extend beyond making. Fablabs create a level of engagement between SMEs that could serve to fill the existing gap with large enterprises." 6C: "With low-cost digital design and fabrication tools such as 3D printing and the ability to digitize almost any object companies can boost their growth, bold new innovations become apparent. Very young entrepreneurs get to "touch and feel" the results, and can experiment to their heart's content. These ideas can grow quickly into real products. In addition, we help to meet the new consumer demand for customization. Customers today increasingly demand solutions that are customized just for them. Fablab tools are changing these economies of scale."
6. Do you think the synergy between Fablabs and companies has a strong potential to tighten the web for innovation and strengthen the local economy in the underdeveloped area?	1C: "Fablabs, Enterprises and research institutions should work together to develop Fablabs services in key emerging sectors such as manufacturing, electronics and service, in Italy underdeveloped areas. In these areas, the government in order to incentivize the creation of Fablabs, should offer preferential tax, financial and investment policies to encourage more people to set up Fablabs and offer services to companies. A Fablab could serve as a platform for public innovation and mass entrepreneurship, which are emerging engines to power the country's economy." 2C: "Underdeveloped areas often suffer abuses motivated by engineering consultancies and large corporations' financial interests. Fablabs can arise as an alternative to these structures, turning into local, non-profit consultants of sorts. We can meet some of the rural area's needs, particularly digital de-isolation, by creating independent Internet networks that work in mountainous or isolated areas, setting up local, democratic servers, regional Internet radios, etc. In our open space, everyone is welcomed with no prejudice, in the spirit of working together."

	3C: "NGOs, development professionals, and other stakeholders in underdeveloped areas should be interested in learning how to integrate digital fabrication tools and 3D printing into their local developing communities. By enabling the small-scale manufacturing of parts and products at the point where supply chains fail, Fablabs can serve to connect rural or low-demand areas with much needed manufactured items." 4C: "Fablabs have the potential to act as centers to promote creativity and innovation, and to bring about long-term social innovation in disadvantaged and rural communities. In essence, Fablabs can become the delivery vehicles for a range of national policies designed to redress inequalities and for the benefit of developing countries." 5C: "As entrepreneurs in underdeveloped areas we all asked ourselves how digital technologies could be merged with nature, heritage and agriculture. Our Fablab, including our philosophy and practices, can be seamlessly transposed onto rural areas. We open up areas struck by digital exclusion. We can develop autonomous Internet networks in mountainous areas, install organic solar panels, and let local Internet radio emerge. We can even transform abandoned water troughs into eco-jacuzzis. Thus, our Fablab user-friendly space is a place that can boost the disadvantaged areas and spreading throughout the local companies." 6C: "Underdeveloped areas with low population density have little ability to collectively demand goods and services, meaning that private industries looking for economies of scale or high-return investments neglect those markets. So, local SMEs and craftsmanship is a driving force for sustainable economic development. Consequently, Fablabs can be a driving force of development in these areas by providing to local SMEs access to innovative technologies and services which can boost local jobs, labor skills, and improves income potential and quality of life in these areas."
7. How successful do you feel your Fablab has been in providing companies with a	1C: "Fablabs provided to Italian companies new spaces for individual creation, fabrication and artistic expression. We enable individual production by providing both the physical tools, such as 3D printers and laser cutters as

	high quality human resources and infrastructures?	well as a network of members who are willing to share their knowledge to help others through a collective effort. These spaces have emerged through the convergence of a number of phenomena such as the availability of affordable digital manufacturing technologies, ubiquitous computing and network technologies." 2C: "We gave a technological advantage to Italian companies, pioneering access to information and communication technologies and innovative solutions in an era where SMEs were suffering for the economic crisis in Europe." 3C: "Fablab 3D Printing technology presents an opportunity to localize manufacturing, allowing for greater customization of needed items and more effective delivery of replacement parts. The combination of technology, aid, and entrepreneurship evident here holds great promise but relies on strong relationships. Through our tools and infrastructures we intend to help begin the discussion and to direct SMEs to relevant resources that can be critical for their further development." 4C: "Our space represent a real opportunity to empower Italian entrepreneurship. The collective nature of our Fablab allows entrepreneurs to realize projects that they would otherwise have not been able to alone. It is like a cooperative systems where members are motivated to contribute to the collective effort instead of pursuing their own interests at the group's expense." 5C: "Italian SMEs are marked by the lack of economic opportunities, social services, and infrastructure available to their development. Poor governance year and year out reinforces deficient markets, low demand, and limited growth by failing to establish the institutions that allow for contract enforcement or property rights and, in turn, sustained investment. So Fablabs with their services can enable local SMEs to participate in the game of intense competition, low prices, and reliable access to consumer and capital goods." 6C: "Giving SMEs access to a Fablab, where they may build parts for their products, allow entrepreneurs to learn more about the design process, work more efficiently on their

	prototypes and possibly allow them to work on projects, which simply were not feasible due to the restrictions of the current infrastructure. A Fablab give new possibilities for using advanced infrastructure to SMEs and could increase the potential for more advanced contests in the future."
8. Do you feel your Fablab environment can incentivize the sharing of knowledge amongst users and being an instrument of networking?	1C: "Fablabs are a suitable place to establish small local community. Fablabs as facilitators of knowledge and builders of community fit well into the context of Italian SMEs. Fablabs usually already have the necessary basic infrastructre and are well equiped in terms of space and computer pools. The only thing missing is a better capacity to attract SMEs in order to support knowledge creation in addition to knowledge consumption." 2C: "This global and informal network is identified by a set of shared technologies, procedures, and values, which relate to the idea of open source software, hardware and data, rather than to any formal governance structure. The global Fablab network is simply a platform that enables Fablab users and companies worldwide to share best practices concerning how to manage independent spaces based on open access, open source software and hardware ideals, while working on their individual and collective prototypes." 3C: "The implementation of Fablabs in local community is a growing trend, both in Italy and internationally. Fablabs promote interdisciplinary work, help to form communities and enhance education, especially promoting networking between entrepreneurs. Fablabs can also be seen as a motor for innovation by giving SMEs access to a workspace, where they can realize their ideas and build physical prototypes hands-on. A Fablab can be defined as a place with a community, where members share knowledge, build physical prototypes and objects by using manufacturing tools and machines in a hands-on manner." 4C: "Inside our Fablab the design of new products and tools becomes a community building effort, creating new networks between multiple actors and stakeholders. Monitoring, sharing and making sense of various "objective" and "scientific" data and protocols or creating DIY kits. In this sense, Fablabs

	embody new networks and alliances between various human and nonhuman actors that extend the notion of political and social participation." 5C: "If a company is satisfied of our service, the same company can be an instrument of networking for other companies. In fact, local industry clusters can promote the Fablab to its members and incubators can encourage startups to use the Fablab facilities and network for prototyping. The Fablab's response to attract professional users has been to segment its activity around three identified user groups, the general public, companies and research bodies." 6C: "The underlying concept for the success of Fablabs results from the positive effects of physical prototyping. Prototyping is an important tool in product development and improves communication and learning through exchange of knowledge and its practical part. The motivation and effectiveness of learning increases through the involvement of multiple senses and the application of knowledge. Local entrepreneurs by working on projects in Fablabs, can learn design and manufacturing skills in parallel and enlarge their personal network."
9. Do you think the use of the fabrication tools will result in more disruptive innovations or eccentric creativity?	1C: "In any Fablab works creative personalities which have working styles that are often at odds with the structure of conventional workplaces. In a Fablab, we naturally seek each other as colleagues and collaborators, and generally prefer working with each other, even across disciplinary boundaries, over working with other personality types in our own professions. The classic company workplace organized by product-type rather than working-style tend to isolate creatives, and can significantly impede the productive capacity. For this reason we try to offer a jobsite to brilliant and highly productive workers in order to properly harness their skills." 2C: "Fablabs foster innovation and creativity so they can adapt faster to the new economy and sustain company growth. In order for companies to remain competitive in the global economy, technological improvements require an increased knowledge base for industrial innovation. In this regard, I think that Fablab technology and services is a central component

	of the strategy of any community, regardless of the existing growth patterns. Companies need to invest in creative products and foster a talented workforce in order to stay competitive in the global economy." 3C: "When the philosophy of open source goes from the hard disk to the material world and combined with imagination, collaboration, interaction and appetite for creation then comes to the Fablab to make it happen. Against a background of consumerism , we learn to create our own (DIY), reusing what society considers garbage and we can freely use our creativity." 4C: "While it may seem counterintuitive as an economic strategy, the main way that Fablabs are teaching creativity is by pushing participants to stop thinking about "making" as work. Most Italian entrepreneurs, if they do something, are always thinking, How do I turn this into a product and make money? They are not thinking, I am just doing this for fun." 5C: "Usually people working at Fablabs are highly creatives, by nature, highly skilled at developing interdisciplinary solutions to complex problems, and the advent of social media has enabled us to bypass many former social barriers. Fablabs in all fields, but especially in manufacturing, have been diligently collaborating for the past several years on the formation of new prototypes and jobsites that are better suited to our needs. The result is a Fablab movement, an international network of exhibition fairs, publications, member's clubs, and funding structures which place a high priority on the exchange of experimental ideas and so stimulate creativeness." 6C: "Fablabs services continue to expand rapidly. To understand it properly, there is one essential point that must be fully grasped: The goal of Fablab creativity in the way of services offered is not replication, but rather innovation. In an international economy based on mass-production and mass-consumption, creatives are at a significant economic disadvantage because of our emphasis on the long-term testing and revision of single prototypes, rather than the manufacture and distribution of familiar goods in large quantity. To successfully compete in the global

	marketplace, Fablabs must find ways to mass-produce and distribute our one-of-a-kind products. Our Fablab meets this challenge by building new kinds of virtual and actual workspace that are organized around peer-to-peer production and technology innovation.