A Conceptual Framework for Software Startup Ecosystems: the case of Israel[1]

Fabio Kon, Daniel Cukier, Claudia Melo - University of São Paulo, Brazil
{fabio.kon,danicuki,claudia}@ime.usp.br

Orit Hazzan, Harry Yuklea - Technion, Israel
oritha@technion.ac.il, harryy@tx.technion.ac.il

ABSTRACT

Startups are an effective way of promoting innovation in the software industry. This paper extends the theoretical and practical understanding of the key elements and factors that promote the growth of a successful software startup ecosystem in a certain region, by presenting a conceptual framework, delineating the major forces leading to a fruitful environment for digital entrepreneurship. The framework is systematically derived from a meticulous qualitative research carried out in Israel, which hosts one of the most fruitful software startup ecosystems in the world. Data collection was based on semi-structured interviews, observations, and a questionnaire. The data analysis led to findings related to sociocultural, institutional, technological, methodological, and educational aspects of entrepreneurship, startups, and their ecosystem. Finally, this paper proposes a generalized version of the framework by eliminating aspects that are specific to Israel, so that the methodology and the conceptual framework can be used as a basis for future research in other regions of the world.

Keywords: Startups; Entrepreneurship; Startup ecosystems; Conceptual framework; Internet; Software; Open Source.

HIGHLIGHTS

- We analyze what influences the success of the Israeli software startup ecosystem.
- We derive a conceptual framework of the Israeli software startup ecosystem.
- We describe a SWOT analysis of the Israeli software startup ecosystem.
- We list lessons learned for entrepreneurs and policy makers.
- We conclude proposing a generic conceptual framework for startup ecosystems.

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1 Introduction

During the 20th century, a significant part of innovation in the high-tech industry was carried out within medium and large organizations (Chesbrough, Vanhaverbeke, and West 2008). In addition, after the Bayh–Dole Act of 1980 in the United States (Mowery 2004) and similar legislation in other countries, a framework for technology transfer from public universities and research centers to the high-tech industry was established. This promoted an increase in the speed in which scientific advances were transformed into technological products and successful businesses.

However, the popularization and wide use of the Internet in the 1990s and of mobile technologies in the 2000s further sped up the creation and adoption of new technologies. While the development cycles, from idea conception to product commercialization, within large companies and traditional technology transfer mechanisms typically last from 5 to 10 years (Ries 2011) due to the inherent bureaucracy and lack of agility associated with large, structured organizations, in the Internet-age, innovative ideas can be developed, tested and adopted in 1 or 2 years and, in some extreme cases, in a matter of a few months (Benkler 2006; Goldman and Gabriel 2005). After 5 to 10 years, many times, these technologies are surpassed by a new generation and become obsolete. This makes the traditional mechanisms for innovation not always suitable for a wide range of new technological ideas related to software and the Internet.

Software startups provide a much more agile framework for the conception and development of innovative ideas. A *startup* is a temporary organization in search of a scalable, repeatable, profitable business model (Blank and Dorf 2012). A small startup founded by two or three entrepreneurs with a handful of employees can produce and test the feasibility of tens of possibilities for a new business idea, producing a viable product in a matter of a few months. This agility fosters the creation of thousands of software startups around the world annually. Based on the largest startup database (Crunchbase 2014), there has been more than 200,000 founded startups in the last 10 years. These ventures are concentrated around a few major regional startup hubs where a supporting ecosystem flourishes. In this paper, we derive theoretical findings about startup ecosystems from a detailed qualitative study of one of the most fruitful hubs for software startups worldwide: Israel.

In the 21th century, the capacity of a country to develop new science and transform it into innovative technologies, turning them into successful, sustainable business that generate revenue and high-quality jobs, is of paramount importance for the country development and quality of life of its citizens (Europe 2012). With our research, we expect to contribute to the understanding of how fertile software startup ecosystems work, leading to a better understanding of how their contributions to the regional and national economies can be fostered.

In this paper, we describe the research carried out on the Israeli software startup ecosystem from July to December 2013. Based on 48 meetings and interviews with startup founders, CTOs, CEOs, developers, angel investors, VCs, academics, and incubator and accelerator managers, as well as observations made on tens of startups and other organizations, we derived a conceptual framework and shed light over some key research questions regarding the nature of startup ecosystems in general and the Israeli case in particular. We expect that this work can provide valuable information and insights for both academics and practitioners interested in improving the effectiveness of regional startup environments worldwide. It can also be used as a basis for future studies in other parts of the globe, leading to comparative analysis.

The remainder of this paper is organized as follows. Section 2 discusses related work on startup ecosystems and on the Israeli case. Section 3 presents our research questions and methodology. Section 4 provides a brief description of the Israeli context. The second part of the paper reports the results of our research. Section 5.1 presents the conceptual framework for the startup ecosystem. In Section 5.2, we answer the research questions and present a SWOT analysis of the Israeli ecosystem. In Section 6, we present our conclusions, layout a summarized list of lessons learned from this research, present a generalized version of our conceptual framework, and discuss future work.

2 Related work

The past research and literature related to the work described in this paper is divided into three categories: (1) Startup ecosystems in general; (2) Israeli startups and its ecosystem; and (3) frameworks and

models. As we describe in this section, there is already some significant body of knowledge on this subject. However, many of these works are in the form of journalistic and non-academic books and reports; academic literature in the field is still scarce. Also, we did not find research efforts targeting specifically at *software* startups, which is the focus of this paper.

2.1 Startups and their ecosystems

Focusing on the success of individual startups, Kakati (2003), carried out a cluster analysis showing that it is possible to find patterns shared by successful and unsuccessful ventures. The author suggests that it is not the product uniqueness relative to competitors that makes a startup successful. Instead, it is linked to the firm's ability to meet the unique requirements of customers. According to Kakati, the critical attributes for the startup success are the entrepreneur's quality, the resource-base capability, and the competitive strategy; also, it is advisable to use multiple performance criteria to measure the startup success, instead of one single measurement (such as ROI or market share).

Regarding startup ecosystems, in the *Secrets of Silicon Valley*, Piscione (2013) explores the characteristics of the first and most successful startup ecosystem of the world, which generated more than 6,000 innovative companies. For her, there is a shared set of attitudes, values, goals, and practices that turn the Valley into a unique place that is difficult to reproduce. Nevertheless, some of the Valley characteristics could be (and actually already are) reproduced in other places. Piscione points out the characteristics of a healthy startup ecosystem: (1) the presence of a high ranked University (e.g., Stanford), (2) the cultural mix of experienced and high-talented entrepreneurs, investors, and academics, (3) a wellness mindset and quality of life, with casual offices, healthy work culture, and disdain for hierarchical communication models, (4) people from many parts of the world and the Immigration and Nationality Act of 1990 that encouraged highly skilled immigrants to move to urban centers, (5) risk and failure being embraced as part of the entrepreneurial journey, (6) authentic entrepreneurs with passion to make a difference in humanity, (7) a well established patent industry, (8) passionate, authentic, driven by ideas, fearless in risk-taking, trustworthy, and resilient people, (9) no idea considered crazy, (10) the Venture Capital industry on virtuous cycle, where successful entrepreneurs take their exits earnings to invest in new startups, and (11) network culture of freely exchanging ideas. As we will see in Section 5, many of these characteristics are also present in the Israeli case.

Hwang and Horowitt (2012) claim that what explains the success of the Silicon Valley as a fruitful environment for innovation is not only the availability of qualified labor, capital, and technology but also, and most importantly, the unique differences in social behavior presented by people in the Valley. They proposed a Rainforest model of innovative ecosystems in opposition to a conventional plantation or agricultural model. The rainforest metaphor, with its diversity and inherent chaotic processes, reflects better what is important for innovation to emerge. They claim that the capacity of the ecosystem to promote innovation derives from its diversity of talents, trust across social barriers, motivations that rise above short-term rationality, and social norms that promote rapid, "promiscuous" collaboration and experimentation among individuals (Hwang and Horowitt 2012). Our research results show that this distinct social behavior is highly present in the Israeli ecosystem as detailed in Section 5.2.

Breznitz and Taylor (2014) argue that even in the presence of all factors for the good health of a technological hub, the entrepreneurial ecosystem will not flourish if social fragmentation is observed. In other words, the local high-tech industry must develop rich multiple, locally centered social networks to enable growth of the ecosystem. The authors analyze the case of Atlanta's technology cluster, arguing that the reason for its stagnation was the lack of a cohesive social structure. Strong network structure is a key element in a resilient technological cluster (Suire and Vicente 2014). In the answer to our Research Question 1 in Section 5.2, it becomes clear that the local social networks, described by Breznitz and Taylor, are very strong in Israel.

Feld (2012) presents what he calls *the Boulder thesis* with four essential characteristics in a successful startup community: (1) it must be led by entrepreneurs and not by other important players such as government, universities, service providers, big companies, which Feld calls feeders; (2) the leaders (entrepreneurs) must have a long term commitment to the community (at least 20 years); (3) it has to be inclusive, which means that everybody who wants to participate must be welcome; and (4) it must have high quality events to engage people, specially acceleration programs and mentoring sessions. Our research shows that all the four characteristics of the Boulder thesis are present in the Israeli ecosystem. Although demographic diversity among entrepreneurs is still low, there are proactive initiatives to promote the

entrance of more women, religious Jews, Arabs, etc., into the ecosystem. Brad Feld did not use a scientific approach to propose his thesis. Our framework applied to the case of the Israeli startup community with a more rigorous methodology serves to confirm Feld's argument.

One particular item in the Boulder thesis that it is worth to emphasize in Israel is the long-term commitment, specially nurtured by the Zionist thinking. The literature defines this as Embeddedness: the nature, depth and extent of an individual's ties to an environment (Jack and Anderson 2002). It is a mechanism whereby an entrepreneur becomes part of the local structure. Some technological clusters are more resilient than others, and one characteristic of resilient ecosystems is its level of embeddedness (Suire and Vicente 2014).

Graham (2012) considers high growth rate one of the most important characteristics of startups, and the secret for a great startup ecosystem is to have the right people working there. He claims that two kinds of people create a tech hub: investors and tech experts, but "a startup with the best people will beat one with funding from famous VCs". Graham also defends that a tech hub can only exist with the presence of a first-rate university, which is certainly the case of Israel in the fields of Computer Science and Engineering. For him, a high-tech city needs to be more liberal and tolerate odd ideas. A technology ecosystem grows organically and takes time (Graham 2006a; Graham 2006b).

Cometto and Piol (2013) analyses the story of the New York City entrepreneurship ecosystem. In spite of having some history of successful startups, the numbers are lower than those in the Valley (the Valley is five to six times larger than New York in volume of invested capital). A recent (2013) partnership between Cornell University and Technion and an ambitious high-tech program created by the Mayor Bloomberg aims to transform New York into the largest innovation center in the world. The potential advantages of NYC that Cometto and Piol cite are: (1) easy access to capital, as being close to the financial center of the world; (2) the new on-going, long-term project for Cornell NYC Tech University campus; (3) tolerance for high risk and failure; (4) a great sense of community, generosity and networking; (5) NY Tech Meetup, a non-profit organization with over 36,000 members supporting the New York technology community (nytm.org); (6) a big angel investors community based on the giving back culture; and (7) a large community with open access to the business world.

2.2 Israeli startups and its ecosystem

Startup Nation (Senor and Singer 2011) is the most famous account on the Israeli startup scene. In this best seller book, the authors claim that some factors led to the success of Israel as a startup ecosystem: (1) the military service, which is a compulsory duty for all 18 year old Jews; (2) the culture of doubt and argument, where leadership can always be questioned if it is reasonable; (3) assertiveness versus insolence; critical, independent thinking versus insubordination; ambition and vision versus arrogance; (4) the historical background, which makes Israel a place where people want to improve and succeed; (5) incentives for employing immigrants, specially highly-qualified scientists and knowledge workers; (6) Israel's smallness, which creates an opportunity to specialize in quality based on creativity. The book is written in a journalistic style and does not use a systematic approach to analyze Israel's ecosystem. In this paper, we add to the anecdotal accounts of *Startup Nation* by using qualitative research procedures and techniques (Corbin and Strauss 2007) to answer a set of well-defined research questions and develop a conceptual framework to help understand the elements that compose Israel's ecosystem as well as the relationships among them, all grouped in a unifying general view.

According to a ranking reported by Telefónica Digital, the Israeli startup ecosystem is considered the second best startup hub in the world (Herrmann et al. 2012), just after the Silicon Valley. The report states that, differently from the Valley, Israelis care more about "building a great product" than "changing the world". They prefer smaller but faster, frequent exits. This can be explained by the fact that although Israel has the highest density of tech startups in the world, its local market is very small, so most of its startups are forced to grow internationally and/or be acquired early (Haan 2011). Thus, it seems that, currently, Israel's specialty is on creating a large number of short-lived startups that either fail or are sold to large foreign corporations after a few years.

Some academic works emphasize the role of intelligent policy-making in promoting innovation by aggressive pursuit of strategic objectives, fast adaptation to market conditions and combating market failures (Avidor 2011). Numerous policy design comparative studies (Roper 2000) aim to identify the "secret ingredient" of Israeli public policy for sustainable entrepreneurial capital formation and propose a generic

model that can be replicated in other economies (Yuklea 2009).

Dan Breznitz (2005) studied Mamram, the Computer Unit of the Israeli military, and concluded that it serves as a collaborative public space, acting as an originator and strengthener of innovation social networks, gathering, processing, and disseminating information. A number of innovation scholars consider military spending a major source of technological progress (Taylor and Wilson 2012). Piscione (2013) argues that Israel's success lies in the compulsory military service and in immigration, not recognizing other aspects of the Israeli ecosystem. Haan (2011) claims that besides the military industry, other two important aspects that helped Israel to be one of the most evolved places to start a tech company are the specific immigration of tens of thousands of highly educated Russian Jews from the former Soviet Union and the strong presence of high quality education. Haan also states that, in Israel, the ecosystem of universities, ventures, and incumbent companies facilitates exploration and exploitation, providing the five main components of capital that fuels growth: human, financial, social, knowledge, and entrepreneurship.

Patents are one of the most commonly used quantitative measure of innovation, as 'each patent represents an individual "quantum" of invention' (Taylor and Wilson 2012). Israel ranked 6th in the world in the number of patents per capita (Lopez-claros and Mia 2006). This might be partially explained by a somewhat counter-intuitive fact: Israel is a very small country with very limited natural resources, and this can be considered an advantage for innovation, while some scholars argue that abundance in natural resources is an obstacle to innovation (Taylor and Wilson 2012).

Some of the Israeli cultural characteristics are considered favorable for developing startups. Innovation is an act of revolt; a culture of individualism should aid it, while a culture of hierarchy, tradition, respect for status quo and authority should obstruct (Mokyr 2002). Israel has one of the lowest "power distance" ranking, showing that hierarchies are very flat (Hofstede, Hofstede, and Minkov 1991). High-levels of cultural individualism correlate with national innovation rates (Taylor and Wilson 2012). Israel is in the 19th position on the individualism ranking of 53 nations (Hofstede, Hofstede, and Minkov 1991). Moreover, some types of collectivism present in Israel (e.g., patriotism and nationalism) also foster innovation at national level (Taylor and Wilson 2012).

In a survey conducted in 2000, Meseri and Maital (2001) tried to identify problems in Israelis practices with regard to technology transfer from universities and research centers to the industry. The authors report that while Israel is one of the world leaders in the productivity and intensity of its basic research in science and technology, its ability to transfer the fruits of this knowledge-creation to commercial applications is considered inadequate, ranking 41st in *company-university cooperation* and 40th in *development and application of technology*, according to the IMD's World Competitiveness 2000 Yearbook. The survey covered 8 technology transfer offices and units but was inconclusive in terms of finding the reasons for this problem. One way to mitigate this problem might be through incubators interposed between research universities and the industry to support knowledge transfer. The incubator role is transforming theoretical knowledge into financial gains and this happens mainly via informal contacts and networks of innovation among the involved parties (Rothschild and Darr 2005).

2.3 Frameworks and models

Although there is a large amount of literature on startups and entrepreneurship in general, we could find only a few of them that try to develop conceptual frameworks or present a comprehensive view of startup ecosystems as a whole. Some of them focus on specific areas such as entrepreneurship education (O'Connor 2013) and the VC industry evolution framework (Avnimelech and Teubal 2006). Kang and Park (2012), for example, present a specific framework that can be used to assess the mechanism of influence of government R&D support and inter-firm collaborations on innovation in biotechnology SMEs.

Chorev and Anderson (2006) proposed a model identifying critical factors for success. It divides these factors in two groups: internal (e.g., team, product, marketing) and external (e.g., politics, economy, education). Their study is based on experience and tacit knowledge of Israeli high-tech venture leaders. Similar to our study, they use interviews to collect data. Based on the experience collected from 13 high-tech leaders, they found that one of the major faults in many startups is a focus on technology, while the marketing departments are established very late. Moreover, funding has to be timed correctly (and sometimes investors do not add any value and may become an obstacle). The authors propose the top eight factors for high-tech startup success, in order of importance: (1) team commitment, (2) team expertise, (3) customer relationships, (4) core team expertise, (5) management, (6) strategy, (7) R & D, (8) the idea itself.

External factors as politics, general environment and economy are shown as non-critical aspects for startup success. According to the authors, this study has still to be tested for causality and can be further adapted and expanded based on future research.

In a new book, to appear in 2014, Frenkel and Maital propose a new methodology for mapping national innovation ecosystems (Frenkel and Maital 2014). Their methodology is based on a workshop with 15 to 30 experts in the field and draws the *quality anchors* and *processes and trends* that are most relevant to that particular ecosystem, leading to a visual innovation ecosystem map. In the book, the methodology is applied to multiple countries and the results are presented. The proposed methodology resembles in some aspects our research; the major difference is the fact that our work is based on the 48 meetings with experts, carried out over a 4-month period, while Frenkel and Maital's methodology is based on one workshop with experts.

A framework for measuring innovation level in different countries is proposed by Zloczysti (2011). The framework measures levels of education, R&D, financing, networking, competition, implementation and demand as criteria to measure innovation. It also considers culture (social climate) as a factor that influences innovation levels. Most of the elements found in this framework are also present in our framework, with the difference that we explore the relationship between these criteria, not showing them as isolated or unrelated factors.

Thus, to the best of our knowledge, currently, there is no other comprehensive framework trying to capture the major elements involved in a fruitful software startup ecosystem and identifying the major relationships among them. Consequently, the theoretical framework that emerged from our research, as described in this paper, adds to the existing body of knowledge in the field and serves both education on entrepreneurship and future research on the area.

3 Objective and Methodology

The main objective of this research is to advance the knowledge in the field of Entrepreneurship and Startup Engineering by exploring the characteristics of successful Software Startup Ecosystems. To achieve that, in this paper, we focus on the development of a theoretical framework based on one initial case study: the Israeli Software Startup Ecosystem. Based on qualitative methods with elements from Grounded Theory (Corbin and Strauss 2007) for the identification of the key factors that led to the emergence of a successful ecosystem, our goal was to develop a conceptual framework (Miles and Huberman 1994) of the Israeli startup scene that may help in analyzing the current status of ecosystems as well as finding opportunities for their improvement. In the end of this paper, we generalize the framework by removing the elements that are specific to Israel, constructing a generic theoretical result that can be applied to further research in other regions.

To achieve that, we formulated the following 7 research questions, which emerged from discussions among the authors of this paper and other researchers interested in entrepreneurship. As can be seen, these questions reflect a multi-faceted analysis of a region in general (RQ1 – RQ3) and its software industry in particular (RQ4 – RQ7). Questions RQ1 – RQ6 refer to the present situation, while RQ7 refers to the future.

- RQ1 - What are the *sociocultural* characteristics found in Israel that foster the entrepreneurial spirit?
- RQ2 - What are the *institutional* mechanisms in place in Israel that promote entrepreneurship?
- RQ3 - What is the role of *education* in fostering entrepreneurship in Israel? What are the formal and informal, explicit and implicit pedagogical material and mechanisms that nurtures the entrepreneurial spirit?
- RQ4 - What are the characteristics of successful innovative *teams and entrepreneurs*? What is the prime motivation of the software entrepreneur?
- RQ5 - Which *technological* aspects influence the success of software startups and how? In particular what is the role played by Object-Orientation, Languages, Frameworks, Patterns, Models, and Architectures? What is the role of Open Source Software?

- RQ6 - Which and how *methodological* aspects influence the success of software startups? What is the level of adoption of well-known business and software development methods? Is this relation changing along the start-up life cycle?
- RQ7 - What are the opportunities for the further development of the Israeli software startup ecosystem in the future? What could be a threat?

The field research was conducted from July to December, 2013 and started with a broad study of the literature on entrepreneurship, startup engineering, and the Israeli high-tech industry. Some of the most relevant works we studied were discussed in Section 2. We also visited related work on frameworks and models of startup ecosystems, although, in that initial moment, we did not delve into that profoundly as we did not want to be too influenced by them; we wanted our framework to emerge from the data collected on the field. This approach is described by Corbin and Strauss (2007) as a potentially powerful use of theoretical frameworks in qualitative studies: the researcher first develops a light theoretical body that provides a useful list of concepts, insights, and direction; thus remaining open to new concepts and ideas when carrying out the study, letting them emerge from field data. In a later stage, we revisited the literature on frameworks and models to compare to our findings and refine them.

As qualitative studies are highly context- and case-dependent, we observed four characteristics to promote a trustworthy study: credibility, transferability, dependability, and confirmability (Lincoln and Guba 1985). To promote credibility, we first developed the data collection instruments from experts' opinion, either on innovation or software development. Although we have used a purposive sampling of interviewees from top universities and startups, combined with a snowball approach, we tried to include participants considering similarities, dissimilarities, redundancies, and varieties to acquire greater knowledge of the wider group. We collected and analyzed data in a systematic and iterative way, from a great number of participants, which improved both confirmability and dependability. To promote transferability, we described protocol details, the data collection and analysis process, and finally added quotations with our major findings.

We based the methodology on two concepts proposed by Glaser and Strauss (1999). The first, *constant comparison* refers to the act of collecting and analyzing data simultaneously during the course of the research; in such a way that one enriches the other. The second, *theoretical sampling* implies that the decisions about which data should be collected is influenced by the theoretical framework that is being constructed (Suddaby 2006).

To facilitate the repetition of this study and the application of this methodology to other regions, a detailed description of the protocol and methodology we used is included in Apendix A of this technical report. An up-to-date version of the protocol is publicly available at
http://ccsl.ime.usp.br/startups/files/ResearchProtocol.pdf

3.1. Data Collection Method

To collect the data, we used meetings with experts, semi-structured interviews, observations, and a questionnaire. The five authors of this paper worked on these data in the following way. The first three authors are Brazilians with a long experience in software development (ranging from 15 to 25 years) both in the academia and in the industry. They bring to the research a comprehensive knowledge of the focused field (Software) and also an outsider, non-Israeli perspective, which allows them to see characteristics and facts sometimes not grasped by people who are immersed in the culture for several decades. The two last authors are Israeli researchers, specialized on qualitative methods and software engineering education and entrepreneurship; they bring to the team a more in-depth knowledge of the local culture as well as complementary skills relevant for the research.

To select the people to interview and startups to visit we started collecting suggestions from staff and faculty members from the Technion Bronica Entrepreneurship Center, from the Hebrew University of Jerusalem Yissum Technology Transfer company, and from the economic news website of the Israeli Haaretz newspaper, *The Marker*. We then followed a snowball approach in which people that we met and interviewed recommended additional people for us to contact. Overall, we approached 78 people via email or Linkedin messages and were able to meet, in person, 48 of them.

From August to December, the first author carried out 48 meetings in several cities, primarily in Tel-Aviv, followed by Haifa and Jerusalem. 14 of these were informal conversations with experts in the high-tech and startup industry in which the researcher took detailed notes. The core of the material was composed of 34 semi-structured interviews, whose full audio was recorded in 25 cases and detailed notes were taken in 9 cases. Most formal interviews lasted for about one hour; the shortest of all lasted for 15 minutes while the longest lasted for 2 hours and 16 minutes. These interviews covered mostly startup founders, CEOs, and CTOs, but also a few angel investors, VCs, developers, and incubator and accelerator managers, as shown in Table 1. During this process, 25 different startups and 6 accelerator/incubators were visited and observations were systematically written down. The first author also attended 16 events, lectures, seminars, meetups, and demo-days, which are characteristic of the Israeli startup ecosystem.

As the interviews were carried out, the key elements of the startup ecosystem, as mentioned by the interviewees, were annotated and the conceptual framework presented in Section 5 was iteratively constructed and refined by the researchers. To answer RQ7, a selected group of the 25 most experienced participants was asked to answer a SWOT questionnaire in an online form and 20 of them did provide their input. Table 1 presents the number of participants by research tools.

Table 1- Number of participants in each phase of the study

	Founder (non-CTO/CEO)	**CEO**		**CTO**		**Angel Investor**	**VC**	**Incubator/ Accelerator**	**Other***	**Total**
		founder	non-founder	founder	non-founder					
Semi-Structured Interview	5	6		9	2		3	7	2	**34**
Informal Conversation			1			1			12	**14**
Questionnaire		4		5	2		3	3	3	**20**
Total**	**5**	**6**	**1**	**9**	**2**	**1**	**3**	**7**	**14**	**48**

* Professors, researchers, independent consultants, and R&D managers.
** Some people participated in more than one activity so this total is not the sum of the rows.

3.2. Data Analysis Method

To identify and improve our understanding of the key concepts that are relevant for the existence and operation of a fruitful startup ecosystem, we developed a conceptual framework (Miles and Huberman 1994), extracted from the 34 interviews and observations we carried out. The framework was created iteratively: after each interview, the first author would identify the key elements mentioned explicitly by the interviewee as something important for the ecosystem; then, each key element was added to the framework together with the relationships with other elements in the framework; the same was done with respect to the observations This process was repeated for 3 months as more interviews and observations were undertaken. During the last month of the data collections, as well as during subsequent months after the process had ended, the framework was further revised by the co-authors of this paper, who made improvements in terms of clarity and completeness.

After this process was completed, this material was then processed once more to generate the answers to the research questions presented in Section 5.2.1. The 20 answers to the SWOT online questionnaire were then analyzed and the summarized results are presented in Section 5.2.2. A combination of all results led to the lessons learned presented in Section 6.1.

4 The Israeli context

After centuries of persecution and prejudice against the Jews in Europe and Asia, secular Jews developed, in the late 19th Century, an organized political movement defending the establishment of a state for the Jewish people in Palestine. After the large suffering and mass murder of Jews by the Nazi in World War II, a shift in public opinion and changes in world politics led to a UN resolution recognizing the creation of the State of Israel in 1948. The resolution was rejected by the Arab states in the region, initiating a conflict that now lasts for 65 years (Brenner 2012). On the one hand, the conflict created severe adverse conditions for economic development; on the other hand, it triggered the need to develop sophisticated defense-related technological R&D, which contributed directly to the build-up of the high-tech sector in Israel (Peled 2001).

During the course of the 20th Century, a few million Jews immigrated to Israel, a territory with very little natural resources, composed partially by a large desert with little water and, then, almost no infrastructure. With support from Jews worldwide and several western governments, the first four decades of the country were dedicated to creating the basic infrastructure for its economy. Incidentally, this was a period of strong presence of the socialist state in all the aspects of the economy. Government initiatives led to the development of cities, constructions of roads and railways, establishment of industries, and the creation of a series of Kibbutzim nationwide. The Kibbutzim were rural communes where settlers worked and lived with their families sharing the responsibilities and the products of their work collectively. Striving to develop new technologies that would enable the inception of a significant agricultural production in a desert land, people mainly from the Kibbutzim were driven by the idea of building a strong country around democratic and socialist ideals. These ideals motivated millions of Jews inside and outside Israel to contribute to the development of the country.

Even before the creation of the modern state of Israel in 1948, the Zionist movement realized that a poor country without natural resources would only have a chance of succeeding if it invested massively in its human capital via education, science, and technology. In 1901 the 5th Zionist Congress calls for the establishment of Jewish University in Palestine (a territory governed by the Ottoman Empire) and, in 1912, the cornerstone of Technion is laid on the slope of Mt. Carmel in Haifa followed by the creation of The Hebrew University of Jerusalem in 1925. After the creation of the independent state of Israel, David Ben Gurion, its first prime minister, and of all following governments, put a top priority on the strengthening of its major universities and the creation and reinforcement of more advanced research centers such as the Weizmann Institute of Science and the Science Command of the Israeli Army, which later became an agency called RAFAEL (Haan 2011).

After certain economic difficulties in the 1980s and a change in the government towards a more liberal view of the economy, public policies changed towards strengthening the private sector. Although still with a strong well-fare state and government-supported funding for health, education, and research, nowadays, the private sector is the one that drives most of the Israeli innovation and economy.

Beginning in the 1970s, large high-tech multinational companies started to establish R&D centers in Israel attracted by the comparatively cheap, high-quality scientific and engineering labor. Nowadays, Israel hosts R&D centers from most major IT companies in the World, including Intel, IBM, Microsoft, Google, HP, Yahoo!, Facebook, Oracle, SAP, Cisco, Siemens, and Motorola (Haan 2011).

Since the 1990s, a large growth in the high-tech sector has been observed, yielding a significant impact in the country's economy. More specifically, according to the Organization for Economic Co-operation and Development (OECD), in 2009, the share of the companies involved only in the Information and Communication Technologies (ICT) sector accounted for 13% of the total business sector value in Israeli, one of the top shares in the world, second only to Korea. This derives largely from the large investment on R&D performed by the country, which is the largest in the world as a percentage of GDP as reported by the OECD and shown in Figure 1.

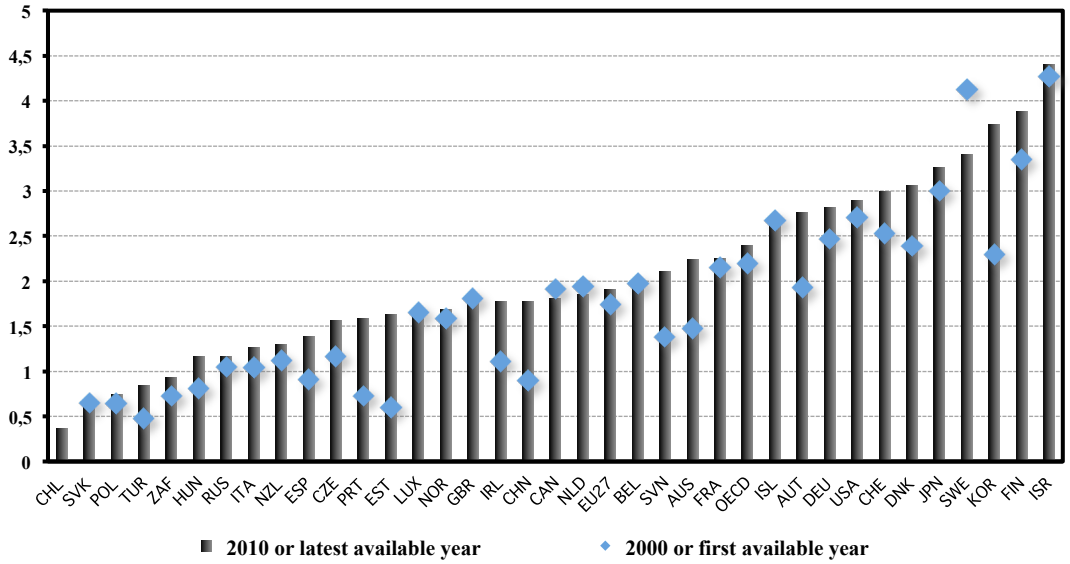

Figure 1 - Gross domestic expenditure on R&D (% of GDP) (OECD, 2013)

In recent years, Israel has marketed itself as the Startup Nation, inspired by the book by Senor and Singer (2011). In fact, the numbers show that, when comparing to the population size, no other country in the world has such a large number of startups per capita. In the Tel-Aviv region, where most high-tech entrepreneurs are concentrated, startups are a daily topic of conversation for almost anyone, ranging from a multinational company employee to a taxi driver[2]. The quest for innovation, for developing a new great product, and for founding a successful company that can make a big hit on the market seems to be a new ideal for Israeli youngsters. Israeli academia works nowadays closely with Israeli practitioners in consolidating the accumulated knowledge in entrepreneurial and innovation management fields and making it available to the global audience through international cooperation programs such as European Commission's "Horizon 2020". The close proximity of Israeli academics to the field allows effective initiation of research on controversial aspects of entrepreneurship at global scale, such as efficiency of technology transfer from academia to industry or the real role of VCs in fostering entrepreneurship, leading many times to seminal papers in specific fields (Kandel, Leshchinskii, and Yuklea 2011).

According to Senor and Singer (2011), in 2011, 3,850 startups were active in Israel – that is, 1 startup per 2,000 citizens; Israel has more companies listed on NASDAQ than any other country outside North America; currently, the estimated numbers are similar[3]. According to the OECD Library, "In the majority of countries for which data are available, venture capital investments represent a very small percentage of GDP, e.g., often less than 0.03%. Exceptions are Israel and the United States, where the venture capital industry is more mature and represents 0.5% and 0.2% of GDP respectively" (OECD 2013).

According to the Israeli Bureau of Statistics, in 2012, more than 30% of the Israeli export is associated with ICT industries, while only about 7% of Israel's human resources are employed in the ICT sector (approximately 200,000 employees). According to the Ministry of Science and Technology, Israel is ranked 16th in technological export. In 2013-2014, Israel is ranked 27th in the Global Competitiveness Index (out of 148 countries), 3rd in capacity for innovation, 6th in the number of patents, and 8th in the ease of access to venture capital (Schwab 2013).

According to the OECD Better Life Index[4] "Having a good education is an important requisite for finding a job. In Israel, 82% of adults aged 25-64 have earned the equivalent of a high-school degree, higher than the OECD average of 74%".

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[2] The first author of this paper was surprised in the first week of his field research when a taxi driver brought up the subject of Internet startups and carried out conversation on the topic for several minutes; "*Everybody here has a startup now*", he said.

[3] The startups geographical distribution can be viewed at http://mappedinisrael.com.

[4] http://www.oecdbetterlifeindex.org/countries/israel

5 Research Findings

In this section, we present our research findings: Section 5.1 introduces the conceptual framework and Section 5.2 presents the answers to the research questions. The latter is divided into two subsections, addressing the current state of the ecosystem (Section 5.2.1) and its future (Section 5.2.2).

5.1 Israeli Startup Ecosystem Framework

The evolved framework for the Israeli Software Startup Ecosystem is presented in Figure 2. Only elements and relationships that were explicitly raised in the interviews were added; the framework was devised by following the methodology described in Section 3. Continuous arrows denote relationships that were observed all, or almost all, of the times, while dotted arrows denote relationships that were identified only part of the times. The labels in the arrows characterize the type of relationship represented by them.

In the center of the diagram in Figure 2 - Israeli Software Startup Ecosystem Framework, we see the **Startup**, which is the major entity in which we are interested. It is created by one or more **Entrepreneurs**, who are highly influenced by the **Family**, **Society**, and **Culture** in which they live, nurturing the entrepreneurial spirit. Culture is shaped by **Demographic** characteristics, such as national origin, race, religion, gender, language, and influenced by geography, politics, and conflicts with neighboring countries and populations, as we will see in more detail in Section 5.2.

Startups develop products based on available **Technologies**, with a high tendency to use of **Open Source** software as a foundation to save costs and gain development speed. Some startups, mostly the most advanced ones, rely on structured **Methodologies** such as **Agile Methods** for software development and Customer Development and Lean Startup for business development. Since Israel's local market is very small, in most cases, it is used only in pilot experiments. Most startups target either a **Remote Market** (e.g., USA or Europe) or the entire **Global Market** (e.g., in the case of mobile phone apps or Internet services). **Legal framework**, including Labor, Tax, and Intellectual Property legislation, as well and patents and the level of bureaucracy required influence the decisions of which market to target and where to host the company.

Product and customer development, as well as marketing and production, require different levels of **Funding**. This is available both from the public sector, in the form of tax incentives and R&D funding, and the private sector, from **Venture Capitalists**, **Angel Investors**, and **Financial Markets**. Governmental programs, such as *Yozma*, active from 1993 to 2003, that offered tax incentives for VCs and doubled private investments with government funds, as well as R&D grants from the *Office of the Chief Scientist* of the Ministry of Economy, have been essential for the healthy development of the ecosystem. Currently, Israel counts with one of the best collections of VC funds and angel investors in the globe, making capital available for entrepreneurs.

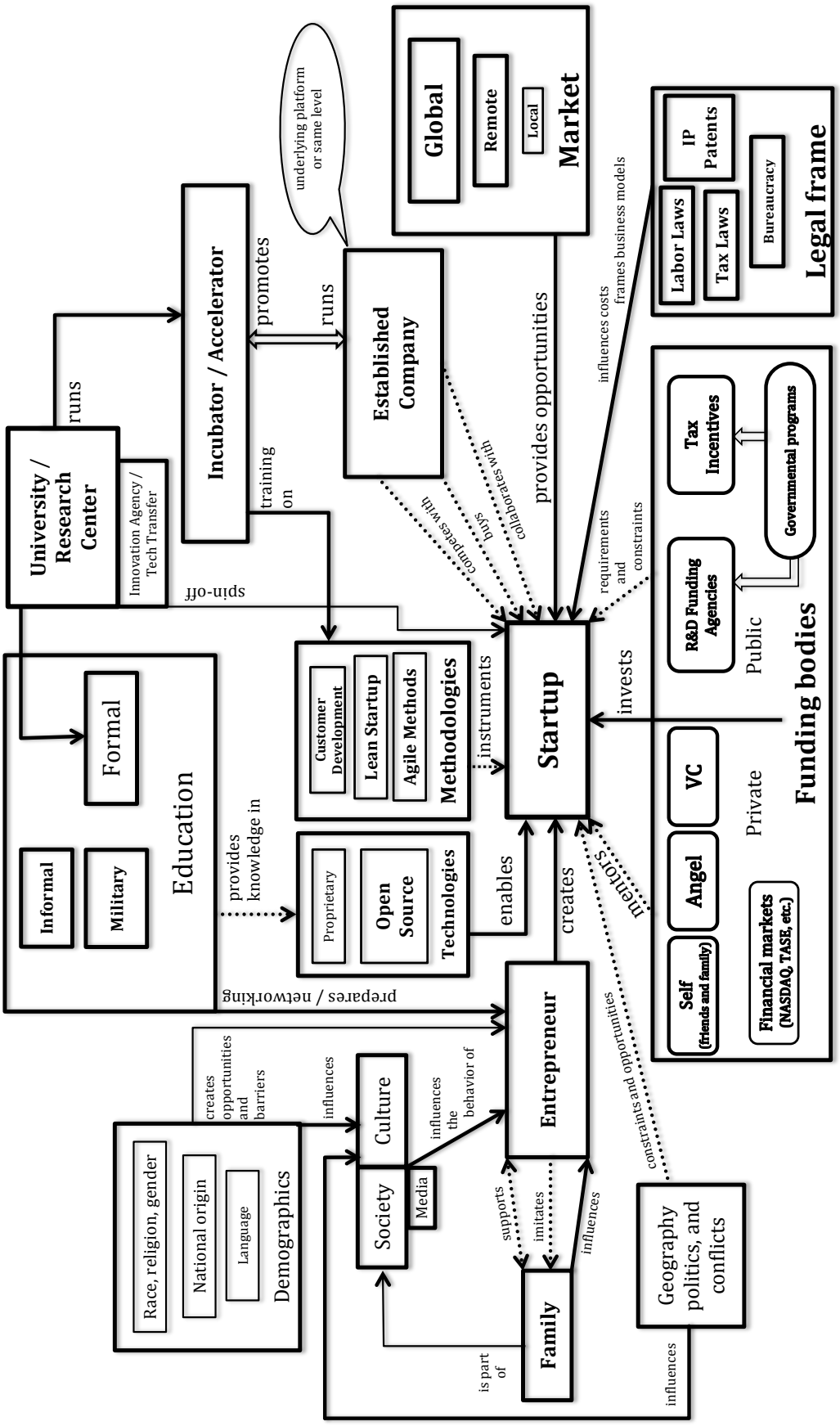

Figure 2 - Israeli Software Startup Ecosystem Framework

High-quality **Education** is a key factor for the success of any innovative environment (Zloczysti 2011). According to the 2013 Shanghai Jiao Tong Academic Ranking of World Universities in Computer Science[5], Israel hosts four top-50 Computer Science departments: Technion (18th in the world), the Weizmann Institute of Science (23rd), the Hebrew University of Jerusalem (28th), and Tel Aviv University (44th). Very good engineering programs are available at the Technion, Tel-Aviv University, and Ben Gurion University in Be'er Sheva. The Bezalel Academy of Arts and Design in Jerusalem produces highly skilled designers and creative artists who are essential for software startups. Other institutions such as the Interdisciplinary Center in Herzliya and the Academic College of Tel-Aviv Yaffo also make a contribution. Besides the academic training they receive in the university, entrepreneurs gain practical experience in real projects carried out during their compulsory military service, typically lasting 2 years for women and 3 years for men. People working in special technological units such as 8200 and Mamram typically serve from 4 to 6 years, being exposed to collaborative teamwork around advanced, state-of-the-art technologies.

Large **Established Companies** such as IBM, Microsoft, Google, HP, and Intel hold advanced research centers, mostly in Haifa and the Tel-Aviv/Herzliya region. They produce and consume high-tech products and ideas cross-fertilizing the startup ecosystem. University and research centers sometimes also create **spin-off** startup companies around products of their research with the help of their Innovation and **Technology Transfer** Agencies.

Incubators are programs, lasting for 1 to 2 years, designed to help startup companies in their early stages providing a physical space, supporting administrative staff, as well as mentorship and networking with experts. Israel has about 20 incubators which are private enterprises highly financed by the government[6]. **Accelerators** consist of short-term programs (typically 4 to 5 months) in which entrepreneurs are immersed on training and mentorship to develop their business model. Currently, there are a handful of accelerator programs ran by the Technion, the Academic College of Tel-Aviv, Microsoft, and VCs.

5.2 Answers to the Research Questions

In light of the conceptual framework described in the previous section, the qualitative analysis of the data we collected led to answers to the seven research questions that motivated this study. The answers to the six initial questions are presented in Section 5.2.1 and were based on the interviews, observations, and questionnaire. Section 5.2.2 presents the SWOT analysis that was based mostly on the questionnaire answers by 20 experienced experts on the field but also on the interviews and observations; this analysis answers the seventh research question and helps reflecting on the future of the ecosystem.

5.2.1 Current state of the ecosystem

In this section, we answer the six initial research questions presented in Section 3. The answers were derived primarily from the analysis of the data collected in the 48 meetings with entrepreneurs and experts in the field. When necessary, we also refer to related literature on the subject and incorporate observations made in the 25 visited startups.

RQ1 - What are the sociocultural characteristics found in Israel that foster the entrepreneurial spirit?

Our research found a few key factors that promote the entrepreneurial attitude in Israel: technical experience at the IDF (Israel Defense Forces), immigration, family, hostile environment, and Israeli cultural traits. We detail these factors below.

Our research confirmed the widely known **role of the military** in feeding the startup ecosystem with human resources with motivation for entrepreneurship, as had been previously documented in the literature (Senor and Singer 2011; Chorev and Anderson 2006). However, differently from the previous literature that presents the military experience as a universal way to empower youngsters towards entrepreneurship, our findings led to a slightly different view.

On the one hand, most of the entrepreneurs we interviewed originated from IDF high-tech units such as the 8200 or the Mamram and/or participated in elite programs such as Talpiyot and Psagot. They are all

[5] www.shanghairanking.com
[6] www.incubators.org.il

very skilled technical professionals that report that their years in the military provided them two key advantages: (1) advanced technical skills acquired via training and practical experience in the military and (2) networking with a large group of other highly skilled professionals willing to work together in a new venture or simply helping making new connections and providing free consultation.

On the other hand, there was a small fraction of the interviewees that reported that the military experience helped little or not at all. All 4 interviewed women mentioned that their experience in the army did not help; some of them mentioned that the army is a "*man, macho thing*" and that women are normally put into secondary positions. Only one of the female interviewees worked in a technological unit of the army as a programmer, but even she said that, after that experience, she learned that she did not want to be a programmer and looked for a career in art/creation. Another small fraction of the interviewees was composed of men that served in non-technological units, normally as soldiers. Most of these also reported that the army experience helped little or not at all. Existing literature on the subject claims that the overall military experience brings significant value to the skills and spirit required for entrepreneurship (Chorev and Anderson 2006). However, many of our interviewees stated that what really makes a difference is the training and practical experience with advanced technologies and leadership that is accomplished with the technological units and programs.

We observed that a large number of the entrepreneurs are either **immigrants** themselves or descendants of people that immigrated to Israel throughout the 20th century. Many interviewees mentioned that the spirit of the immigrants favors entrepreneurship, as has been reported in the literature (Light & Bhachu, 1993). One VC mentioned: "*The Jews have being forced to leave their countries, forced to go to places they didn't know and restart their lives again, they were forced to be entrepreneurs*". An experienced startup founder said: "*Like in other countries, immigrants make great entrepreneurs because they made this with their own lives*", i.e., their own lives involved a big enterprise: moving to a different country.

The role of the **family** is also very significant in various ways. First, our interviews confirmed a recent finding of the literature that most people become entrepreneurs by *imitation* (Kedrosky 2013). Most of the times, entrepreneurs grew up in families in which the parents were entrepreneurs, either by creating their own business or by creating and leading projects within existing organizations; in a few cases, an older brother or an uncle assumes this role. Second, the emotional and, in a few times, financial *support* of the family for the risky business of trying something new is also relevant. A youngster in his first startup remarked: "*You can rely on your family to provide a safety net and invest in the high-risk business of being an entrepreneur*". Third, we observed the paramount importance that Jewish families give to *education*: most entrepreneurs we interviewed had several university degrees, including one or two undergraduate degrees, MBAs, masters and sometimes, PhDs.

In addition to the inhospitable geographic environment where Israel is located, the **conflict** with its neighbors, which Israel has been facing since its independence in 1948, provides a mind-set in which risk taking is considered normal. An investor and entrepreneur said: "*There's an inherent risk on being in Israel, for example, we receive threats from Iran all the time, if you live with the risk of destroying your country, the risk of starting a company is nothing*". A former entrepreneur and now VC manager mentioned: "*I have been in the war in Lebanon; after that I went to work in the Silicon Valley, I wasn't afraid of anything; in Lebanon, I could be shot at any time, compared to that, nothing bad could happen in the SV*".

Finally, and maybe a result of all the factors above, as well as Israel's history, are some **Israeli cultural traits** found in the personalities of many local entrepreneurs, as laid out below:

- *Direct communication*: Many people mentioned that Israelis are very *direct* in *communication*; this, on the one hand, may sometimes be interpreted as rudeness, but on the other hand, facilitate communication and make problems and difficulties be reported, and dealt with, very early.
- *Perception of equal status*: Israelis also have a *perception of equal status* and have direct, open access to all levels of hierarchical organizations, which works very well in small enterprises such as startups.
- *Chutspa*: Also, *Chutspa* is an Israeli cultural trait somewhat related to audacity and insolence that an incubator founder exemplified as "*I don't care what the system is, this is going to work. The fact that there are so many rules doesn't mean I need to follow them, because someone invented them; we can find a different way of doing it.*" He also pointed out that another side of Chutspa is "*the ability to solve problems in alternative ways, Israelis are masters of improvisation and improvisation is very important for startups*".

- *Networking*: Last but not least, most interviewees mentioned that networking is very easy and important for the development of startups in Israel. A startup CTO stated: "*Connections are free in Israel*" while another mentioned "*We had some doubts about how to scale our infrastructure and then we approached the Waze guys and they received us and showed us how everything worked. And they didn't even know us and they didn't ask anything in exchange*". An accelerator manager said "*Here, everybody either knows everybody or knows someone who knows, in a single step*" The general feeling is that most people want to help; they will receive you and provide feedback to your ideas, and make introductions without asking anything in return.

These cultural traits match the social behavior that Hwang and Horowitt (2012) observed in Silicon Valley and claimed to be a key aspect for an innovative ecosystem.

RQ2 - What are the institutional mechanisms in place in Israel that promote entrepreneurship?

Throughout the 20th Century, generous donations from Jews worldwide as well as hard work of Israeli scientists helped to establish a solid infrastructure for high-quality **scientific institutions** across the country, including Technion, the Hebrew University of Jerusalem and the Weismann Institute of Science. Since the early 1960s, these institutions have the preoccupation of applying the science and technology developed within their organization to real-world products via **technology transfer** to the industry. In 1959, the Weismann Institute founded Yeda, a company aimed at promoting the transfer of research findings and innovative technologies developed by Weismann scientists to the global marketplace. In 1964, the Hebrew University of Jerusalem followed the same path, creating Yissum, and later and the Technion established T^3 - The Technion Technology Transfer office. This creates an overall mindset that science and technology should not be developed only for its own sake, but that it has an important role in the development of the country and should seek to produce a positive impact on society.

As we saw in Section 5.1, the availability of **funding** for new ventures is a key factor for the efficiency of a startup ecosystem. In Israel, this availability was very limited until the 1990s when the government released the **Yozma** program within which new risky high-tech ventures could get public funding if they also got private investment. Typically, the government would double the investment provided by private sources, an incentive that resulted in a very large growth in the Israeli venture capital industry since then. Currently, government support mostly takes the form of R&D funding provided by the Office of the Chief Scientist (**OCS**), which does not take equity in the companies, but demands to be paid back in case the company becomes profitable in the form of a percentage of the revenue. While many companies make use of the OCS programs successfully, some interviewed entrepreneurs mentioned they prefer to avoid it due to its bureaucracy and to the restrictions imposed by the OCS that the intellectual property must stay in Israel, which may add difficulties in case of an exit or transfer to another country.

Nevertheless, most of our interviewees used private sources for their funding. Normally, **seed investments** in the range from 25,000 to 250,000 USD come from **angel investors** or friends and family that receive equity, i.e., a share of the company. This money is used to develop an initial prototype of the product and to make the first experiments in real markets, acquiring the first users and customers. The startups that succeed in this first step, i.e., that develop a good initial product and/or acquire some initial customers, normally seek funding from **Venture Capital funds (VCs)**. Interviewees report that VC funds are scarcer in Israel but the landscape is improving. VC investment typically ranges from 1 to 5 million USD. As can be seen in Figure 3, the capital raised by high-tech industries has been growing significantly since 2009 and reached its all-time peak in 2013; about 1/4 of the capital comes from Israeli VCs while 3/4 comes from international VCs and other sources. VCs receive a significant share of the company and they expect to get their money back if and when the company is sold, i.e., a return of their investment (**ROI**). In some cases, the founders do not want to sell the company even when it is successful and prefer to buy back from the VC their share on the company. Since most of the startups fail (our interviewees many times mentioned that around 90% of the startups fail), VCs expect to have an 8x to 10x exit, i.e., they expect that when the company is sold, their shares will value 8 to 10 times more than what they invested initially. This big difference in the share value and the high expectation causes friction and tension between entrepreneurs and VCs during the startup development.

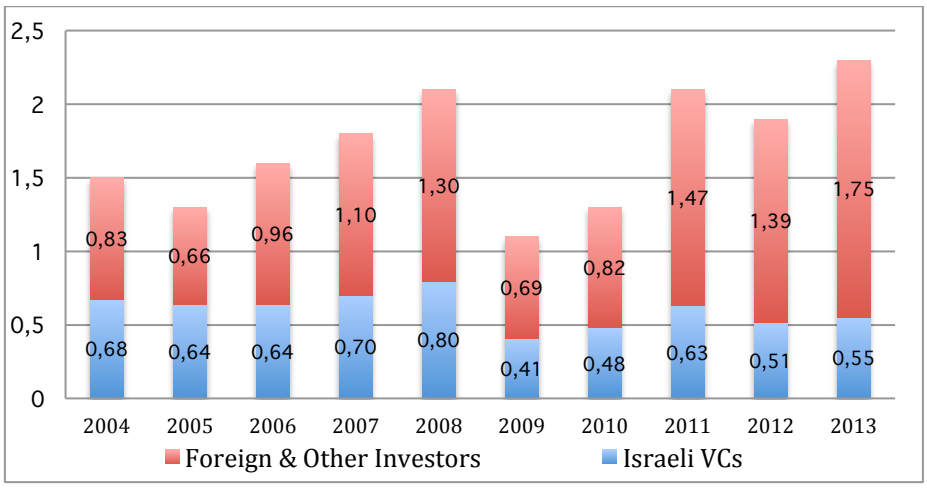

Figure 3 - Israeli High-Tech Capital Raising in US$B (IVC Research Center, 2014)

As described in Section 5.1, Incubators and Accelerators play an important institutional role in the ecosystem by providing education, mentoring, and a relatively safe environment for new entrepreneurs to develop their startups (Rothschild and Darr 2005). **Incubators** were established in the 1990s and most of them are private enterprises in which the startups are heavily funded by the government. While some interviewees mentioned that this was a good initiative of the government, others criticized it, saying that there is very little risk for the incubator manager and no incentives for them to perform well. A young serial entrepreneur that became a VC after founding four successful startups in a row said: "*Yozma was good but the incubators was a foolish thing: it allows the incubator to leverage its money without taking risks*". On the other hand, **Accelerators** of different flavors seem to be a unanimously well-received idea. Some accelerators are nonprofit programs ran by educational institutions, such as universities or colleges, or by IT companies, which use the accelerator as a way to promote their brand. Others are ran by VC funds or other private groups that normally take equity on the companies and expect to make profit through successful startups. In most cases, there is a highly competitive selection process to be accepted in an accelerator and founding teams are chosen based on their personal skills as well as on the quality of the proposed business or product.

One of the problems currently faced by Israel is the lack of diversity in the entrepreneurs' demographic profiles; as we observed and was pointed out by several interviewees, most entrepreneurs are male secular Jews from an European background. Some interviewees believe that this problem could be mitigated by the action of educational institutions, incubators, and accelerators. The founder of an incubator that is ran with private money and targets underrepresented sectors such as women, Arabs, Africans, and orthodox Jews, said: "*We find so many entrepreneurs in Israel because of the ability to fail miserably, colossally and still believe that you're going to succeed. Most people (and animals and plants) are risk-adverse but humans are unique in the fact that they take risk; and they do that when they have some kind of support (or back-up option). People coming from high socioeconomic background find naturally that support in their environment. In our incubator, we provide that safety net to those groups that don't have the opportunity to take the risk; they feel confident that they can take the risks and our net will catch them if needed; otherwise, they don't have a chance to succeed.*"

Finally, the Israeli startup community self-organized, in a somewhat chaotic manner, a vibrant agenda of **events** such as seminars, technical lectures, **meetups**, and other types of informal gatherings in which all kinds of people get together to exchange ideas and discuss new possibilities around high-tech entrepreneurship. A typical week in Tel-Aviv have dozens of public events and open meetings in which participants bring new ideas and problems and try to self-organize to create the next startups or help the existing ones move forward. These events are highly publicized in the **media**, especially in newspapers, blogs, and social networks.

RQ3 - What is the role of education in fostering entrepreneurship in Israel?

Education seems to be the most important single factor in fostering entrepreneurship. As mentioned, Israel has a significant number of **world-class research universities**, colleges, and highly advanced military and civilian **R&D centers**, which promote the education and training of thousands of highly skilled IT

workers every year; from these, at least a few hundreds present a strong entrepreneurial spirit. This highly skilled workforce is fundamental for the strength of the ecosystem.

In addition, a number of initiatives focusing explicitly on **entrepreneurship education** are also very relevant. All academic programs that we could observe in universities and colleges offer to their students the option to take at least a one-semester course on Entrepreneurship both at the undergraduate and graduate levels. Some institutions, such as Technion, have a specific center devoted to promoting entrepreneurship among its students[7].

Accelerator programs, associated with universities, colleges, companies, and VC funds, work as a hands-on intensive course on startup development. Currently, hundreds of young entrepreneurs participate in these kinds of programs every year, developing their real startups.

Our observations revealed that there are two types of entrepreneurship education experiences: academic and practical. In the **academic experience**, beginners learn by reading books and papers, attending lectures and seminars, and engaging in practical exercises. In this way, a significant body of knowledge on entrepreneurship and startup development methods can be learned quickly. But, this is not sufficient; as most interviewees mentioned, what really makes a good entrepreneur is the **practical experience** gained by working on multiple startups over several years.

Last but not least, the **education received at home** and the culture of the family and friends is, most of the times, a serious determinant in defining an inclination towards entrepreneurship.

RQ4 - What are the characteristics of successful innovative teams and entrepreneurs? What is the prime motivation of the software entrepreneur?

In terms of size, the large majority of the startups we observed had **between 2 and 4 members** as founders. Just a few of them had a single founder, as most interviewees mentioned that they appreciate having a partner with whom to exchange ideas and discuss the next steps of the startup. Most of the single-founders mentioned that they were looking for a co-founder but could not find one yet. In the other extreme, one of the startups had 8 co-founders; one of its founders reported they get along very well but this is seen as an exceptional case.

In general, startup founders self-organize in teams of 2 to 4 members as a means to group together a small number of people that collectively share good **skills** in both the **product** and the **business** aspects. In the case of software startups, in the product side, it is important to have someone knowledgeable in **software development** or in the particular field of computer science related to the product. In many cases, it is also desirable to have someone with good skills in **design** and/or creative media, to help creating user interfaces and web sites. In the business side, it is important to bring people with experience in **management** and knowledge in **marketing**.

Software startups typically are born with one chief executive officer (**CEO**), who leads the management, and one chief technology officer (**CTO**), who leads the technology/product development; both are equally seen as the top level management of the company without a hierarchy among them. As it grows, additional hierarchical layers are added, for example, Vice-Presidents (**VPs**) of product development, R&D, marketing, sales, etc.

In all cases, there is always the alternative of hiring services to fulfill gaps in the skills of the founding team, but the commitment many times will be lower. Most software startups have at least one person with background in technology as a co-founder (normally, a degree in Computer Science or Computer Engineering) but there are some exceptions. A startup founder with an expertise in marketing complained: "*We had so many CTOs. To be honest, when you're two entrepreneurs and none have a computer background is very very difficult. The programming is so important/core for the business, everything that didn't go well until today was about the software because we don't know how to do that. We had 5 CTOs in two years. In a startup you must invest all your energy, it's very difficult, you need to work a lot but you do it because it's your baby. If it's not your baby and you need to go through all that you just leave and go work in a big company and make more money; 'why would I work here?' This kind of commitment you only get from a founder.*" With regard to the difficulties in communication, the founder

[7] Bronica Entrepreneurship Center - www.yazamut.technion.ac.il

added: "*I'm so far from Computer Science that I don't even know how to communicate with those people; it's like people from a different space, I don't understand very well what they want.*"

Many startup founders reported very good experiences in being advised by more experienced entrepreneurs or professionals, who act as **mentors**. It is very common for software startup founders to seek advice in marketing, funding, monetization, and technology from professionals with many years of experience in the IT industry. Also, it is very common for successful entrepreneurs to mentor younger founders in a pro-bono fashion, i.e., without charging for their services. Sometimes, startups form an **Advisory Board** of experienced professionals or well-known scientists/professors, which also adds credibility for the new venture.

Most startups we visited had a combination of **introverts** and **extroverts**, which seems to provide a good team balance. Many technical people described themselves as introverts but several mentioned that they were shy in their 20s and, as they got used to speaking in public and talking to people, they became less shy and now, that they are in their 30s or 40s, this is no longer an issue. This kind of change in personality and the power of introverts is well explored in a recent book on the subject (Cain 2012).

With regard to **motivation**, most entrepreneurs seemed fascinated by the possibility of creating something new and by doing something that would have a big **impact** in the world. When asked if **money** and becoming rich is an important factor, most mentioned that it would be a nice thing and that this also played a role, although not necessarily the most important one. A successful startup founder said: "*In Israel, differently from some other countries, if you want to be rich, the only option most of the times is becoming an entrepreneur*". About the popularity of entrepreneurship, he added: "*Startups are almost taking the place of Lotto in Israel. I actually don't like that very much; my take is that I want to make something important in the world; money will be a consequence, it's not the main motivation.*" It is also interesting to note that some people are also motivated to work in startups even if they themselves do not intend to be an entrepreneur; a non-founder CTO explained why he likes to work in startups: "*In a big company, if you succeed, it's the system that did well, not you; in a startup, even if you're not the founder, you're the one that succeeds; and when you fail, you take it personally even if it's not your money.*"

Recent research carried out in Israel shows that entrepreneur's **experience** shows a positive correlation with venture success, more specifically, entrepreneurs who have participated in previous startups and/or have previous managerial or scientific experience generally receive more venture capital funds in more financing rounds and file more patent applications (Blank 2008). Our interviews with VCs and serial entrepreneurs corroborate that finding. Although there is often the common **tale of the very young entrepreneur in the 20s** who quickly becomes billionaire, a **myth** inspired in the lives of Bill Gates, Steve Jobs, Mark Zuckerberg, and the like, the reality shows that young entrepreneurs tend to make many more mistakes and fail quite often. In our interviews, experienced VCs and serial entrepreneurs agreed that most **successful software entrepreneurs** normally are **between 30 and 45 years old** and are in their second, third, or fourth startup. The general feeling is that good entrepreneurs learn from their mistakes in their initial ventures and become more effective as they become older. Indeed, as the software field becomes older, the tendency is that the average age of successful entrepreneurs will also increase.

Research carried out in Israel, studied **cognitive styles** of people from radical-innovation teams in R&D and manufacturing, (Miron-Spektor, Erez, and Naveh 2011; Miron-Spektor, Erez, and Naveh 2012). They found that about 50% of people have a mix of thought patterns, while the rest fall into three distinct types: creative, conformists, and detail-oriented people. The research showed that most innovative teams had 20 to 30% of creative people; since they may not care for rules and can initiate conflict, having too many of them may cause problems. Conformists support the creative, boosting cooperation and team's confidence and accounted for 10 to 20%. Finally, detail-oriented people are less willing to take risks and focus on standards and budget control, accounting for less than 10% of highly innovative teams. This result can serve as a hint for entrepreneurs when they are forming the founding team, when they hire their first employees, and later when the business starts growing.

Finally, it is interesting to note that a few entrepreneurs we interviewed mentioned that they had problems in school or during childhood that later showed up not to be a problem but rather, a characteristic of some entrepreneurs. A male entrepreneur mentioned: "*In the school, I was never a good student, I never worked well learning from professors*" while a female startup founder said: "*I get bored very easily,*

everyday I invent many new things and it's very dynamic and speedy and I like that path. I have ADD[8]*, I can't concentrate, I like to do lots of stuff. Most entrepreneurs are ADD by the way.*"

RQ5 - Which technological aspects influence the success of software startups and how? In particular what is the role played by Object-Orientation, Languages, Frameworks, Patterns, and Architectures? What is the role of Open Source Software?

Among the professionals we interviewed, we had 10 CTOs and 8 other people with skills in software development (managers, programmers, and CEOs) to whom we addressed more technological questions to assess the current state of the practice in software development in Israeli startups. We also participated in large events and meetups targeted at the startup developers community.

Good **software architecture** principles are widely used and most interviewed developers had a good knowledge of **object-orientation** and **design patterns**. Most systems were based on modern programming languages and frameworks, although some teams showed to be **somewhat over-conservative** in their choice of technology. An incubator manager mentioned: "*Israeli startups are not very flexible with the adoption of new technologies; for example, adoption of Ruby on Rails is low; it took 3 or 4 years after it became popular in the US. We still see startups using .NET, here.*" This restrained use of new technologies was also identified in a study by Telefónica Digital (Herrmann et al. 2012).

The interviews showed massive use of **Open Source Software** by startups. All of the 25 observed startups used open source either as an underlying platform (e.g., with Linux-based servers or Java-based services), as a development platform (e.g., Eclipse-based IDEs, git, open source compilers), or as supporting libraries and tools (e.g., OpenCV for computer vision and MySQL and PostgreSQL as databases). A CTO from a large startup said: "*We use a lot of open source. There's no point in reinventing the wheel and there's some very advanced technology that's developed very quickly, bugs are fixed quickly, and, with open source, we can go there and fix it if needed; and we do that sometimes. Also, avoiding being locked to a certain company is very important.*" Many founders mentioned that open source acted as an enabler for their business. A founder and CTO mentioned: "*We would not be able to even start our company if we had to buy licenses for all the tools, libraries, frameworks, and components we use*". When asked if they contribute to open source projects with new code, all of them said they did not have the chance since the startup already consumed all of their time. Some of them do contribute by sending bug reports back to project developers and one company regularly releases, as open source, the libraries for accessing its products.

RQ6 - Which and how methodological aspects influence the success of software startups? What is the level of adoption of well-known business and software development methods? Is this relation changing along the start-up life cycle?

Our data analysis showed that, overall, the adoption of well-established methodologies is not prioritized by Israeli startups. It was common to find entrepreneurs that proudly stated that they do not adopt any known software development or business methodology; they simply follow their own **intuition and experience**. We see this as a potential threat to these startups that are likely to incur in common mistakes that modern methodologies try to avoid. A clearly different trend was found in startups that had passed through a mentoring period in an Accelerator; these startups used **Lean Startup** (Ries 2011) most of the times and had a systematic concern for **Customer and Product Development** (Blank and Dorf 2012). This visible difference is evidence that accelerator programs are really valuable in educating entrepreneurs to act more rationally and effectively while developing their business. Some new VCs are also paying more attention to structured methodologies: a young VC partner of a new large Israeli fund mentioned that methods such as Lean Startup, Customer Development, and Design Thinking are "*very important, mainly in the early stage. It is difficult to put the structure later*".

With regard to software development, on the one hand, many entrepreneurs in early stage startups expressed despise for well-known methodologies. When asked, most of them said that they were "*Agile*" but did not follow any specific agile methodology. In fact, we observed that a few best practices defended by **Agile Methods** (Cockburn 2006) such as **automated testing, continuous integration, and incremental and iterative development** were often adopted in a somewhat disorganized way. On the other hand, a clear

[8] ADD - Attention Deficit Disorder.

trend we observed was that, as the startup and its software grew and as they hired more developers, entrepreneurs and CTOs realized that they were making too many mistakes and they needed to add some more structure to their development methods. The founder and CTO of a quickly growing startup said: "*We didn't use any methodology until a few months ago, but we just increased the size of our R&D from 12 to 21 and found the need to adopt something. I decided to adopt Scrum and the teams loved it. In a short time, we are already seeing improvements.*"

Among the startups with more than 10 software developers, all of them mentioned the use of some sort of agile method. **Scrum** (Schwaber 2009) was cited many times and Extreme Programming (Beck and Andres 2004) was cited in two cases. No other methodology was mentioned. From our interviews, we also learned that development methodologies in general and agile software development in particular, are **not part of the curriculum** of most Computer Science and Computer Engineering courses in Israel and that students graduate with a gap in their education with respect to that. Most developers mentioned that their courses in the university were "*too theoretical*" but, while some consider that to be a problem and say that the curricula should be updated, others do not consider it necessarily a problem: "*The degree was not tailored to the industry, but it gave me amazing tools to understand the core concepts, which didn't change much*". Nevertheless, recently, more attention has been given to this topic, as university and colleges are starting to offer such courses. One of which is offered by the Technion, in which "the Agile principles [are learned] throughout the software development life cycle by using simulations and games that show how a team is supposed to work in an Agile environment"[9].

5.2.2 SWOT Analysis and the Future

In this section, we analyze the 20 answers to the online questionnaire we received from Israeli experts in the field of entrepreneurship and startups. The questionnaire format was inspired by the SWOT analysis first proposed in the 1960s for the context of corporate planning (Humphrey 2005). Here, we apply it, instead, to an ecosystem; the questionnaire addressed the Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T) of the Israeli software startup ecosystem. Strengths and Weaknesses refer to the current situation of the ecosystem, pointing out to Opportunities and Threats, which refer to the future of the ecosystem. The Opportunities and Threats of the ecosystem, as conceived by the responders, enables us to answer RQ7 - What are the opportunities for the further development of the Israeli software startup ecosystem in the future? What could be a threat? Table 2 summarizes the major results of our SWOT analysis.

Table 2 - Summary of the SWOT analysis

	Positive	**Negative**
Current	**Strengths** • Military Service • Already existing ecosystem • No giving-up culture • Risk taking and failure acceptance • Immigrant entrepreneurial spirit • Easy access to capital • High quality education and technical skills • Branding as Tech Center • Collaboration and Openness	**Weaknesses** • Far from target markets • Focus on exits • Technology over business • No local market • Young and inexperienced people
Future	**Opportunities** • Peace • New fields • Emerging markets • Education of new entrepreneurs	**Threats** • Brain drain • Conflict • Competition • Quantity and quality • Education • Demographics

[9] webcourse.cs.technion.ac.il/236605/Winter2013-2014/en/general_info.html

Strengths

The experts pointed out multiple strengths of the Israeli startup ecosystem. Most of them, such as the military service, cultural aspects (e.g., risk taking, failure acceptance, collaboration and openness mindset, no giving-up and entrepreneurial spirit), easy access to capital, high quality education and technical skills, have already been elaborated in Section 5.2.1 as part of the answers to the research questions.

9 out of the 20 respondents mentioned the **Military service** as one of the strengths of Israel. The R&D and hard training structure of the army enables engineers to develop a high level of expertise in technology. Moreover, the military service makes people used to risk taking situations and develops strong networking and personal relationships.

9 experts agreed that the already **Existing startup ecosystem** itself is a strength. There are many entrepreneurs and startup founders, so having a startup is considered common and acceptable in the society. The existing success cases also stimulate people to create new ventures and successful entrepreneurs serve as mentors for the new ones, keeping the wheels turning.

6 respondents wrote that Israelis have a strong determination to get things done. There is a **No-giving-up culture** in Israel. Entrepreneurs are persistent people, not satisfied with the status quo, and they know that with hard work they can improve things.

5 experts mentioned the **Risk taking** culture. In Israel, failure is acceptable and common. People are not afraid to fail and start again, learning from past experiences.

5 respondents argued that the **Entrepreneurial spirit** is part of the Israeli culture and one of its strengths. Some attribute this characteristic to the "the natural entrepreneurial drive of immigrants in general, and Jews in particular".

4 experts mentioned the **Easy access to capital** as a force that enables the Israeli startup ecosystem. Startups in all stages, from early to late, have a very mature investment industry to count on when they need resources to grow.

4 respondents said that **Education** in Israel has high quality, producing talented workers, with good **technical skills**. This education comes not only from Universities but also from the Army experience.

4 experts mentioned Israel **Branding as a high-tech center**. They consider this as a strength, since this brand attracts not only investors, but also talented people. Moreover, startups from Israel are already born with the "Israeli seal of quality".

3 respondents identified that the ecosystem has a **Culture of collaboration and openness**. People believe that technical knowledge and business experience must be shared, and if one helps the other, the whole system grows together more efficiently.

Weaknesses

The experts pointed out five weaknesses of the Israeli software startup ecosystem. As before, some of them have already been mentioned in Section 5.2.1; some were new or highlight the ecosystem from a new perspective.

8 respondents said that Israel has the disadvantage to be so **Far from the target markets**. Time zone is one difficulty, the Hebrew language is mostly spoken only in Israel, and the cultural differences between Israel and target markets sometime are considered an obstacle to tackle these markets.

4 experts mentioned that most of the entrepreneurs start a business thinking on the day they will sell it to another company. This focus on exits rather than on growing the business itself can hurt the company's product quality on the long term, creating a non-sustainable business.

4 respondents considered that Israeli startups **Focus** too much **on technology**, instead of looking at business and marketing issues. There is not much knowledge on disciplines like user experience (UX) and design and, as a result, high technology products have sometimes poor appeal to the end user.

4 experts mentioned that there is **No local market** in Israel. This means that, in order to grow, startups must think globally from day one. Some experts considered this as a strength, but sometimes, the testing of new ideas in the absence of a local market is more difficult.

4 experts said that, although there are many talented young entrepreneurs, there are also **Too many inexperienced people**, who do not have enough knowledge on business and people management. This lack of management skills brings challenges for Israelis when building larger companies.

We now answer RQ7, which relates to the future of the ecosystem, referring to the Opportunities and Threats, as conceived by the respondents. As can be seen here, most of the factors were not mentioned as part of the answers to RQ1-RQ6 and, therefore, may highlight new directions, approaches, and thinking styles needed to further develop the ecosystem.

Opportunities

The experts identified 4 major opportunities for the further development of the Israeli software startup ecosystem: Peace, New fields, Emerging markets, and Inclusion of new segments.

6 respondents mentioned that the possibility of reaching the **Peace** with the Arabs and Palestinians would open a large number of new prospects for Israel. The large markets represented by the neighboring Arab countries, which are almost completely closed to Israel at the moment, could represent the opportunity for many new ventures. The investment and funds available in these countries could also be used by startups. Finally, joint ventures between Israeli and Arab partners could be very successful by combining skills and access to multiple cultures and regions.

5 experts mentioned that **New fields** could be better exploited by the Israeli high-tech entrepreneurs. Specifically, they cited: (1) Biomedical technologies, Health IT, and Medical devices, (2) Sustainability, Alternative energy, and Water management, (3) Mobile apps, and (4) 3D printing and other customization technologies. In the same spirit mentioned in Section 5.2.1, some mentioned that the fact that Israel historically lacked natural resources, such as water and energy, led to the development of alternative technologies that could be better exploited commercially now that sustainability is in the global agenda.

4 respondents considered that **Emerging markets** could be a good opportunity for entrepreneurs. In particular, they mentioned explicitly the Arab markets in neighboring countries and the Russian-speaking world; in both cases, the large share of Israelis that speak either Arab or Russian could help accessing those regions.

3 experts argued that **Education of new entrepreneurs** could help improve the outcomes of the startup ecosystem. One of them mentioned that the accelerators are doing a good job in educating entrepreneurs and that this could have a positive impact in the future. Another one mentioned that incubators in Arab regions within Israel and in Palestine could engage new sectors of society into the ecosystem, promoting its growth, and partially solving the lack of diversity in the field. In the same line, a third one mentioned that involving women, Arabs, and religious Jews into the game is an opportunity that should be sought.

Threats

The respondents identified 6 major threats to the ecosystem: Brain drain, Conflict, Competition, Quality and Quantity, Education, and Demographics. In addition, 2 respondents also considered Dependency as a threat.

6 experts considered that **Brain drain** is a significant threat. They mentioned that many skilled engineers and scientists choose to leave the country and normally move to the US and Europe where, many times, salaries are higher, working conditions are better and there is less instability in the geopolitical condition. Although this is a real factor, at the same time, however, Israel benefited very heavily from immigration of highly skilled workers into the country (a factor mentioned earlier in the paper). Thus, it is natural that some level of immigration out of the country would also happen.

6 respondents mentioned the **Conflict** with the Arabs and possibility of escalation of war as a significant threat. According to them, this makes business more difficult and may, in the future, slow down interests of foreign companies in local startups.

6 experts mentioned that **Competition** from other emerging countries could threat Israel's position as a leader of high-tech entrepreneurship. They mentioned that large countries like India and China might turn into innovative and entrepreneurial cultures, which would reduce Israel's competitive advantages since it is such a small country.

6 respondents showed concern for the high **Quantity** of low **Quality** startups. As they see the ecosystem, there are too many startups in Israel, which makes it difficult to choose the good ones for funding; also, there are not enough engineers for all of them, which makes it hard to assemble good teams for all startups. In addition, they note that there are too many small exists instead of a culture of building sustainable businesses that can grow in the long term.

5 experts worried about the decreasing quality of **Education** in Israel. They claim that the government invests less in education and that diminishing budgets for R&D and technology education can hamper Israel's leadership in the high-tech industry. In fact, according to the OECD (2013), the expenditure per student in higher education in Israel has dropped around 15% between 2000 and 2009, in part, but not only, due to an increase in the number of students. While the average expenditure per higher education student in OECD countries in 2009 was 13 728 USD, in Israel, this amounted to only 11 214 USD.

4 experts mentioned **Demographics** as a significant threat. Ultra-orthodox Jews, Arabs, and women are together a majority that very rarely is involved in high-tech entrepreneurship and innovative startups. In addition, Arabs and ultra-orthodox Jews have many more children than other sectors of society, pointing to a future with relatively less entrepreneurial drive in the overall population. Respondents argued that well-educated families tend to have fewer children and that the growth of religion and superstition might pose a problem to scientific and high-tech-based industries.

6 Conclusions and Future Work

Software startup ecosystems are flourishing in multiple parts of the world. While they all have specific features determined by the socioeconomic and cultural characteristics of the environment in which they are embedded, there are common elements that they all share. In this paper, we described our research about the Israeli software startup ecosystem, which led to a conceptual framework, which identifies the key elements that are relevant for the successful operation of the ecosystem in the Israeli context. This framework not only helps understanding the functioning of a fruitful ecosystem but also can serve as a basis for future comparative studies across ecosystems.

Our research findings advances the knowledge of the field of Technological Innovation in the particular area of software startups by providing a deeper understanding of one of the most successful startup hubs on the planet. Focusing on the Israeli software startup scene, our work detailed the role of immigrants, family, military, conflict, culture, technology, government funding, angel and VC investment, incubators, accelerators, innovation-focused events, universities, R&D centers, entrepreneurship education, founding teams, founder personality and skills, motivation, product and customer development, lean startup, agile methods, marketing, management, software architecture, and open source. We concluded the research with a SWOT analysis based on the vision of experts in the field. In Section 6.1, we summarize some of the most important lessons we learned in the form of a collection of recommendations for high-tech entrepreneurs and policy makers. In Section 6.2, we propose a new, generalized version of the conceptual framework for software startup ecosystems by focusing on the aspects that are not dependent on a particular region. Then, in the remaining of the paper, we discuss how future work can use this generic framework as a basis for further extending the theoretical and practical understanding of the field.

6.1 Lessons learned

The following guidelines summarize what we learned from our data analysis and can serve as recommendations for entrepreneurs and policy makers.

Lessons for entrepreneurs:

1. Older entrepreneurs tend to be more successful. Contrary to the myth of the young, 20-year old genius entrepreneur, the ideal age for creating new ventures seems to be between 30 to 50 year-old. Entrepreneurs should learn from mistakes of the past, have more management experience and have previous working experience in larger teams both in startups and larger organizations.
2. Diversity of the founding team is a valuable asset. Founding teams featuring a mixed set of skills are more complete. For example, a team composed of one technical-oriented person, one business

person, and one designer reflects such diversity.

3. Good networking is a key to success. In Israel this is facilitated because people are open to help each other asking nothing in return. It is easy to reach almost anyone in the ecosystem.
4. Building a successful business normally is not simply the result of a good idea; having ideas is easy. The difficult part is the hard work required both before starting the venture (years of practice) and after (thousands of hours of work to get to a sustainable business).
5. Right level of spending between development and marketing is crucial. Several entrepreneurs report that their previous startups failed either because they spent too much money without marketing validation or because they spent too little money and did not invest enough in the development of the product and validation of ideas. Thus, it looks like that finding the correct balance between development and marketing is a key factor.

Lessons for policy makers:

1. Vibrant environment. A fruitful environment for startups should feature hundreds of events per year in a small geographical region, typically, a single city. These include lectures, workshops, conferences, informal meetings, social events, and parties around technologies, business, financing, marketing, etc. The city of Tel-Aviv is currently doing very well in this aspect; other regions in Israel and other startup hubs around the world, such as São Paulo, are not.
2. Attract talent and avoid excessive brain drain. Countries should reflect about public policies that favor local scientists and skilled engineers, encouraging them to stay in their region. Brain drain, if limited to reasonable levels, should not be seen as a terrible problem; nowadays, a certain level of mobility is natural and can open opportunities for international collaborations.
3. Continuing investment in education. Fruitful startup hubs and high-tech industries can only flourish around world quality universities and research centers. Continuous investment in all levels of education over several decades is absolutely essential for the development of nations in the information age.
4. Promoting demographic diversity. The inclusion of different sectors of society into the entrepreneurial ecosystem is important to nurture a feeling of inclusion across multiple segments and decrease the tensions among different social and ethnic groups. Diversity also promotes new ideas, increases networking, and opens new markets for new ventures.

6.2 A Generalized Framework

The conceptual framework presented in Section 5.1 emerged from the 48 interviews and observations we carried out in Israel in 2013. Nevertheless, most of the elements and relationships it brings had been alluded to before in the literature, sometimes in a disconnected manner, in a variety of unrelated sources. Except for a few elements, such as the importance of the Military, most of the concepts presented in the framework are relevant not only for Israel but for any region in the world that wishes to develop a healthy innovation ecosystem for software startups.

We produced a generalized version of the conceptual framework by removing all of the aspects that, according to our interviewees, are tightly coupled to the specific reality of Israel. This new, generic version of the framework, presented in Figure 4, can now serve as a theoretical foundation to evaluate and reflect on other startup ecosystems around the world. As described in the following subsection, within the next two years we expect to apply this framework to other startup hubs and work with other international research groups interested in collaborating with us to explore and refine this generic framework.

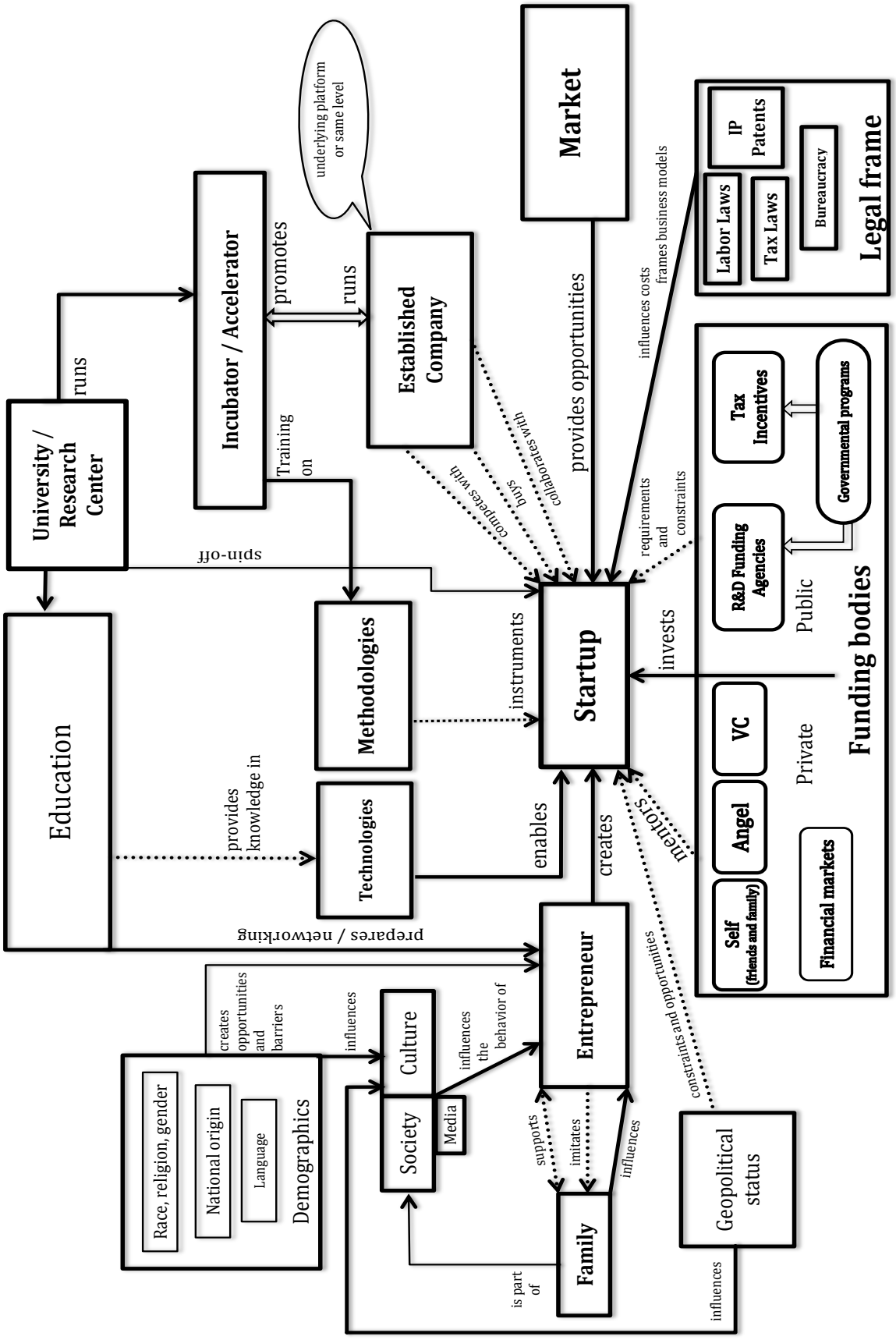

Figure 4 - Generalized Conceptual Framework of Software Startup Ecosystems

6.3 Future Work

The Israeli framework presented in Figure 2 emerged from the Israeli ecosystem and helps to understand the reality of that country with respect to entrepreneurship in IT. However, many of its components are, in fact, fundamental elements that must be present in any successful startup ecosystem. Most of the elements presented in the generalized version of the framework, depicted in Figure 4, can be observed in any major startup hub worldwide. In future work, we will investigate the application of this conceptual framework to other regions, including Silicon Valley, São Paulo, New York, Angola, and Montevideo, and analyze how the framework can be mapped to different contexts according to the different cultures and socio-political-economic realities. On the one hand, this process will lead to further refinement of the generic framework and a better theoretical understanding of the key elements needed in different types of startup hubs, ranging from world leaders in the field (Silicon Valley and Israel), to strong mid-range centers (New York and São Paulo), to smaller centers in developing countries (Angola and Montevideo). On the other hand, we expect this research to lead to a systematic, validated methodology that could be applied to any region to identify its strengths and weaknesses and derive recommendations for public and private players in the ecosystem to improve the health and productivity of their environments, contributing to the socioeconomic development of their regions and nations.

We are also interested in understanding more profoundly the role of agile software development methods in the success of startups as well as the potential for startups around open source software and open innovation networks (Benkler 2006).

6.4 Final Thought

We believe that technological innovation can be a very significant force to face the key challenges of humanity today, helping us to construct a better global society. In particular, technologies targeting lower energy and natural resource consumption, production of high-quality jobs, and a better quality of life, especially for underserved populations, should receive careful attention from the public and private sectors. Finally, science and technology are a universal language that can be used to bring together people from different cultures and countries in joint ventures, promoting mutual understanding and peace.

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Apendix A.

Research Protocol

for constructing a Conceptual Framework and

Mapping Regional Software Startup Ecosystems

Developed in a collaboration between University of São Paulo and Technion (2013-2014)

The examples below mention the first region in which this protocol was applied, Israel, but it was designed so that it can be repeated in any region.

The team of researchers

- Prof. Fabio Kon, University of São Paulo, Brazil
- Daniel Cukier, PhD student, University of São Paulo & Elo7 Brasil
- Claudia de Oliveira Melo, Post-doc, University of São Paulo & Thoughtworks Brasil
- Prof. Uzi de Haan, Bronica Entrepreneurship and Innovation Center, Technion
- Prof. Harry Yuklea, Bronica Entrepreneurship and Innovation Center, Technion
- Prof. Orit Hazzan, Department of Education in Science and Technology, Technion

Major research study steps:

1) Preliminary literature review

2) Data collection: Interviews and non-participative observation

3) Data coding and analysis

4) Constructing the Conceptual Framework

5) SWOT Analysis Questionnaire

6) Comprehensive bibliographic review

7) Putting forward Recommendations

8) Writing final report/paper about the research.

1) Preliminary literature review

Carry out broad study of the literature on

1. Entrepreneurship
2. Startup engineering
3. Innovation and the high-tech industry in the region under study (Israel)

2) Data collection: Interviews and non-participative observation

Interview preparation

Optional preliminaries (done in day 1, before setting up the interview date)

- If the interviewer and interviewee have the availability for multiple meetings, this preliminaries should be carried out: In the 1st meeting, try to know the people, observe the startup environment, and try to schedule an interview with 2 or 3 members of the startup team for a few days later.
- If this is not possible, then proceed directly to the interview without preliminaries.

The interview

- Arrive between 5 and 10 minutes before the time scheduled for the interview.
- Explain the overall goal of the research in general terms:
    - GOAL: *Study the Startup Ecosystem from a CS/IT perspective to obtain a better understanding of the current state-of-the-practice in Software Startups in Israel, identifying best practices as well as problems/difficulties and opportunities for improvement in Israel.*

- Explain the basic procedure and ask if it's OK (if not, adapt to fit needs)
- Explain the reasons for recording and confidentiality
- Explain results will be sent first hand to them
- All results will be published in an anonymous form
    - except in particular cases in which it might be interesting to disclose the name of the person or company but only with explicit approval of the involved people.

Benefits for the startup:

- Simply mention quickly: “I hope it'll be the beginning of a fruitful collaboration”.
- If more details are asked, can offer:
    - Technical reports with results of the research will be sent first hand to them.
    - In many cases, such interviews clarify to the interviewees many issues related to their company since the interview provides the interviewees with the opportunity to take a time break and reflect.
    - If they're interested, we can provide a short assessment of what I observed in the company, including opportunities for improvement.

During the interview:

- Depending on the profile of the interviewee, some of the questions might be skipped or adapted (e.g., for a CEO with business background, we might adapt the questions about code quality; for a developer, we probably won't ask about investment).
- The researcher (interviewer) will make a few notes on paper or computer.
- The complete audio will be recorded.

Interviewee sample:

- Our goal is to reach around 20 startups.

- Whenever possible, we will try to seek some diversity in cultural origin, gender, race, religion, etc. in our interviewee universe.

Interview Duration: typically, 30 to 75 minutes

Background information

This is not filled by the interviewee, but instead, the interviewer collects this information before and after the interview.

Personal information (treated with confidentiality)

Name:

Email:

Age:

Degree of highest completed education:

Area:

Year degree was obtained:

Current job position:

Company (treated with confidentiality)

Name:

URL:

Domain:

Number of company employees:

How long ago was founded (age/months):

Stage of life (e.g., initial idea, self-funded startup, seed fund, VC funded, etc.):

Oral Questions

The questions below serve as a guide to the researcher (interviewer) who will adapt the language and the direction of the interview based on the real-time feedback from the interviewee.

This is not necessarily the order in which the questions will be asked. Interviewer will feel the person and adapt to what his intuition tells about it.

Last but not least, some of these topics have already been covered in books such as Startup Nation and Technion Nation. We don't want to repeat that; that's our starting point and we'd like to go further

1) What are the factors in Israel that foster/promote entrepreneurship?

2) What are the institutional mechanisms in place in Israel that promote entrepreneurship?

- legislation
- educational, scientific and technological institutions
- government (national, municipal and local) agencies/programs
- seed funds, angel investment, VC
- NGOs

3) Do you believe education has a significant role in entrepreneurship? At home? Fundamental school? Middle School? University? Self-education? Informal? Overall education or entrepreneurship-specific education? Can you think of explicit or implicit pedagogical material and mechanisms that nurtures the entrepreneurial spirit?

4) What are the characteristics of entrepreneurs? What are the characteristics of successful innovative teams? (mix of introverts and extroverts?) What are the roles of different kinds of people? Is diversity important? What is the prime motivation of the high-tech entrepreneur: wealth, fame, self-esteem, proof of technology etc.?

5) Which and how technological aspects influence the success of software startups? In particular, what is the role played by Object-Orientation, Languages, Frameworks, Patterns, Models, and Architectures? Does your team has a concern for code quality? How do you promote and control that? Do you have a large technical debt? Do you manage that in any way?

6) Which and how methodological aspects influence the success of software startups? In particular, what is the role played by Agile Methods, Lean Startup, Customer Development? Which agile methods practices do you use? Is there something in agile methods that doesn't work very well for your company? Do you consider a systemic plan or the intuition being the dominant success trigger of stat-ups? Is this relation changing along the start-up life?

What don't you do very well and would like to do better?

7) What's the relationship of your company with Open Source software? Do you use it? Do you contribute? Do you believe open source has a significant role in the startup ecosystem?

8) If you had to name 4 key elements for a healthy startup ecosystem in a country or region, what would them be?

9) Do you have any question to me or see any ways in which we can collaborate?

3) Data coding and analysis

After each interview:

- Researcher will iteratively produce a working document (ResearchQuestionNotes.odt) structured around the initial research questions.
- For each research question, researcher writes notes based on the answers by interviewees on related topics.
- Interviewer (and, whenever possible, other researchers participating in the study) listen to the recorded interview, coding the collected data, analyzing it and registering the partial findings.
- Relevant sentences from interviewees are included in the ResearchQuestionNotes.odt document as well as observations from researcher.
- All notes are tagged with the name of the interviewee.

- Colors are used to identify the researcher who makes the notes.

4) Constructing the Conceptual Framework

- Based on the coded information, a Conceptual Framework will be iteratively created.
- Each time a new significant element or concept is introduced, the Conceptual Framework is extended to include it.
- Each time a new relationship is mentioned among the elements, it is included in the framework.
- The labels in the arrows characterize the type of relationship represented by them.
- Only elements and relationships that were explicitly raised in the interviews are added.
- Continuous arrows denote relationships that were observed all, or almost all, of the times, while dotted arrows denote relationships that were observed only part of the times.
- At regular intervals (e.g., once per month), the Conceptual Framework is shared with all researchers in the team and discussions about refining and improving it are carried out.
- The Conceptual Framework and the collected information will serve the basis for papers, new research proposals, and Teaching Material on Startup Engineering for IT students.

5) SWOT Analysis Questionnaire

In order to collect additional information from experts in the field, an online questionnaire with questions for a SWOT analysis is sent to people with over 10 years of work experience on startups and entrepreneruship and who has worked with at least 2 different startups.

The full questionnaire is available at:

https://docs.google.com/spreadsheet/viewform?usp=drive_web&formkey=dE5zWUlTbFVFWHdmdS05TEd1VkU4S3c6MA#gid=0

The answers are compiled and grouped to identify what are the elements that are more frequent among the expert respondents.

6) Comprehensive literature review

After the conceptual framework is constructed, a more comprehensive literature review is conducted, this time also including related work on ecosystems, models, and frameworks. This was not done a priori not to bias the construction of our conceptual framework, which should emerge from the data.

Information collected in this phase will be instrumental in devising the Recommendations and for writing the final paper reporting the research findings.

7) Putting forward Recommendations

Based on the Conceptual Framework, analysis of the interviews and observations, SWOT questionnaire, and the literature review, put forward recommendations for the major stakeholders in the ecosystem, in particular for Entrepreneurs and for Policy Makers.

8) Writing final report/paper about the research

All researchers from the team are invited to work collaboratively on a document presenting the results of the research. A preliminary version is produced and shared with members of the ecosystem for feedback; in particular, all interviewees and respondents of the SWOT questionnaire are invited to provide their feedback. Finally, a refined version of the document is produced and submitted for publication.