AMERICAN UNIVERSITY OF BEIRUT

UNIVERSITY INDUCED HEALTHCARE ENTREPRENEURSHIP CLUSTER

by
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AN ABSTRACT OF THE THESIS OF

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With no clear blueprints available to build clusters, policy makers struggle for tools, processes and mechanisms to build the clusters that provide competitive and comparative advantages for their economies. This paper explore the challenges and requirements for universities to catalyze healthcare entrepreneurship clusters within their economy. The researchers conduct semi structured interviews with senior decision makers in key institutions that would naturally be a member of such clusters in order to derive the requirements and the impediments to creating them. The interviews result in an overarching sentiment that universities cannot induce such a cluster without close cooperation with their academic hospitals and that entities from across the triple helix must be engaged in cluster formation. The thesis findings form the basis to creating a blueprint for healthcare entrepreneurship clusters creation.

CONTENTS

CHAPTER 1

INTRODUCTION

Since the dawn of this millennium, industry influencers and policymakers have been trying to emulate the success of Silicon Valley in an attempt to increase the economic competitiveness of their nations. This relying on clusters to induce economic growth is championed by economists and academics (e.g. Porter 1998). The main motive of this research is enhancing the competitiveness of a nation by creating and developing a cluster of healthcare startups, SMEs and multinational corporations.

Since this research will address the implementation of its findings in Lebanon, an overview of the current state of the Lebanese economy and Beirut's entrepreneurial ecosystem is first outlined. Then a view of the economic potentials of the healthcare sectors is stated along with the consequential challenges, healthcare entrepreneurs' role in addressing these challenges and the benefits of Lebanese healthcare entrepreneurship successes for the Lebanese economy.

1.1 Lebanese economy

Lebanon has a consistent deficit in his balance of trade (BOT) since the end of civil war in 1990 and was at 17B$ in 2018[1]. Unemployment rates are difficult to pinpoint because of the lack of official data, current estimations indicate 25% general unemployment

[1] IDAL

rate and 35% youth unemployment rate. Historically the Lebanese diaspora remittances and relatively high interest rates assured that BOP remains relatively neutral however recent years registered significant deficits with 2018 closing with a deficit of 4.8B$[2] .

In 2016, Lebanon had roughly 200,000 university students (127,161 private & 72,518 public), 41,197 Grade 12 students and 40,405 BT students[3]. These relatively high numbers of educated youth and the current unemployment estimations indicate that Lebanon has potential capacity to grow its "knowledge economy" with healthcare sectors being part of this economy.

In principle, the growth of the "Knowledge economy" and more specifically healthcare startups represent an excellent process to reduce the deficit of BOT, create sustained cash inflows and provide direct highly skilled employment and low skills employment through the local multiplier effect. In the USA, Highly skilled sectors such as technology have the highest multiplier effect with five non-tradable jobs for each technology job (Moretti 2010), the Lebanese multiplier effect remains to be determined.

1.2 Lebanon's Ecosystem

The high tech cluster or ecosystem in Lebanon's capital, Beirut, has been in the making since the early 2000s with many individual entrepreneurs establishing ICT firms and the lunch of USJ's Berytech in 2002. The ecosystem's growth was propelled with the

[2] BDL
[3] Ministry of education, CRDP

introduction of BDL's intermediate circular 331 that facilitate investments flow into startups and prompted the establishment of supporting entities. Today, the cluster has been reinforced in the greater Beirut area (major universities' campuses, BDD, ANTWORK, UKLebanon tech hub, Berytech, Flat6Labs…) but the ecosystem is still relatively nascent as it was assessed by a recently released World Bank report (Mulas, Qian, and Henry 2017).

1.3 The potentials in Healthcare Markets

The ability of firms to serve global markets has been increasingly facilitated by technological advancements in communications, transportations and business practices. This business landscape enables small newly formed firms (startups) to compete/cooperate with any well-established player in any given industry. Moreover, these advancements shorten the cycle of introducing new products/services to international markets and reduce the barriers that hinder a startup's ability to add value and disrupt established global industries.

A proxy to the global healthcare market is the world 60 largest economies healthcare sector data estimated by the economist intelligence unit:

World Biggest 60 economies healthcare data and forecasts:

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Life expectancy	71.9	72.2	72.5	72.8	73.0	73.2	73.4	73.7	73.9
Male	69.9	70.2	70.4	70.7	70.9	71.1	71.4	71.6	71.8
Female	74.1	74.3	74.6	74.9	75.1	75.3	75.6	75.8	76.0
Infant mortality rate (per 1000 live births)	23.4	22.8	22.1	21.5	20.9	20.4	19.8	19.3	18.7
Doctors (per 1000)	1.7	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9
Healthcare spending ($/person)	1311.5	1332.0	1363.9	1300.0	1323.3	1356.1	1392.2	1434.0	1495.2
Healthcare spending (% of GDP)	10.2	10.2	10.2	10.4	10.5	10.5	10.6	10.6	10.5
Healthcare spending(billion$)	6965.1	7150.1	7380.2	7077.1	7247.4	7562.8	7903.6	8291.5	8734.6

The Economist Intelligence Unit, December 2016

This potential market is also demonstrated by the World Bank data on healthcare spending that give an estimation of the regional market that Lebanese healthcare startups and firms could serve:

Healthcare spending in the MENA in 2016 is 1estimated at **175 Billion$**

Healthcare spending in Lebanon in 2016 is estimated at **3.4 Billion$**

The aforementioned data indicate that the enhancement of living standards globally, the increase of life expectancy and subsequent increase in the percentage of elderly worldwide is translated in increases of healthcare bills and projected growth across healthcare sectors. This growth poses new challenges: How to reduce healthcare costs without affecting the services and care quality? How can these sectors integrate ICT,AI and robotics advancements into their activities? How can the various industry players enhance the value they deliver to patients and have better economic health?

The answers to these challenges lie within the scope of healthcare entrepreneurs and the ecosystems supporting their endeavors.

Within the Healthcare industry, Lebanon has a cumulative expertise and a legacy of being a MENA leader in terms of academic and research institutions, healthcare infrastructure and human resources. The potential to reach the global markets and the relatively small size of the Lebanese economy (GDP of 56.4 Billion$ in 2018) makes any successes in a Lebanese healthcare cluster have a significant contribution to GDP growth.

CHAPTER 2

RESEARCH QUESTION

The potential economic wealth that is locked within Lebanon's universities, the exported skilled human resources, specifically in Healthcare, and the current economic situation of Lebanon lead to developing the following research question in an attempt to better inform decision makers on turning around Lebanon's economic metrics:

How can a higher education institution create a cluster for healthcare entrepreneurs and entities that commercialize innovations and produce successful startups?

In order to address this question we need to properly define some of its terms:

Cluster: "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in particular fields that compete but also cooperate" (Porter 1998).

Entrepreneur: For the purpose of this research, entrepreneur is defined as "a person who creates a new product or service and found/co-found for this purpose a company that has a high potential to scale to a MultiNational Corporation."

Startup: "A human institution designed to create a new product or service under conditions of extreme uncertainty" (Eric Reis, the Lean startup 2011

CHAPTER 3

LITERATURE REVIEW

To create a context for the research question the existent bodies of knowledge are reviewed. The literature address the definition and roles of an entrepreneurial university in its society and national economy, how it interacts with industry and governments in the triple helix model. Moreover, the review look into the constituents of entrepreneurial ecosystems and roles and constituents of healthcare clusters. Finally, the review look into the previously developed models for creating startups out of higher education institutes and what might be the barriers facing entrepreneurship in healthcare.

3.1 The role of the Entrepreneurial University

The definition of an entrepreneurial university lacks a consensus among academics(D. A. Kirby, Guerrero, and Urbano 2011) with an tendency to describe it as a university with the ability to innovate, recognize, and create opportunities, work in teams, take risks, and respond to challenges(D. Kirby 2002), as a university that seeks to innovate in how it goes about business and to work out a substantial shift in organizational character(Clark 1998), and a natural incubator that provides support structures for teachers and students to initiate new ventures(Etzkowitz 2003).

In “Anatomy of the entrepreneurial university”, Henry Etzkowitz defines three phases in the evolution of a “Research University” into an “Entrepreneurial University”:

The academic institution gains the ability to define its priorities, diversifies its financing resources and becomes independent of government financing and strict control

The academic institution establishes its technology transfer entity and seeks commercialization of the intellectual property resulting from the work of its faculty, staff, and students.

The academic institution in collaboration with government and industry actors improves the effectiveness of its regional innovation environment.

Although these phases were identified as taking place sequentially in the development of MIT induced "route 128 phenomena", non-linear and even reverse sequences may be identified: "the Blekinge Institute of Technology" in Sweden took off from phase three (Etzkowitz 2013).

Thus the evolution into an Entrepreneurial University may take place in any sequence or even virtually simultaneously as the university turns its intellectual resources toward the creation of economic output from knowledge as well as knowledge for its own sake. This is achieved when universities' capacity to generate and disseminate technology transform them from education and research institutes (the 1^{rst} and 2nd mission) relying solely on informal ties to commercialize knowledge to key innovation stakeholder(adding the 3rd mission) with their own internal organizational mechanisms and resources that facilitate commercializing innovation (e.g. Technology Transfer Offices, accelerators & VC capacities…).

This evolution is not accidental nor a strict top down approach since universities are too bottom-heavy and resistant to such approach.(Clark 1998) This transformation result from a collective entrepreneurial action from faculty staff and students across departments and functions who develop new structures and processes to reach the entrepreneurial university. (Clark 1998)

3.2 The triple helix model

The role of the entrepreneurial university is conceptualized in a "Triple Helix" model with Government and Industry being the other two components of the triad (Etzkowitz and Leydesdorff 2000, Etzkowitz 2013).These three spheres are composed of R&D and non R&D innovators, institutions in one single sphere and institutions spanning several spheres, individual innovators and institutional innovators. They interact by transferring technology, collaborating and moderating conflicts, networking and collaborative leadership of innovation. The main purpose of these interactions is generating and diffusing practical knowledge and innovations to advance economies and societies. (Etzkowitz and Leydesdorff 2000)

Among the individual innovators two important types surge: innovation organizers and academic entrepreneurs. The academic entrepreneur simultaneously advance the frontiers of knowledge and exploit its practical and commercial results for industrial and financial returns. Different academic entrepreneurial styles and degrees of involvement are recognized:

- Direct interest in the formation of a spin-off firm and in taking a leading role in this process
- Handing over innovations and discoveries to a technology transfer office for disposition
- Playing a supporting role, typically as a member of a Scientific Advisory Board
- Having no interest in entrepreneurship, but rather in firm formation as a useful source for developing the technology needed to advance basic research goals

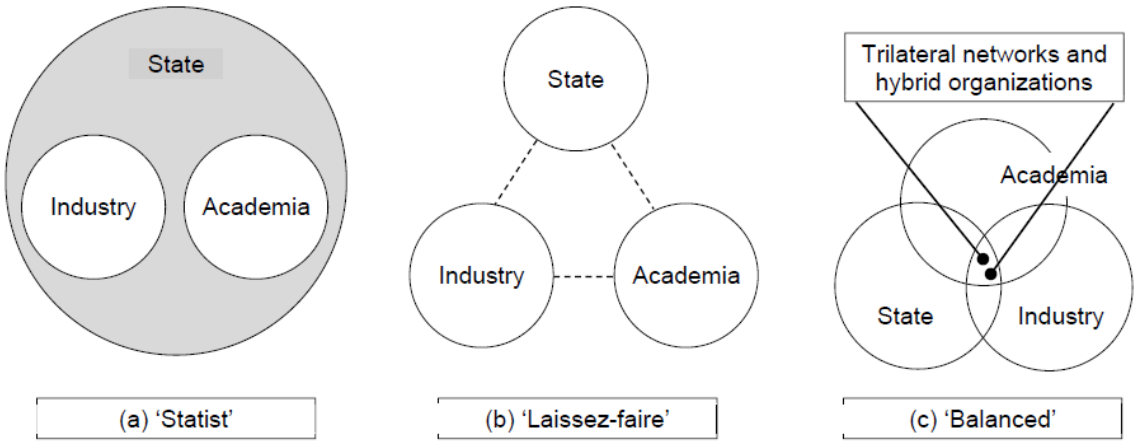
Innovation organizers can come from any institutional sphere. They coordinate a mix of top-down and bottom-up processes and innovation stakeholders from different organizational backgrounds and perspectives, who come together to build a platform for new ideas, promote economic and social development and ensure agreement and support for their realization. This 'cross-institutional entrepreneurship' spans the Triple Helix spheres to improve the conditions for knowledge-based development.

Triple Helix systems emphasize boundary permeability among its three spheres allowing individuals' mobility within and between the spheres and engaging in recombination of elements to create new types of organizations.

Triple Helix systems fall under 3 main configurations:

- A statist configuration: government drive academia and industry and limit their capacity to initiate and develop innovative transformations (in Russia, China, some Latin American and Eastern European countries)

- A laissez-faire configuration: Limited government intervention in the economy (in the USA and some Western European countries). Industry is the driving force and the other two spheres act as ancillary support structures with limited roles in innovation: government regulate social and economic mechanisms and universities provide skilled human capital;
- A balanced configuration: University and other knowledge institutions act in partnership with industry and government and even take the lead in joint initiatives. (Etzkowitz and Leydesdorff 2000)



The triple helix configutations (Etzkowitz and Leydesdorff, 2000).

The Balanced configuration is specific to the transition to a Knowledge Society because the most favorable environments for innovation are created at the intersections of the spheres. This is where creative synergies emerge and create new venues for interaction and new organizational formats, as individual and organizational actors not only perform their own role but also 'take the role of the other' when the other is weak or under-performing (Etzkowitz 2003; Etzkowitz 2008).

The balanced configuration is marked by the formation of “hybrid institutions”. Multi-sphere (hybrid) institutions operate at the intersection of the university, industry, and government institutional spheres and synthesize elements of each sphere in their institutional design. These institutions have smaller-scale hierarchies and less centralized decision-making which increase flexibility and responsiveness to changing market demands.

A university’s transition from a purely academic and research institute to an entrepreneurial university within this Triple Helix concept increase its capacities to provide entrepreneurial education, theoretical and practical experience in developing a business, and entrepreneurial mindsets that contribute to firms’ formation and job creation(Etzkowitz 2013). This transformation developed self-generating resources for university development (e.g. royalties and equity in successful startups) which secure research funding for academic projects and ensure the stability of research laboratories. This transformation also create possibilities of testing faculty’s expertise outside the university boundaries, which make an impact on the regional and national economy. Another important outcome is the cultural and social impact of this transformation. Job creation and tax revenues from university startups combined with social and cultural benefits (e.g. stronger university-community ties) increase attractiveness to national and international talents and investors while creating a positive social perception of entrepreneurs, all these effects further enhance the entrepreneurial ecosystems in the university’s region. (Ranga and Etzkowitz 2013)

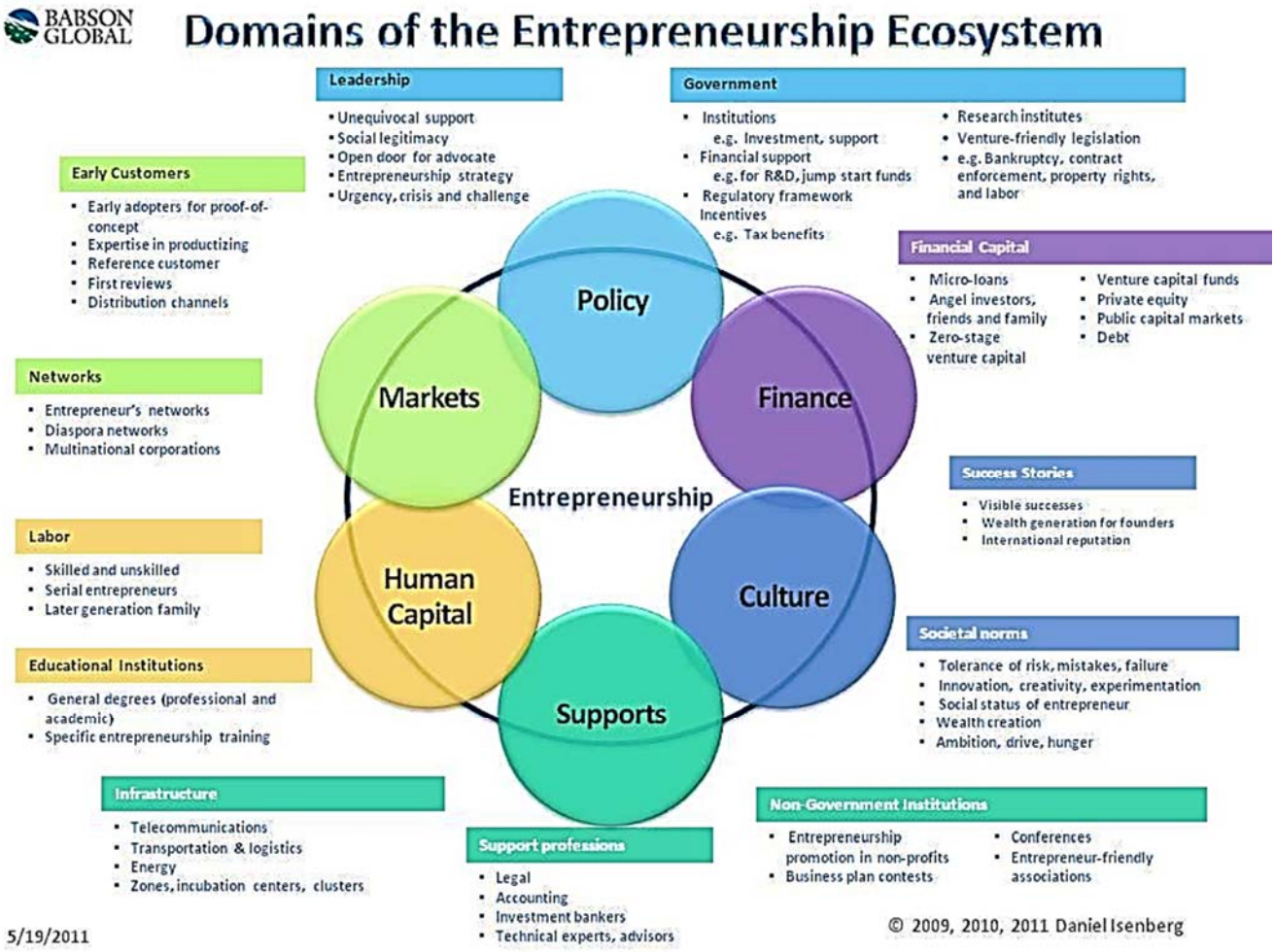
3.3 Isenberg's ecosystem model

The triple helix model proposed by Etzkowitz remains too aggregated for developing policies to promote and develop entrepreneurial ecosystems. A more detailed model of an entrepreneurial ecosystem is proposed by Dr. Daniel Isenberg in his "Principles for Cultivating Entrepreneurship" paper.

Isenberg argue that entrepreneurs are *contrarians* driven by *aspiration* who incorporate and make risky investments because they perceive the related risk lower than others' due to their perception that they possess some asset (e.g. IP rights), or assessment(e.g. People will host a stranger on their couch for a minimal rent), or information, or idea, or ability. "Entrepreneurs, in the broadest economic sense, buy inputs low, transform them through risk, and sell them high" (D. Isenberg 2011).

When it comes to entrepreneurship, innovation is not the sole contrarian merit (e.g. generic drugs) and ownership doesn't translate into aspiration (in most SMEs). In an essence, the entrepreneur role in the economy is to constantly demonstrate the fallacy of conventional wisdom, to constantly challenge the status quo and the perceptions of other economic groups.

Entrepreneurship policies should stem from the observation that when societies in which entrepreneurship occurs with any regularity or is self-sustaining are examined, a unique, complex environment or ecosystem is discovered. This entrepreneurship ecosystem consists of a dozen elements consolidated into six domains that, although they are idiosyncratic because they interact in very complex ways, are always present if entrepreneurship is self-sustaining.



So although the combinations are always unique for every cluster, in order for there to be self-sustaining entrepreneurship in a given society, a cluster needs conducive policy, markets, capital, human skills, culture, and supports. Therefore policy makers shouldn't try to identically copy other successful clusters instead they should cultivate their own entrepreneurship ecosystem(D. J. Isenberg 2010), this will require time and resources, as well as experimentation and learning until the right unique configurations evolve. This point was also emphasized by Michael Porter who argued that successful clusters should be built by capitalizing on local resources of uniqueness instead of mimicking other successful

clusters because pursuing areas of specialization is more effective than competing with well-established rival locations. (Porter 1998)

3.4 Healthcare entrepreneurial clusters

One setback in Isenberg's model is the lack of demonstrated relations between the 12 components of the ecosystem, which might be attributed to the complexity of these relations, however in healthcare entrepreneurship literature(W. Powell, Packalen, and Bunker Whittington 2010) studies biotech clusters in the USA and demonstrated a part of this relations.

This study found that the diversity of organizational forms, the presence of an anchor tenant and the mechanism of cross-realm transposition are essential for clusters. The anchor tenant doesn't directly compete nor dictates the other agents' activities in the cluster. These tenants (especially Public/Private Research Organizations and VCs) function as social network forming organizations. In these social networks, cross-realm transposition is achieved by a network of affiliations that bridge loosely or non-connected social worlds (academia and business) and facilitates the absorption of practices, goals, and status into new domains.

The origins of three robust health sciences clusters (VCs in the Bay area, PROs in Boston and failed acquisition in San Diego) are different, suggesting that the forming entities took opportunistic moves with whatever resources were available to them.

These three clusters are characterized by high venture formations and dissolutions which creates easier labor market mobility, high rates of experimentation in new scientific ideas and business models and a regional community that present catalysts and reduce the risks of starting new ventures. These three aforementioned consequences further reinforce the clusters.

In contrast, underdeveloped clusters where characterized by the anchor tenant's inclination to manage the social network and dictate its rules which hindered the cluster emergence. This is due to pushing for a preferable attention by a top-down analysis of comparative advantage, this attention actually dulls the entrepreneurial spirit and depletes the region's reserves of this precious resource. (Isenberg 2011)

Universities and the first generation of biotech companies played a key role in partnering with smaller younger companies and transforming the network dynamics from competitiveness to a relational model

Moreover, the job mobility between firms and firms-universities was crucial for the clusters sustainability and expansion.(W. Powell, Packalen, and Bunker Whittington 2010)

the role of PROs in Boston cluster is further discussed by (Owen-Smith and Powell 2004) that demonstrated that Geographically concentrated information flow in research intensive industry is an advantage since 1) knowledge spills across organizations more readily when they are colocated; (2) the size and mobility of the science and engineering

labor pool in a region increases localized spillovers; and (3) strategic alliances among firms increase the likelihood of such spillovers.

Despite the effect of individual firms' alliances on knowledge flow, Boston biotechnology cluster is dominated by organizations that pursue open science (e.g. universities) that render the cluster more accessible. When public research organizations (PROs) anchor networks, the systems manifest greater spillovers since they increasingly conduct research that is advanced scientifically and immediately valuable to the industry. Some high-technology sectors, most notably biotechnology, owe their rapid emergence to the robustness and expansiveness that PROs add to networks(W. W. Powell 1996).

PROs differ from research-intensive firms on two key dimensions: (1) their disparate approaches to rules for the dissemination and use of scientific findings, and (2) sharply divergent selection environments. Moreover, PROs are known for their resilience and durability that provide stability to highly volatile tech sectors. PROs also provide tech sectors with longer term criteria of evaluation that lacks in for profit firms and promote information transmission since they emphasize the open information disclosure characteristic of public science. Therefore networks centered on PROs yield greater benefits to general membership than to specific structural position

In Boston's network, dominated at first by PROs, membership positively affects innovation, but centrality has a negligible effect since most important knowledge paths flow through PROs that are committed to open norms of information disclosure. However, the qualitative change in the Boston network's reliance on PRO ties suggests that as the importance of proprietary information channels grows in the region, the centrality effect

increased, and the Boston biotechnology community shifted from structural reliance on PROs towards dependence on for-profit organizations (Diagnostic Biotechnology Firms & VCs), thus local centrality began to generate benefits for innovation.(Owen-Smith and Powell 2004)

As in the clusters of Boston and Bay area, the role of Universities as an intermediary was critical in the cluster flourish. This relationship between universities, USO and large biotech firms is further discussed by (Yusuf 2008) that demonstrated that the rise of complexity and costs of R&D pushed Multi-National Corporations (MNC) to focus their in-house activities in advanced and specialized R&D. Subsequently, MNCs limit basic research and early stage development or outsource it to Public & Private Research Organizations (PRO) since they are equipped to conduct multidisciplinary research. This trend reinforces MNC appetite for open innovation strategies and signal that the universities researchers are becoming a principal channel to introduce new knowledge to commercial domains.

Fruitful commercial oriented research generates IP and relevant knowledge that translate financially in consulting fees, royalties and licensing. These cash flows enhance the infrastructures and human capital of universities. However, this intense commercial orientation if mismanaged could hinder the university main function, education.

Since R&D in biotechnology and pharmaceuticals is a complicated and risky process, SMEs are discouraged from utilizing it due to financial constraints and MNCs are discouraged when the technology is untried and could hinder sales of an existing product.

This result in many ideas and patents remaining stuck in the universities' labs with academic researchers that lack business know how and supporting social networks, this make researchers unwilling to relinquish their secure jobs to enter the entrepreneurial world.

For this aforementioned reason, knowledge intermediaries were created to mitigate part of the R&D risks and complications by creating and bridging ties between academia and business world by directing innovations to fit market needs and establishing dynamic frameworks for these innovations.

Along with established knowledge intermediaries, students present a medium of knowledge exchange between firms and universities and key university professors function as a social network spanner by connecting MNCs to universities through consulting and professional dealing. These knowledge networks leverage other entrepreneurial agents activities if 1) the university was able to create general purpose intermediaries and sustaining excellence in research 2) MNC proactively pursuit innovation as a competitive strategy. (Yusuf 2008)

The biotech clusters studied by (Owen-Smith and Powell 2004,W. Powell, Packalen, and Bunker Whittington 2010) demonstrate some key cluster's attributes that induce and facilitate entrepreneurial endeavors. These attributes are further discussed in the next section.

3.5 The importance of clusters

The importance of clusters is discussed by (Porter 1998) who found that clusters promote the coexistence of cooperation and competition at different dimensions: intense competition on customers among local rivals and vertical cooperation involving companies in related industries and local institutions.

Clusters affect competition in three broad ways:

1- Increasing the productivity based in the area.

2- Driving the direction and pace of innovation which underpins future productivity.

3- Stimulating the formation of new business which expands and strengthens the cluster itself.

Clusters advantages:

- Better access to employees and suppliers
- Access to specialized information
- Presence of complementarities
- Better access to institutions and public goods
- Better motivation and measurements

Porter argues that clusters represent an alternative model to organize the supply chain and a middle ground between arm's length markets and vertical integration. Porter

also noted that over consolidation, cartels and groupthink among cluster participants can be a powerful form of rigidity, sometimes caused by government intervention or suspension of competition, which hinder cluster evolution and may diminish its advantages. However, governments must ensure the increase in productivity in the nation and in the clusters, they increase it by enhancing the quality of inputs such as educated labor force and physical infrastructure and by protecting IP and enhancing the legal environment. (Porter 1998)

Porter also identified four issues to strategic cluster planning:

1- Location choice: clusters location is critical to company's "home base" of a product line. Activities such as R&D, strategic decisions and sophisticated product provision are influenced by the local environment of the "home base" (Demirbag and Glaister 2010)

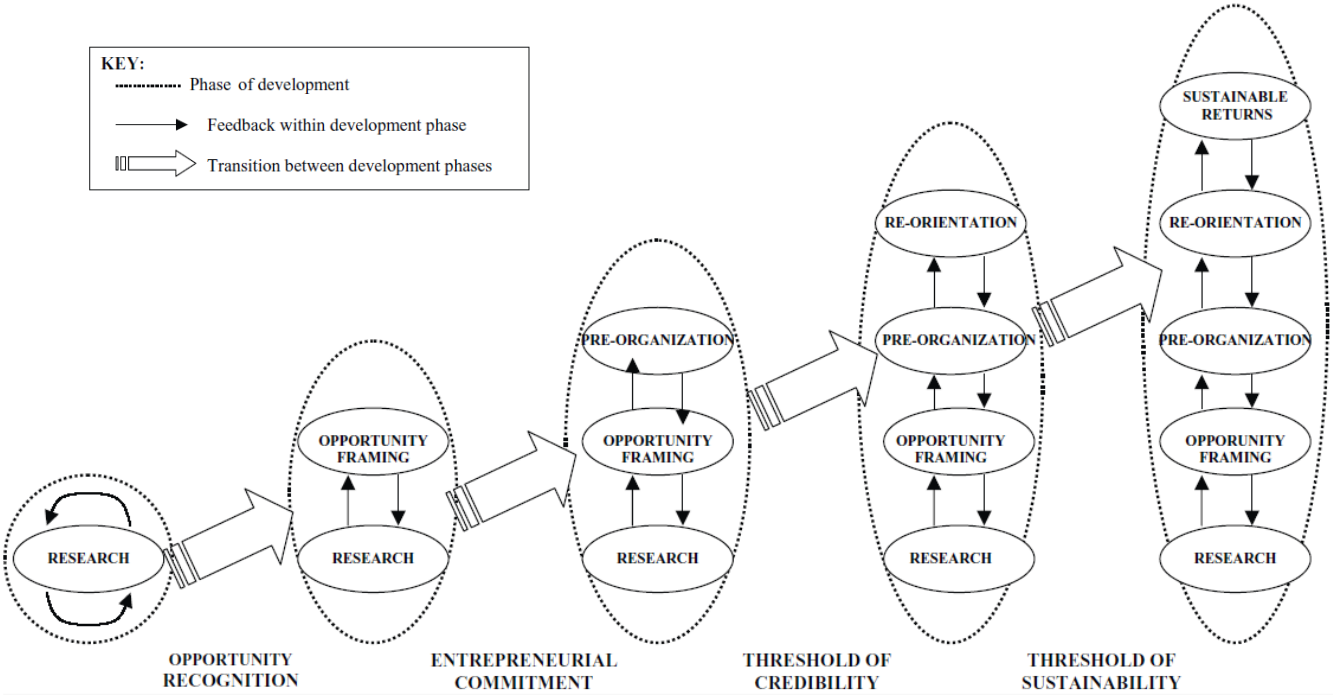
2- Local engagement among cluster members: the social glue that bind cluster members facilitate the flow of resources and information. The mere colocation of cluster members create the potential of economic value but doesn't assure its realization, this realization is assured by cluster members' substantial local presence and development of ongoing relationships with local governmental entities and other local institutions.

3- Upgrading the cluster: In successful clusters, cluster members may deliberately choose to work with local suppliers or train local talent to develop local capabilities. (Universities and the first generation of biotech companies' role discussed by Powell et al. 2009)

4- Working collectively: the need for a new agenda of collective actions by the private sector that enhance public goods, a function of government entities, since the cluster members have lots to gain from upgraded public goods.

3.6 A framework for university induced startups

The key role of University and University Spin Offs (USOs) in developing healthcare cluster has been demonstrated through the aforementioned literature. However, there's a need to conceptualize the process of creating and scaling university spin offs in order to replicate them.



The critical junctures in the development of university spinout companies. (Vohora et al. 2003)

In “Critical junctures in the development of university high-tech spinout companies” (Vohora, Wright, and Lockett 2004)the authors propose a model that could answer this need.

1-Research phase

The main focus of academic entrepreneurs, prior to the commercial opportunity being recognized, was on perfecting academic research and publication of their work towards a particular scientific community. In this phase, academic entrepreneurs create valuable know-how, technological assets and valuable IP with a potential opportunity for commercialization.

1-2: Opportunity Recognition Juncture

Capturing the valuable breakthrough to create solutions that satisfy unfulfilled market needs, by synthesizing scientific knowledge with commercial market understanding. This process is enhanced by the high level of social capital and strong social network, and the process is further exasperated by idiosyncratic pieces of information that allow academic entrepreneurs to see particular opportunities that others cannot, even if they are not actively searching for such opportunities. However, lack of business acumen and industry experience would prevent academic scientists from proceeding towards commercializing their technologies.

2-Opportunity framing phase

This phase typically involves the university’s Technology Transfer Office (TTO) along with the academic scientist. It consists of evaluating the possible application of the

technology in the markets and inspecting the sufficiency of evidence that proves its applicability followed by the identification of the “possible markets” and the domains to develop the applicable technology in. The poor business/industry acumen of scientists result in lots of well-developed technologies with little proof of concept, no proof of market, and no commercial management. This issue coupled with an unclear and imprecise definition of needed resources repel equity investors.

2-3 Entrepreneurial Commitment Juncture

Entrepreneurial commitment is requisite for the development of the potential venture from a vision that the academic entrepreneur has created mentally, to a venture that is operational and engaged in business transactions. This critical juncture is a result of the need for a committed entrepreneur to develop the University Spin Off (USO) and the inability of academic entrepreneur to fulfill this role for four reasons: 1) hemophilic social network and lack of access to success stories/role models in entrepreneurship 2) lack of prior business experience and insecurity about adapting to the commercial environment 3) lack of humility and lack of self-awareness over personal limitations 4) identifying, accessing and acquiring surrogate management/entrepreneurs due to limited social networks.

3-Pre organization phase

USO develop strategic plans and start their implementations: deciding what existing resources to develop, what resources to acquire and when and where to access these resources. These critical decisions shape the USO and determine its development path

and future possible alternative paths. This phase represents the steepest learning curve for academic entrepreneurs that lacks markets experience.

3-4 Credibility Juncture

This critical junction is defined by the ability of the USO to acquire the resources determined in the pre organization phase. Poor business perspective and heavy reliance on technological nontangible assets may hinder USO access to a key resource: seed financial capital needed to acquire other entrepreneurial inputs. Moreover, lack of credibility and limited social circles hinder the acquisition of needed human resources, the acquisition of early customers. Excessive attachment to the university at this juncture may hurt the USO customer perceptions, finance providers perception, and organizational legitimacy and trust.

4-Reorientation phase

USO faces the challenge of continuously identifying, acquiring and integrating resources and then subsequently re-configuring them in an attempt to generate economic returns from productive activities. The reconfiguration of the resources is more prevalent in the cases of prior lack of financial capital of inexperienced management. In this phase, academic entrepreneurs learn how to develop acquired resources and how to assemble new capabilities to generate financial returns.

4-5 Sustainability Juncture

Sustainable returns are revenues from customers, milestone payments from collaborative agreements or investment from existing or new investors. These cash inflows mark the ability of the entrepreneurial team to create value by developing the appropriate

resources, capabilities and social capital. At this juncture, USO's existing configurations of resources undergo a significant transformation to achieve a sustainable resources configuration and generate sustained revenues.

5- Sustainable returns Phase

At this phase, the USO attains the sustainable revenues and a precise business model. By this phase, USOs relocate out of the university campus into a commercial environment and establish their own commercial identity and self-sufficiency while maintaining linkage to the university via academics who remain engaged in university's scientific research whilst acting as a technical advisor to the USO. (Vohora, Wright, and Lockett 2004)

3.7 Healthcare Entrepreneurship Cluster challenges

Fundamental problems of facing entrepreneurs in healthcare:

The conflict between medical science and available resources: balancing the provision of services according to the patient's needs/expectations in the area of drugs and procedures with the available financial resources of health care providers.

Standardization and calculation of services: the majority of healthcare activities are based on individual care and this generates problems such as scaling and process measuring.

Business knowledge and management: Health care is a knowledge-intensive sector that requires lifelong learning. However, there is a lack of business knowledge and skills within healthcare start-ups.

The strong influence of institutions:

1-Central/governmental institutions who primarily regulate the industry, make the expertise reviews and approval of process give licenses for health insurance companies.

2- Pharmaceutical and biomedical companies influencing, lobbying and offering instrumentation, drug support or testing. (Kovalainen and Österberg-Högstedt 2013)

A case study conducted by “European Cluster Observatory” and “Technopolis Group” in May 2015 titled “Framework conditions to support emerging industries in the area of healthcare” stated that (European) Emerging healthcare industries are developed within a diverse group of clusters ranging from biotechnology to medical devices including entities from other sectors (ex: agriculture, hospitality) that deliver services/products with wellbeing implications.

This study concluded the following:

- Trust between actors in the healthcare sector is the most critical entrepreneurial condition for emerging healthcare industries.
- Cross-sectoral business and innovation activities is the most prominent factor when it comes to human capital prerequisites.
- Lack/weakness of collaboration platforms is a bottleneck for cross-sectorial innovations in healthcare

- Public Funding is perceived as more important than private funding in RDI activities
- The system of grants distorts the market by creating unrealistic short term demand for projects and allowing survival of R&D that isn't economically fruitful.
- Legislative norms and financial and time costs of standards are the most prevalent concerns across the industry.

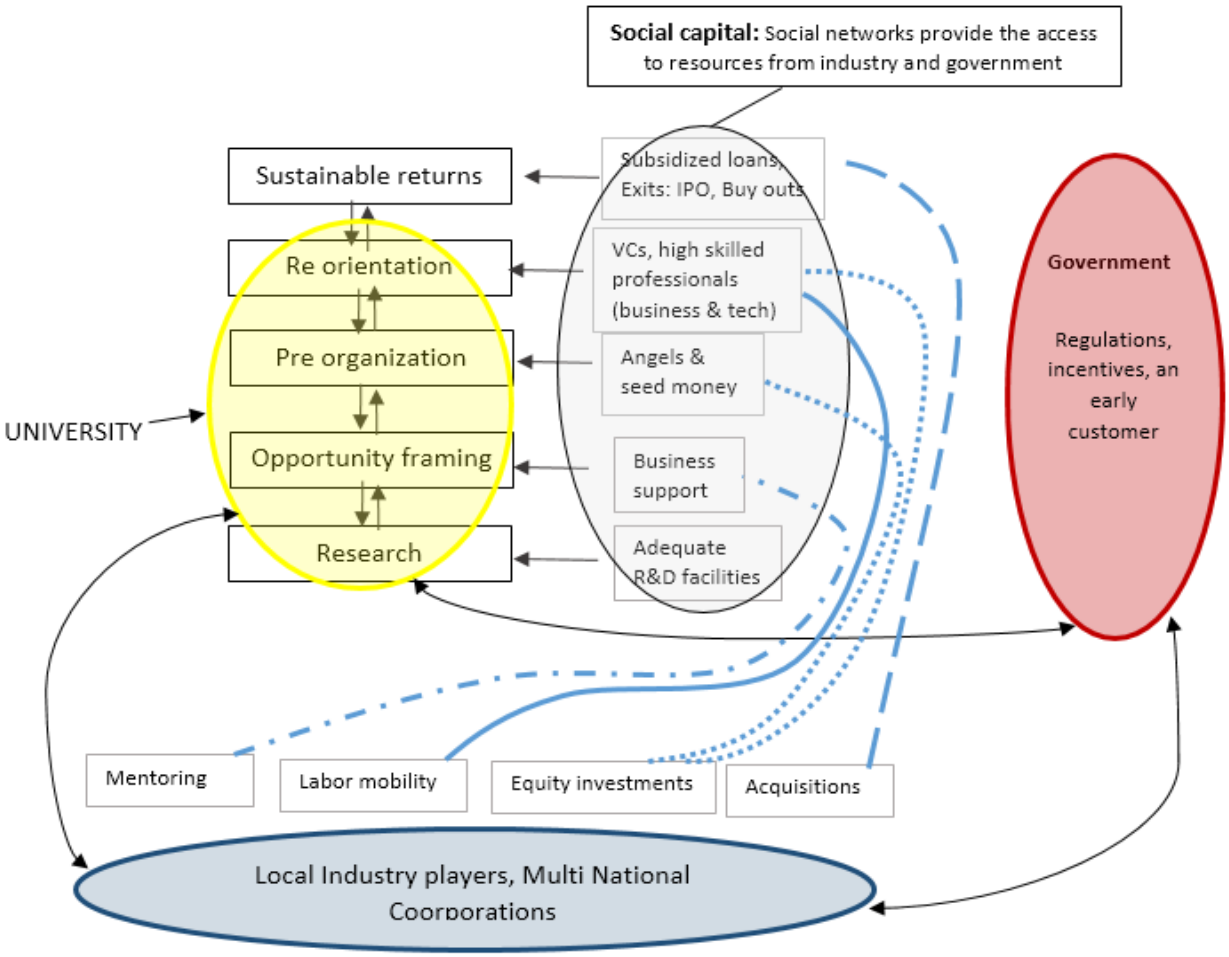
CHAPTER 4

THE PROPOSED MODEL

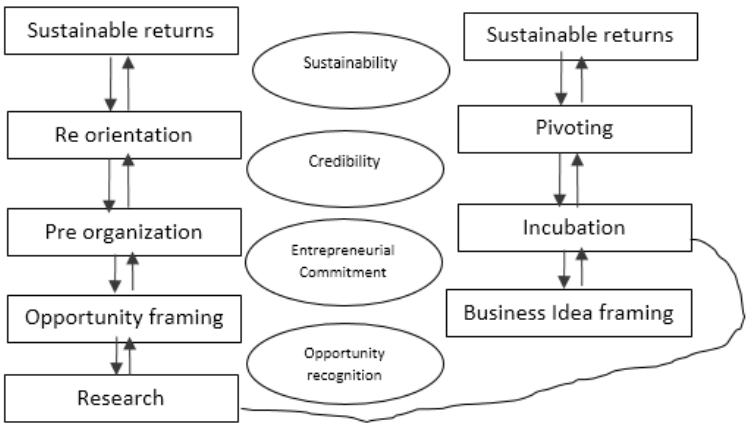
With no blueprint for creating healthcare clusters previously developed, the proposed healthcare cluster blueprint will be based on a mix of top down and bottom up measures, where a higher education institute actively promote entrepreneurship in a "major neutral" or "sector neutral" manner to all its student and simultaneously develop and ensure access to all resources needed by healthcare entrepreneurs to grow their startups to MNCs or sell them to existing MNCs.

The proposed model to manifest this blueprint will compile: Isenberg's model of the entrepreneurship ecosystem, Etzkowitz's Triple Helix model, (W. Powell, Packalen, and Bunker Whittington 2010) and (Porter 1998) findings on social networks and clusters formations and (Vohora, Wright, and Lockett 2004) critical junction framework for University Spin Outs to provide a holistic framework for developing healthcare related startups.

4.1 Proposed framework for healthcare university startups development

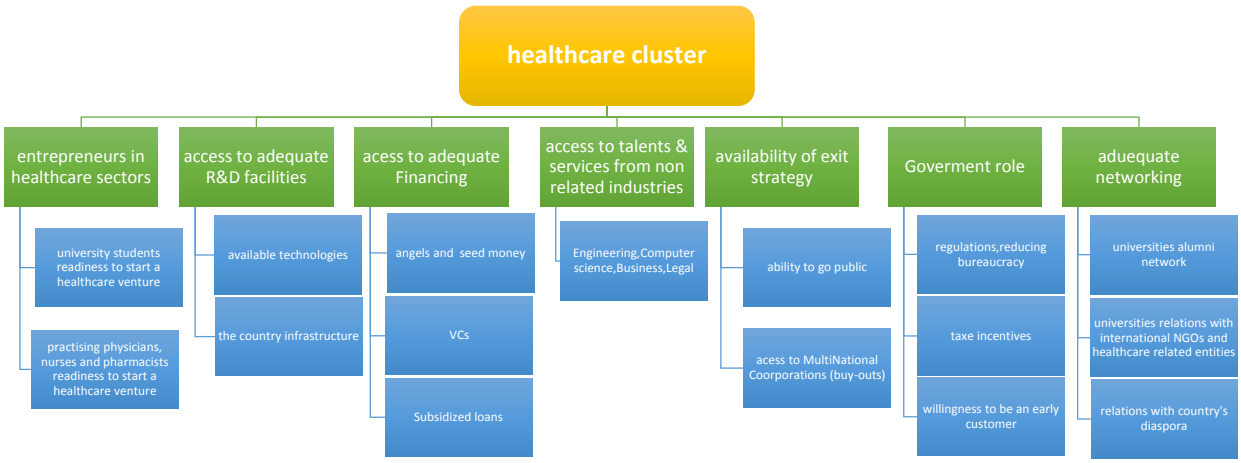


the critical juncture framework is presented with relation to the effects of the 3 pillars of "Triple Helix" and the constituents of "Isenberg entrepreneurial ecosystem model" are distributed according to their contribution to each phase of the critical juncture framework, these inputs are assigned to the industry



pillar of the triple helix and not university or government for simplicity and because of the implicit assumption that the industry is the pillar best suited to manage and execute the development policies since it's driven by value creation and wealth increase. Furthermore a proposed model is created to account for startups that arise from entrepreneurs' opportunity recognition that lead them to lunch their startups prior to any substantial R&D.

4.2 Proposed components of a university induced healthcare cluster



Entrepreneurs in healthcare sectors:

"The goal of the university in the Entrepreneurial Society is not just to promote technology transfer and increase the number of startups but to ensure that people thrive in the emerging entrepreneurial society."(Audretsch 2014)

How can a university encourage its students and staff in wellbeing related majors to start a venture that solves a problem they identified in their prospective profession?

Access to R&D facilities: Universities possess labs and research facilities and could solicit donations and grants related to healthcare to upgrade/expand its facilities. These facilities could incubate USOs from the first phase of(Vohora, Wright, and Lockett 2004) framework, the research phase, all the way to the credibility critical juncture. This role of universities was demonstrated in (W. Powell, Packalen, and Bunker Whittington 2010, Yusuf 2008) through the universities' ability to act as intermediaries that mitigate part of R&D risks and incubate innovation that challenge industries' status quo.

What would a financially sustainable operating model for these facilities look like?

Access to adequate financing:

Through the various stages in the life of a startup different financial actors provide equity capital or debt capital, the attitudes and activities of these actors toward entrepreneurs and startups is a make or break factor in the development of clusters.

Healthcare businesses are characterized by business complexity: they develop, manufacture and offer products and services that are "risky". This risk didn't affect biotechnology cluster in San Francisco because it has developed prior robust financial capacities but with Boston and San Diego clusters Public Research Organizations had to provide seed money or assure academic entrepreneurs access to early equity capital. (W. Powell, Packalen, and Bunker Whittington 2010)

What would it be the optimum business model for universities to assure pre-seed and seed stage startups adequate financing?

Access to talents and services from non-health related industries: such as engineering practices, computer science and IT, business, legal ….

As it was discussed by (Yusuf 2008) and (Vohora, Wright, and Lockett 2004) the academic entrepreneurs access to human capital with adequate business know how and other complementary skills is a substantial factor in USO success.

How could a university encourage collaborations between its students from diverging faculties to cofound startups?

Availability of exit strategies: rare are the startups that grow to become large privately owned ventures. Exit strategy remains a major concern of the majority of shareholders in a given startup.

How could a university leverage its alumni network, formal and informal connections with decision makers to promote its startups to Multinational corporations that benefit from acquiring a given startup?

Adequate networking: entrepreneurs rarely walk their path alone, the need for mentors, coaches, and experienced board members remains an essential part of their success.

How could a university leverage its alumni network, formal and informal connections to expose its entrepreneurs to the right people at the right time?

Government: The health care sectors are highly affected by legislation and regulations and are susceptible to malpractice claims or other litigations. Therefore, success in the healthcare industry relies partially on the legislative environment and on the government approval and that could hinder the cluster development. Moreover, the government involvement in providing of health care to its citizens give it the chance to adopt innovative solutions and give USOs and health care startups the credibility they need early in their development

How could a university influence other stakeholders (particularly state officials) to provide the support needed outside the university own capabilities?

CHAPTER 5

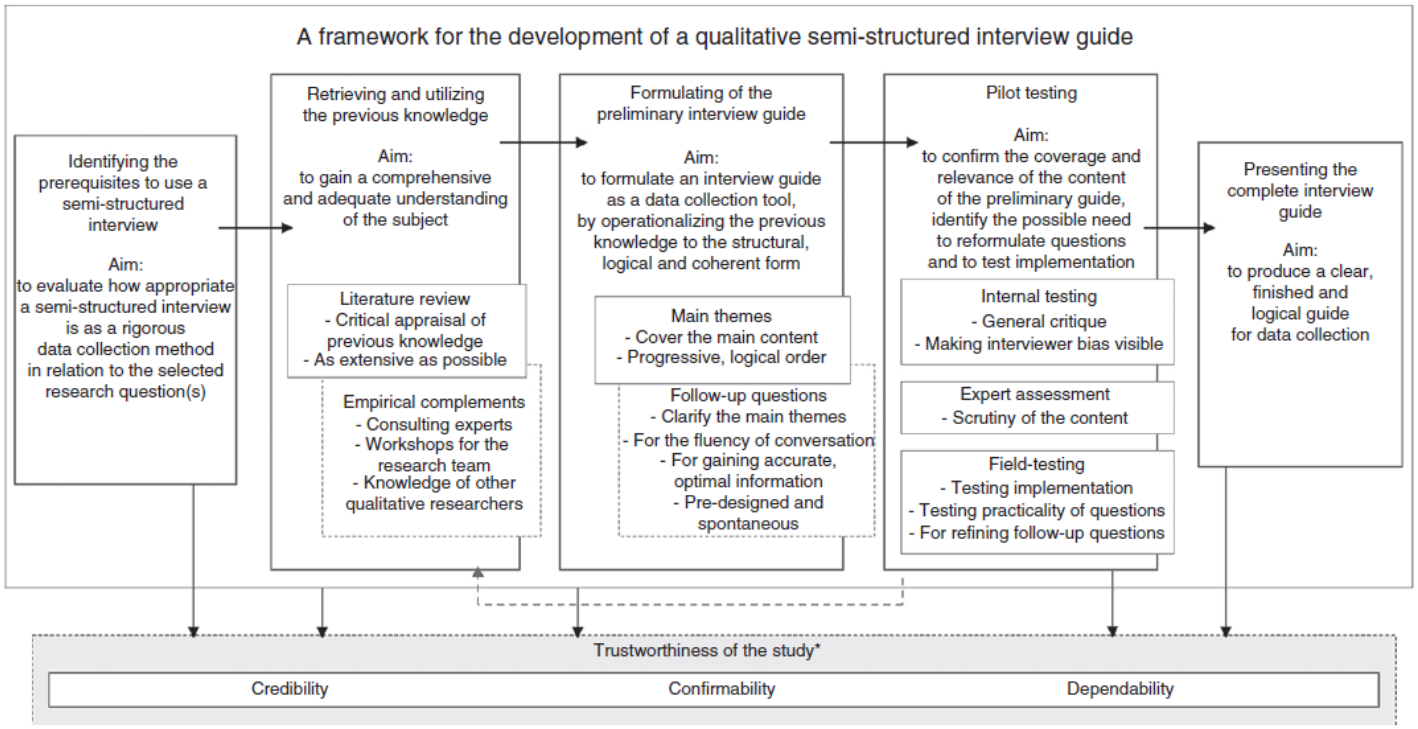
METHODS

Semi structured interviews will be held with key decision makers within the American University of Beirut, with state officials, with key people in Lebanon's nascent entrepreneurial ecosystem and with influencers within healthcare sectors in the MENA region.

According to (Kallio et al. 2016), a semi-structured interview guide development included five phases:

1) identifying the prerequisites for using semi-structured interviews;
2) retrieving and using previous knowledge;
3) formulating the preliminary semi-structured interview guide;
4) pilot testing the interview guide;

Presenting the complete semi structured interview guide.



The phases of a semi-structured interview guide development, (Kallio et al. 2016)

Identifying the prerequisites for using semi-structured interviews:

Researchers determine some aspects of the phenomenon based on previous knowledge before the interview (Turner III 2010).

One of the semi-structured interview's advantages is the possibility to focus on the issues that were meaningful for the participant which allows the expression of diverse interviewee's perceptions (Cridland et al. 2015).

Retrieving and using previous knowledge:

Previous knowledge create a predetermined framework that is based on pre-interview preparations (Turner III 2010)

The critical appraisal of previous knowledge could be conducted by carrying out an extensive literature review focused on the purpose of the study (Krauss et al. 2009).

Formulating the preliminary semi-structured interview guide:

The aim of is to formulate a tool for interview data collection using previous knowledge. The aim of the guide is generating answers from participants that are spontaneous, in-depth, unique and vivid.

An interview guide is a list of questions that direct the conversation towards the research topic during the interview. Questions that start with: what, who, where, when or how encourage the interviewee to provide descriptive answers.

The form of a semi-structured interview guide is considered loose and flexible which allowed the opportunity to change the order of questions and easy movement from question to question.

Well-formulated questions in the guide must be: (1) participant-oriented and not leading (2) clearly worded (3) single-faceted (4) open-ended.

A semi-structured interview guide consisted of two levels of questions: main themes and follow-up questions.

The main themes covered the main content of the research subject and within them, participants are encouraged to speak freely about their perceptions and experiences.

The order of the main themes could be progressive and logical. They could be used as a warm-up to break the ice and create a relaxed environment.

Follow-up questions are used to make the main themes easier for the participant to understand and to direct the conversation towards the study subject. The aim is to maintain the flow of the interview and gain accurate and optimal information. Follow-up questions could be pre-designed or spontaneous based on the participant's answer. Pre-designed follow-up questions could be beneficial in increasing the consistency of the subjects covered by interviews carried out by different interviewers. As a spontaneous follow- up question, the interviewer could ask participants to expand on some particular point that came up in the interview, by asking for more information or an example of the issue.

Pilot testing of the interview guide:

Confirm the coverage and relevance of the content of the formulated, preliminary guide and to identify the possible need to reformulate questions and to test implementation of it. Testing the interview guide provides a chance to make informed adjustments to interview questions and subsequently improve the quality of data collection. It also produces useful insights about research integrity and improves the pre-assessment of research ethics and the researcher's ability to conduct data collection.

The pilot test of the interview guide could be conducted using three different techniques: internal testing, expert assessment and field-testing.

Internal testing: evaluating the preliminary interview guide in collaboration with the investigators in the research team. This technique could provide critical information

about the interview guide in general, for instance removing ambiguities and inappropriate leading questions and highlighting any possible interviewer bias.

Expert assessment: exposing the preliminary interview guide to a critique by specialists outside the research team. Assessment by external specialists is beneficial in assessing the appropriateness and comprehensiveness of the interview guide contents in relation to the aims and the subjects of the study. It allows researchers to discuss the relevance of their questions and gain valuable guidance about its wording and arrangement.

Field-testing: the preliminary interview guide is tested with potential study participants. This is the most commonly used form of testing in the development of a semi-structured interview process. Field-testing simulates the real interview situation and provides crucial information about the implementation of the interviews, it assures intelligibility, make the questions more relevant and test whether they truly elicited the participants' varied perceptions and experiences.

Presenting the complete semi-structured interview guide

Produce a clear, finished and logical semi-structured interview guide for data collection. The presented guide is based on and reflects the previous phases of the development process. It provides useful mechanisms for fulfilling the research's purpose and is universal so that other researchers could also use it.(Kallio et al. 2016)

Interview Guide

The interviewers are split into 7 categories representing the 3 spheres of the Triple Helix model:

Category I: Institutional Investors

Category II: Supporting Entities: Accelerators and Incubators

Category III: Healthcare Facilities: Public Hospitals, Public primary care units, Private Hospitals

Category IV: Governmental executive and regulatory entities

Category V: Universities entrepreneurship related functions: Technology Transfer Entities, innovation parks, incubators, external relations offices

Category VI: University academic departments related to Health Tech

Category VII: Health Tech Entrepreneurs

The answers to the interview questions designated for each category will collectively answers the questions of each of the proposed components of a university induced healthcare cluster.

5.1 Ethical Issues & Protection of Participants

Ethics are an important aspect of research as they ensure that no one involved suffers or is harmed from research activities (Donald R. Cooper & Pamela S. Schindler, 2014).

An informed consent was included in the interview, which explained its purposes in the study and the assured that participants could withdraw from the study at any moment.

All interviewees must sign the consent form at the start of the interview. Refer to Appendix A for the consent form.

The interviews conducted will confidential until the end of the research. The disclosure of its transcripts will require the interviewee signed approval. The results will be reported in the aggregate form unless the author chose to include a particular interviewee's input the latter case require the interviewee's signed approval. The data collected from the interviews will be stored on a laptop protected by a password. The data will only be access by the Principal Investigator as well as the co-investigator. Data will be kept for 10 years and then destroyed.

The interviews have no risk on those participating more than risks of daily life. Moreover, participants have no direct benefit from the study. The findings, however, will help policy makers and decision makers in various entities to develop their entrepreneurial ecosystems.

CHAPTER 6

RESULTS

Out of 18 contacts, we interviewed 14 senior leaders and entrepreneurs across academia, industry and government

Category	Health Tech Entrepreneur	Government Official	Academic Hospital	Head of university Entrep. functions	Professor	Ecosystem Support	Institutional investor
Contacted	3	3	2	2	3	3	2
Interviewed	2	2	2	2	2	2	2
Code	ENT	GOV	HOS	UNI	PRF	ECO	INV

The findings of the semi structured interviews are outlined below along with reference to the background of interviewees who pointed them out:

6.1 Financing Challenges

Investment Horizon (10-20 years) is too long for Lebanese investors, institutional and High Net Worth, who prefer a 3 to 5 years horizon due to business model risks, dependability on other stakeholders , country risks and geopolitical risks (2 INV, UNI, ENT)

“We got to advanced negotiation with US investors but it didn’t work since they asked to relocate to the states, they consider Beirut a war zone” (ENT)

In terms of backing a healthcare specific accelerator, it is the issue of medium to long horizon that will prevent private capital investments, add to it an expected weak ROI. The cluster have to target entities who care about building a Health Tech accelerator. Big

Universities are capable of building such partnerships with regional and international players to fund this accelerator (2 INV, 2 ECO, HOS)

Current Equity investors need risk mitigation schemes to fund Health Tech startups in R&D Phase. Possible Funders with long horizons are Governments or MNCs and NGOs with mandates to invest in such projects. But Government has limited capacity and Local Businesses have limited pockets, the reliance is on universities and their academic hospitals and International VCs with track record help as well since most Lebanese VCs are nascent (2 INV, ECO)

Lack of R&D grants, their percentage from GDP is very small. Institutional investors are not big believers in R&D and the donors still has to accept the high failure probability for R&D investments. To support startups and attract MNCs, we need a national constant R&D budget irrespective of the outcome (Siedschlag et al. 2013). A stimulus grant to support development from idea stage to proof of concept could be applied on campus (2 ECO, UNI, HOS)

You need "fresh money", this should come from outside investors. This is where we need national plan to attract investors to invest in R&D and to buy R&D, as a secondary market for R&D composed of MNCs, foreign businesses and local businesses. We need to encourage MNCs to pick Lebanon as a R&D center for them, our relatively cheaper skilled labor is one advantage(Demirbag and Glaister 2010). (UNI, GOV)

To get the investors in, you'll need the adequate infrastructure, provided by the government. We need to showcase our universities and research capacities abroad, mainly

showcase commercial R&D examples to put us on the map as an R&D hub for MNCs (Siedschlag et al. 2013), the challenge is getting the first success story. (UNI, GOV, ECO)

Entrepreneurs get seed capital to reach a product-market fit, get early users and experiment with them and then move to growth phase with VC rounds. In Lebanon, there are growth funds and seed capital (accelerators, angels) but there is a gap in the in-between capital, it's like a valley of death. (ENT)

Long cash cycles: long cash conversion cycle in Lebanese Market, Slow process of equity funding compared to western markets. Entrepreneurs are turning to competitions grants to survive (2 ENT)

Universities don't have financial capabilities to hire high caliber faculty members that will be dedicated to research rather than teaching and we don't have labs to support such members We don't hire someone to spend hours in labs in healthcare related research which is very expensive in terms of man costs and technical costs. This result in few in depth expertise and few players in terms of R&D (UNI, ECO)

In Software based solutions, most of the R&D is AI and machine learning software driven innovation, it doesn't require extensive physical infrastructure for it. (ENT)

6.2 Secondary Markets and Exit Challenges

Currently Lebanon suffer a lack of transactions in Secondary PE market, and we do not have Big Local businesses or MNCs present in Lebanon to shop for startups

acquisitions. Add to it the absence of proper channels to expose Lebanese businesses to MNCs or PE acquirers (INV)

The exits that happened in MENA were for companies that were multi country multinational firms. Focusing only on Lebanon or Levant will make it hard to find acquirers. (INV)

Main challenges for MNCs is lack of ease of doing business: it is hard to acquire local startups: MNCs face complexity in payment methods, and online banking solutions for enterprises. Lebanon need a political decision from the seniors in government to move to an Estonia like E government. MNCs also face regulatory hurdles in closing the M&A deals. Taxes on M&A makes regionals shy away from acquiring a SAL company (2 GOV)

The exit of Careem was eclipsed by the current macroeconomic and geopolitical state of MENA. However there is now a track record of unicorns. (ENT)

6.3 Culture and Social Networks

“I talked to lots of people when I was starting and I didn’t get the same enthusiasm that I got in USA, there people have seen success stories out of stories coming to them like me and they want to be part of these success stories and make them happen” (ENT)

We have students willing to go beyond the required in R&D, but this depends solely on the students (PRF)

Across campuses there is a distance between Medicine and Engineering functions. We also lack of forms for Healthcare practitioners-Engineers none forced interactions, we

need a structure encourage more cross disciplinary collaboration, hosting health hackathon within our campus is a start (PRF, HOS)

We lack communication between Hospital and University, time to meet, with deans and chairs of departments, mainly with engineering school. We haven't been to tangible result in cooperation with the university's departments. We lack cooperation with university departments to start or get ideas for R&D projects. The Mindset and Culture of integrating Medicine with other disciplines is already there. The structure need to be put in place to encourage more cross disciplinary collaboration. (2 HOS)

Resistance to change and hoarding know how: Older physicians have a resistance to work with "young techies" due of perceived asymmetry of knowledge and entitlement, also it's tough to get the younger locally trained physicians to leave old practices without a curriculum restructuring. The younger physicians trained abroad have more tendency to collaborate with entrepreneurs but tend to restrict knowledge transfer and refrain from collaborating with local peers. (2 ENT, 2 HOS)

We should have physicians who have the vision to found startups and we believe we do have them. These individuals have the vision and do not resist change, they are able to accommodate and to transform, and they understand that they need to dominate the tech than resist it. (UNI)

You always have to identify the champions who are willing to take on the new initiative and push it within the organization. They're the ones who are going to use it and encourage others to use it. The availability of these champions to back Lebanese Made

solutions and the willingness within our academic hospital and university is always there. The decision is always based on the perceived added value of the solution. (HOS)

The Private University collaboration was a success due to a champion from the inside who carried through the process. Our work resulted in publication in peer reviewed journals and some preliminary prototype. (ENT)

Lebanese culture is geared towards commerce and away from R&D intensive businesses and it is translating in lack of R&D centers (INV, PRF, UNI)

Like Nouvo Merkato, or dot.com bubble, the ecosystem in Lebanon failed to create a true culture of entrepreneurship, we don't have people trained to become entrepreneurs the way IC331 demand it, and we distributed money for free. (UNI)

We need international partnerships and we need to expand the social capital of the entrepreneurs and the university. The diaspora is already doing a very good job in supporting local entrepreneurs, they like to connect fellow Lebanese citizens and they like to help as much as they can. What they lack to invest more efforts, energy and money to the ecosystem is some sort of a confidence model, they still lack confidence in what comes out of a Lebanese startup. Usually this lack of trust is mitigated by an intro from reliable "common connections". This is understandable because they haven't seen lots of success coming out yet from Beirut. (PRF, ENT, INV)

An online platform could organize the efforts of the diaspora in building the ecosystem, it could link innovators to seasoned entrepreneurs and business men, specific technical consultancy and investors. This platform should be a digital platform with secure

identifying and limited access to be more professional. It could be open to everyone but exclusive to certain services (GOV, PRF)

Diaspora mainly helped our entrepreneurs through, LebNet and LIFE help you with business development but it is not easy to get the diaspora to help out. However currently they're not engaged enough. Leb Net members helped us in setting a plan for the startup to move forward, humbling me providing critical connections in USA and France (PRF, ENT, INV)

Entrepreneurs need older people to mentor them, guide them, open doors to them and provide connections with suppliers, partners, R&D institutions, and access to markets. This is lacking big time in Lebanon and MENA. We still lack success stories that provide a proof that the time invested in a startup will pay off, we need role models entrepreneurs. (ENT)

In Lebanon we have a tough time curbing with the uncertainties of our startup and the pressure from parents who do not get what we do. Skipping on advanced degrees and not getting "paid" from your work. Cultural norms pushes youth to get married, get a job, buy a house and settle down. (ENT)

6.4 University-Hospital Interaction

Hospitals could drive such a cluster because they are the largest end user of the technology, they could play a key role in facilitating access to private sector and adopting locally produced technology (ECO, INV)

The cluster will direct the research in hospitals and universities, it needs to be an independent entity having the university hospitals as parts of it and the university leadership as outside backing end supports (ECO)

There must be a university entity that support the cluster formation and development of local Health Tech. This entity should have visibility as much as possible since people at university have information overload. People need guidance and new ways to reach out to them, keep in mind that they aren't exposed to the ecosystem for a million reason. If this is a certain university's initiative, other universities will not join in and try to build their own initiative. (HOS)

We need to Identify anchor tenants for this Hub using our diaspora network. We prefer an anchor tenant who has global appeal, rather than having local anchor tenant. (GOV)

The cluster could use the university as an extension by pushing research down to its department and having cross departmental and cross disciplinary applied research. Startups and SMEs can outsource R&D to universities or leverage university assets for faster more productive R&D (2 ECO)

In such a cluster you'll need more upstream downstream activities across the value chain to push the cluster to be more innovative. (ECO)

The way a lot of things happen here as personal initiative, that's how we're building HealthTech. There isn't an invitation or a push for innovation on HealthTech with

the exception of certain type of grants. I wanted to host health hackathon within our university. We should be running on a national level health hackathon. (HOS)

We need to produce a map or a process for this professional with an idea to go through to build a functioning business around it. (HOS)

The cluster should steer away from operations and focus on R&D and prototyping, and build strong relations with international regulators to facilitate licensing Lebanese IP and innovation. (ENT)

Universities in Lebanon are privately owned institutions that are driven by the interest in generating a cushion fee revenue without necessarily having a deep thought about potential long run implications of investing in research. The short term focus of these universities prevent them from using the funds they have today for research add to it not having a clear vision and mission about research. (UNI)

You could not have gathered enough insights on big enough pain point in any industry through just 3-4 years of your college education. However, it's important for these universities to instill an entrepreneurial culture. There's a need to create engaging programs for R&D residency at Lebanese Universities (PRF)

No forum for Communication between Hospitals and Entrepreneurs: managers lack startups in the field of connections with physicians and much easier contact with staff and Dr, mainly proximity to my staff on my cellular phone. (HOS)

We wish startups could leverage the electronic data further to the good of the patient. If you were to launch a medical device, one of the things you'll need to do is to collect data: this data will help you validate your value proposition (HOS, ECO)

Our Hospital don't have the means to develop hardware in house (HOS)

If the big universities cooperate together using certain benchmarks, protocols and criteria we can advance medicine in Lebanon significantly. MoH can enforce such benchmarks and sets of standards on all local hospitals. These benchmarks have implicit both financial and marketing incentives for hospitals (HOS)

The major problem of the ecosystem is operating from a supply side and not from demand side. They create knowledge without examining economic demand of it (UNI)

We approached 3 private universities and Lebanese University for R&D projects. We have some sort of success with one private university, the other 2 and LU were a complete failure due to bureaucracy, tons of paperwork, sticks in the wheel… However the quality of the successful R&D collaboration output wasn't commercially viable, this is expected out of undergrad students working on completely new tech. (ENT)

There's a gap in support when you move past the early stage and before you reach the growth stage, mentors aren't adequate for this stage, funding is scarce, teams breakdown. Founders hit rock bottom without FFF to lift you up. (ENT)

We are not as structured and effective in bridging the transition from just an Idea into a prototype into eventually commercializing the product/service. I've toured

institutions in USA that have actually built units and departments dedicated for commercializing HealthTech. (HOS)

6.5 Cluster-Government interaction

The universities are the best candidates to build think tanks that influence policy makers and support cluster at large in helping governments draft policy and regulations. The mindset and education of the decision maker is hindering a fast enough changes in the country and the cluster could help alleviate this hurdle (GOV, ECO)

Hospitals should be efficiently regulated like the banking sector. Ministry of Health should take charge in forcing protocols, technology best practices and technological requirements in order to have enough domestic market for the early stage of the startup. Force a “buy Local” rule: The IDF and Israeli banks must purchase from local industries. This enforcement and regulation will reduce the commercial aspects of Healthcare players’ behavior and help developing the cluster. (GOV, HOS)

Today there’s no demand for Lebanese R&D, why would the government spend 1 B$ on R&D? Challenge from government side is to think long term, have financial means, and have trust that the ecosystem has the right skills, people and equipment. (UNI)

Slow Regulations: The new SALT law draft: the draft has a long journey before being published and enforced. On another hand, we have issues in financial regulation in regard of recognizing the R&D investment and expenditures in financial reporting for

Lebanese firms. We can provide tax cuts to Lebanese companies to incentivize their R&D spending. (GOV)

There's a lot of work to be done on improving the cost of operation for Lebanese businesses. It's generally expensive to be based in Beirut compared to the advantages you'll get. For example, the legalities and navigating the government bureaucracy is tough in terms of modifying company structure to account for new investment rounds. Taxation and reporting is a pain in the ass, they're at 25% of our overhead. The 2019 budget included some clauses to stimulate startups and support them. First clause is exempting technology firms from paying NSSF fees for the first 2 years. Second clause is facilitating access to IDAL services (2 ENT, GOV)

Lebanese people are risk averse when it comes to their career given that life in Lebanon has already too much risk built into it. The only way that it could work is for government to provide safety nets for the startup employees in a way of another, for example the Founder doesn't get NSSF from his own company. (ENT)

The government is trying to push in the direction of digitizing the nation and growing the knowledge economy. They also face walls, political and administrable hurdles, there's a lack of support from certain ministers or high rank officials. (HOS)

6.6 Access to Markets

Access to international markets, it's a main challenge across all startups verticals. Need incentives/subsidies to export Lebanese products. Tariff, customs and lack of

exporting abilities present challenges both in supply chain management and market penetration. (INV, ECO)

Need visibility of Lebanese products in the international markets. We need to organize PR efforts to enhance the international recognition of Lebanese Tech. We need to leverage the presence and prominence of our diaspora for such efforts. Currently there's a negative pre judgment of what could've come out of Beirut (ENT, INV, GOV)

Being in Beirut create trust issues for our European and American clients, we prefer to have contact info with USA codes. Everyone calls a USA number, and having an office in the states facilitate access to capital. Being located in Europe or USA facilitate exposure to new technologies and more sophisticated talent pool and facilitate access to industry conferences and networking opportunities. (ENT)

If you have resident researcher who have gotten enough experience to solve one of their domains pain points, sure. But most of students doing startups in healthcare, this scares investors because they don't trust students' recognition of the market and the pain points (ECO)

The main challenges to access to foreign markets is having the right bridges: Companies, corporate partners, international VCs, convince outsiders that we have quality inside Lebanon. The international brand of established Lebanese universities and their alumni diaspora make them more suitable than other entities to form such a bridge for entrepreneurs (UNI)

Our target is actually UK, Germany and USA, users came organically from these countries. Users in these markets are accustomed to using apps and there is less friction in convincing people to use them, and those users are more generous with their feedback and how they want the app to improve compared to their Arab counterparts. The partnership with Kings College Hospital gave us trust of users and access to professionals in diabetic medicine industry to vet what we're doing. (ENT)

6.7 Access to Data

"I cannot convince a 6 individuals committee to spend 100K on a startup with no access to real data or real physical proof, that increase the risk a lot" (ECO)

No means to collect proper data if you were to launch a medical device, one of the things you'll need to do is to collect data: this data will help you validate your value proposition (ECO)

We need free license and access to data for startups, coded in international codes. Open out the data and create a knowledge sharing system that is not necessarily open but it curates whoever needs the data and make sure they get it (ECO)

We don't have biostatistics in Lebanon, in healthcare this is a major issue. Academic hospitals are already putting money in these domains (electronic records and data management) (HOS)

In acceleration applications, entrepreneurs sites statistics about the US and EU, what about Lebanon and MENA? (ECO)

6.8 Talent Acquisition and Retention

We don’t have experienced investors, we don’t have experienced sales people nor experienced technologists. They haven’t been through the whole cycle yet: building companies, selling them and starting new ones (ENT, ECO)

In total we hired 25 since the beginning of the startup, all of them were techies, many people left because they weren’t competent enough, they felt too much stress compared to working for traditional companies. Hiring business people in Lebanon hasn’t proved its worth yet, majority of them specialize in one business area (accounting, marketing, HR…) and never develop the other areas therefor you can’t really work with them. (ENT)

What’s really lacking is an elevated and improved work culture, we need better drive and work ethics that will dramatically elevate this economy and this country. The universities need to manage the expectations of their graduates. Those graduates need to be placed in a real work environment that shows them what’s expected from them. Instructors and professors have a big role to play as mentors and role models. (ENT)

Lebanon have an excellent pool of candidates pro rata to the population. However in general talent is rare across the majors, even in not so advanced fields like business acumen and sales, this is partially due to lack of access to education in Lebanon. USA for example has larger population, stronger purchasing power, and better ability to get advanced education, there is much more competition but the pool is much larger than Lebanon. (ENT)

The standards of living in Lebanon are advantageous in comparison to Silicon Valley. The lower cost of living translate into ability of paying locally competitive salaries to attract talent, but those salaries are not as high as in the valley. (ENT)

It boils down to lower salaries coupled with lower standards/cost of living, so the Lebanese sophisticated talent is exported and for some reason they don't comeback until it's too late and they're retiring, this result in a smaller pool of talent in Lebanon. Entrepreneurs in the health industry lack access to experts, especially well versed expertise in technology on the board side and the advisory side. This is detrimental for younger entrepreneurs who don't have 20 years' experience in the industry. (ENT)

We need international consultants to bridge the know how gap on creating compliant R&D. Lebanese Entrepreneurs face difficulties in validating and developing their products if they don't go abroad and get the consultancy and expertise on Hardware. Those do not exist in Lebanon today, even if they do, they're probably relying on knowledge transfer from abroad (ECO, ENT)

In 2014 we started teens who code because we couldn't find developers that can work in advanced tech fields. What we lack in Beirut are developers with advanced knowledge, we have developers that do the mainstream work. We don't have specialized talents less frequently used fields that turn out crucial to certain startups. (ENT)

You can't hire the tech from abroad because you can't afford to match their current compensations. You teach the junior developers and they leave you for higher paid jobs in Beirut. (ENT)

6.9 University Innovation impediments

Outdated school curriculum (dated back to 1997) with no applied/practical knowledge in Lebanese schools up to grade 12 (PRF)

“Lebanese are great entrepreneurs but not necessarily in R&D intensive enterprises, they find a working idea and try to cash it in 2 or 3 years.” (INV)

Faculty incentives favor publishing over innovation, professors have limited time and resources and trade off innovative R&D for publishing in respected journals. Universities are not incentivizing R&D as a mean to promote the professor. This presents a challenge to alter the aspirations of older generation professors and pushing them to innovate (ENT, PRF, UNI)

To boost commercial research, we need to introduce a course from first year to help introduce students to entrepreneurship and technology innovation and at 2nd and 3rd year they start working towards their FYP as a commercial startup, we provide lab material and technical resources as well as social network (PRF)

There should be a phase that universities need to focus on before raising capital. Creating a dynamic organized systemized way by which students can go in and work on some research or grab an aspect of whether it’s hardware, software, pharma whatever and move with it. (ECO)

A lot of current startups are launched by people who don’t have a business background or leadership training, they’re physicians, nurses, technicians… (HOS)

6.10 Hardware Innovation Barriers

If a Lebanese startups residing in Lebanon told you they're creating the best hardware in the world, you will not give them the benefit of the doubt. We equate being here with at max being second best, not best. There's a pre judgment of what could've come out of Beirut and it's a cultural investment barrier. This bad perception of Health Tech coming out of Lebanon push entrepreneurs to refrain from manufacturing hardware in Lebanon (ECO, ENT)

It's really hard to prototype hardware in Lebanon, quality 3d printing are scarce, industrial design and material engineers are rare and access to advanced raw material in plastics and polymers is tough . (ENT)

A local startup in Health Tech Hardware can have a huge advantage in proximity and after sale, the main red flag is the actual availability of technical knowledge and high caliber staff (HOS)

I'm not saying that we don't have talents that are capable of creating top notch hardware. But I think they cannot do it by themselves, they need support and it's usually hard to get it. They need the right infrastructure to do so, it's not easy to get few hundred thousand dollars to go to china, meet some people, go through design for manufacturing process, and then end up with a product that can go to market. Smart car seat had issues with hardware implementation and required capital to minimize the physical size of the product. (PRF, ECO)

What we skip is what we do before we go to china, the average founder is bringing parts and material from outside and prototyping in house in Beirut. It's a logistical nightmare. Ordering material from abroad is a hurdle since customs seize them until they figure out if they're safe to enter the country (ENT, ECO)

The IP today is coming more from the Design and data analytics, assembling the pieces and mass production doesn't have to happen in Lebanon. However what we need is advanced prototyping facilities. (ENT)

The amount of advanced hardware design today in china is replacing half of the amount that you need to do. This replacement of R&D efforts degrades any competitive advantage for the Lebanese entrepreneurs because these capabilities are available to everyone else in the globe. Locally we are challenged to move things around, internationally we are challenged in creating and capturing the know how to create new products (ECO)

"We have two models for medical devices and machines:

1- Only focusing on R&D and building the tech and IP that you could sell to MNCs for 100M-500M$,

This model doesn't bother with setting actual business operations.

2- Building all business operations around the IP

This model is extremely difficult because access to market is very difficult." (ENT)

6.11 Intellectual Property Challenges

No proper enforcement of IP rights in Lebanon, this discourage people from people from investing in trying to commercialize local R&D. (INV, 2 GOV, 2 UNI, ECO)

Converting R&D to commercial products requires an IP rights systems that is very solid, we lack this in MENA. We need to update the content of IP laws and their enforcement mechanisms and we need to educate our law enforcement personnel on them (2 GOV, UNI)

We need on the other hand mechanisms to protect international IPs working in Lebanon. We have to work both on enhancing the recognition of Lebanese IPs abroad and facilitating registering IPs abroad for Lebanese entrepreneurs (GOV)

Lack of effective technology transfer capabilities, there's shy ones in AUB and USJ and other universities are starting to develop their own. The availability of any technology transfer office or IP policies aren't communicated properly down the organization to academics, staff, and students (UNI, ECO, HOS)

It's not about my investment in research it's about the standards that my faculty members are required to adhere to when doing research (UNI)

Academic Institutions in Lebanon are ill prepared to approach American and European entities that protects IP due to the limited experience that we have in Lebanon. (UNI)

There's lots of IP challenges: enforcement of IP protection, lack of sophisticated talent, the infrastructure, and the costs of registering patents abroad… IP makes sense if it's done in the same market, you're registering in USA, making revenues there and getting investments there (ENT)

Technically it is not that difficult to patent abroad, we have lots of Legal firms that are specialized in patenting and have connections with international offices as well as capabilities in some universities. The issue is its costs and the perception of returns on such patents. (ECO)

Do we have any regulations or systems in place in Lebanon for managing clients' data? (ECO)

We don't have proper R&D centers in Lebanon, when we have them we could achieve a lot. (UNI)

6.12 Compliance Competencies

"If you don't know the rules of the game you'll build a functioning product that you can't sell" (PRF)

Lebanese Physicians, Hospital managers and Hospital staff have a knowledge gap when it comes to adhering to FDA regulations when it comes to R&D. Academic hospitals have clinical trials in our hospital, but all of them are from foreign companies (PRF, HOS)

Lebanese HealthTech entrepreneurs face 3 knowledge gaps: Technical, Business and Regulation (PRF)

The lack of alignment with FDA's requirement for commercial R&D is not an AUBMC problem but a national problem. (HOS)

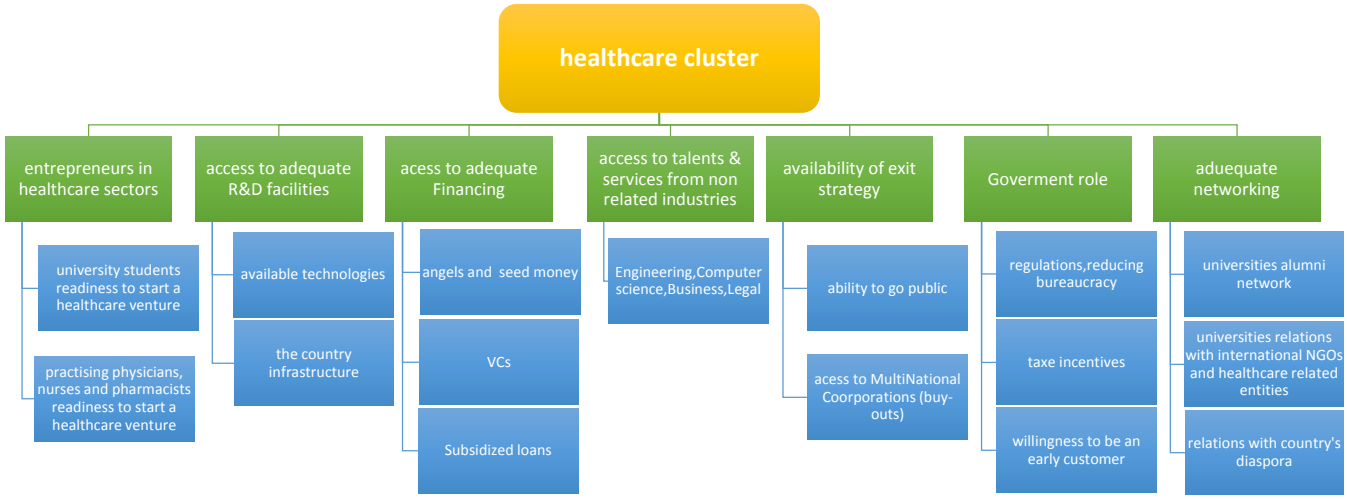
The nationally imposed rules need to be aligned with the FDA's requirements to avoid any hurdles for hospitals to adhere to R&D rules. (HOS)

A rigorous documentation is required by FDA amounts to thousands of pages to prove the safety and efficiency of the product. Leapfrog the process: Hardware partners are American SMEs that sometimes aren't as agile as we need, but they have FDA approved products and have a seal of quality that makes it easier to market our solutions. (ENT)

CHAPTER 7

DISCUSSIONS

The initially proposed model by the researchers was the following:



An overarching view from the interviews ***favored an entity external from the university*** to support the healthcare cluster. However, interviewees stressed the pivotal role of the University-Academic Hospital duo in such a cluster and the need to have all major universities/academic hospitals as part of the cluster.

No consensus was established on the identity of the anchor tenant that will catalyze the cluster, the opinions were mixed across the categories of the interviewees with (5/14) suggesting the academic hospitals of Beirut as the best suitable catalyst. As for the components of the proposed model:

Entrepreneurs in HealthCare Sectors: the general sentiment of the interviewees emphasized the need to encourage entrepreneurship in these sectors given the limited Lebanese successes in Health Tech today. This issue is more pressing for professionals who must to be engaged more in the entrepreneurial efforts.

Access to adequate R&D Facilities: the sentiment of the interviewees emphasized the lack of adequate know-how, processes and mechanisms to produce R&D compliant with international standards over the need to update universities' R&D facilities. Also, they emphasized the need for advanced prototyping facility with ties to international manufacturing hubs. On another note, universities in Lebanon need to allocate more resources to advance their R&D capacities.

Access to adequate Financing: the pain point that interviewees agreed on is the scarcity of pre seed money or the grants provided to support R&D before the commercialization phase, most interviewees stressed on the need to attract international donors and investors to fill this gap since the government and local businesses have limited resources to deploy. Also, angels and VCs were seen as having short horizons to invest in Health Tech R&D intensive startups.

Access to Talents: the main pain point posed by the interviewees is the scarcity of sophisticated labor force in certain advanced technologies required by the Health Tech industry. They perceived this bottleneck as a result of the brain drain and the tendency of

the resident sophisticated personnel to hoard the knowhow and leverage it to achieve personnel interests.

Availability of Exits: the focus of the interviewees was on the Private Secondary market, either through PE acquisition or industry M&A, preferably from Multi-National Companies, MNCs. They stressed the need to organize the efforts to attract MNCs and facilitate the ease of doing business in Lebanon to revive this Secondary Market. No significant interest was expressed in pushing startups for IPOs.

Role of Government: A consensus among interviewees stressed the importance of accelerating the regulatory process and draft new laws to enhance Lebanon's ease of doing businesses, tax incentives included. Interviewees stressed the importance of governmental entities to act as an early customer to the newly formed startups. A major pain point emphasized by the interviewees is the need to facilitate filing for international IPs and the need to enforce the IPs in Lebanon.

Adequate Networking: The interviewees emphasized the effect of the Lebanese diaspora network on the cluster over the capital of the university itself. Also, interviewees stressed the need for more internal networking between universities and their hospitals.

CHAPTER 8

HEALTHCARE ENTREPRENEURSHIP CLUSTER MODEL

To answer our question: ***How can a higher education institution create a cluster for healthcare entrepreneurs and entities that commercialize innovations and produce successful startups?***

The HE institute and its academic hospital are best positioned as the catalysts to such a cluster and founders of its Strategic Niche Management (SNM).

8.1 Building a Triple Helix SNM as an anchor tenant

Strategic Niche Management (SNM) is a form of the Trilateral Hybrid Organizations proposed in Etzkowitz Balanced Triple Helix.

SNMs initially introduced as a government top down approach aimed to create protected spaces for innovation and experimentation with new technologies that are initially protected from mainstream market selection criteria. SNM aimed also to foster learning processes amongst its network of technology stakeholders (Hegger, Van Vliet, and Van Vliet 2007).

Recent Literature argues for SNMs that expand from entities nurturing experimentations to intermediaries supporting national networks or clusters related to their niche. The SNM management and governance represent a triple helix-based system intermediary whose focus would be on the niche network rather than on individual projects

or experiments. A triple helix-based system intermediary would be nested within a niche innovation network and co-governed by public sector (regulators), academia (knowledge producers) and industry (knowledge users) network stakeholders.(Barrie, Zawdie, and João 2017, Barrie, Zawdie, and João 2019)

Scottish IBioC and Scotland industrial biotechnology cluster were taken as a successful example for such intermediary. IBioC adopted a neutral actor between the cluster members and was able to bridge structural holes in the network and increase the network density and enhance the level of network connectedness, strengthening its ties, without significantly increasing the risk of over-embeddedness. (Barrie, Zawdie, and João 2019)

These strong ties are necessary for complex knowledge to be transferred and exploited via technological development (Michelfelder and Kratzer 2013) and an increase in these strong ties foster an environment of trust, reciprocity and cooperation throughout the network (Carpenter, Li, and Jiang 2012). This resulted in increase of Academia-Industry IP transfer and increased knowledge spill over in the network. IBioC also reduced the path length of the network and increased the centrality of key stakeholders which facilitates the emergence of shared expectations, a critical factor in the success of the niche.(Barrie, Zawdie, and João 2019)

The “manager role” of this triple helix intermediary can be assumed by any individual/entity from any of the 3 triple helix spheres. This network manager drive the network by undertaking shielding, nurturing and empowering activities (Weber et al. 1999,

Kemp, Schot, and Hoogma 1998, Smith and Raven 2012). This intermediary would have the mandate to accelerate sustainable transformation by enhancing cooperation and collaboration amongst triple helix actors, whilst connecting them with external actors. (Barrie, Zawdie, and João 2017).

The network manager will be responsible of running the consensus space, knowledge space and innovation space conceptualized by (Ranga and Etzkowitz 2013). The consensus space provides the forum for triple helix actors to brainstorm, debate and assess plans to advance towards a knowledge-based system through a number of co-created practices. It provides the basis for the formation of the triple helix system and requires the build-up of social capital to engender trust and effective knowledge transfer. The knowledge space forms through a range of activities that allow knowledge to be generated, diffused and used amongst the triple helix actors. The innovation space comprises of activities undertaken predominantly by hybrid organizations spanning the boundaries between the triple helix actors and is predominantly driven by industry (Ranga and Etzkowitz 2013).

8.2 The SNM structure

For the purpose of this thesis the researchers will refer to the Strategic Niche Management intermediary as “BeyMedTech”:

BeyMedTech will operate on 3 levels that reflect (Ranga and Etzkowitz 2013) concept:

1- The “consensus space” will be provided through the BeyMedTech assembly and its board

The assembly and the board focus on fostering international ties, pushing for more collaboration among members, drafting policies and lobbying government to advance the cluster

BeyMedTech Assembly: 30 seats

6 government: BDL, PM, MOEd, MOH, MOIn, MOEc, MOTel (Potential), MOF (Potential)

9 Academia:

Universities with Academic Hospitals: LU, AUB, USJ, LAU, BAU, USEK

Universities with entrepreneurship interest who don’t have Academic Hospitals affiliations: NDU, ESA, Balamand

15 industry:

5 Hospitals: AUBMC, LAU RIZK, Hotel Dieu, Bellevue, CMC,

2 institutional investors with Health Tech startups in their portfolios

Ecosystem partner: Berytech

7 For Profit Corporations, startups and established businesses

Governance Board: 9 seats

PM, MOH, 2 Universities, 2 Hospitals, 2 Corporations, Entity Manager

2- The “knowledge space” will be provided through the BeyMedTech programs

Within the oversight of its board and general assembly, BeyMedTech will

- Facilitate Academia-Industry joint R&D ventures and increase universities’ knowledge spill over

-Run “extracurricular” activities within Universities and Hospitals to foster an open innovation culture and bridge the social network gap between professionals and students

-Help universities shift their curriculum and internal processes to facilitate their entrepreneurial university transition

3- The Innovation Space will be provided through the BeyMedTech spaces

BeyMedTech spaces are a network of “maker spaces” situated within universities/Hospitals premises

These spaces are accessible to all network members and designed to complement each other when it comes to the technology and infrastructure available.

The main purpose of decentralizing these spaces is reducing the upfront investments on universities and hospitals and limiting any concentration of resources/power within one entity that could hinder the collaborative environment of BeyMedTech.

CHAPTER 9

FUTURE RESEARCH AGENDA

As this research poses a general plan for building the health care technology cluster, many parts of this plan require more in-depth research to help guide stakeholders decisions:

9.1 Cross Disciplinary R&D & Innovation Culture

- The social networks inside universities and the current barriers to formal and informal cross disciplinary collaborations

- The barriers to triple helix collaborations in Beirut

- The effects of various compensation and career development schemes on faculty's tendency to work on commerciable R&D

9.2 Hospital University Relationship

- The effects of personal ties and social capital on knowledge channels between a university and its academic hospital

- The potential role of Hospital-University Duo as anchor tenants

- The innovation barriers for practicing professionals

9.3 MultiNational Corporations interactions with local stakeholders

- The alignment of MNCs research goals and universities research mission

- Factors deteriorating the Risk/Reward profile of outsourcing R&D to Lebanese Universities

- The incentives and deterrents of Alumni and Diaspora to direct MNC contracts to Local businesses

9.4 Academia/Industry Technology Transfer

- The role of social capital of Technology Transfer personnel in the technology transfer process

- The effect of tax subsidies on joint R&D collaborations

- The mechanisms and policy tools to converge the interest of stakeholders within academia and industry spheres

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APPENDIX A:

Developing a Healthcare Entrepreneurial Cluster in Beirut.

I am Zahi Hilal, a graduate student conducting my Master's studies in the Maroun Semaan faculty of Engineering and Architecture at the American University of Beirut in the Engineering Management program.

As part of my thesis, I am conducting a research study about commercializing the outcome of university R&D in healthcare related sectors and the hurdles that hinder the development of successful startups based on this R&D.

These interviews will allow the gathering of data and insights that help the development of a blueprint for universities to create a culture and an environment where entrepreneurs and startups successfully flourish.

The feedback and insights from each interview are examined and compared with other interviews to refine the l model proposed by the investigators

The transcript of this interview will remain confidential until publishing the research. The disclosure of its transcripts prior to research publishing will require your signed approval.

The outcome of these interviews will be reported in the aggregate form unless the author chose to include a part or the whole transcript of your input, the latter case require your signed approval.

If you have inquiries about this research subject or your participation, please feel free to email me at zhh09@mail.aub.edu.

By signing this document you acknowledge that you read it and accept its terms

Interviewee's Name Interviewee's Signature