ON DESIGNING OF A TECH-HUB FOR STRENGTHENING THE MANUFACTURING SECTOR IN DEVELOPING COUNTRIES

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Abstract: *In this paper, we want to show ideas on how building a Tech-Hub for boosting and strengthening the manufacturing sector in developing countries. We think this goal can be attained by creating a network composed of universities and enterprises between developed and developing countries, we think that this method will make more effective, easy and fast the process of creation of new products or processes by start-ups or enterprises of developing countries.*

Keywords: TECH-HUB DESSIGN; TECHNOLOGY TRANSFER; INNOVATION NETWORKS; MANUFACTURING; DEVELOPING COUNTRIES

1. Introduction

The scientific community has highlighted the importance of clusters and the role played by the central hub in their governance and dynamics inside and outside them, usually with large-sized companies to expand its influence beyond its borders for the creation, distribution, dissemination and skills development to strengthen its value chain. However, there are not enough studies that explain the limited creation and maintenance of clusters in the manufacturing sector, where the productive structure of a country is based mainly on the extraction and export of raw materials or products with low added value. As we see in Fig. 1, it is the case of almost all the Latin American countries; with some exception like Mexico, Brazil and Argentine.

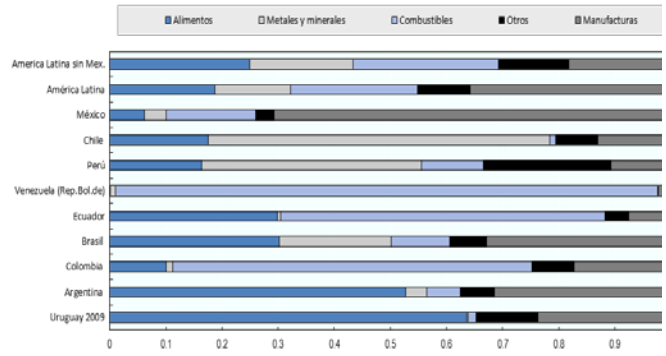

Fig. 1 *OECD, CAF, & ECLAC. (2013). Perspectivas económicas de América Latina 2014. Logística y competitividad para el desarrollo (p.38); elaborado con datos de CAF (2013).*

Some economic studies have been suggesting policies to promote innovation systems at national and regional levels in developing countries; but despite government efforts, it had not been boost the sector neither improve their poor competitiveness, productive diversification and sophistication indicators. Manufacturing is an industry strongly based on experience and tacit knowledge, which certainly requires promotion policies and public funds for technology transfer and innovation, but also an important proximity between local stakeholders and a specialized international network. Therefore, in this article we advocate on the relevance and feasibility of a Tech-Hub Peru, working on design issues and modeling its structure.

2. Literature Review

The scale of analysis applied in Latin America, was mostly related to the national and regional innovation systems and firms cluster inward and outward delimitations. However scholars like Kaumann (2001, p.4) suggest that there are at least three different social systems that interacts in the process of product (goods and services) innovation – *'business', 'science' and 'policy'*- interacting with a different modes of interpretation, decisions rules, objectives, and specific communicative standards. This clearly suggests an extended ecosystem going beyond the specific national, regional or industrial sector. The process of collaboration between actors belonging to different systems are based on diversity playing different roles, where individuals are not the specific elements of systems, but communications is (2001, p.4). Thus, as he remarks, "*in the particular case of industry-science interaction this might, among other things, result in product innovation*".

The scholars use the term innovation when they are referring to new products, services, process, materials or organizations forms that arrives to the market, or create new markets, regardless of their successfulness'; because the newness become attractive more widely, usually, after a process of broader use. In an industrial context, most innovations are based on some kind of problem solving, when firms facing a particular problem turns to a supplier, or some other related actor, to get help in specifying the problem and defining procedures for its solution.

However, it is not a straight line; it is necessary a firm's 'absorptive capacity', term coined by Cohen & Levinthal (1990 p.128), which is "*the ability to exploit external knowledge as a critical component of innovative capabilities*" that are "*largely a function of the level of prior related Knowledge*". That includes "basic skills or even a shared language… of the most recent scientific or technological developments in a given field".

In addition, the manufacturing sector presents a complex interaction environment, with multiple layers, and fuzzy boundaries; thereby, the processes of technology transfer and innovation should be incubated and developed taking account of these dynamics. Because the combined forces of globalization of markets and deepening divisions of labor, make knowledge creation and innovation increasingly important. As Bengt-Åke Lundvall (2007) state "*the most important resource in the current economy was knowledge and the most important process was learning*" (p.99).

In the arena of clusters, Malmberg & Power (2006) emphasizes that *"knowledge in clusters is created through various forms of local inter-organizational collaborative interaction; increased compete-tion and intensified rivalry; spillover following from the local mobility and sociability of individuals"* (p.411).

Also Bengt-Åke Lundvall (2007) discuss the limits of national, regional, sectoral and technological innovation systems highlighting that "*the innovation process may be seen as an intricate interplay between micro and macro phenomena where macros-structures condition micro-dynamics and vice versa new macros-structures are shaped by micro-process*" (p.101)

In a more social system view, Bengt-Åke Lundvall (2007) summarizes that a series of empirical studies demonstrates that "*a key to transform technical innovation into economic results is training and organizational change*". However, he claims that "*the impact of innovation on economic performance will typical depend upon change in 'people', 'orgware' and 'socware'"* (p.101), the last

two words referring to how people interacts each other inside and outside their organizations.

There were Malmberg & Power (2006) that pointed out that industrial systems should be assumed to have a distinctly localized component, where the interactive processes of innovation and knowledge creation, goes necessary in a spatial proximity for intensified face-to-face interaction, shortened cognitive distance, use common language, consolidated trustful relations between the actors, promote easy observation and immediate comparison. Thus for them "*there are reasons to believe that the knowledge-enhancing structures of a given geographical territory are more important than other characteristics (such as general factor supply, production costs, etc.) when it comes to determining where we should expect economic growth and prosperity in today's world economy*".

3. The Peruvian Context

In this chapter, we propose to understand the contextual factors that firms encounter in their innovative activities, as Bengt-Åke Lundvall (2007) suggest, those have an important impact in their style and mode of innovation and learning, and in turn, affects the country's competitiveness. Becoming a kind of feedback loop, ranging from micro (firms) to macro (nationwide), and back again to micro.

Productive Structure and Product Markets

The Peruvian productive structure is mainly the same since 1950 (see fig.2), it is based on services that counts for over 60%, followed by agriculture and mining within an average of 15%, manufacturing 14% and other (construction; electricity and water) that change mostly from 4% to 9% basically for the boom in building constructions.

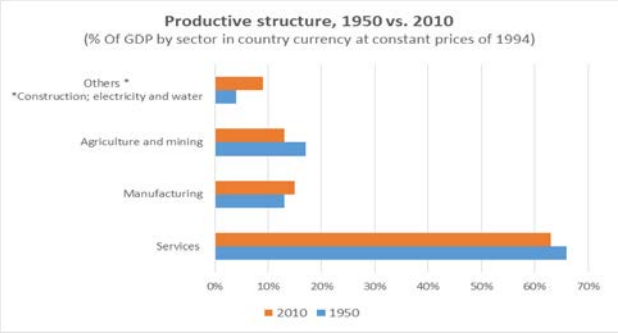

***Fig. 2**: Peruvian productive structure 1950 vs. 2010. Data from BCRP (Central Reserve Bank of Peru)*

If we go inside the manufacturing category, we found is almost the same through the last years; being the food industry the first contributor, followed by chemical, textile and leather, fabricated metal products, manufacturing non-metallic products and paper industry the most relevant as we can see in the Fig.3.

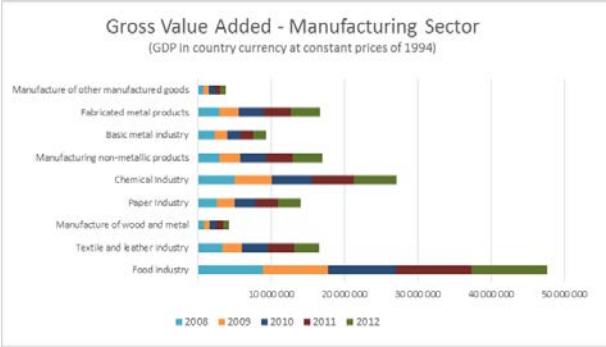

***Fig. 3**: Gross Value Added - Manufacturing Sector, 2008 to 2012. Source: CEPLAN (2013) - Report of the productive structure of Peru, for 2021 and 2050*

Competitiveness Index and Products Sophistication

In 2013, according to the Observatory of Economic Complexity (OEC), created and supported by the "MIT Media Lab Macro Connections group" (AJG Simoes, CA Hidalgo, 2011) Peru had an index of -0553 (ECI) being ranked in 85 of 124 countries. This atlas describes an economic complexity index (ECI) according to the level of complexity of the products each country is able to do and export, analyzing a multiplicity of knowledge, know how, networks people and organizations that are embedded in the manufacture of this products.

The main products exported in 2013 were gold ($ 8.29B), copper ore ($ 7.79B), petroleum refining ($ 3.17B), refined copper ($ 2.12b) and gas oil ($ 1.65B); and the main imported products were petroleum refining ($ 3.2B), crude oil ($ 3.08 B), automobiles ($ 1.8B), truck load ($ 1.57B) and informatics ($ 959M). Equally that weak productive sophistication we can see in a non-traditional exports reported by the Central Bank in 2012, that reached 21%, the composition was Agricultural (28%), Textiles (20%), chemical (15%), Sidero-metallurgical (11%), Fishery (9%), Non-metallic Mineral (6%), Metal-Mechanics (5%) and others (2%).

Likewise, the last ranking of the World Economic Forum 2016-2015 ranks the Peruvian economy 69 of 140 countries giving an overall value of 4.2 (scale 1- 7). Based on twelve pillars of global competitiveness and its interrelations with 113 indicators, we can see in the Table 1 that despite the middle position, the pillar are mostly in the lower third worst countries. Especially on indicators relevant for this study, as those of innovation, business sophistication, technological readiness, higher education and training.

***Table 1**: Peruvian pillars of global competitiveness 2016-2015 vs. 2015-2014. Source: Translated and prepared with data from the Global Competitiveness Reports - World Economic Forum (WEF)*

Superior third (1 to 60)
Middle third (61 to 80)
Lower third (81 to 140)

N°	Pillars	2015-2016 Rank	2015-2016 Value	2014-2015 Rank	2014-2015 Value	Change Position
1	Institutions	116	3.3	118	3.3	2
2	Infrastructure	89	3.5	88	3.5	-1
3	Macroeconomic environment	23	5.9	21	5.9	-2
4	Health and primary education	100	5.3	94	5.4	-6
5	Higher education and training	82	4.1	83	4.1	1
6	Goods market efficiency	60	4.4	53	4.5	-7
7	Labor market efficiency	64	4.3	51	4.3	-13
8	Financial market development	30	4.5	40	4.5	10
9	Technological readiness	88	3.4	92	3.3	4
10	Market size	48	4.4	43	4.5	-5
11	Business sophistication	81	3.8	72	3.9	-9
12	Innovation	116	2.8	117	2.8	1

Going a Little further on innovation pillar, the fig. 4 shows the poor performance in all the indicators, being the worst ones applications for PCT patents, company spending on R&D, Gov't procurement of advanced tech products and quality of scientific research institutions.

***Fig. 4**: Innovation Competitiveness Index (pillar 12). Source: Translated and prepared with data from the Global Competitiveness Report 2016-2015 - World Economic Forum*

Labor Markets

According to the National Institute of Statistics and Information (INEI 2011) of a total of 15.3 million workers, 74% belongs to a Micro and Small Enterprises (MSEs), they are mainly located in the region of Lima (98%). As could see in the distribution of employment by economic sector for 2010 (Fig. 5) the 33% are on primary activities, followed by 28% in services and only 6% and 4% in low and high tech industries respectivily. On the other hand, labor productivity is weak and vulnerable, with high levels of informality, underemployment and self-employment; in 2011 the INEI reported an increased rate of suitable job (46.7%) having been only 23.5% in 2010. The index of informality since 2002 is over 65%.

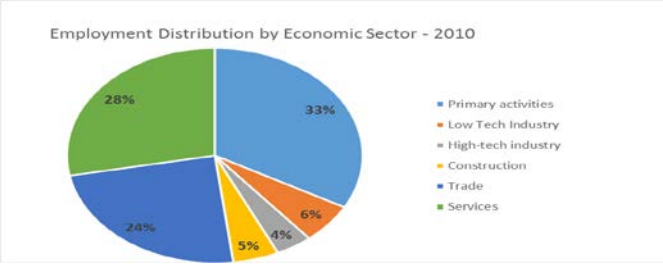

***Fig. 5**: Distribution of employment by economic sector - 2010 Source: CEPLAN (2010)*

Financial Markets

By 2013, Peru was already very attractive for international investors, and is usually grouped with Mexico, Panama, Colombia and Chile as one of Latin America's high-growth economies. Nevertheless, in words of Miguel Castilla, Peru's finance minister for almost a decade, the financial market, is failing to meet demands from both issuers and investors. "*this is partly due to "excessive regulation" and partly because of a shortage of investable assets, so the reform will encourage the offer of hybrid instruments*".

Currently, most of the local investment is from pension funds, Peruvian companies get 70% of their finance from the banking system and just 30% from capital markets. However, about 90% of that took the form of foreign currency bond issued overseas, which are only available to the biggest corporate names. Between 2009 and mid-2013 Peru has experienced significant inflows from foreign investors into local currency government bonds (BTP). Regarding the Global Financial Development Report 2011-2013, Peru financial system is characterized in the Table 2. The overall economy value was below the 25th percentile.

***Table 2**: Peru and Their Financial System Characteristics (av. 2011-2013). Source: The World Banck*

Financial institutions				Financial markets			
Private credit by deposit money banks to GDP (%)	Account at a formal finantial institution (%, age 15+)	Bank lending-deposit spread (%)	Bank Z-score	Stock market capitalization + outstanding domestic private debt securities to GDP (%)	Market capitalization excluding top 10 companies to total market capitalization (%)	Stock market turnover ratio (%)	Stock price volatility
26.2	20.5	15.8	16.6	61.7	36.2	5.2	23.1

National Educational System

Education in Peru is divided into three levels of mandatory basic education: preschool (3 to 5 years), primary (3 to 5 years) and secondary school (3-5 years). It has improved its coverage levels, especially in primary education; however, there are serious problems regarding the quality of education, as most primary school students does not achieve the expected learning, in 2009, only 23.1% of students in second grade achieved the expected learning in reading comprehension and only 13.5% in math. The completion rate in secondary education also had an increase in the range 17-19 years (60.7%) and 20-24 years (73.9%).

Many of technological colleges (IST) do not have trained teachers in pedagogical neither with updated specialties; their students develop their practices with obsolete and shabby equipment. Most technical careers offer consists of accounting, secretarial, computing, administration and nursing; however, the labor market for these specialties are saturated, without the rivalry that are made with the same graduates specialties at local universities.

The average annual expenditure on state universities in Peru is less than US$1600 per student. Additionally to deficiencies in quality, there are a low demand-oriented in engineering and science careers. Thereby, the distribution of professionals by main occupation has not changed in decades, and remains concentrated in the professions of law, social sciences and humanities, which despite being saturated remain the most demanded and supplied.

Intellectual Property Rights

The ninth edition of the International Property Rights index (IPRI) which ranks countries on three main components: Legal and Political Environment (LP), Physical Property Rights (PPR), and Intellectual Property Rights (IPR), ranked Peru in 79 of 129 countries in 2015. Table 2 shows the position within a global and regional scale (Latin America and Caribbean).

***Table 1**: Peruvian rank in International Property Rights Index. Source: website of the 2015 International Property Rights Index*

	Score	Globally	Regionally
Peru overall IPRI	4.6	79 of 129	12 of 22
Overall Intellectual Property Rights	4.5	77 of 129	12 of 22
Protection of IPR	3	110 of 129	18 of 21
Patent Protection	6.9	52 of 107	7 of 18
Copyright Protection	3.5	62 of 105	7 of 22

Welfare Regimes

For Wellbeing in Developing Countries (WeD), the research group funded by ESRC and published by the Centre for Development Studies at University of Bath, "*the distribution of income and wealth in Peru is one of the most unequal in the world*". Because of the perpetuated inequality, affecting different measures of wellbeing. Or as Wood and Copestake (2007, p.8) says "*Peru is an 'unsettled' society in welfare/wellbeing regime terms*".

Peru is considered by the World Bank as a mega-diverse country with a geography that in their three regions (coast, highlands and jungle) has a great diversity of climates and microclimates that favor biodiversity. This diversity is also social, with races, languages (Spanish, Quechua, Aymara) and lifestyles adapted to each region. However, this geographical diversity and remoteness is not the fundamental source of Peru's social stratification, in fact, since the colonial times there is a cultural dualism, with highly unequal ethnically diversified society with culturally structured forms of social exclusion, which is translated into political exclusion, economic inequality and a fundamental problem of institutional legitimacy. Thus, the preconditions for a political settlement capable of delivering universal improvements in wellbeing are weak. Rather, it is a society dominated by strong ethnic and cultural identity, social closure and mutual exclusion.

4. On Tech-Hub Peru design

Our Tech-hub concept

Tech-Hub Peru will be a physical place where we:

- Evangelize and build firm's absorptive capacity: by developing international high-level postgraduate courses in engineering, technology and innovation. The courses must be hands on, market and industry oriented, with an international value from academic and practitioner point of view.
- Develop an ecosystem: as a cluster facilitator, building an international network that includes micro, small and medium-sized enterprises, universities or other research and

technological center; initially between Europe and Latin America.

- Do research and development: as a business support and facilitator for knowledge creation, technology transfer and innovation in manufacturing sector

The hub extends

Using a rich picture technique, we propose the following design for the Tech-hub ecosystem, there are represented in the upper middle-left corner the Degli Studi of Salerno University within the networks of business and industries that could be already interested in this enterprise, as well as other international universities; symbolizing the scope of these relations the globes within the continents. In the opposite side, represented by Peruvian flag, are the local universities, businesses within their extended value chain, the professional, labor and trade associations, the government institutions related with manufacturing and science and technology promotion. In the middle, the 'hub' leader within a committee that is tied initially with Salerno University (see Fig. 8).

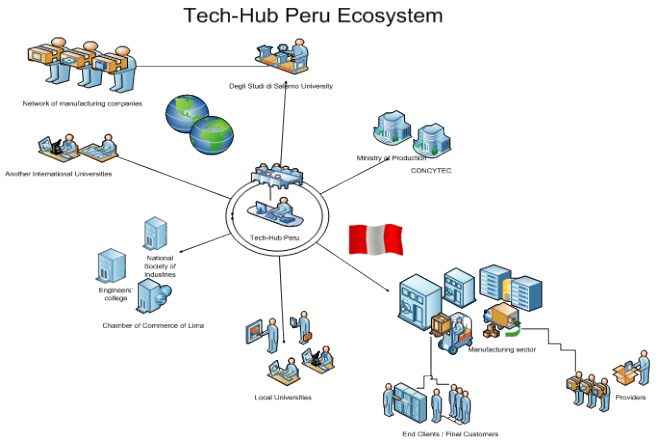

***Fig. 8**: Rich picture of Tech-Hub Peru ecosystem*

Describing the ecosystem

As we could see, we already use the term ecosystem, as a system of systems, trying to symbolize the Kaumann (2001) social systems that interacts in the process of product innovation – 'business', 'science' and 'policy'-. Going beyond national innovation systems, we are incorporating from the very beginning a more experience and industrialized country, that has knowledge explicit and tacit, different kinds of technologies for manufacturing sectors and the experience in business-university innovative projects, and last but not least funding experience from government and European community.

From Peruvian ecosystem, we will begin to search stakeholders from public and private sectors looking to get interested in being part of this project from the very beginning, as sponsors or allocating funding resources. Particularly those institutions related with the promotion of science, technology and innovation like CONCYTEC or sectorial and professional associations as SNI (Industrial National Society) and Engineering College in Lima (CIL). Then, we will continue with the evangelization on technology transfer and technological innovation for competitiveness through talks, conferences, seminars in collaboration and with the support of our first members and stakeholders. Subsequently, we will design special middle and high level international training courses for the preparation of technicians and professionals in areas of industrial, mechanical and electronics engineering; based on hands on with an international travel and work experience. In parallel, we will organize in-house meetings to collect needs and expectations of executives, entrepreneurs and associations in the manufacturing sector.

Governance and Organization

The Oversight Board will have an important role in supervision and opening national and international network of companies and contacts at the highest level to position the hub. The center directors are executives responsible for driving the hub, one at local place in the role of general manager and another one with the role of international manager. They will have two areas of counseling, one related to the expertise in industry and technology and the other with internal and external communication, both been key elements in the conception of this center. The layout of organization is presented in Fig. 9, the key roles here below:

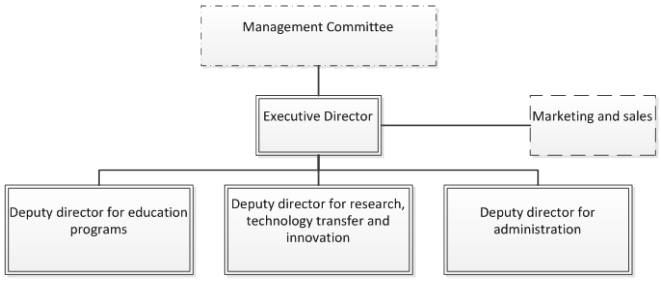

***Fig. 9**: Organization chart of Tech-Hub Peru*

The key roles and decision makers:

Board of Directors

- Local Chair
- International Chair

Chief Executive Officer

The operational and support roles:

Marketing and sales

Deputy Directors:

- for education programs
- for research, technology transfer and innovation
- for administrative stuffs

In order to manage and funnel these flow of information and knowledge from the international partners and expectations, inquires and needs of information, knowledge and technology from local businesses, institutions or government, we will have a stablished permanent committee which have a regular weekly meetings in order to prioritize projects and activities. To provide the services, the hub will have three executive branches, a central research, technology transfer and innovation, one for training and one for training and administrative support. The head quarter will be located in Lima.

Building a common understanding

Following Kaumann (2001), we will put communications as a central and specific elements of our ecosystem; what these mean is we will use specific communication methods and channels in order to spread our vision, mission and values inside and outside the cluster, to motivate individuals, institutions, and public audiences about important competitiveness in manufacturing industry through technology transfer and innovation.

- **Mission**: Provide an international cluster environment in which old, new and emerging companies can develop and grow, building the best combination of cutting-edge knowledge, dynamism, technology infrastructure, funding opportunities and innovative approaches, relevant to their business and profitable for manufacturing industry
- **Vision**: Stimulate and manage the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; being a trusted key stone in international cluster building for manufacturing industry in developing countries.
- **Values**: Cutting-edge knowledge and technology, passion, engagement, innovation, leadership, trustfulness, reliability, valuable networks.

Goals

Capacity-building and international contacts will be the core of our proposal; we propose five goals to respond to the need of technology transfer and innovation in Peru:

- Development of applied research; oriented to the solutions of practical problems, both of industry and society
- Training and high level education; based on projects in abroad industrial locations
- Technological development and innovation in industry;
- Introduction of new technologies in the country; and
- Creation of knowledge-based industries (spin-offs)

Sectors of intervention

Tech-Hub will start by launching high levels of learning programs in engineering, technology and innovation, in partnership with Salerno University and their Italian cluster. The courses will be hands on, market and industry oriented, with an international value. Those will be useful also as an evangelization stuffs and Firm's absorptive capacity development, thus immediately after we could start working on science, technology transfer and innovation projects in three areas, those are:

- On design, construction and / or adaptation of machines for agribusiness, metalworking, public transport. To have a positive and significant impact on improving the competitiveness of the Peruvian productive sector, we will choose the right scope (national, regional or sectoral).
- On aeronautics related services, not in the design or construction of ships, rather in the maintenance and logistics around the air transport; as well as in training and EASA / FAA certification.
- On design and construction of boats and yachts to enjoy all Peruvian sea and large coast as a tourism potential. Until now, the population lived on backwards to these rich possessions; thus, sailing could be an important sector for the economy of Peru and will have certainly a future.

Financing

We will do initial orientation seminars to familiarize potential sponsors with the concept of Tech-Hub Peru, giving information objectively on characteristics and objectives, its problems and potentials, and the responsibilities and obligations of the key player. Being a private initiative, we will need to look actively for funds to cover operational and developing expenses:

- By selling international high-level postgraduate courses in engineering, technology and innovation, paid either by people taking those or by their enterprises. We will try to have the sponsor of government, professional associations or international organizations
- By submitting research, technological and innovative projects to national or international grant funds aimed to promote innovation in developing countries. Also, partnering projects looking for government programs that usually demand co-financing through the allocation of facilities, man-hours, equipment and experts of the participating entities, through a win-win business models
- By selling services of consultancies in research, technology transfer an innovation for manufacturing; or helping to formulates and manages projects.

5. Discussion

A wide range of studies suggest the importance of innovation as a competitive trigger especially in a knowledge economy, but, in a developing countries there is also a high need of evangelization and building of firm's absorptive capacity. This is almost a fact in manufacturing of high tech with innovation in all channel value; also, it is an industry highly linked to experience and tacit knowledge, which refers to a knowledge difficult to communicate to others via words and symbols, thus, there is a need of face-to-face and hands-on learning experience.

Following the literature review, we propose an ecosystem for Tech-Hub Peru, in order to include the dynamics of broad social environment where we will introduce new ways of production, anchored in a more productive and competitive manufacturing through technology transfer and innovation. In addition, our strategy takes care of firm's absorptive capacity through proximity to capture tacit knowledge from most developed and experienced economies. However, it is not without significant risks.

The first steps until the consolidation heavily depends on the capacities of the cluster facilitators in a local front, engaging stakeholders, getting government support, building trust relationship and maintaining a long, solid and profitable relationship with Salerno University. Deploy a platforms like this requires interdisciplinary perspective and different fields of knowledge, thus, it could be costly and hard to engage all professionals and stakeholders needed. Another risks is the no consecution of financial funds to lunch the high-level educational programs, to start building testing and reverse engineering labs for research and technologies adaptations, as well as for operational and initial projects.

6. Conclusions and Recommendations

The design of Tech-Hub Peru proposed here, defines its scope, vision, missions, goals, network cooperation and governance, organizational structure, physical (geographical location of local office), services offers and initial sectors of intervention. Being proposed as a private initiative, it will be necessary to get government support to finance the initial activities, and to contact all Peruvians stakeholders who may be interested in joining this initiative, both in public and in private, directly or indirectly.

As Tech-Hub Peru is a private initiative, it will be convenient to be managed as an adaptive ecosystem. Thus, we could capitalize on field studies in order to build a model. We also encourage to have more studies and suggest to build consistent data of clusters life cycles, especially on birth and development phases.

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