# DEVELOPING INCLUSIVE INNOVATION PROCESSES AND CO-EVOLUTIONARY APPROACHES IN BOLIVIA

Carlos Gonzalo Acevedo Peña



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Faculty of Computing Department of Technology and Aestetics Blekinge Institute of Technology Sweden

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Este trabajo está dedicado a mi familia y mi país de los cuales me siento muy orgulloso de formar parte.

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# List of Abbreviations and Acronyms

Air BP	Bolivian Enterprise of Jet Fuel Distribution
BOB	Bolivian Boliviano (Currency)
BTH	Blekinge Institute of Technology
CADEPIA	Regional Chamber of Small Enterprise and Handicraft Production
CartonBol	Bolivian Carboard
CAPN	Food and Natural Products Centre
CASA	Water and Environmental Sanitation Centre
CBT	Biotechnology Centre
CDC	Departmental Committees for Competitiveness
CI	Cluster Initiative
CIATEC	Centre of Applied Innovation and Competitive Technologies
CIDI	Industry Development Research Centre
CIP	Productive Centre for Innovation
CPE	Political State Constitution
СТА	Agro-industrial Technology Centre
CyTED	Ibero-American Program for Science, Technology and Development
DICyT	Directorate for Scientific and Technological Research
EBA	Bolivian Enterprise of Almond
ECEBOl	Bolivian Enterprise of Cement
EMBATE	Technology Based Enterprise Incubator
ENTEL	National Enterprise of Telecommunications
FDTA	Foundations for Agricultural Technology Development
GDP	Gross Domestic Product
GMP	Good Manufacturing Practice
ICT	Information and Communications Technology
IDH	Direct Hydrocarbon Taxes
INE	National Institute of Statitics
INIAF	National Institute for Agricultural and Forestry Innovation
LACTEOSBOL	Bolivian Enterprise of Dairy Products
MDPyEP	Ministry of Productive Development and Plural Economy
MDRyT	Ministry of Rural Development and Lands
MSME	Micro, Small and Medium sized Enterprise
MSc	Master of Science

NIS	National Innovation System
OECD	Organisation for Economic Co-operation and Development
OTRI	Research Results Transfer Office
PAPELBOL	Bolivian Enterprise of Paper
PDTF	Manufacturing, and Technology Development Program
PhD	Doctor of Philosophy
PNCTI	National Plan of Science Technology and Innovation
PND	National Plan of Development
POA	Annual Working Plan
ProBolivia	Promoting Bolivia
R&D	Research and Experimental Development
RIS	Regional Innovation System
SBI	Bolivian Innovation System
SBPC	Bolivian System of Productivity and Competitiveness
SENASAG	National Service of Agricultural Sanitation and Food Safety
SIBTA	Bolivian Agricultural Technology System
SICD	Scandinavian Institute of Collaboration and Development
Sida	Swedish International Development Cooperation Agency
SITAP	Territorial Information System to Support Production
SME	Small and Medium Enterprise
S&T	Science and Technology
ST&I	Science Technology and Innovation
SUB	Bolivian University System
UDAPRO	Productive Analysis Unit
UMSS	Universidad Mayor de San Simón
USA	United Sates of America
USD	United States Dollar (Currency)
UTT	Technology Transfer Unit
UTTO	University Technology Transfer Office
VCyT	Vice-Ministry of Science and Tecnology
YPFB	Bolivian Enterprise of Oil Prosecutors Deposits

## Abstract

The concept of National Innovation Systems (NIS) has been widely adopted in developing countries, particularly in Latin American countries, for the last two decades. The concept is used mainly as an ex-ante framework to organize and increase the dynamics of those institutions linked to science, technology and innovation, for catching-up processes of development. In the particular case of Bolivia, and after several decades of social and economic crisis, the promise of a national innovation system reconciles a framework for collaboration between the university, the government and the socioproductive sectors. Dynamics of collaboration generated within NIS can be a useful tool for the pursuit of inclusive development ambitions.

This thesis is focused on inclusive innovation processes and the generation of co-evolutionary processes between university, government and socio-productive sectors. This is the result of 8 years of participatory action research influenced by Mode 2 knowledgeproduction and Technoscientific approaches.

The study explores the policy paths the Bolivian government has followed in the last three decades in order to organize science, technology and innovation. It reveals that Bolivia has an emerging national innovation system, where its demand-pulled innovation model presents an inclusive approach. Innovation policy efforts in Bolivia are led by the Vice-Ministry of Science and Technology (VCyT). Moreover, NIS involves relational and collaborative approaches between institutions, which imply structural and organizational challenges, particularly for public universities, as they concentrate most of the research capabilities in the country. These universities are challenged to participate in NIS within contexts of weak demanding sectors.

This research focuses on the early empirical approaches and transformations at Universidad Mayor de San Simón (UMSS) in Cochabamba. The aim to strengthen internal innovation capabilities of the university and enhance the relevance of research activities in society by supporting socio-economic development in the framework of innovation systems is led by the Technology Transfer Unit (UTT) at UMSS. UTT has become a recognized innovation facilitator unit, inside and outside the university, by proposing pro-active initiatives to support emerging innovation systems. Because of its complexity, the study focuses particularly on cluster development promoted by UTT. Open clusters are based on linking mechanisms between the university research capabilities, the socio-productive actors and government. Cluster development has shown to be a practical mechanism for the university to meet the demanding sector (government and socio-productive actors) and to develop trust-based inclusive innovation processes. The experiences from cluster activities have inspired the development of new research policies at UMSS, with a strong orientation to foster research activities towards an increased focus on socio-economic development. The experiences gained at UMSS are discussed and presented as a "developmental university" approach.

Inclusive innovation processes with co-evolutionary approaches seem to constitute an alternative path supporting achievement of inclusive development ambitions in Bo-livia.

*Keywords*: Bolivia, National Innovation Systems, Inclusive Innovation, Co-evolution, Developmental University, Cluster Development, Triple Helix, Mode 2, Technoscience.

Part 1

## **Chapter 1 - INTRODUCTION**

## 1.1 Background

Bolivia is a landlocked developing country with a population of about 10 million people. This is a multi-ethnic country organized geographically in nine regions. One of these regions is Cochabamba, where the experiences presented in this thesis took place. The Bolivian economy has been traditionally based on natural resources exploitation; natural gas and mining represent 87% of total earnings on export. Morales (2014) explained that since 2006, the Bolivian economy has been highly dependent on hydrocarbons exploitation, in hands of few large companies, characterizing it as a point source for taxes revenues. Mining, on the other hand, is focused on the exploitation of silver, tin, zing, and lead, whose exploitation has been in mainly charge of small companies and cooperatives, with just few medium and large companies. The dispersed production and fluctuating incomes in this sector (highly dependent on international prices), made it difficult for the government to get taxes revenues. However, the good international prices of hydrocarbons and minerals in the last decade, has allowed a growing tendency in the Bolivian economy, the highest in the last 30 years.

Policy reforms in the last ten years in Bolivia have been marked by the severe socioeconomic crisis left by the dictatorship (1964-1982) and neoliberal (1982-2005) governments. Most Latin American countries lived these governmental tendencies almost simultaneously. During the dictatorship period, Bolivia experienced an apparent economic prosperity because of international loans and good international prices for Bolivian exports, such as tin and oil. Nevertheless, that situation was followed by one of the largest foreign debt crisis in Bolivian history along with hyperinflation and strong social repression. Panizza (2009) explains that in such context free market reforms were perceived as the best solution for problems of the region, thus were adopted the reforms proposed by the "Washington Consensus". These reforms led the neoliberal period in Bolivia. Katz (2001) pointed out that neoliberal economies in Latin America prioritized opening up of domestic economies to foreign competition, deregulation of a vast array of markets, and privatization of public-sector firms. At the beginning, these measures helped to control the hyperinflation crisis in Bolivia. Nonetheless, Grugel, Riggirozzi, & Thirkell-White (2008) explained that during this period, the consecutive governments in Bolivia consistently failed to construct anything resembling a social consensus over the direction of the economy; the crisis of neoliberalism was manifested in a tendency to national disintegration, a loss of control by ruling elites and an inability even to crisis-management because of lack of economic resources. These measures increased dramatically poverty, inequality and unemployment in the country. Finally, dissatisfied public opinion about exporting hydrocarbons via Chilean ports triggered huge socio-political protests, which ended expulsing the then president and calling to new elections in 2005. In this context, a centre-left party rises to power in Bolivia led by Mr. Evo Morales. A new wave of centre-left governments in several Latin American countries brought a new set of reforms, policies and social common sense. This new period was named "post-neoliberalism".

Grugel & Riggirozzi (2012) elucidated that post-neoliberalism is a reaction against what came to be seen as excessive marketization at the end of the twentieth century and the elitist and technocratic democracies that accompanied market reforms. The political project associated with post-neoliberalism, which has sometimes been mistaken for a simple return to populism (Castañeda, 2006), is best understood as a call for a "new form of social contract between the state and the people" (Wylde, 2011) and the construction of a social consensus that is respectful of the demands of growth and business interests, sensitive to the challenges of poverty and citizenship. Evo Morales was elected president with a speech loaded with issues such as poverty and inequality, promising to implement new economy and development policies ensuring redistribution of wealth. Morales (2014) listed the more important measures adopted by the government as: "nationalization" of natural resources; ceilings and floors for interest rates; wage setting for the private sector, which is not limited to the minimum wage; establishment of barriers to foreign trade, although the average import tariff remains low; and maintenance of fuel prices at "artificially" low levels.

One of the key elements of that reform program was to bring forth a new political state constitution, which was approved in 2009 refunding Bolivia as the "Plurinational State of Bolivia". Several countries in Latin America have adopted similar strategies changing or transforming substantially their constitutions. Schilling-Vacaflor (2011) highlighted that the new Bolivian constitution strengthens the mechanisms of participatory democracy, incorporates enhanced social rights, and aims to establish a plurinational and intercultural state. One important early outcome of this processes was a national feeling of dignity recovered, along with recognition, inclusion and representation in the political power from the large traditionally excluded groups in society.

Redistribution measures, hitherto, has been accompanied by a moderate decrease of inequality in terms of extreme poverty (See Seery & Arandar, 2015). These measures have been focused on conditioned cash transferences of money to families through bonus and rents. Morales (2014) studies affirmed that conditioned transferences have proven to be an effective initial tool against extreme poverty. In fact, the Gini coefficient in Bolivia showed a decreasing trend from 56.9% in 2006 to 46.6% by 2012 ("World Development Indicators" 2015). Nevertheless, besides the starting positive results obtained, there is still the need to invest in long-term strategies for sustainable development. In this context, it has been widely recognized the need to generate national strategies to foster endogenous sources of science, technology and innovation (ST&I), as a path for development.

The new constitution also recognizes the important role of science, technology, and innovation in development processes. It points out the role of innovation as a process resulting from diverse institutional interaction within the country. The new constitution explicitly states in its chapter VI, section IV, article 103, part III:

"The State, universities, productive firms and services both public and private, nations and peoples of indigenous origin; native nations and agrarian groups, will develop and coordinate processes of research, innovation, dissemination, application, and transfer of science and technology to strengthen the productive base and promote the overall development of society, according to the law".

In these terms, important efforts have been initiated within the implementation of the "National Plan for Development 2006-2011". This plan proposed policies, strategies, programs for development, and gave a high priority to increasing capabilities in ST&I to support the productive sector. It also defined strategic sectors for productive development within a systemic approach through the creation of the Bolivian Innovation System (SBI), under the recently created Vice-Ministry of Science and Technology (VCyT). The plan also encouraged several ministries, like the Ministry of Agriculture and the Ministry of Plural Economy, to promote national supporting programs linked to innovation and competitiveness in the prioritized productive sectors. However, aside from those programs, core activities planned by the VCyT in the framework of the SBI were delayed, because of lack of allocation of resources. The main progress achieved to date, was developing a participatory process of planning for the SBI finished in 2013, and starting activities such as creating national research networks, national student contests, access to scientific databases, and diagnostic surveys measuring the national research capabilities.

## **1.2 Research Problems**

According to Yoguel, Lugones, & Sztulwark (2007), the main characteristics of neoliberal policies on Science and Technology (S&T) were: first, a general perception that public goods were dispensable because knowledge could be incorporated through the purchase of capital goods; second, the selection of prioritized industrial sectors was rejected, because it was the market that should lead the selection; and third, there were no policies that promoted networks, except by isolated experiences through horizontal polices. The post-neoliberal period in Bolivia started in 2006. Based on previous national experiences and the regional tendencies in Latin America, reforms in this period adopted National Innovation System (NIS) as an ex-ante concept framework to support technology-based development strategies. Nevertheless, hitherto, it has been an incipient progress in the allocation of resources, and policy regulation in ST&I, which promote institutional interactions in the system. One of the main lessons left by the contemporary history of Bolivia, particularly after neoliberal practices, was "*to stop importing development policies*". Therefore, new development policies have been focused on fostering participatory processes, generation of local institutional competences and creation of endogenous ST&I capabilities. In this context, this research will try to make a modest contribution over three main concerns summarized in the following paragraphs.

Firstly, the adoption of NIS in Bolivia has brought more questions than answers especially when it comes to effective strategies and policies for the reduction of inequality and poverty. Those aims together with social inclusion are extremely sensitive issues in the socio-economic context in Bolivia. Up to now, the VCyT has presented three versions of a plan promoting a national innovation system of ST&I (2007, 2010, and 2013). The last one was built after a wide consulting process. NIS dynamics involve internal institutional transformations towards co-evolutionary processes of interaction. Therefore, it is needed to study the evolving process of innovation policies generation and its implications from different institutional perspectives.

- Putting the plan in a socio-political context, analysing its components and dynamics proposed.
- Deliberating whether or not new national innovation policies drive institutional relations in Bolivia into own dynamics of innovation.
- Pointing out what the main considerations for policy-makers are, in terms of systemic learning and innovation processes for inclusive development ambitions.

Secondly, the role of universities has been increasingly recognized as a key factor in NIS and inclusive development strategies in low-income countries (Arocena & Sutz, 2014; Brundenius, Lundvall, & Sutz, 2009; Trojer, Rydhagen, & Kjellqvist, 2014). However, the nature of their role in regional economic development is less well understood than is often presumed (Bramwell & Wolfe, 2008). This long debate has put focus on important conceptual approaches like Mode 2 knowledge-production (Gibbons et al., 1994), Entrepreneurial University (Etzkowitz, 2008), Developmental University (Brundenius et al., 2009), and Technoscience (Haraway, 1988; Trojer et al., 2014). The "National Plan of Science Technology and Innovation (PNCTI)" (2013) recognized explicitly the key role of universities in knowledge generation processes oriented to solve socio-productive demands. Particularly the role of public universities, where they concentrate about the 61% of researchers and 74% of the research centres in the country VCyT (2011). Notwithstanding, the diagnosis presented by VCyT (2013) delineated some characteristics of the university sector:

- It showed sporadic interactions with the productive sectors lack of service offers.
- Its research activities have shown weak internal coordination between research centres, high dispersion, duplicity of efforts, fragmentation of research fields, and lack of diffusion of research results.
- The wide majority of them do not have developed research policies oriented to attending governmental and social needs.
- There is a disconnection at universities between pre-graduate and postgraduate training programs, with researching programs.

There is a need to develop institutional competences and linking mechanisms in public universities to enhance their role in innovation systems for regional socio-economic development, based on their own the institutional capabilities.

Finally, demand-pulled models of innovation and inclusive innovation system approaches require in practice contextualized mechanisms of interaction and participation. These mechanisms must allow government, university, and socio-productive sectors to meet one another, in order to face and create operative shared agendas of collaboration. Since these are built based on local organizations' capabilities, cultural factors, and interaction structures, there is a need to develop own local experiences of institutional collaboration in emerging innovation systems enhancing its self-organizing properties within co-evolutionary approaches.

## 1.3 Objectives

## 1.3.1 Main objective:

The main objective of this research is to develop knowledge about inclusive innovation processes focusing on the generation of co-evolutionary processes between the university, government and socio-productive sectors in Bolivia.

## 1.3.2 Specific objectives:

- a. To achieve the main objective, the research has the following specific objectives:
- b. To describe and analyse how national innovation polices are evolving in the framework of the Bolivian Innovation System.
- c. To develop and analyse university approaches in Bolivia to participate in innovation systems dynamics towards co-evolutionary processes with society.
- d. To develop and analyse local cluster approaches fostering innovation for inclusive development in the practice.

This licentiate thesis is covering an initial research about inclusive processes of innovation in Bolivia that will be deeper studied in the PhD thesis.

## 1.4 Research Questions

The main research questions boarded in this study are:

- a. How can Bolivian innovation policies evolve with own dynamics and characteristics?
- b. How can public universities in Bolivia develop internal mechanisms to participate in innovation systems, fostering co-evolutionary processes between science and society?
- c. Based on local experiences, how can clusters processes evolve to promote innovation for inclusive development aspirations?

## 1.5 Expected Outputs

a. The research provides some useful insights on the evolution of innovation policies in the last decades and explains why inclusive innovation is primarily relevant in the Bolivian context. It defines policy recommendations to make interactions in the system more dynamic, coordinated and socially inclusive.

- b. The research reveals and develops practices for public universities in Bolivia aiming to increase the incidence of their research activities in society. It also contributes to the research literature on "developmental university" approaches by enhancing the role of university technology transfer offices.
- c. This action-driven research develops local cluster experiences as a useful interacting mechanism for public universities. Cluster dynamics link specific research capabilities with the demanding socio-productive sector by developing innovation processes supporting inclusive development in their regions.
- d. The research contributes to perceive different institutional perspectives and levels fostering co-evolutionary processes for inclusive innovation systems.

## 1.6 Significance

As innovation systems are highly context-dependent, this thesis presents local initiatives that modestly contribute the (local experience-based) understanding of innovation processes and inclusive approaches. The research presents a robust concept framework for policy makers, academics and society in general. This study links concepts such as: National Innovation Systems, Inclusive Development, Triple Helix model of innovation, Developmental University, Mode 2 knowledge production, Co-evolution processes and Technoscience.

The thesis is focused on a participatory-action research approach performed at the "Universidad Mayor de San Simón (UMSS)", aiming to increase its institutional innovation capabilities and incidence on the socio-economic development in the Cochabamba region. In particular, those activities performed at the university Technology Transfer Unit (UTT), which inspired several aspects of the university research policy and the development of the current Bolivian innovation policies. These experiences can be useful tools, fostering more dynamic relations between the academic sector at UMSS, the domestic demanders of ST&I and the local and national governments. The experiences presented try to grasp how some mechanisms contribute the democratization of knowledge, based on pro-active institutional attitudes, to linking university research capabilities with the socio-productive sectors. These experiences were matured from within a context of lacking demanding dynamics and low-income socio-productive sectors.

These experiences presented can enrich discussions in other developing countries in general and in particular in Latin America, where our institutional structures have shaped our capability to survive and innovate in adverse conditions.

## Chapter 2 – CONCEPTUAL AND METHODOLOGICAL CONSIDERATIONS

## 2.1 Conceptual Framework

This work is guided by several concepts complementing one another in the practice. The conceptual framework presented helped the authors of this study to simplify, describe, and analyse a complex reality.

## 2.1.1 National Innovation Systems

Edquist & Hommen (1999) point out that theories of innovation process can be classified as being linear or systems-oriented. On the one hand, linear views of the innovation process support a supply-side orientation in innovation policies. On the other hand, systems perspectives on innovation yield a much more fruitful perspective on the demand side, in terms of both theoretical and policy relevance.

The concept of National Innovation Systems (NIS) was introduced during the 1980's and early 1990's by authors like Christopher Freeman, Bengt-Åke Lundvall, and Richard Nelson. Lundvall (2010) explains that the development of the concept of NIS was mainly based on two assumptions: First, it is assumed that the most fundamental resource in the modern economy is knowledge and, accordingly, that the most important process is learning. Second, it is assumed that learning is predominantly an interactive and, therefore, a socially embedded process, which cannot be understood without taking into consideration its institutional and cultural context. On these basis Lundvall, Vang, Joseph, & Chaminade (2009) propose the following definition:

"The national innovation system is an open, evolving and complex system that encompasses relationships within and between organizations, institutions and socio-economic structures which determine the rate and direction of innovation and competence-building emanating from processes of science-based and experience-based learning."

Arocena & Sutz (2003) analysing the concept from the perspective of underdevelopment in the South highlighted the following aspects:

- NIS is an ex-post concept, built in the North on the basis of empirical findings, although in the South it is an ex-ante concept.
- The NIS concept carries a normative weight.
- The concept is fundamentally relational.
- The NIS concept has policy implications.

In the case of Bolivia, it is an ex-ante concept framework used to inspire the creation of innovation policies and promote relationships in the context of emerging innovation systems. Chaminade, Lundvall, Vang, & Joseph (2009) explain that an emerging innovation system is a system where only some of its building blocks are in place and where the interactions between the elements are still in formation. In this context, innovation policies are crated to support development goals according to the their specific socio-economic institutional context.

## 2.1.2 Inclusive Innovation Systems

The concept of inclusiveness is related to social equity, equality of opportunity and democratic participation (Papaioannou, 2014). When considering the link between innovation systems and developing countries, one cannot escape the problems of poverty and inequality so deeply embedded in the socio-economic context of these countries (Cozzens & Kaplinsky, 2009). In a Latin American context characterized by the absence of active product redistribution policy and transformation of firms' absorptive capacities, a traditional innovation approach could result in the increase in the productivity gap between sectors and thus in the increase in inequality within countries (Bortagaray & Gras, 2014). Social inclusion aspects have been recently incorporated explicitly in development agendas and as part of innovation policies in several Latin American countries. This action responds to historical social claims of inclusion, which was aggravated by the crisis generated during the neoliberal period.

In the framework of the NIS dynamics and its relation with underdevelopment, Arocena & Sutz (2012) explained that high inequality implies that important social needs do not express themselves as effectivedemand for innovations; since high inequality constrains the available stock of capabilities, it also affects the supply side of innovations. Furthermore, Cozzens & Kaplinsky (2009) point out that innovation and inequality co-evolve with innovation sometimes reinforcing inequalities and sometimes undermining them. These conditions are highly evident in the Bolivian context, where critical socio-productive structural problems have created weak institutional linkages between the knowledge generating sector and a wide demanding sector, formed not only by the productive sector but with other society actors as well. Bortagaray & Gras (2014) highlighted that the distinctive character of inclusive innovations is that they are triggered by social demands or needs, and the social objectives are, at least, as important as the economic ones.

Foster & Heeks (2013) explain that conventional views of innovation (often implicitly) understand development as generalized economic growth. By contrast, inclusive innovation explicitly conceives development in terms of active inclusion of those who are excluded from the mainstream of development. Differing in its foundational view of development, inclusive innovation therefore refers to the inclusion within some aspect of innovation of groups who are currently marginalized. Additionally, George, McGahan, & Prabhu (2012) defined inclusive innovation as the development and implementation of new ideas, which aspire to create opportunities that enhance social and economic wellbeing for disenfranchised members of society.

Inclusive innovation approaches are important elements in the path of a higher aim, which is inclusive development. Johnson & Andersen (2012) define inclusive development as follow:

"Inclusive development is a process of structural change, which gives voice and power to the concerns and aspirations of otherwise excluded groups. It redistributes the incomes generated in both the formal and informal sectors in favour of these groups and it allows them to shape the future of society in interaction with other stakeholder groups."

The challenge for Latin American governments is to generate national innovation systems able to develop inclusive processes of innovation and learning. Bortagaray & Gras (2014) analysis suggested that the main barrier to implement this type of social or inclusive innovation is the lack of a general framework from which to establish what is the demand or need, how to assess it and satisfy it, how to turn that demand into a source of opportunities for knowledge production. In this sense, other complementary concepts were needed in this work to explore the processes and relationships from where innovation and learning take place, particularly from the perspective of inclusivity.

## 2.1.3 Triple Helix model of innovation

The Triple Helix model of innovation was developed by Henrry Etzkowitz and Loet Leydesdorf in the 1990s. This model is used in this study as a fundamental relational configuration needed to configure complex innovation and learning processes in developing countries. Etzkowitz (2008) explains that a triple helix regime typically begins as university, industry, and government enter into a reciprocal relationship with each other in which each attempts to enhance the performance of the other.



Figure 2.1: The Triple Helix Model of University-Industry-Government Relations Etzkowitz et al., (2000)

Sunitiyoso, Wicaksono, Utomo, Putro, & Mangkusubroto (2012) summarized the three dimensions developed by Etzkowitz to explain the evolution of the dynamics subjacent to the model:

- The first dimension of the triple helix model is internal transformation in each of the helices, such as the development of lateral ties among companies through strategic alliances or an economic development mission by universities.
- The second dimension is the influence of one helix upon another.
- The third dimension is the creation of a new overlay of trilateral networks and organizations from the interaction among the three helices.

The Triple Helix model presents a practical and useful structure that allows building a concrete framework of understanding for emerging innovation systems in developing countries, as is the case of Bolivia.

## 2.1.4 Developmental University

The role of universities in national innovation systems is still in debate in Latin American countries, particularly when it comes to public universities, where most of these countries have concentrated a significant segment of their research capabilities. Sutz (2012) explained that underdevelopment can be very partially but not inaccurately characterised as an "innovation as learning" systemic failure. A systemic failure is defined as the inability of a system of innovation to support the creation, absorption, retention, use and dissemination of economically useful knowledge through interactive learning or in-house R&D investments (Chaminade et al., 2009). From this context, especially looking into Latin American emerging national innovation systems, the context of "developmental universities" arises, thinking of a more socially inclusive knowledge production at universities. Brundenius et al. (2009) explain that the term "socially inclusive knowledge production" is used to emphasize the purposeful action towards producing knowledge with the explicit aim of solving some of the pressing problems of those "being excluded from common facilities or benefits that others have". This aim can be extended to the support of production, particularly for smalland medium- enterprises that find it particularly difficult to buy ready-made solutions

in the world market, and could benefit from a more "tailor-made" approach to their knowledge needs.

Arocena, Göransson, & Sutz (2015) pointed out that developmental universities are those involved in the promotion of processes of learning and innovation for fostering inclusive development. The idea of a developmental university is an important framework for the Bolivian case, because it is useful and represents the current context linked with the institutional values in society. This concept draws challenges and a vision for universities, especially for public universities, by proposing internal transformations and proactive attitudes supporting local development issues. Arocena et al. (2015) remark that such universities are committed specifically to social inclusion through knowledge and, more generally, to the democratization of knowledge along three main avenues: democratization of access to higher education, democratization of research agendas and democratization of knowledge diffusion.

#### 2.1.5 Mode 2 Knowledge Production

The mixing of norms and values in different segments of society is part of a diffusion process which at the same time fosters further communication among them by creating a common culture and language (Gibbons et al., 1994). The different approaches described above offer a good concept framework of the purpose, the components, and the relationships needed to create dynamic innovation and learning processes in society. Nevertheless, when it comes to the practice at the bottom of the pyramid, still are needed deeper approaches on the question of how knowledge and innovation are generated to solve specific problems in society in a transdisciplinary context. Nowotny, Scott, & Gibbons (2013) argued that changes in scientific knowledge production as well as other socio-economic and politico-cultural transformations are characterized by co-evolutionary processes. These processes consist in relationships that are neither causal nor linear, but reflexive and interactive.

Gibbons (2000) explained that in Mode 1, problems are set and solved in a context governed by the, largely academic, interests of a specific community. By contrast, in Mode 2, knowledge is produced in a context of application involving a much broader range of perspectives; Mode 2 is transdisciplinary, not only drawing on disciplinary contributions but can set up new frameworks beyond them; it is characterised by heterogeneity of skills, by a preference for flatter hierarchies and organisational structures which are transient. It is more socially accountable and reflexive than Mode 1.Mode 1 and Mode 2 each employ a different type of quality control. Peer review still exists in Mode 2 but it includes a wider, more temporary and heterogeneous set of practitioners, collaborating on a problem defined in a specific and localised context. Thus, in comparison with Mode 1, Mode 2 involves a much expanded system of quality control. The Mode 2 knowledge production concept looks for the contextualization of the knowledge production and studies its processes of generation based on the creation of a shared and wider research agenda within society. This concept studies the process of dialogue between the demanding sector and users with the traditionally isolated academic processes of knowledge generation.

## 2.1.6 Technoscientific approach

Close to the epistemological and practice-driven approach of Mode 2 is the Technoscientific approach developed at the research division of Technoscience studies at Blekinge Institute of Technology (BTH). Citing the paper "Inclusive innovation processes – experiences from Uganda and Tanzania" Trojer, Rydhagen, Kjellqvist (2014) illustrated some bases of the Technoscientific approach.

It is important to recognize that knowledge always is situated as it grows in specific contexts, as e.g. Haraway (1988) gives profound accounts of. Knowledge transfer is thus always difficult, and may be particularly so when people with scientific schooling, administrative drill and entrepreneurial skill move out of their habitual context to meet people in informal settings. Haraway's proposal is to recognize and admit the localisation of 'knowledges' in bodies, including our own, to be aware of the symbolic meanings of the knowledge that we hold and that it might differ from others' symbolic meanings. To live with and make use of the 'situatedness' "... we do need an earth-wide network of connections, including the ability to partially translate 'knowledges' among very different – and power-differentiated communities" (1988:580). If so, different ways of articulating a demand for knowledge might be recognized and acknowledged.

Knowledge has been shown to spread in locally established clusters, where social bonds and trust through face-to-face interaction facilitate sharing of relevant and specific knowledge.

## 2.1.7 Cluster Development

The Mode 2 and Technoscientific approaches explain that the determinants of a potential solution involve the integration of different skills in a framework of action. However, the consensus may be only temporary depending on how well it conforms to the requirements set by the specific context of application. Looking at the "not yet" dynamic context of relations within the Bolivian Innovation System, it is imperative to start developing stable platforms of action and consensus between the organizations involved in concrete innovation and learning processes. These platforms catalyse linking processes, institutional dialogue, networking, and trust building around specific socio-economic fields.

One alternative comes from the concept of cluster which originally was defined by Porter (2000) as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and associated institutions (e.g. universities, standards agencies, trade associations) in a particular field, cluster firms compete but also cooperate".

Nevertheless, when it comes to the precarious conditions of the productive sector in Latin America, Parrilli (2007) describes the emergence of clusters formed by small and medium enterprises (SME) so-called "survival clusters". These clusters are formed by micro and small craft firms, working with obsolete technology and manual techniques to produce, with no division and specialisation of labour, low-quality non-standardised goods for low-income consumers in local markets.

These are the conditions of most the Bolivian SME's where their relevance lies on the fact that, like in most Latin American countries, SME's comprises the largest share of firms, employment and gross domestic products. Additionally, based on his empirical

work in Latin American countries, Parrilli (2007) suggests how to improve SME cluster development formulating the "stage and eclectic" approaches:

- The "stage approach" is linked to the need of identifying the characteristics of each cluster and its effective potential to grow, which cannot be independent from the present development stage. Targeting feasible and progressive stages of development for dynamic "survival clusters" can help these local production systems respond to the new challenges represented by globalisation and to face the threatening entry of new competitive production systems in the world market.
- The importance of an "eclectic approach" is emphasised and linked to the need of considering the relevance of several different determinants of development. These determinants are the ones that the main streams of literature on SME cluster development (i.e., "collective efficiency", "social embeddedness" and "policy inducement") identified over time.

This concept offers an operative framework to build dialogue and consensus forums to link the demanding socio-productive sectors in Bolivia with the academic sector. These clusters allow melting all the concepts mentioned above congregating the actors in a trust building process and bottom-up contributions to the NIS's dynamics.

## 2.2 Methodological considerations

The necessity of involvement in the context of technological development as wellas in the context of use is connected to the large-scale introduction of very complex technologies that have consequences for the sustenance of life on our planet (Rydhagen, 2002). Mode 2 and Technoscientific approaches have inspired my 8 years practices in the Technology Transfer Unit (UTT) at the Universidad Mayor de San Simón (UMSS). During those years, UTT transformed its competences and encouraged UMSS to enhance its participation within innovation systems. I worked at UTT developing internal networks within UMSS, research projects, and cluster development linking the university sources with government and producers. Thus, I chose participatory action research as my main research method. McIntyre (2008), explained that this approach is characterized by:

- the active participation of researchers and participants (in this case socio-productive actors, researchers and government officers) in the construction of knowledge
- the promotion of self- and critical awareness that leads to individual, collective, and/or social change
- an emphasis on a co-learning process where researchers and participants plan, implement, and establish a process for disseminating information gathered in the research project.

The research included a process of literature review about the concepts mentioned above, and international experiences on these issues. The papers presented are based on a local practice-driven research, with specific personal experiences as cluster facilitator of the Food Cluster Cochabamba at UTT (6 years), co-facilitator in the National Research Food Network at the VCyT (2 years). These experiences included meet-

ings, workshops, activity planning, projects design, research planning, interviews, and project implementation. Additionally, the study included a review of official documents about national policies of innovation in Bolivia in the last 30 years. These documents included for example, the last National Plan of Science, Technology and Innovation, laws and regulations, research databases. Finally, co-authoring with two recognized innovation practitioners in the country has enriched two of the papers presented in this thesis. One of the co-authors represents to the policy-maker perspective working currently at the VCyT in charge of the Bolivian Innovation System secretariat. The other one comes from the university side promoter of the Technology Transfer Unit and the Innovation Program at UMSS, thus attempting to reflect transdisciplinary discussions also in my research work.

My ambition with this study is, particularly, to reach Bolivian policy-makers and academics, in order to enrich and in some cases open debates about the issues presented in this study. This study seeks to inspire researchers in developing countries, linking the different concepts presented, looking at them as drivers of inclusive innovation purposes. Additionally, the papers presented in this thesis will be translated into Spanish to make their diffusion easier in the Latin American community.

Part 2

## **Chapter 3 – PAPERS**

## 3.1 Introduction to the Papers

This licentiate thesis is a compilation of three papers as outlined below.

**Paper I**: Acevedo, C. G., Céspedes, W. M. H., & Zambrana, J. E. (2015). *Bolivian Innovation Policies: Building an Inclusive Innovation System*. Journal of Entrepreneurship and Innovation Management, Vol 4, Issue 1, June 2015, pp. 63–82.

*Abstract*: This study explores the policy paths the Bolivian government has followed in the last three decades to organize science, technology, and innovation. We present strategies proposed by the government to make its National Innovation System more dynamic and socially inclusive. We analyse the process and strategies followed under the light of the Triple Helix (government-industry-university) model of innovation.

*Keywords:* National Innovation System; Triple Helix; Inclusive Innovation; Developing Countries; Bolivia.

**Paper II**: Acevedo, C. G., Céspedes, W. M. H., & Zambrana, J. E. (2015). "Developmental University" approaches in developing countries: Case of the Universidad Mayor de San Simón, Bolivia.

*Abstract*: This paper presents the case of the Universidad Mayor de San Simón (UMSS) where pro-active institutional efforts have shaped collaborative dynamics categorized

as a "developmental university" approach. This study offers some empirical insights about the role of public universities in emerging inclusive innovation systems within a lack of demanding context, in Bolivia. This is a participatory action research performed at the university technology transfer office. These experiences developed new institutional competences for this university unit as innovation intermediary and manager, promoting co-evolutionary processes of collaboration between the university with the demanding sectors of science, technology and innovation.

*Keywords*: Developmental University; Inclusive Innovation Systems; Technology Transfer Office; Mode 2; Cluster Development; Bolivia

**Paper III**: Acevedo, C. G. (2015). Cluster initiatives for inclusive innovation in developing countries: Food Cluster Cochabamba, Bolivia.

*Abstract*: This paper presents the case of the Food Cluster Cochabamba, which was created by a public university as a mechanism to increase the relevance of its research activities in the context of a developing country. This experience enhances the role of university technology transfer offices in emerging innovation systems; it moreover, explores the role of clusters as university mechanisms to develop inclusive innovation processes in developing countries.

*Keywords*: Cluster Development; Inclusive Innovation; Developmental University; Innovation Systems; Bolivia.

## 3.2 Paper I

## Bolivian Innovation Policies: Building an Inclusive Innovation System

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## 1. Introduction

Bolivia, as many other countries in Latin America, is creating policies and institutions and building networks to strengthen the dynamics of its National Innovation System (NIS). This more systemic view of the innovation processes explicitly recognizes the potentially complex interdependencies and possibilities for multiple kinds of interactions between the various elements of the innovation process (Edquist et al., 1999). The Bolivian government uses this systemic approach at the policy level to unify strategies and gather national institutions to address social priorities such as poverty and inequality reduction, food safety, and interactive local production of knowledge as well as to increase industrial competitiveness.

We start this study by briefly introducing the concept of NIS and its relevance for developing countries focusing on Latin America. Then we present a narrative description of the main policies and institutional context promoted to organize science, technology, and innovation in Bolivia since the end of the dictatorship period. Finally, we analyse the "National Plan of Science, Technology and Innovation" under the light of the Triple Helix model of innovation, used as a tool to discuss the characteristics of the model adopted in Bolivia.

## 2. National Innovation Systems (NIS)

## 2.1 Concept framework

The concept of National Innovation System (NIS) enhances the role of innovation and interactive learning in economic growth and development within national borders. Lundvall et al., (2009) define the national innovation system as an open, evolving, and complex system that encompasses relationships within and between organizations, institutions, and socio-economic structures, which determine the rate and direction of innovation and competence-building emanating from processes of science-based and experience-based learning.

Based on the successful experiences in developed countries, sooner rather than later, the NIS concept was also introduced in developing countries as a conceptual framework to create new policies and strategies to organize science and technology as well as the production and diffusion of knowledge for development responding to urgent social needs. Developing countries are less developed in terms of institutional composition, sophistication of scientific and technological activities, and linkages between organizational units (Kayal, 2008), thus strategies that could work in some countries could do not work as well in another. Thereby - according with the innovation system approach - innovation is considered to be deeply dependent on the local specificities of social, political, and economic relations, being therefore directly affected by both history and the particular institutional context of countries or regions where it occurs (Scerri et al., 2013).

We use in this study the Triple Helix approach developed by Henry Etzkowitz as a starting perspective to understand and discuss interactions between the main institutions in the Bolivian innovation system development process. Arocena et al. (2000), cited by Etzkowitz et al., (2003), point out that the Triple Helix explains the formation and consolidation of learning societies, deeply rooted in knowledge production and dissemination and a well-articulated relationship between university, industry and government. The model helps explain why the three spheres keep relatively independent and distinct status, shows where interactions take place, and explains why a dynamic triple helix process can be formed with gradations between independence and interdependence and conflict and confluence of interest (Etzkowitz, 2008).



Figure 3.1: The Triple Helix Model of University-Industry-Government Relations Etzkowitz et al., (2000)

This model can be used at different levels (macro-meso-micro) within a nation as an operative framework to strengthen innovation policies and mechanisms proposed according to the local context and priorities. Triple Helix strategies are especially important to less-developed countries and in particular to Latin American countries with scarce R&D activities undertaken by firms, and mostly concentrated at universities and research institutes (de Mello et al., 2008).

## 2.2 NIS in Latin America

Alcorta et al., (1998) locate the origins of national research coordinating organizations in Latin American countries in the 1950s, with the creation of the first national councils for science and technology (the National Institute for Scientific Research - Mexico, 1950; the Brazilian National Research Council - Brazil, 1951; and the National Council for Science and Technology – Argentina, 1958). During the 1960s and 1970s, a significant number of Latin American countries established some form of systemic policy thinking to develop science and technology (S&T) organizational structures. The mere creation of such institutions, however, did not make them operational or dynamic, and in some of the countries (Bolivia, Paraguay, and Nicaragua) S&T plans as well as the so-called S&T funds existed on paper only (Velho, 2004).

In 1964, a wave of military coups (that began with the Brazilian coup) started in Latin American's governments, and lasted until the first half of the 1980s. The relationship in this period between the state and the industrial sector was important, but it was not focused on innovation (Arocena et al., 2000). Influential thinkers in Latin America argued that the way in which the research councils were operated was "marginalising" local science from local needs. They associated this with the character of the industrialization model adopted – defined by its reliance on technology transfer – which did not require local R&D activities but only the accumulation of specific capabilities to operate technology developed elsewhere (Velho, 2004).

The end of the dictatorship period was followed by a democratic transition - so called neo-liberalism - proposing macroeconomic policy and economic reforms highly influenced by the Washington Consensus. This model prioritizes the opening up of domestic economies to foreign competition, the deregulation of a vast array of markets, and the privatization of public-sector firms (Katz, 2001). All of these measures, but primarily the latter, were implemented with wide opposition from social movements. Yoguel et al., (2007) describe three main characteristics of S&T policies of that time: first, a general perception that public goods were dispensable because knowledge could be incorporated through the purchase of capital goods; second, the selection of prioritized industrial sectors was rejected, because it was the market that should lead the selection; and third, there were no policies that promoted networks, except by isolated experiences through horizontal polices.

Eventually, political and economic breakdowns in Venezuela after 1998 and in Argentina after 2001 and widespread social protests in Ecuador and Bolivia in the early years of the twentieth century culminated in the election of governments committed to the introduction of counter-cyclical policies, programmes of national (and sometimes regional) economic investment, and the extension of social policy coverage (Grugel et al., 2012). These events opened the scenario up to a new attempt to build a more democratic and socially oriented economic model in Latin America called post-neoliberalism (find more in *"Contemporary Latin America: development and democracy beyond the Washington Consensus"* by Panizza, 2009). Grugel et al., (2012) assert that post-neoliberalism is not so much an attempt to return to state capitalism as it is an attempt to refashion the identity of the state, redefine the nature of collective responsibilities, build state capacity, and rethink who national development is for. In this context, a renewed set of strategies for development has emerged in Latin America. Post-neoliberal governments look at NIS as a tool to orient science, technology, and productive structures to achieve sustainable national development. Under these conditions, the concept of inclusive innovation has been enhanced at the time that governments strengthen national innovation systems involving social actors in the decisionmaking process.

#### 3. Bolivian innovation policies

## 3.1 Background

The Bolivian GDP increased 6.8% and 5.4% in 2013 and 2014 respectively following a positive tendency in the last decade. The rate of growth in 2013 was the highest in the last thirty-eight years (Central Bank of Bolivia, 2013). The main economic activities that contributed to this growth were: crude oil and natural gas exploitation, financial services, charges for bank services, and internal revenue (INE, 2014). This performance follows the positive tendency in the Latin American region in the last years and exposes the high dependence on natural resources exploitation.





During the last thirty years, the Bolivian government has created institutions and established councils at the national and regional levels as an attempt to organize S&T. After the dictatorship period ended in 1982, Bolivia found itself in an instable transition to democracy. At the beginning, Bolivia experienced an apparent economic prosperity because of international loans and good international prices for Bolivian exports, such as tin and oil. Nevertheless, that situation was followed by one of the largest foreign debts crisis in Bolivian history, along with hyperinflation that destroyed the purchasing power of the population. During the 1990s, like many countries in Latin America, Bolivia followed several economic reforms including an extensive privatization of the state enterprises and reduced spending in social services. Arriarán, (2007) considers that the transition to democracy in Bolivia seemed to be characterized by a kind of divorce between the economic and the political. The economy was, in fact, stabilized (stopping hyperinflation). However, it was done based on a model that paradoxically widened social gaps and neglected distributional and equity aspects.

In 2000, the Bolivian Agricultural Technology System (SIBTA) was created under the Ministry of Agriculture as a funding and technology diffusion mechanism to support the agricultural sector. The SIBTA supported agricultural research and extension, creating four regional semiautonomous foundations (FDTAs): *highlands, valleys, tropical, semiarid lowlands* (Chaco). The evaluation of Hartwich et al., (2007) of this experience suggested that to foster efficient agricultural innovation processes in a decentralized funding scheme such as the SIBTA's approach, the government needs to actively establish priorities, assure that others participate, guarantee transparency and accountability, maintain responsiveness to the demands of users, focus on impact, delegate administrative responsibilities to local agencies that are closer to the farmers, strengthen linkages among the various innovating agents, and provide a strategic vision.

The Ministry of Planning of Development created other systemic initiatives in 2001 with the Bolivian System of Productivity and Competitiveness (SBPC). This initiative introduced a new understanding of the industrial sectors as regional productive chains and proposed mechanisms to organize institutions such as universities, industry, and public bodies around this perspective. At the regional level, Departmental Committees for Competitiveness (CDC) were created in 2004 as operative tools for the system. They were supported by international cooperation, promoting agreements with regional institutions such as universities and suggesting regional strategies based on studies of local productive chains. There were 18 productive chains studied, generating important information but mostly proposing strategies difficult to replicate in the unstable Bolivian context. Eventually, the CDCs became more decentralized from the SBPC, focusing on supporting the medium-large private industries at the regional level. The general reflections of Hartwich et al., (2007) about the Bolivian systemic approaches during the neoliberalism period state that governance in innovation systems is less about executing research and administering extension services and more about guiding diverse actors involved in complex innovation processes through the rules and incentives that foster the creation, application, and diffusion of knowledge and technologies.

#### 3.2 Plans, reforms and support structures 2006 - 2014

A new government was elected in December of 2005 with a strong indigenous rhetoric and brought significant social stability by increasing the political participation and power of the traditionally excluded indigenous groups and other social movements. The recovery of the social and indigenous esteem was an early effect of these measures involving an important participation of social and indigenous movements in consultation and governance processes. The new government enjoyed a wide majority in the parliament, which allowed it to push forward larger reform processes with the main goal of creating a new political state constitution (CPE), which was approved in 2008 by the Congress of the Nation.

With the new CPE, Bolivia adopted a new *plural* economic model, so-called "nationalproductive" model (García, 2008). This model recognizes several forms of economic organizations - community, state, private, and social cooperative - and is mainly focused on an active participation of the government in economy, the industrialization of natural resources, a focus on social needs, and the redistribution of wealth.

The government started the reforms with the nationalization of key industries, reaching 19 firms by 2014: (e.g.: YPFB (*hydrocarbons*), 2006; Huanuni (*mining*), 2006; EN-TEL (*telecommunication*), 2007; Vinto (*smelter*), 2007; Air BP (*jet fuel*), 2009; Corani (*electricity*), 2010). Another early measure implemented was to reduce the president's salary, which implies by law that no other public servant can earn more than the president. According to the Ministry of Economy and Finance, the president's salary was 18,800 BOB per month by 2014, or about 2,845 USD. This austerity measure limits the possibility of economically incentivizing the research community (at public universities) that increase their current activities (researching and teaching) by participating in future initiatives that encourage collaboration with productive actors and the government.

In 2006, the Ministry of Planning and Development presented the "National Plan for Development 2006-2011" (PND), later approved by a supreme decree in 2007. This plan was important for the new political reforms, because it was used as reference for following actions at the national and regional levels. The plan proposed policies, strategies, programs for development, and gave a high priority to increasing capacities in science, technology, and innovation to support the productive sector. It also defined strategic areas for productive development with a systemic and socially inclusive approach through the creation of the Bolivian Innovation System (SBI). The plan oriented Bolivian governmental institutions to face the challenges of gathering and organizing all the actors of the system in order to find technology-based solutions, while recognizing and including ancient indigenous (non-academic) knowledge in the process of innovation as well.

The responsibility of the SBI lies in the Vice-Ministry of Science and Technology (VCyT), created in 2006 under the Ministry of Planning and Development. In 2007, the VCyT presented a proposal to establish the SBI, which schematizes institutional complexity and relations between the actors, and identifies 15 geographical sub-regions based on productive and cultural similarities to increase the scope of the actions (Carvajal et al., 2007). In 2009, the VCyT was moved to the Ministry of Education, but remained in charge of promoting the SBI. The VCyT prepared a new planning draft in 2009, and after an extended participatory consulting process, published an official version in 2013. This plan is focused on long-term strategies for the period

2014-2025. It seeks the development of human and institutional capacities under the rhetoric of sovereignty in science and technology with the perspective of social inclusivity. We will discuss the strategies presented in the plan in more detail in the following section. Meanwhile, we mention other initiatives carried by other ministries according to the framework of the Bolivian Innovation System presented in the PND, but independently from the VCyT's proposal.

In 2008, the National Institute for Agricultural and Forestry Innovation (INIAF) was created under the Ministry of Rural Development and Lands (MDRyT). It was formed following the PND guidelines as a component of the Bolivian Innovation System (SBI). It is a decentralized institution with the aim of establishing guidelines, implementing policies, and generating technologies for agricultural and forestry innovation. This institution replaced the functions of the former SIBTA. The INIAF supports farmers and seed suppliers to increase the productivity on prioritized sectors (wheat, potatoes, corn, rice, vegetables, livestock and forage, quinoa, forests and sugarcane). The INIAF seeks to increase the scope and impact of the former experiences by using participatory and inclusive mechanisms to build consulting platforms at four levels: national, regional, local, and by product. These platforms involve researchers, local producers, institutions (private, public and mixed), and agents from the government at all levels.

On the other hand, the Ministry of Productive Development and Plural Economy (MDPyEP) implemented three strategies to strengthen the productive sector according to the PND guidelines. In 2008, the MDPyEP created three decentralized development agencies - ProBolivia, Insumos Bolivia, and Promueve Bolivia - with the aim of changing the productive matrix and supporting competitiveness in the manufacturing sector. At the same time, a new norm was approved that allows these agencies to execute public-public and public-private financial transfers. In this way, in 2012 these agencies started promoting contests as a strategy to motivate public-private as well as academic and non-academic partnership for innovation projects in prioritized sectors (food, leather, wood, metal-mechanic, textile, and handicrafts). A second strategy was the creation of "productive complexes" (regional clusters) supported by the regional governments based on the capacity of the local productive chains. The productive clusters will be technically strengthened by productive centres for innovation (CIP) in collaboration with public universities and regional governments. The third strategy to change the productive matrix was the creation of state enterprises in strategic national priority areas (in addition to those ones nationalized). By now, five new state enterprises have been built (LacteosBol (dairy products), 2007; PapelBol (paper), 2007; CartonBol (cardboard), 2010; EceBol (cement), 2008; and Eba (almond), 2009), but there are many others pending. In order to manage this process, the Development Service for State Enterprises (SEDEM) was created. These state enterprises seek to ensure the supply of basic products for the population and the industry, but a lot of controversy was generated around unfair competition from the state with the local-private industries. Anyhow, it is part of the strategy adopted by the government to mobilize resources and strengthen the national economy. Most of these strategies are in the very first phases

of implementation. Follow-up studies will complete analysis and will determine their impact on the society.

In 2012, the Ministry of the Presidency started a wide consulting process to create a long-term roadmap for national development so-called *"The Patriotic Agenda: Bolivia towards 2025."* This document was presented in 2014 with the aim of continuing the reform process started with the National Plan for Development (PND). The Patriotic Agenda was built based on 13 core guidelines, identifying science and technology explicitly in the 4<sup>th</sup> guideline as *"sovereignty over identity and development of science and technology."* In that section, innovation is located in the core of the proposal and is considered a result of a process of systemic convergence that involves the academic sector, the government, the productive sector, and the native-indigenous sector (both as knowledge-generators and users of science and technology) as main actors.

## 3.3 General Comments

The Bolivian government promotes several initiatives around the systemic vision of innovation for development, looking for a closer partnership between the academic, the productive, and the governmental sectors to reduce poverty.

We have considered the initiatives presented by the VCyT as a core element in the system, which is in charge of organizing institutions for innovation to give a conceptual framework and promoting policies to make it more dynamic. However, we argue that the dimension of the current Bolivian Innovation System exceeds the scope of the System of Innovation under the VCyT, which responds mainly to the Ministry of Education's concerns, but is complemented mainly by the initiatives of the Ministry of Agriculture and the Ministry of Productive Development. We expect in the short-term the Patriotic Agenda and its executing organisms to coordinate (at the highest level) all the systemic initiatives to promote innovation for sustainable social development.

## 4. National Plan for Science, Technology and Innovation (PNCTI)

## 4.1 Main components of the PNCTI

In 2013, the VCyT presented a National Plan for Science, Technology, and Innovation (PNCTI). It was the result of a graduated consulting process that involved 940 representatives of the three main sectors identified in the system (667 academic, 141 social-productive, and 132 government). In this plan, the VCyT defines the Bolivian System for Science, Technology, and Innovation (ST&I) as follows:

"The set of interrelated and complementary actors, using science, technology, and innovation in a coordinated and constructive form that generates integral solutions for productive, social, and environmental problems, with a focus on participatory equitable and sustainable development." (VCyT, 2013)

The plan is organized in two phases of implementation; the first one (2014-2019) looks to strengthen the system, and the second one (2020-2025) looks to consolidate the system according to the challenges proposed in the *"Patriotic Agenda: Bolivia through 2025."* 

The PNCTI presents eight prioritized sectors to be fortified: health; agricultural development; industrial and manufacturing transformation; local and ancient non-academic knowledge; natural resources, environment and biodiversity; energy; and mining.

The Bolivian System of ST&I was presented in terms of the interactions (demandpulled) between three main sectors: the knowledge-generating sector, the science and technology demanding sector, and the government sector. The VCyT presents a Triple Helix approach formed by bilateral relations among the government, the knowledgegenerating sector, and the sector that demands science, technology, and innovation. These sectors are defined in the PNCTI as follow:

- *The governmental sector* involves all the entities with the capacity to generate, regulate, promote and implement policies related to science and the technological development of the nation. The main representatives of this sector are the Ministry of Education, the Vice-Ministry of Science and Technology (VCyT), and institutions yet to be created to support the system according with the plan.
- *The knowledge-generating sector* involves universities, public and private research centres, and the local and ancient non-academic knowledge developed by indigenous groups. The role of this sector includes activities of human training skills for research, technology development, technology transfer, and professional management of the productive sector.
- *The sector that demands science, technology, and innovation* is represented by the socioproductive sector that encompasses the society (in general), agricultural producers, indigenous groups, and the industrial sector (public, private, small, medium, and large enterprises).

In this model, social actors and indigenous groups are explicitly included and recognized as knowledge producers as well as users of science, technology, and innovation. This approach responds to the claim of inclusion of the traditionally excluded segments of the population as dynamic actors in innovation processes and development strategies.

The challenge for the Bolivian government in a demand-pulled model of innovation is that this model needs a dynamic demanding sector able to mobilize and organize internal resources into a long-term productive vision that involves sectorial leaderships that would be able to facilitate collaboration with other institutions in the system and look for common goals rather than institutional claims. The Bolivian economy is still highly dependent on natural resources, and most of the population works in a low added value sectors. This context could influence the performance of a demand-pulled model of innovation. Sometimes in non-dynamic sectors, financial programs of cooperation are exploited for the traditionally best-positioned companies and organizations, which as a result contributes to maintaining inequalities. In fact, Benavente (2005) and Yoguel et al. (2007) present evidence from Chile and Argentina respectively pointing out that the experiences of horizontal financial agencies showed a tendency to concentrate supporting resources for the productive sector in a reduced number of firms, probably those most dynamic in their sectors, but not contribute to reducing inequality as expected.

## 4.2 PNCTI first phase of implementation (2014-2019)

This phase of the PNCTI is focused on the passage of a new Law of Science, Technology, and Innovation and its regulation. It will create a decentralized unit to execute the PNCTI and another to manage the financials of the social-productive and academic sectors (both under the VCyT).

The starting actions performed in the last years by the VCyT as a foundation for the system were:

- Establishment of 12 scientific and technological research networks in prioritized fields, gathering more than 400 scientists. These networks offer scenarios to discuss socio-productive needs and to apply for resources by proposing projects based on trans-disciplinary collaboration.
- Facilitation of free access to 19 international databases linking national scientist to over 3000 Scientific Journals.
- Presentation of 2 editions (2009 and 2011) of surveys about the Bolivian science and technology potential. These reports put an end to a decade without similar studies performed at the national level.
- Yearly promotion of *"scientific olympics"* (national contest) as part of a program for the popularization of science. This contest has the purpose of increasing scientific and technological capabilities for high-school students through competitions in mathematics, chemistry, biology, informatics, and robotics. In more than four years, more than a half million students from all over the country have participated in the olympics.
- Organization of tailor-made workshops for public, private, and academic partners in order to spread the concept of innovation systems, understand the role of key stakeholders, and use this concept as a policy tool in the Bolivian context.

This phase seeks to consolidate these initiatives and allocate resources to make them sustainable in the time. 75% of the Bolivian capacities (infrastructure and human resources) in science and technology lie in public universities (VCyT, 2011). This tendency is repeated in most Latin American countries. In this context, the VCyT identifies universities as key institutions for initial mobilizing activities. In addition to the started actions mentioned above, the VCyT proposes the implementation of a *National Program for Developing Human Talent* in strategic scientific and technological areas - food, biodiversity, mining, and energy - as well as looking for the support of existing research infrastructures at universities in collaboration with the socio-productive sector. The first phase also stipulates initial activities through the creation of several mechanisms to facilitate linkages between the actors and implement support programs. Nevertheless, the implementation of most of them will be clarified in detail in following planning documents to be elaborated for the second phase (2020-2025). Meanwhile, the PNCTI presents a scheme of the bilateral relations in the system including these organizations and institutions to be created:



Figure 3.3: Sectors and interactions in the Bolivian System of Science, Technology, and Innovation (VCyT, 2013).

The second phase (2020-2025) of the plan suggests a consolidation of the functions of the mechanisms to be started during the first phase, directing them towards objectives to be presented in the *"Patriotic Agenda: Bolivia towards 2025."* In this phase, there is expected to be an increased scope of activities of the Unit of Execution and for the Financing Program, promoting the implementation of new mechanisms (organisms to transfer research results, scientific parks, incubators, and so on). At the same time, the training programs are initially supposed to focus on master degree programs that could be continued by PhD programs to enrich the critical mass of researchers. Then it comes to the challenge of creating strategies for incorporation of new professionals, not only in the academic sector, but also in the productive sector. Finally, the phase includes plans to transform the monitoring system of science and technology into an observatory of science and technology that also includes prospects studies in different sectors.

## 4.3 General Comments

The PNCTI presented proposes the creation of new institutions and several new experiences of organizations where Bolivia has few or no successful experiences yet (industrial parks, incubators, innovation platforms, and organisms for technology transfer). To achieve the proposed goals, the plan also demands building innovative culture among the involved actors, creating a solid law for S&T and reliable platforms to create trust and networking, as well as breaking institutional barriers for collaboration and ensuring inclusivity. Recent experiences at the public University of San Simon creating the first university Technology Transfer Office have shown that these kind units can support the articulation of regional innovation systems. The public university can work as a relatively neutral and reliable platform for dialogue in order to support innovation processes and reinforce trust after decades of deteriorated relations among the actors.

#### 5. Concluding remarks

The Triple Helix model of innovation can be used as an ex-ante concept and as a strategic tool to open up roads for a catch-up process with an ultimate goal of creating a learning society (Etzkowitz et al., 2003). This can be the case in Bolivia, where a Triple Helix approach has been adapted and expanded to be more socially inclusive, recognizing indigenous groups and other social movements as important actors in the production and use of knowledge in terms of ST&I. At the same time, it is necessary to give one more step in PNCTI breaking linear models of interactions and start to focus on non-linear relations in order to establish new roles in the traditional institutions in the system. This can increase the cohesion between actors to create better synergies emerging also from bottom-up initiatives in the system. Triple Helix processes can enrich the current practices denoting not only the relationships of university, industry, and government, but also internal transformation within each of these spheres (Etzkowitz et al., 2000).

Currently, several governmental bodies promote diverse initiatives focused on fostering innovation culture based on Triple-Helix partnerships to contribute to national development by responding to socio-productive needs. Since 2006, Bolivia has had a relatively stable socio-political environment. This situation allows for the construction and implementation of long-term strategies and reforms to achieve social goals. The VCyT promotion of the Bolivian Innovation System since 2007 has driven the development of a medium-term plan to strength the National System of Science Technology and Innovation (2015-2019). This proposal, complemented by initiatives of other ministries, needs a national coordinator body in order to make an efficient use of the limited resources available. The long-term plan, so-called *"Patriotic Agenda: Bolivia towards 2025"*, will orient efforts of all the governmental bodies promoting innovation for development towards a common goal and a more efficient use of the national resources allocated.

We must be conscious of the fact that demand-based strategies in non-dynamic socioproductive sectors need strong leaderships from the sectors and strategies to create cross-boundary organizations to catalyse processes of networking at national and subnational levels, ensuring the inclusivity at several levels of the more needed population to reach the social impact. The reflections of Cozzens et al., (2009) based on studies of developing countries explain how innovation and inequality co-evolve with innovation, sometimes reinforcing inequalities and sometimes undermining them.

The success of NIS rests on the degree of integration and matching efficiency between the various drivers and components of the system (Kayal, 2008). The creation of national research networks became an important scenario to recover and open new bridges with the research community to discuss national policies, diffuse research results, and share bottom-up initiatives contributing to the system. Since most of the research and high-level training capacities are concentrated in few public universities, this gives them a key role in the Bolivian Innovation System. This social responsibility for the national development is transforming the traditional missions of universities. They are evolving from providing higher education and scientific knowledge into constantly encountering claims from society and government to transcend institutional spheres in the knowledge production process. This is done by promoting institutional dialogue and involving social actors as sources of knowledge and users.

Finally, no one of these important efforts will be complete if the national government does not consider substantial reforms to market policy to promote and support the local industry (private-public) and entrepreneurs. This issue has been a constant demand in all the dialogue platforms. Bolivia is part of a regional policy learning process looking at the national innovation system concept as an alternative for development and competence building. The Bolivian policies for innovation means one step forward focusing efforts also on the legitimacy of science, technology and innovation by including the indigenous groups and society in general as important actors in the creation of knowledge in collaboration with the traditional institutions mentioned in the Triple Helix model of innovation (university-government-industry). We expect that further studies can determine the impact of these policies in the evolutionary processes. The experiences gained can contribute to the perspective of social inclusive innovation systems, but wider perspective of inclusion is needed to face national challenges of development as proposed in the *"Patriotic Agenda towards 2025."* 

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## 3.3 Paper II

## "Developmental University" approaches in developing countries: Case of the Universidad Mayor de San Simón, Bolivia

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## 1. Introduction

1.1 The Universidad Mayor de San Simón

The Universidad Mayor de San Simón (UMSS) was created in 1832, in the region of Cochabamba, Bolivia. It is a public university, declared as an autonomous university in 1931. It is also part of the Bolivian University System (SUB) and currently is the second largest university in Bolivia in terms of student population, with approximate-ly 65,000 students by 2014. Public universities provide under-graduate education to 76% of all students in the country.

The main activities at UMSS are focused on undergraduate education. Teaching activities are spread over a range of about 82 undergraduate courses offered by eleven faculties and one technical school. Graduate programs, mostly specialization and master programs, are primarily oriented at training professionals for the local and national markets. Students in these programs are usually people already holding a job, wishing to improve their skills in order to enhance their performance at work, and increase their chances when competing in the labour market. Unlike under-graduate education, which is fully funded by the government, graduate training requires students to pay for their full tuition. Only graduate programs (research based) implemented with the support of international cooperation offer scholarships or some other special treatment.

Research is one of the three core functions of UMSS, together with education (training of professionals), and (community) outreach. The Directorate for Scientific and Technological Research (DICyT) is the university body in charge of managing and organizing the research system at UMSS. The research capabilities at UMSS are formed by 42 research units, and 219 researchers (Rectorado - Vicerrectorado, 2012). According to DICyT (2012a), before 2000, the main features of the research activities at UMSS were: i) heterogeneity, in terms of uneven support to research units and the number and quality of projects undertaken; ii) volunteering-like research, since projects undertaken came from individual initiatives, disarticulated, for each research unit sets its own objectives on its own or, sometimes, coordinating with their partners; iii) and

precarious, since research units without sustainable conditions appeared and vanished and, often, researchers were not granted any job stability.

Hitherto, R&D activities at UMSS have been financed (except by researchers salaries) mainly by the international cooperation. In the last decade, the most prominent cooperating organizations came from Sweden, Belgium, Holland, Switzerland, Germany, Spain and Canada. After 2005, another source of research funds were allocated derived from the Direct Hydrocarbon Taxes (IDH) collected by the central government. Besides limited resources allocated, remarkable isolated efforts have been performed in the research centres to accumulate and improve their research capabilities. However, in order to have an institutional impact in society, it is needed to develop effective linking mechanisms with the local demanding sectors. The more relevant institutional approaches to reorient research activities were promoted by the Technology Transfer Unit (UTT). This unit was created at UMSS in 2004, located in the Faculty of Science and Technology. UTT introduced the perspective of innovation systems at UMSS to develop linking mechanisms between the university, the government bodies and the socio-productive actors. The main experiences gained in this process are presented in this paper.

#### 1.2 The Bolivian Innovation System

Recent reforms started in 2006, established the need to create a National Innovation System (NIS). This proposal followed to the discontinued initiatives of the Bolivian System of Agrarian Technology (SIBTA) and the Bolivian System of Productivity and Competitiveness (SBPC). The NIS was thought of as a tool of the National Development Plan (2006-2011), to strengthen the national research capabilities and linkages with the productive sectors. The promotion of the Bolivian Innovation System (SBI) was in charge of the recently created Vice-Ministry of Science and Technology (VCyT), which is currently under the Ministry of Education.

The complexity to operatize the concept and the lack of allocation of resources at the VCyT have held the programs presented (2007-2010) in the planning stage, none of them with significant advances in terms of their execution. However, after a wide participative process (2012-2013), a qualitative advance was made through "National Plan of Science Technology and Innovation 2014-2025". This plan offered a more contextualized framework and a long-term vision to organize national institutions proposing demand-side oriented innovation policies. The plan organized institutions in the system in terms of bilateral and trilateral relations between three main sectors identified: i) the government sector; ii) the knowledge-generating sector; iii) and the demanding sector of ST&I. Complementarily to the traditional institutions that conform the last two sectors aforementioned (such as universities and industries respectively), this plan includes explicitly indigenous groups and social grass roots organizations to play a role in both sides, as knowledge generators and as demanders of ST&I. This approach aimed to be more participative and social inclusive by recognizing academic and non-academic (ancestral) knowledge as a source for demand-oriented innovation (See Acevedo, Céspedes, & Zambrana, 2015).



Figure 3.4: Institutional relations within the Bolivian System of Science, Technology and Innovation, synthetized scheme.

In Bolivia, most research capabilities are located in public universities. In fact, 60% out of all researchers and 72% out of all research centres are located in public universities (VCyT, 2011). As per the type of research activities performed in national research centres, the following figure shows their proportions.



The survey was developed by (VCyT, 2011) following the Frascati Manual classifications (OECD, 2002) including additionally categories such results transfer, local knowledge, and technology transfer. The survey revealed that an important proportion of the research capabilities (68%) are oriented to basic research and applied research, corresponding mainly to the activities performed in university research centres. On the other side, 4% in experimental development can be linked to two main reasons. On the one hand, reduced research capabilities in the industrial sector. On the other hand, lack of linkages between academic research activities oriented to support the industrial sectors. This separation between the university and the industrial sector is in part the result of import substitution policies, which consequently has direct repercussions on the innovation capability in the country. Sutz (2014) looking at similar tendencies for the case of Uruguay calls to the reflexions of Rodrik (2008) explaining that:

"...Innovation in the developing world is constrained not on the supply side but on the demand side. That is, it is not the lack of trained scientists and engineers, absence of R&D labs, or inadequate protection of intellectual property that restricts the innovations that are needed to restructure lowincome economies. Innovation is undercut instead by lack of demand from potential users in the real economy-the entrepreneurs. And the demand for innovation is low in turn because entrepreneurs perceive new activities to be of low profitability."

Then, from the public university perspective in Bolivia, what is the role of universities in emerging national innovation system within non-dynamic demanding sectors?. There is a strong need to generate an environment (normative, financial, institutional) that facilitates interactive dynamics of collaboration between the university, the government, and the socio-productive sector. On the other side, when the question comes to the public university and given its autonomous condition, there is a need also to promote internal reforms to reorient its research capabilities.

The study was based on eight years of participatory action research performed by the authors. The experiences gained at UMSS present local efforts from the university side to participate in innovation system dynamics, which can be useful for academics and policymakers. Additionally, the transdisciplinary perspective of the authors enriched this paper. Two of them worked from the academic side at the Technology Transference Unit and Cluster development at UMSS and the third from the policy-making side working at the National Innovation System secretariat in the VCyT.

## 2. Theoretical Framework

#### 2.1 National Innovation Systems (NIS)

The concept of national innovation system (NIS) has been widely used by policymakers and studied by academics in the last decades. Lundvall, Vang, Joseph, & Chaminade (2009) defined the national system of innovation as an open, evolving and complex system that encompasses relationships within and between organizations, institutions and socio-economic structures, which determine the rate and direction of innovation and competence-building emanating from processes of science-based and experience-based learning.

In the case of developing countries especially in Latin America, the concept of NIS has been used as a concept framework to create policies and strategies so as to support development goals, but the debate is still unfinished when it comes to the question of making it operative in a specific context. Edquist & Hommen (1999) explained that

the systemic approach of the innovation processes explicitly recognizes the potentially complex interdependencies and possibilities for multiple kinds of interactions between the various elements of innovation processes. Complementarily, many empirical studies recognized that university-government-industry interactions are key elements in systemic processes of innovation. The institutional structures within these relationships were better explained by looking at the Triple Helix (university-government-industry) model of innovation (See Etzkowitz, 2008). The Triple Helix model of university–industry–government relations tries to capture dynamics of both communication and organization by introducing the notion of an overlay of exchange relations that feeds back on the institutional arrangements (Leydesdorff & Meyer, 2003:196).



Figure 3.6: The Triple Helix Model of University-Industry-Government Relations (Etzkowitz & Leydesdorff, 2000)

Etzkowitz (2003) explained that in this model, industry operates within the Triple Helix context as the locus of production; government as the source of contractual relations guaranteeing stable interactions and exchange; the university as a source of new knowledge and technology, the generative principle of knowledge-based economies.

According to Lundvall (2010) the NIS concept is based on two main assumptions: i) the most fundamental resource in modern society is knowledge and, accordingly that the most important process is learning; ii) it was assumed that learning is predominantly an interactive and, therefore, a socially embedded process which cannot be understood without taking into consideration its institutional and cultural context. Complementarily, when the discussion reached to the issue of underdevelopment, Sutz (2012) called to the reflection explaining that this issue can be very partially but not inaccurately characterised as an "innovation as learning" systemic failure. She argued that it is a failure not only due to the relative weakness of innovation processes in developing countries, but also due to the lack of opportunities to learn through such processes. This failure is systemic because it is built-in in the productive specialization of most developing countries, where the learning content of productive activities is weak.

In those terms, it is more than obvious that universities play a key role in learning and innovation processes. However, nowadays there is no consensus about the role of university in NIS and its mechanisms of interaction particularly for developing countries, because NIS dynamics are context dependent.

#### 2.2 Universities in National Innovation Systems

Latin American universities are institutions that concentrate a relative important proportion of the research capabilities in their countries. Nowadays, however, their institutional relevance in society is questioned in terms of an increased claim for orienting more effectively their research activities towards supporting local socioeconomic development. On this issue, Vaccarezza (2011) pointed out that current Latin American research, suffers from a double periphery status: firstly, regarding its relatively marginal position from the international scientific community; secondly, regarding its capacity to integrate into the "context of application" marked by innovation and production flow of international capital. This situation becomes even more critical in the Bolivian case, where according to the VCyT (2011) about 90% of the research capabilities in the country are located at universities, mainly in public universities (infrastructure, equipment and researchers). Inspired by these general concerns, in the last two decades, academic discussions have been paying attention to several concepts and mechanisms linked to the NIS dynamics to enhance the participation of universities as active actor in socio-economic development.

Universities are well recognized in society by their traditional two missions of teaching and researching. Brundenius, Lundvall, & Sutz (2009) argue that the notion of the *"third mission"* of universities is related to different ways of conceiving the relationships of universities and the society to which they belong. Similarly, the concept of *"Mode 2 science-production"* complements these notions by explaining how knowledge is produced based on fluid dialogue between the academy and other society actors. Gibbons (2000) formulates that in *Mode 1*, problems are set and solved in a context governed by the, largely academic, interests of a specific community. By contrast, in *Mode 2* knowledge is produced in a context of application involving a much broader range of perspectives; Mode 2 is transdisciplinary and not only draws on disciplinary contributions but also on new frameworks beyond them; it is characterised by heterogeneity of skills, by a preference for flatter hierarchies and organisational structures, which are transient. It is more socially accountable and reflexive than Mode 1.

In Bolivia, most policymakers still regard universities (especially public universities) as potential "knowledge generators" to contribute socioeconomic development by transferring research results, technology and innovation. Bramwell & Wolfe (2008) explained that this mechanistic view of the way in which basic scientific research is transformed into commercial products, demonstrates a misconception of the commercialization process itself, as well as the role universities can and should play in that process. The flow of knowledge does drive innovation, but knowledge transfer from universities to industry is a fluid, complex and interactive process involving many different actors. Brundenius et al. (2009) argue that linking universities closer to users is fundamental for enhancing their role in relation to economic development. Especially in countries, where a significant proportion of the research effort is located at universities, it is important to find ways to enhance the interaction between the university and industry as well as with other users in society.

This non-isolated or self-sufficient understanding of the role of universities represents basic foundations of new emerging concepts. Etzkowitz (2008) looking at some experiences in California (USA) proposed the concept of the *"entrepreneurial university*". He argued that the "capitalization of knowledge" is the heart of a new mission for the university, linking universities to users of knowledge more tightly and establishing the university as an economic actor in its own right. This model is impractical in the Bolivian context since, besides the fact of autonomous condition of public universities, public university values are strongly linked to social concerns and the social common sense cannot share such institutional behaviour. Additionally, research activities in Bolivia are performed in a context with almost non-existent institutional or public normative structures about intellectual property and technology transfer procedures.

On the other hand, new perceptions emerged such as the "developmental university", which was conceived from developing countries. This concept agrees in a better way, with the Bolivian context and needs. Brundenius et al. (2009) explained that the developmental university is open and interacts with different groups in society, including industrialists, but it does not operate according to the logic of making profit. Its major aim is to contribute to social and economic development while at the same time safeguarding a certain degree of autonomy. Focused on the Latin American context, Arocena, Göransson, & Sutz (2015) went further, arguing that such universities are committed specifically to social inclusion through knowledge and, more generally, to the democratization of knowledge, along three main avenues: democratization of access to higher education, democratization of research agendas, and democratization of knowledge diffusion. Additionally, they point out that developmental universities are those involved in the production of processes of learning and innovation for fostering inclusive development.

This conception of the role of universities contributes widely to improving the way in which different university bodies interact and contribute to society. At the same time, it can be used as a framework to adapting and creating new mechanisms from the university side to support NIS strategies, and in general to society aims, looking for more relevant results oriented to the local context. Under this umbrella, university bodies like technology transfer offices (UTTOs) can play crucial role leading institutional transformations and linking the university research dynamics with the socio-productive demands. Wahab, Rose, & Osman (2012) called to (Maskus, 2004) arguing that the technology transfer concept is not only concern about the transfer of technological knowledge or information but also the technology recipient's capability to learn and absorb technology into the production and function. Recently authors such as Codner, Baudry, & Becerra, 2013; O'Kane, Mangematin, Geoghegan, & Fitzgerald (2014) argued that the main role of UTTOs is to build legitimacy of university actions in society. They explained legitimacy in terms of Suchman (1995), defining legitimacy as a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions.

#### 3. The Case of Universidad Mayor de San Simón (UMSS)

#### 3.1 Research activities background

The development of research capacities at UMSS has been historically associated to international cooperation. This support has allowed the creation of scientific competences, physical infrastructure, and the acquisition of modern scientific equipment. However, the absence of institutional strategies and priorities to support research resulted in a scattered landscape of research at UMSS. The research community was challenged to confront two main driving forces. On the one hand, from society, an increasing claim to link research activities with "real life" needs in the region. On the other hand, following rigorous standards of quality, influenced by the global trends, trying to build a presence in the international research community.

According to the report *"Universidad en Cifras 2012"*, the UMSS have 42 research units and 219 researchers, where 18% hold a PhD degree, 35% MSc, and 47% are graduates. The following figure explains how both researchers and research units are distributed throughout the different faculties.



Figure 3.7: Distribution of researchers, research units, and research projects by university faculties at UMSS, based on the report published by (Rectorado - Vicerrectorado, 2012)

Additionally, there are researchers undergoing training inside of current research programs at UMSS (2 MSc, 25 PhD, and 3 Postdoctoral), who after finishing the training processes will be incorporated as permanent staff in research centres. The accumulation of research resources along the different faculties has a direct relationship with the prioritized fields from the international research cooperation. We can observe that more than 50% of research resources and activities at UMSS are centred in the Faculties of Science and Technology, and Agronomy. In terms of research funding planned for the periods 2012 to 2016, research salaries are fully covered by own university funds, but other research activities are financed fully by external sources as is shown in the following figure.



Figure 3.8: Research funds allocation (2012-2016) by financing source, based on (DICyT, 2012b)

The Swedish cooperation supports mainly PhD training programs (carried 50% at UMSS research centres and 50% in Swedish partner universities). It is supported as well: equipment acquisition, infrastructure, R&D management, as well as support to local post-graduate programs, innovation management, ICT, and access to electronic scientific journals. Since 2005, UMSS was benefited from IDH shares, which has been used to support mainly equipment acquisition and R&D management. A small portion of both, Sida and IDH sources, were allocated to competitive basis for research-related activities open to all of the scientific community at UMSS, under specific thematic guidelines. Other international agencies support mainly R&D management local post-graduate programs, and international PhD training programs. All the financial resources allocated to research centres follow a procedure developed by DICyT for promptly and transparently selecting and financing research proposals, following international standards: applying the principle of programming, complying with institutional priorities, open calls and competition, promoting team work and collaborations, subject to external assessment. The procedures developed and put into practice at UMSS have been well recognized by other universities in the country, as a model to replicate.

Besides the relatively important resources accumulated, compared with other public and private universities, recent efforts at UMSS has been focused on changing the volunteer-oriented research activities, into a more institutionally organized multidisciplinary research, in order to increase their impact on societal needs.

## 3.2 University Technology Transfer Unit (UTT)

The Technology Transfer Unit (UTT) was created in 2004 at UMSS in the Faculty of Science and Technology (FCyT). It was created following the model of a Research

Results Transfer Office (OTRI), influenced by linear models of interaction under an offer-pushed dynamics paradigm. UTT started its functions generating a database of the installed research resources at FCyT (equipment, laboratories, services, human resources). It was thought as a contact point with the industrial sector where it might benefit from hiring services offered at the research centres. After a couple of years of functioning and promoting, hardly any firm approached UTT, while claims asking for a higher participation of university solving social needs were increasing. The few visits to the office corresponded to medium size firms expressing non-specific supporting requirements, or problems to be solved in a short period of time, but with almost no budget to invest. Therefore, the UTT's logic of working proved to be not practical in the Bolivian context. During this period, several meetings with and interviews to industrial representatives confirmed:

- Self-sufficient attitude coming from the large firms in terms of seeking university collaboration;
- Medium size firms showed more interest in collaborating with university research centres, but lacked the funding to invest in research activities, and expressed concern about intellectual property issues;
- Small and micro firms were interested in getting support from the university. Nevertheless, they were characterized by no clear demands (as individual firms and as SME associations) in terms of research activities, lack of funding, low level of training, short term vision focused almost completely on marketing, and low level of collaboration with other institutions due a generalized attitude of distrust.

Therefore, in 2006 UTT adopted a new approach for interaction processes. It was thus highlighted the need to enhance the incidence of UMSS' research activities in local socio-economic development by linking the innovation system approach with UTT's initiatives. Under this vision UTT created an Innovation Program at UMSS, which enjoys of Sida supporting funds (2007-2017), mainly for mobilization and training activities. Within the Swedish cooperation framework, the program got the partnership of the Scandinavian Institute of Competitiveness and Development (SICD) at the Blekinge Institute of Technology (please visit: www.sicd.se). This partnership contributed to enrich the internal debate about the participation of the university in socio-economic development, and how innovation processes are operatized. These processes were understood as co-evolutionary processes of non-isolated institutions in dynamic relations. In terms of Trojer (2014), innovation processes are co-evolving processes, where relevance and context of application and implication constitute essential elements.

These processes were structured in terms of the Triple Helix (government-universityindustry) model of innovation, because it was easier to build a common understanding framework also in non-academic contexts. However, the question of how these co-evolving processes are carried out was better answered by the concept of Mode 2 knowledge production. Both concepts Triple Helix and Mode 2 research processes were explained earlier in this paper. Furthermore, Trojer (2014) highlights that coevolution is not only a hand in hand process between actors within and outside universities. It is an integrating process between Mode 2 researchers and predominantly Mode 1 researchers and partners in society.



Figure 3.9: Innovation structure adopted by Technology Transfer Unit (UTT) at Universidad Mayor de San Simón (UMSS), based on the Triple Helix model of innovation (Etzkowitz, 2008).

The Innovation Program promoted by UTT aimed *to develop at UMSS institutional competences and capabilities for studying, promoting and actively participating in systems and processes of innovation at the local, regional and national levels* (UTT, 2006). This objective had implications on the activities performed by UTT inside and outside the university. On the one hand, building innovation culture and capabilities at UMSS, sensitizing research activities towards socio-productive demands, inspired by Mode 2 knowledge production paradigm. On the other hand, linking research resources with the demanding socio-productive sector by promoting cluster development generating an innovation system environment based on the Triple Helix model of innovation.

According to UTT (2015) the main actions promoted by UTT are oriented to: developing an efficient system of innovation management at UMSS; making the academic community (professors and researchers) more dynamic, participating in activities related with innovation systems (regional and national); developing information systems and standard procedures for contracts with external actors, taking into account intellectual property aspects; researching innovation systems and cluster development (2 PhD students at UTT); promoting cluster development in the Cochabamba region, supporting innovation system dynamics; and generating capabilities to influence innovation policies at the regional and national levels.

#### 3.3 Systemic interaction approach: Cluster development

Cluster development was adopted by UTT as a permanent platform of interaction where concrete demands (from governments and socio-productive actors) can be developed or made visible. It was aimed to orient multidisciplinary research activities and find synergies with other institutions to meet those demands. After an empirical context diagnosis, UTT chose to start cluster activities within the diverse food sector in Cochabamba. Mainly because UMSS has installed already relative important research capabilities related to this sector, namely in the faculties of S&T and Agronomy; and also because Cochabamba enjoys a long tradition related with the food industry and it is a prioritized sector in government development plans.

UTT started a process of sensitization in 2007 characterized by visiting, informing, and inviting the main institutions in the region to be part of the clustering processes (e.g.: regional government, SMEs, firm chambers, financial agencies, and other supporting agencies). During the meetings the research capabilities cumulated at UMSS were highlighted, and the significance of interaction within innovation processes was explained. The aim was to gather a critical mass of institutions and people committed to participating within cluster initiatives.

The "Food Cluster Cochabamba" by UTT, was launched in 2008. It was created open to any SME and government bodies (regional and local) with activities linked to the food sector. From the university side, several research centres and laboratories of services located in the Faculty of S&T were involved, as a starting point:

- Food and Natural Products Centre (CAPN)
- Agro-industrial Technology Centre (CTA).
- Biotechnology Centre (CBT).
- Manufacturing, and Technology Development Program (PDTF).
- Water and Environmental Sanitation Centre (CASA).
- Industry Development Research Centre (CIDI)

Inspired by the Food Cluster initiative, and responding to the explicit request expressed by the leather productive sector, the "Leather Cluster Cochabamba" was created in late 2008; aiming to support environmental issues linking research centres such as CASA, CTA, CIDI and PDTF. Both sectors (Food and Leather) enjoy a long industrial tradition in the Cochabamba region and have been prioritized in development programs for the region. The Innovation Program at UTT allocated resources for organizing periodical planning workshops for each cluster (twice a year). These workshops were dialogue forums to generate a shared long-term vision, and openly design short-term common agendas for collaboration. Annual agendas were built based on making visible common demands and strengths expressed from the productive sectors, as well as presenting research results and services available in research centres. Complementarily, in order to facilitate the generation of ideas of collaboration, both clusters organized annual guided tours to university research centres, explaining about the equipment and main functions performed by these. Bilateral meetings were also organized between researchers with productive actors, and government agents to discuss technical issues for new proposals for cluster initiatives. Activities prioritized by each cluster were discussed in detail by an advisory board, composed by volunteer and committed cluster members who showed particular interest on implementing specific cluster initiatives. A "cluster facilitator" provided by UTT has supported each cluster. This person was in charge of organizing the allocation of resources, projects management and networking, while fostering trust building and dynamic dialogue arenas. Interactions within clusters dynamics were open and mostly informal. Therefore estimate annually as cluster members those organizations that participated in any cluster initiative During the year. In the following figure we present the growing tendency of organization units (productive units, firms, research units, government bodies, sectorial supporting institutions) involved in cluster initiatives 2008-2014.







According to UTT (2015), by 2014, the Food and Leather clusters initiatives had gathered about 120 productive units and firms, 15 government bodies, 21 research units at UMSS, and 9 sectorial institutions. Approximately 800 people from the main three sectors have been involved directly in diverse Food and Leather cluster initiatives. Additionally, UTT has mobilized more than 500 pre-graduate students to support different cluster initiatives linking them to their academic activities (research projects, short studies, surveys, industrial practices, training courses, and local productive fairs).

During the first years, the incorporation of productive units and firms in clusters had been linked to the interests of local associations and SME's chambers to participate in cluster dynamics. Nevertheless, cluster forums have been focused on giving a voice mainly to productive units and firms. Representatives from associations and SME's chambers had their own agendas and claims, competing one another for sectorial leadership. This context, at the beginning, made processes of demand identification and trust building more difficult. However, associations and SME's chambers have been good partners mobilizing entrepreneurs, supporting defined activities, and involving cluster members in their own supporting programs. In the case of the Food Cluster Cochabamba, the more dynamic entrepreneurs and producers in cluster initiatives have been those weakly or none linked to associations or SME chambers.

Looking at government bodies, an instable political context and continuous changing of public officials at the regional level have complicated the structuring of long-term supporting programs; however it has been possible to include cluster development in the Annual Working Plan (POA) of the regional Secretariat of Productive Development. On the other side, the more stable situation of the central government allowed establishing a more dynamic relationship, in particular with the Vice-Ministry of Science and Technology (VCyT), which has been able to link some international training programs to cluster initiatives (e.g. CyTED and Sur-Sur international supporting programs) and has used the UTT infrastructure and cluster networks as regional references for operatizing sectorial supporting programs.

From the university side, the dynamics of clusters enhanced the role of UTT at UMSS and in society. Thus in 2010, the vice-chancellor of UMSS formally acknowledged the UTT as a university unit in the Faculty of S&T, with a cross-facultative scope of operation. This recognition allowed UTT to involve research centres from other faculties (e.g. Agronomy, Economy, Biochemistry and Sociology) into the innovation program promoted. Research centres at UMSS have shown a high motivation to participate in cluster initiatives and within innovation systems. Nevertheless, the active participation of research centres in cluster initiatives was limited by the low S&T demands and the lack of availability of funds fostering university collaboration to the productive sectors (just about 6 research projects financed mainly with university sources, so far). However, UTT coordinated the satisfaction of most low technology demands (in terms of knowledge generation, laboratory tests, and pilot practices) by linking pre-graduate students thesis supervised by researchers, and working between research centres infra-structures and the productive infrastructures.

Most of initiatives in both clusters were oriented on the basis of five main guidelines described by Sölvell, Lindqvist, & Ketels (2003): Research and networking; policy action; innovation and technology; commercial cooperation; and education and training. The following points summarize some efforts performed so far:

- The Food Cluster Cochabamba developed a permanent supporting program for firms and producers, obtaining the food safety certification. This was a shared effort between the SME chamber (CADEPIA), the national food-regulating agency (SENASAG), and the food research centre CAPN at UMSS. Up to now, the program supported 30 firms to get or revalidate the certification, which allows them to sell their products in the local market. Students helped firms to enforce the regulations (infrastructure, processes, documentation), and university laboratories analysed about 850 parameters (reduced price) between microbiologic and physicochemical.
- The Leather Cluster Cochabamba was considered by the VCyT as a national node to execute a training program supported by the Centre of Applied Innovation and Competitive Technologies (CIATEC-Mexico). Training activities took place at the UTT's infrastructure. This program made possible to enhance technical and research capabilities for more than 100 leather SME representatives and university researchers both from Bolivia and Mexico. Additionally, this training program trusted the Leather Cluster to openly select delegations of Bolivian entrepreneurs to participate in training courses in Mexico.
- Both clusters have been able to attract financial resources (university and government) and link different research centres to design and build semi-industrial equipment prototypes according the specifications of the cluster members (pneumatic brake shoes, automatized bakery oven, and an automatized lyophilizer for the dairy industry). Additionally, university research funds were allocated to buy complementary specialized equipment and laboratory reagents in order to the enhance laboratory services and students research.
- Both clusters, supported by UTT, have developed more than 40 short courses, and 70 short-term research projects (between production process improvement, new products development, equipment design, marketing studies, management, and logistic) based on specific issues demanded by firms and producers, most of them linked to marketing processes.

It has been difficult to measure specific aspects on the impact cluster initiatives have in firms, however, it has been possible to recognize the relative important orientation of university resources towards cluster causes, as well as the development of new dialogue channels which influence research agendas at UMSS.

## 3.4 Mode 2 and innovation culture: UMSS research community

Based on the initial group of researchers linked to cluster development, in 2012 the UTT officially created a multidisciplinary team of researchers across university faculties named *"UMSS Innovation Team"*. It was created with the aim of making a more dynamic research community at UMSS, fostering both innovation culture and Mode 2 practices institutionally. This team has annual meetings where initiatives of collaboration are discussed, supported and promoted in order to contribute to the development of the national and regional innovation system from within the university. Many of them are also linked to national and international research networks within their disciplines.

The UMSS Innovation Team currently comprises around 35 researchers belonging to diverse disciplines and about 20 university research units. All of them gathered with

the aim of permanently sharing best practices of collaboration and participating on multidisciplinary projects to attend to socio-productive issues from the university mechanisms. The researchers involved come from several faculties at UMSS: e.g. science and technology, agronomy, biochemistry, economy, sociology, and law. This team is the supporting basis for cluster development and other additional initiatives promoted to find new mechanisms of interaction with government and socio-productive actors.

On the other side, in 2010 the UTT started a new initiative, the technology based enterprise incubator (EMBATE). This program aimed to generating innovation and entrepreneurship culture among students, involving the research centres located in the Faculty of S&T. This initiative interpreted the relative important concentration of research centres in the Faculty of S&T as potential decentralized incubator infrastructures to support selected technology-based business ideas from students. Currently, the program links 15 research centres in its dynamics. The program then started organizing several contests (2010, 2011, 2013) to train students on how to generate proposals on entrepreneurial ideas. The program has achieved the generation of around 200 project profiles so far. These activities were developed in collaboration between the Faculty of Economy, the Faculty of S&T, and regional institutions supporting competitiveness. The best ideas generated in the contests will be incorporated and developed in different research centres, once additional funding resources are allocated.

EMBATE was early linked to the Bolivian start-up network under the VCyT, and in 2012, it supported the VCyT as to organize local training activities for its incubators network using the UTT's infrastructure. These activities consisted in transferring entrepreneurship and start-up models developed by "Instituto Politécnico Nacional de Mexico" Start-up Unit, to 12 Bolivian universities including UMSS. EMBATE was recognized by the national government as a useful node for national and international universities linked to its network. More recently, in 2015, this national recognition in-volved to EMBATE within a regional proposal for Latin-American start-ups supported by CYTED, which is a platform that promotes and supports multilateral cooperation in science and technology (See www.cyted.org).

## 3.5 Transformation of the Research Policy at UMSS

Thanks to the Swedish cooperation at UMSS, in 2002 was presented first institution wide research policy document. This milestone achieved allowed, along the years, gradually implement considerable improvements in the quantity and quality of the research community, enhancing a number of research facilities, strengthening the management of research, the overall execution of research activities and creating a positive research environment and culture by the adoption of appropriate routines and practices. A second momentum was achieved during 2012 and 2013, where UMSS worked out a new institutional-wide research policy document. This document was generated through internal workshops, based on the own empirical experiences gained in the research centres and the systemic approach developed at UTT. Complementarily, discussions included several inputs like: The National Development Plan; Energy Development Plan; Plan for Science, Technology and Innovation; Departmental Development Plan; and an analysis of UMSS capabilities. The outcome was a document with the "UMSS Research Concept Framework 2013-2022", which is focused on an institutional commitment to make research at UMSS a relevant instrument for development. According to DICyT (2012a) the institutional objective of research activities, as a substantive function of the university was stated as follows:

"Research at UMSS is a significant activity aimed primarily at contributing to the regional and national development processes, through the generation of useful knowledge and analytical capacity. This activity also intends to contribute to the universal progress of scientific knowledge" (DICyT, 2012a).

At the same time, in order to guide the achievement of the objective stated, UMSS has incorporated in the same document, the following specific objectives to achieve:

- High quality research of regional and national interest is carried out by a robust, motivated and highly trained community of scientists; their outcome are well recognized by their peers at the national and international scientific arena, and are routinely passed on to economic and social actors through well-established mechanisms for transfer and innovation.
- A science, technology and innovation supportive environment prevails at UMSS assisted by an efficient management system.

In this context, it is intended that some research programs already under way, with support of the international cooperation funds, can be given continuity with greater emphasis and care of socio-productive aspects. While it is also expected that new research fields will become contributions to the construction of new programs, which from the beginning would be focussed on their social purpose and give rise to continuous and cumulative processes in the same field. Therefore, six wide research fields have been established to give an umbrella for all research activities at UMSS. They have been chosen as a result of a prospective study of the social needs. These research fields are:

- Sovereignty and safety over food production.
- Technology, production, and industrial development.
- Protection and improvement of health.
- Production, distribution, and rational use of energy resources.
- Habitat and human settlements.
- Social development and citizen participation.

Additionally, in order to gain funds for research projects, either coming from IDH or the international cooperation agencies, by norm, to be considered eligible in any of the research fields, the research proposals presented must involve socio-productive partners or attend to specific social needs with identified beneficiaries. Nevertheless, aside from the institutional efforts described, most research centres still operate as single units looking for partners in society to develop their research agendas. On this issue, the pilot practices developed at UTT has been useful experiences to meet the demand side, but more efforts inside the university are needed, as well as from the other actors in emerging innovation system dynamics. The National and regional government bodies have recognized all the institutional will and efforts from the UMSS' research system (empiric, volunteer, action-driven, normative, and resource orienting) towards supporting innovation system dynamics. University authorities have been invited several times to share the experiences generated in discussion tables and workshops aimed to building innovation policies and development programs. Particularly, the coordinator of the Innovation Program was invited by the VCyT to be keynote speaker in the construction of the *"Patriotic Agenda Bolivia towards 2025"* on the issue of "sovereignty and identity over science and technology". In that context, UTT experiences and cluster development were taken as concrete examples about collaboration dynamics needed to foster emerging innovation systems.

According to Arocena et al. (2015) developmental universities are characterized as universities that provide effective incentives to include in their research agendas problems whose solutions can lead to the democratization of knowledge. UMSS is still far from those ambitions, but its efforts are in that direction, thus we propose an ex-post categorization of UMSS experiences as a "developmental university" approach. Developmental university approaches have a place in emerging innovation systems in Bolivia, playing a key role for the democratization of knowledge and inclusive development ambitions.

#### 4. Conclusions and Remarks

The empirical practices and reforms adopted by UMSS were ex-post categorized in this paper as a "developmental university" approach. Through these experiences UMSS developed own institutional competences and mechanisms to improve its incidence in national socio-economic development.

The experience gained by the technology transfer unit (UTT) at UMSS has demonstrated that offer-pushed models of interaction failed in a context of non-dynamic socio-productive systems in Bolivia. Thus, systemic approaches of interaction adopted since 2007 by UTT fostered more dynamic interactions between the university, the government and the socio-productive actors. These initiatives shaped a dual role for UTT promoting innovation system dynamics inside and outside the university permeating the institutional borders. UTT proved in practice that the concept framework given by Mode 2 science production, Triple Helix model of innovation, and innovation systems were effective to generate open environments of interaction and trust building. These local experiences shared, present useful insights about a pro-active role that public universities can adopt under the perspective of emerging innovation system dynamics in Bolivia.

From the government side, in 2013 the VCyT has proposed demand-pulled innovation model in the framework of an emerging Bolivian Innovation System. This model recognized both, the key role of universities within interacting innovation process focused on the local demands, and the need to enhance local knowledge production processes by making them transdisciplinary, participatory, and social inclusive. In this general context, particularly public universities are challenged to develop more open collaboration dynamics with socio-productive actors. Cluster development strategy at UMSS has allowed the creation of dialogue forums where the socio-productive demands became more visible for academic and government actors, so as to build common agendas of collaboration. Hitherto, the technology gap between the research centres and the absorptive capability in the productive sector has limited the dynamic of the collaboration programs implemented, but helped firms to survive, improving their current productive processes, in accordance to sectorial regulations. Open dialogue arenas gave important inputs to build more democratic research agendas in universities. Inclusive research agendas are result of closer and long-term relationships with the demanding sectors.

The intermediate role of UTT managing innovation processes has been recognized by government bodies because its networking capabilities to identify researchers capable to attend social needs, to understand productive sector dynamics and to be able to exchange criteria with policymakers (national and regional level) while working on ST&I research and policy proposals. UTT also played a role in the management of funding resources giving an institutional umbrella for cluster initiatives, which are trust based and involves mostly informal relationships. UTT promoted co-evolutionary processes of interaction within innovation processes where institutional barriers are permeated and common arenas of dialogue are shaped. Its actions contribute as well the legitimation of university activities in society, giving a chance to make them more participative and democratic. However, it has been evident that more resources must be allocated on issues aimed to improve the absorptive capabilities of the productive sectors allowing an effective use of the university research efforts to attend socio-productive demands. Linked to the use of research results it is also needed to create institutional and national intellectual property regulations, not in the sense of capitalizing knowledge, but in the logic of fostering the democratization of knowledge and privilege endogenous knowledge production aimed to attend inclusive development ambitions.

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## 3.4 Paper III

## Cluster initiatives for inclusive innovation in developing countries: Food Cluster Cochabamba, Bolivia

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#### 1. Introduction

In 2008, the Technology Transfer Unit (UTT) at Universidad Mayor de San Simón (UMSS) created the Food Cluster Cochabamba. It was created in the framework of an innovation program at UTT in partnership with the Scandinavian Institute of Collaboration and Development (please visit www.sicd.se) supported by the Swedish cooperation agency (Sida). Cluster development at UMSS emerged as an adoption and contextualization of the globally promoted cluster concept and experiences deeply studied during the last two decades. Rocha (2004) explained that this increased interest in clusters is the presumed impact of cluster on firm performance, regional economic development, and country competitiveness.

Cluster development was adopted at UTT as an interacting mechanism to increase the incidence of the research activities at UMSS in the local socio-economic development. This proposal was based on the experience gained at UTT between 2004 and 2006 implementing offer-pushed models of interaction, after which became evident the passive nature of the local industry, in terms its will to collaborate in research activities with the public university. Acevedo, Céspedes, & Zambrana (2015) explained that several meetings with and interviews to industrial representatives revealed:

- Self-sufficient attitude coming from the large firms in terms of seeking university collaboration;
- Medium size firms more interested in collaborating with university research centres, but lacked the funding to invest in research activities, and expressed concern about intellectual property issues;
- Small and micro firms were interested in getting support from the university. Nevertheless, they were characterized by no clear demands (as individual firms and as SME associations) in terms of research needs, lack of funding, low level of training, short term vision focused almost completely on marketing, and low level of collaboration with other institutions due a generalized attitude of distrust.

Thus, based on empirical experiences, UTT launched a cluster development project as a pilot platform at UMSS to develop non-linear collaboration approaches incorporating the concept of innovation systems both inside and outside the university. The food sector was chosen to be the first cluster experience at UMSS because the relative high concentration of university research resources oriented to the food field, a long food industry tradition in Cochabamba and the prioritization of the food sector in regional development agenda. According to SITAP-UDAPRO (2015), looking at the manufac-

turing industry in the Cochabamba region, the food and beverage sector involves the 19% of all the economic units, is the second large sector in those terms. This sector is formed by 1% large sized enterprises, 4 % small and medium enterprises (SME), and 95% Micro enterprises.

This paper presents the experience of the Food Cluster Cochabamba promoted from a technology transfer unit in a public university in Bolivia. The experience was analysed from the perspective of a developmental university approach for emerging innovation systems with inclusive aspirations. This is a participatory action research based on eight years of practical experience of the author on cluster development at UTT (2007-2014) and five years experience as Cluster Facilitator in the Food Cluster Cochabamba (2008-2012).

In terms of (McIntyre, 2008), participatory action research is characterized by the active participation of researchers and participants (in this case entrepreneurs, university researchers, and government servants) in the construction of knowledge; the promotion of self- and critical awareness that leads to individual, collective, and/or social change; and an emphasis on a co-learning process where researchers and participants plan, implement, and establish a process for disseminating information gathered in the research project.

## 2. Concept Framework

## 2.1 National and Regional Innovation Systems

The concept of National Innovation Systems (NIS) has become very popular in developing countries as an ex-ante concept framework to foster innovation policies in development agendas. The concept has been constantly evolving in the last decades. This study adopts the following definition:

"The national innovation system is an open, evolving and complex system that encompasses relationships within and between organizations, institutions and socio-economic structures which determine the rate and direction of innovation and competence-building emanating from processes of science-based and experience-based learning." (Lundvall, Vang, Joseph, & Chaminade, 2009)

Most of Latin American countries are currently in process of designing and implementation of strategies to increase the dynamism of their emerging innovation systems. Thinking about countries in the south, authors like (Arocena & Sutz, 2003; Cozzens & Kaplinsky, 2009) highlighted the relevance of inequality and poverty reduction issues associated with the dynamics in NIS. In fact, they recommended, in order to a positive impact of ST&I practices over inequality and extreme poverty reduction, that innovation and learning processes must be reinforced by more inclusive and democratic practices for development. In this context, the concept of inclusive development enriches innovation and learning processes by giving attention (explicitly) to the otherwise marginalized groups in economic growth and development. Johnson & Andersen (2012) defined inclusive development as a process of structural change, which gives voice and power to the concerns and aspirations of otherwise excluded groups. It redistributes the incomes generated in both the formal and informal sectors in favour of these groups, and it allows them to shape the future of society in interaction with other stakeholder groups.

Looking at the implementation of the national innovation strategies, they are highly linked with the regional dimension, mainly following the organizational structures (geographical and political) within the country borders. Therefore, specific regional institutional capabilities are considered as integral components of strategies developed in the framework of emerging NIS. Herliana (2015) considered that in realizing NIS effective and productive, and significantly contribute to national economic growth, is necessary to strengthen Regional Innovation Systems (RIS). On that issue, Asheim & Coenen (2005) argued that RIS can be thought of as the institutional infrastructure supporting innovation within the production structure of a region. They described functional RIS in terms of interactive learning practices between:

- The regional production structure or knowledge exploitation subsystem, which consists mainly of firms, often displaying clustering tendencies.
- The regional supportive infrastructure or knowledge generation subsystem which consists of public and private research laboratories, universities and colleges, technology transfer agencies, vocational training organizations, etc.

Looking to developing countries, Cimoli, Primi, & Pugno (2006) highlighted the incidence of the informal sector in the Latin American economy. They argued, this sector emerged as a refuge or subsistence strategy for the marginalized groups, but it contributed to reinforce, or generate, the exclusion and social tensions. The informal sector is characterized by low productivity, use of obsolete technologies, non-qualified work, and enterprises of reduced size.

The empirical studies of Cooke (2008) highlighted that RIS are not "implemented" by policy but rather they evolve through processes of incremental and sometimes even quite "disruptive" institutional change by markets and the institutional support system.

## 2.2 Clusters development

According to Porter (2000) "clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate. "B. Asheim, Cooke, & Martin, (2006) called to Porter's studies explaining that there are a number of advantages to be gained with respect to the key activity of innovation by operating in a cluster.

- They allow rapid perception of new buyer needs.
- They concentrate knowledge and information.
- They allow the rapid assimilation of new technological possibilities.
- They provide richer insights into new management practices.
- They facilitate on-going relationships with other institutions including universities.
- The knowledge-based economy is most successful when knowledge resources are localized.

Altenburg & Meyer-Stamer (1999) studying Latin American experiences elucidate that clustering seems to enable firms, especially small and medium-sized enterprises (SMEs), to grow and upgrade easily. Nevertheless, Bas, Amoros, & Kunc (2008) high-lighted the difficulty with the cluster concept is to define which organizations are involved, based on what they share, how they influence one another and how they give a group of dissimilar actors some interactive, systemic characteristics. On this question, the UTT at UMSS started clustering processes using the Triple Helix model of innovation (university-industry-government) as an essential working framework for systemic interaction approaches. Leydesdorff & Meyer (2003) explained the Triple Helix model of both communication and organization by introducing the notion of an overlay of exchange relations that feeds back on the institutional arrangements.



Figure 3.11: The Triple Helix Model of University-Industry-Government Relations (Etzkowitz & Leydesdorff, 2000)

UTT promoted the triple helix in cluster development because it easily generated a framework of understanding with non-academic partners. The concept also offered relationships within an equalitarian balance between the three main actors involved in Cluster Initiatives. Sölvell, Lindqvist, & Ketels (2003) defined Cluster Initiatives (CIs) as organized efforts to increase the growth and competitiveness of clusters within a region, involving cluster firms, government and/or the research community. Clusters conceived under this institutional framework can be able to discuss and to build closer collaboration along the cluster lifecycle. Andersson, Schwaag-Serger, Sörvik, & Wise (2004) on "*Cluster Policies Whitebook*" described cluster's lifecycle in terms its organization in long-term evolving relationships: i) agglomeration, ii) emerging cluster, iii) developing cluster, iv) the mature cluster, v) transformation.

Despite the deep studies performed highlighting the relevance of clusters on regional economic growth, when it comes to the question of the contribution of clusters on inclusive development the debate is just beginning. Trojer, Rydhagen, & Kjellqvistt (2014) based on their empirical experiences in Africa suggested that cluster based learning could improve the position offirms and farmers in value chains of different reach (local, national, continental or global), which, if consciously done, could address income gaps and reduce the number of people living in absolute poverty.

#### 3. Food Cluster Cochabamba

#### 3.1 Background

The Food Cluster Cochabamba emerged as a pro-active mechanism from UTT directed to the demanding actors of the food and beverage sector in the Cochabamba region. The cluster was focused on micro, small and medium enterprises (MSME), which according to SITAP-UDAPRO (2015) represent 95% of the manufacturing economic units in that sector. Cluster activities have been financed by the Swedish cooperation (Sida) in the framework the Innova-UMSS program, approved since 2007 at UTT. This funding allowed the mobilizing of human resources, organizing training activities, equipping an auditorium, and office facilities at UTT, as the cluster meeting point.

At the beginning, the UTT director's experience on local developing projects allowed identifying and setting an initial contact with the main institutions in the food sector (outside of the university). At the same time, his position in the university made possible to gather and sensitize a starting group of researchers towards new dynamics and non-isolated mechanisms of collaboration within the food cluster.

The cluster started its functions by organizing a first wide workshop where a critical mass of sectorial representatives discussed and generated a shared vision of the cluster and built a six months agenda of collaboration. This group was composed by: MSME, public servants, researchers from UMSS, representatives of regulatory institutions in the food sector, and local chambers of MSME. The vision generated for the Food Cluster Cochabamba was stated as follow:

"To become the Food Cluster of reference in the region, generating and applying technical knowledge to create added value through innovation, improving the competitiveness of firms in the region by trilateral and responsible collaboration based on trust between university, industry and government benefitting society and environment" (UTT, 2008).

The activities in the Food Cluster Cochabamba coordinated by a "cluster facilitator" and supported by a management team at UTT. Workshops were repeated periodically, twice a year, for identifying demands from the productive sectors and proposing alternatives of collaboration, influenced by the dynamic changing political context in Bolivia. The main actors involved in the food cluster are:

- Productive units and MSME from the food and beverage-manufacturing sector. Their production is mainly focused on Andean cereals based products, baking processes, dairy products, processed fruits, functional food, and non- alcoholic drinks.
- Academic units (UMSS) such as research centres, laboratories of services, pilot plants, researchers, scientific students communities, and pre-graduate programs.
- Government bodies at the national and regional levels. These entities were focused on promoting the national innovation system, supporting programs to the manufacturing sector in general and the food and beverage sector in the region.
- Regional institutions in charge to regulate the local selling of food products, ONGs, chambers and associations of MSME producers.

The cluster was open in its conception, to any actor interested in collaborating within cluster dynamics, mainly not creating any barriers for the large number of informal micro-enterprises in the sector. In this context, cluster relations were mostly trust-based between the university and firms, and some agreements were signed between the UTT and government bodies, if needed. The number of actors involved in CIs has been growing in time. Therefore, in order to have an annual approach of this tendency, cluster members all those organizations were considered participants of any CI, as it is shown in the following figure.



Figure 3.12: Evolution of members in the Food Cluster Cochabamba (2008-2014) by type of organization, based on (UTT, 2015)

In addition, periodical transdisciplinary meetings were organized at UTT in order to discuss and operatize the short-term agenda and CIs prioritized the search for synergies (designing projects, organizing training programs, finding additional resources). The *"cluster facilitator"* was in charge to promoting dialogue within a transdisciplinary context, sometimes translating the needs of the productive sector into research problems, seeking for the government participation in CIs. The UTT's team supported the management of CIs both inside and outside of the university.

Up to now, CIs in the Food Cluster Cochabamba have been organized according the guidelines presented in the survey developed by Sölvell et al. (2003), where the CIs studied were linked to six main objectives: research and networking, innovation and technology, policy action, commercial cooperation, education and training, and cluster expansion.

## 3.2 MSME in the Food Cluster Cochabamba

The Food Cluster Cochabamba was mainly oriented to supporting micro-small and medium-sized enterprises (MSME) of the food sector within the Cochabamba region. According to UTT (2015), the group of firms which participated in cluster initia-tives in 2014 were composed by 74% micro-size firms (1-9 employees), 22% small firms (10-49 employees), and 4% medium-size firms (50-249 employees). These firms

were characterized by their heterogeneity within their manufacturing activities and informality, consistent with the descriptions offered by Parrilli (2007) about SME clusters in Latin America. He described those firms as micro and small craft working with obsolete technology and manual techniques of production, with no division and specialization of labour and low-quality non-standardized goods for low-income consumers in local markets. The following figure shows the manufacturing distribution of cluster firms according the classification of production, published by the national food regulating entity SENASAG (2003):

Food Cluster Cochabamba



Figure 3.13: Manufacturing production in the Food Cluster Cochabamba, based on (UTT, 2015).

Firms in the cluster represent the diversity of food production in Cochabamba region. Most of them process Andean cereals (such as quinoa, amaranth, and cańahua) using them within baking processes based on mixed flours. Other cluster firms process a large variety of fruits from the tropical region (mainly marmalades, dried fruits, and pulps). The milk and dairy sub-sector appears in sixth place; nevertheless it is important to point out its relevance in the cluster, because these firms were in need of a relative higher investment and use of technology, additionally the cluster is linked to the largest milk association involving about of 1,400 producers.

Cluster firms and producers are the engine of the Food Cluster Cochabamba. Contingent upon the ability of these actors, with the support of UTT and its cluster facilitator, the cluster shall be used as a consensus arena, thus defining and making their common demands visible for other institutions (government-university), then new Cluster Initiatives (CIs) can be discussed with the other institutions. University and government bodies in the cluster prioritize actions (in terms of resources allocation) for those CIs that are relevant or are able to involve more firms and producers. Therefore, cluster firms and producers are encouraged to collaborating one another. Acevedo et al. (2015) pointed out during the first years of cluster development productive units and firm's participation was highly linked to the interest of local associations and SME's chambers to participate in cluster dynamics. However, cluster forums were focused on giving a voice mainly to productive units and firms, because association and chambers compete each other for a sectorial leadership collaborating their own agendas. However, they have proved to be good partners in specific CIs emerging from open discussions between producers and firms (e.g. food safety and marketing supporting programs).

Each CIs was promoted by an *"advisory board"* integrated by voluntary entrepreneurs and producers, who led the discussions with other institutions. All these activities were supported by UTT (infrastructure, office facilities, assistants and professional staff) and moderated by the cluster facilitator.

In this context, it has been possible to establish a permanent "Food Safety Certification Program" which supports firms gathering several institutional efforts (UMSS, SME chamber, producer associations, SENASAG). It included 20% reduced costs for laboratory analysis, technical advising, auditorium and desk facilities, and pre-graduate students' assistance, training courses on Good Manufacturing Practice (GMP), administrative support. According to UTT (2014), up until then, 30 firms had been certificated; 850 parameters were analysed in the university laboratories, 11 training courses linked to GMP were given, and were liked about 65 students to support certification process inside the firms.

As to innovation and research activities, with the assistance of UTT, firms have been able to attract research funding for three projects so far, two of them fully funded through university research contests and one co-financed between government body (ProBolivia) and university. These projects were developed based on the firms' demands, within a constant dialogue between entrepreneurs and researchers, both visiting each other. Additionally, cluster firms have been able to develop 43 exclusive short research projects mobilizing about 260 pre-graduated students supervised by researchers in research centres. Students developed these projects together with the entrepreneurs with practices bouncing between the productive infrastructures and the research centres at UMSS. Most of these projects were focused on marketing studies for new products, equipment design and improvement of production processes. Nevertheless, the weak absorptive and investing capabilities have limited the effective use of most of these studies.

It has been evident during that these interacting processes in the food cluster allowed MSME and productive actors to share information with one another and with other institutions involved, increasing their organizational networks. They have expanded their access to research resources at UMSS (infrastructures, equipment, laboratories, researchers, pre-graduate students), common demands now are considered in research projects and have access to get full funding from the university, while individual needs receives special treatment in research centres supported by pre-graduate students. On the other hand, MSME and producers are able to generate concrete demands and con-

vey these directly to researchers and government servants at different levels. Cluster firms and producers, through the UTT as an intermediate agent, have been properly informed and prepared to take advantage of government supporting programs to foster innovation, entrepreneurship, and competitiveness.

## 3.3 UMSS research units in the Food Cluster Cochabamba

The Food Cluster Cochabamba emerged as a pilot mechanism of interaction, brought about by the technology transfer unit at UMSS. By 2014, this experience had been able to involve researchers and pre-graduate students from 14 different research units from the faculties of S&T and Agronomy linking around 30 researchers and 400 pregraduate students after 7 years of collaboration. Cluster Initiatives have been practical and concrete arenas to develop Triple Helix approaches of interaction and Mode 2 processes of knowledge production. These experiences were the foundation for the creation at UMSS of a multidisciplinary cross-faculty team of researchers named "UMSS Innovation Team", where university research experiences are shared and discussed in relation to emerging innovation systems in Bolivia. These experiences along university research policy transformation at UMSS were described and characterized by Acevedo et al. (2015) as a "developmental university" approach. Arocena, Göransson, & Sutz (2015) pointed out developmental universities are characterized as universities that provide effective incentives to include in their research agendas, problems whose solutions can lead to the democratization of knowledge.

Two core institutional research guidelines, "sovereignty and safety over food production" and "technology, production, and industrial development", have legitimized food cluster activities by linking them to other institutional efforts oriented to support objectives national development goals. In this context the possibility to allocate university research resources in CIs increases. It has been possible, so far, to support three research projects (two fully funded, and one co-funded with a government body), as well as to allocate supporting equipment in six research centres in order to enhance laboratory and technical services to MSME.

The Food Cluster Cochabamba, as a permanent interaction platform for university researchers with MSME as well as with government servants, has had an impact on the research agenda. Thus, it has been possible to incorporate cluster activities and new services for MSME into annual activity plans in the research centres. Therefore, cluster entrepreneurs have been openly welcome to visit repeatedly the university research centres linked to the cluster and obtain available relevant information, as well as discuss technical issues with researchers. All these activities coordinated by the cluster facilitator at UTT.

Aside from these modest efforts, mostly volunteer-like and lack of allocation of resources, UMSS has not been able to guarantee the use of research contributions where it is important that find institutional synergies in the region to improve the absorptive capability of the MSME in the cluster. These experiences developed at a pilot level reflect the analysis of Sutz (2012) suggesting that underdevelopment can be very partially but not inaccurately characterised as an "innovation as learning" systemic failure. Therefore, to coordinate a systemic response to the problem becomes a need, taking into account that other than its good will, UMSS has lot of limitations.

## 3.4 Government bodies linked to the Food Cluster Cochabamba

After a dramatic period of socio-political crisis, in the last ten years Bolivia has been started a reforming process oriented to the reduction of extreme poverty and to increase the participation of the traditionally excluded social sectors in the decisionmaking processes. This process has been characterized by the reforms promoted by the central government, such as a new political constitution, nationalization of key industries on the exploitation of natural resources, labour regulations, and the generation of long-term development agendas. At regional and local levels, governments have been characterized by their lack of resources allocation for production supporting programs, internal labour instability at operative level, and reduced organizational scope. The Food Cluster Cochabamba has been able to transcend and manage the political fluctuations mainly because it was hosted at the UMSS. Public universities are relatively more stable institutions, which prevail in the long-term. Because of its long history along social claims, UMSS was perceived as politically neutral or pro-social claims institution. Therefore, UTT has been able to generate a relaxed dialogue atmosphere for discussions between the cluster members.

The Food Cluster Cochabamba started by inviting several secretariats from the local municipality and the regional government, all of them involved in food regulation and supporting programs to increase the competitiveness of the sector. Their participation in cluster activities reduced the ambiguity in sectorial regulations needed for commercializing food products in the local market. Their collaboration allowed cluster firms to participate in several fairs promoting the local manufacturing production. In 2010, cluster activities were included in the annual activity plan of some secretariats at the local municipality and regional government. That disposition allowed government servants to participate frequently in cluster meetings but did not include funding allocation to support cluster activities. Recent regional strategies of development have included cluster development, named "Complejos Productivos", as a core strategy to support prioritized productive sectors in Cochabamba. This strategy responds to systemic approaches proposed by the central government in the framework of a long-term development agenda and emerging national innovation systems. Regional government bodies have acknowledged pilot cluster experiences at UTT as relevant local references for dialogue processes and participative knowledge production, linking university research units with socio-productive actors.

Looking at the central government level, the Food Cluster Cochabamba has been able to build a more dynamic relationship with the Vice-Ministry of Science Technology (VCyT) in the framework of the emerging national innovation system. The VCyT is the government body in charge to design and implement the strategies to make the system more dynamic. Acevedo, Céspedes, & Zambrana (2015) characterized the national innovation policies, published in 2013, as demand-pulled system with inclusive ambitions, resulting from a wide participatory process of construction.



Figure 3.14: Institutional relations within the Bolivian System of Science, Technology and Innovation, synthetized scheme from (Acevedo et al., 2015)

The plan recognizes protagonist role of universities in processes of knowledge generation. However, additionally proposes an inclusive approach, where the role of indigenous groups and other social movements is highlighted in both, demanding of ST&I and knowledge generating sectors. The VCyT recognized the Food Cluster Cochabamba as regional reference for systemic approaches of collaboration. The Food Cluster Cochabamba has been in the National Research Network promoted by the VCyT, where according to VCyT (2012) are linked around 35 researchers from diverse research centres linked to the food sector in the whole country. Since 2012, it has been possible to include five MSME from the food cluster in the annual meeting of the national research network, where firms are able to make their demands visible for the national research community looking for expand their networks of collaboration. Additionally, international agreements managed by the VCyT have allowed cluster members access to financial resources to send representatives to participate of international conferences organized by CyTED Iberoeka linking them with other researches and entrepreneurs in other Latin American countries.

Other important contributions come from ProBolivia, a decentralized agency of the Ministry of Productive Development, which recently established supporting programs for innovation aimed to create funding contests, innovation centres, and productive complexes (clusters). The Food Cluster Cochabamba is able to participate actively in those programs through the UTT at UMSS. In 2013, the Food Cluster gained funding resources to strengthen the capabilities of one research centre in building semi-industrial equipment for the food sector. This project aims to respond the claims of the entrepreneurs in the cluster about the oversized and expensive equipment available in the market. Therefore, the project links 3 research centres and about 15 entrepreneurs for the design and build of two prototypes, an automatized oven for the bakery industry, and a lyophilisation equipment for the dairy industry in the cluster. The implementation of the project implied several administrative challenges because of the heavy normative structures of the government and the university. Nevertheless, this experience opened the path for coming financing collaborations for research activities from any public decentralized agency to UMSS.

## 3.5 Intermediary Agent

The Technology Transfer Unit (UTT) is an operative unit where one of its main functions is to develop at UMSS institutional competences and capacities for studying, promoting and actively participate in systems and processes of innovation at the local, regional and national levels. The UTT plays the role of intermediary agent in the Food Cluster Cochabamba. Trojer et al. (2014) highlighted the role of intermediary agents supporting cluster development for inclusive development in Africa. They explained that linking actors is not enough within innovation processes. Intermediary agents often need to translate between the actors to match supply and demand, as well as spreading information and mediating in conflicts while plays neutral role in the innovation system.

The role of UTT as intermediary in the Food Cluster has been essential for the cluster survival. UTT provided basic financial resources to the cluster for mobilization and organization through its innovation program. It was in charge of managing and spreading information across the cluster members. Its infrastructure facilities offered a neutral atmosphere for dialogue between the producers, entrepreneurs, researchers and government servants. The UTT has supported cluster members to transformation concrete productive demands into research projects looking for funding resources inside and outside the university. Because the cluster is based mostly on informal relations trust-based, UTT gives to cluster a formal representation when it comes to apply for resources and subscribing agreements between the organizations involved. This formal representation also contributes to the cluster be more inclusive, because an important part of micro and small entrepreneurs and producers in the region are not yet part of the formal business sector. Cluster activities help informal entrepreneurs to regularize that condition by orienting and offering reduced costs in laboratory analysis of their products. In that context, UTT also supports the management of financial resources through the university administrative system. Finally, UTT manages knowledge production and its diffusion emerging from cluster initiatives according to the vague university regulation.

## 3.6 Cluster Facilitator

Ingstrup & Damgaard (2013:7) define cluster facilitators as individuals or a team of individuals, who are seated in a formal cluster secretariat within a cluster, facilitating and coordinating cluster development through trust building in order to promote cooperation and sharing of activities and resources among the participating actors of the cluster. The Cluster Facilitator of the Food Cluster Cochabamba was provided by UTT. After my early experience developing on the strategic guidelines of UTT, I was invited to be cluster facilitator. I worked as cluster facilitator of the Food Cluster since 2008 to 2013, and my following comments come from that specific perspective.

One my main challenges as the cluster facilitator was to become a central node in the cluster network, who links all cluster members at the personal level. As cluster facilitator, I was in charge to listening in the debates, understanding the different perspectives emerging from transdisciplinary processes of interaction, and guiding them into crea-

tive alternatives for collaborative solutions. This task requires a high sense of empathy to understand the personal perspective of each member and a high motivation towards the collective welfare, as the dynamics of interaction between the actors shape the cluster identity. It was also part of my tasks, to keep the cluster open for new members, and look for new relevant members for on-going cluster initiatives (CIs).

The cluster facilitator is in charge of information managing, making information accessible for cluster members (contacts, activities, projects, supporting programs, business opportunities, and results). Furthermore, I was in charge to follow the procedures needed to ensure the allocation of resources (financial, goods, and services), committed by the institutions (university, government, producers, etc) for the execution of CIs. This task, in an environment of mostly informal relations, requires trust building within cluster relations, enhancing the competitive atmosphere between socio-productive actors. In fact, according to (Mesquita, 2007) trust in the facilitator, in turn, affects trustingbeliefs of SME leaders toward each other, since such trust acts as a substitute for the initial lack of trust between parties. Facilitators are not out to mediate distrust from the entire relationship; rather, they help lead clustered firms in the pursuit of joint collective efficiencies in demarcated business areas and help them achieve greater levels of competitiveness. Additionally, my experience says that trust building is also about sharing human values between the cluster members. Accordingly, it was my role to spread the cluster values explicitly and take care of their respect in the behaviour of cluster members.

Finally, another important role as cluster facilitator was to promote mode 2 practices in CIs and knowledge production, particularly promoting pro-active and constant interaction between researchers and socio-productive actors. The open attitude of the researches made it easier to break initial institutional barriers, allowing entrepreneurs feel confortable when visiting the university research centres and vice versa. Nevertheless, the scarce resources available in developing countries represent a challenge for innovation and learning processes. This means that cluster facilitators have to be extremely creative looking for other networks collaboration to achieve the goals proposed.

Cluster facilitating functions as part of the Technology Transfer Unit (UTT) at UMSS, enhances both the internal developmental university approach and its role in cluster development in emerging regional innovation system.

## 4. Concluding remarks

The Food Cluster Cochabamba emerged as a pilot experience promoted by the Universidad Mayor de San Simon (UMSS), Bolivia. It was created as a non-linear approach to orient research activities at UMSS into innovation systems dynamics for supporting socio-economic development. Cluster development offered important insights for reforms in the university research policy within a "developmental university" approach. This experience has been able to gather an initial critical mass of small socio-productive actors showing initial positive results. Triple helix based interaction has been able to make socio-productive demands visible for university and government actors in the cluster. Cluster initiatives mobilized resources mainly from the university but also from other partner in the cluster (government, entrepreneurs, institutions) towards solving common demands. Despite, government bodies were not been able to allocate financial resources to the Food Cluster initiatives, new national reforms and supporting programs are emerging under the framework of a National Innovation System linked to a long-term development agenda (Patriotic Agenda Bolivia towards 2025). Both, university research policies and government innovation policies prioritize inclusive development ambitions.

Traditionally, clusters have been thought of to create competitive advantage of some industrial groups over others, based on collaboration to upgrade their technological and innovation capabilities. However, when it comes to the use of public resources in developing countries, poverty and inequality reduction are priorities. Therefore, based on the early experience of the Food Cluster Cochabamba, this study proposes to viewing clusters as a mechanism where innovation and learning processes seek inclusive development ambitions.

Cluster development can be used by a public university to support significantly poverty and inequality reduction as mechanism for the democratization of knowledge, by contributing to reduce knowledge gaps in specific productive sectors. Clusters can be used as open mechanisms expanding the access and opportunities for low-income socio-productive actors in a region.

- Access to: knowledge, technology, research resources, relevant information, funding resources, networking, support programs, technology based solutions, etc.
- Opportunities to: express their demands, survive, collaborate, learn, innovate, partnership, developing of specialized skills, generating added value, incrementing competitiveness, increase absorptive capacity, create sustainability, etc.

Cluster for inclusive development can be a practical alternative to collaborate and make efficient use of the scarce resources available in universities and government programs, in the context of developing countries.

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Part 3

## **Chapter 4 - DISCUSSIONS AND CONCLUSIONS**

## 4.1 Summarizing comments of the papers

Paper I presents a general concept review about national innovation systems and the Triple Helix model of innovation. This paper started its discussions by summarizing some facts of the interlinked Latin American history during the second half of the Twentieth Century presenting some characteristics on science, technology and innovation policies, implemented during the dictatorship and neoliberal governments. This way, the reader is placed in the Bolivian context, revealing the policy path followed in the last 30 years, where several governmental programs were linked to foster science, technology, competitiveness and innovation with development aims. The study revealed both the main policy progress and the lessons learned after the different political regimes, so far. It was pointed out the high relevance of attending the historical claims about social inclusion and extreme poverty reduction. Recent planning efforts of the Vice-Ministry of Science and Technology (VCyT) presented in the "National Plan of Science Technology and Innovation (PNCTI)" (2013) were analysed as foundations of the emerging innovation system in Bolivia. Finally, this paper discussed the process by using the Triple Helix concept framework as a reference, looking for own characteristics in the model according to the Bolivian context.

*Paper II* presented recent efforts developed by the Universidad Mayor de San Simón organizing and allocating research resources towards increasing its incidence in regional socio-economic development. These efforts were enhanced by the creation of the Technology Transfer Unit (UTT) located at the Faculty of Science and Technology. Innovation system and Mode 2 concept approaches inspired the practices at UTT.

One important socially oriented initiative performed was the conformation of pilot clusters using the Triple Helix model of innovation as an institutional framework of interaction (university, government, socio-productive actors). The main research policy guidelines and practices to foster an innovation culture at UMSS were presented as an ex-post "developmental university" approach. Its analysis and discussions pointed out social oriented approaches, driving innovation practices at UMSS towards supporting emerging innovation systems in Bolivia.

*Paper III* presented the case of the Food Cluster Cochabamba, which was created at Universidad Mayor de San Simón (UMSS). It was an initiative promoted by the Technology Transfer Unit (UTT) to develop linking mechanisms between the university, government, and food industry sector in the region of Cochabamba, Bolivia. This study started by describing the role of the main actors gathered in cluster initiatives. The discussions in the paper went around the cluster members, their organization and the main activities performed. Aside from the difficulties to quantify the impact of the activities performed in this early stage of the cluster development within a context of informal relationships, it has been possible to observe an important qualitative advance in terms of organization and orientation and availability of research resources to support the food sector. Final reflections suggested thinking about cluster initiatives, as drivers of innovation for inclusive development purposes.

## 4.2 Concluding Remarks

This study started by drawing a general overview of the innovation policy framework in Bolivia, which reflects and discusses the political intention and the different institutional challenges for the coming years. Therefore, based on local experiences, it was discussed the role of public university and cluster development, having to do with emerging innovation systems in Bolivia.

There are recent innovation policies in Bolivia, which are shaping an emerging National Innovation System (NIS) with socially inclusive approaches. These policies promote the formation of a demand-pulled innovation system characterized by interactions between three main sectors: i) the government; ii) the knowledge-generating sector; iii) and the demanding sector of Science Technology and Innovation (ST&I). A particular characteristic of this model was that indigenous groups and grass roots social organizations were recognized as important agents within both sectors knowledgegenerating and demanding of ST&I. The Vice-Ministry of Science and Technology (VCyT), under the Ministry of Education is officially in charge of the implementation of the NIS program in Bolivia. Simultaneously, other Ministries (e.g. Agriculture and Productive Development) are developing and executing important supporting programs under the NIS's umbrella, attending to particular concerns, but without a direct coordination with the VCyT, however responding to a national development agenda. Therefore, based on an empirical analysis, it was proposed the continuity of the different supporting innovation programs within each ministry, but incorporating the NIS model put forward by the VCyT. It can be used as a cross ministries operative framework for national development aims, expressed and coordinated from the "Patriotic Agenda Bolivia 2025" executing bodies.

On the other hand, emerging inclusive innovation policies were the result of participatory practices of indigenous and diverse grass roots social organizations in decisionmaking processes. They brought the historical claims of social inclusion into innovation policies. This constitutes a bottom-up approach of social dignity recovery in the innovation structures in the country. It was pointed out to another aspect of social inclusion, which involves the drivers of knowledge generation and innovation processes, focusing now on local socio-productive demands and needs. This socio-political context represents a big challenge for the whole university system in Bolivia, which needs to re-think its role and develop new competences in socio-economic development. Universities are still recognized as the main institution in the knowledge-generating sector, particularly public universities, which concentrate most of the research capabilities in the country.

Interactive initiatives and research reforms developed at the Universidad Mayor de San Simón (UMSS) in the last 10 years can make evident important insights on the mentioned concerns, especially for the case of public universities in the Bolivian context. Its Technology Transfer Unit (UTT) created in 2004, as an offering office of university services, experienced the passive attitude and lack of concrete demands from the industrial sector. Frequent meetings between the UTT and regional government secretariats and municipality have shown lack of supporting programs and vision, and addressed to the need of generation of local knowledge for the solution of problems in the productive sector.

In this context, concepts such as innovation systems, Triple Helix model of innovation, Mode 2 knowledge production, and cluster development, were useful ex-ante concepts, inspiring the pro-active initiatives proposed by UTT, both inside and outside the university. Aside from the limitations to measure the socio-economic impact on the socio-productive sectors linked to cluster initiatives, it has been possible to make some qualitative approaches, highlighting the new research policy, social oriented research programs and the relative important allocation of university research resources in clusters initiatives (researchers, pre-graduate students, research centres capabilities, laboratory services, access to research results, access to collaborative funding, etc.). All these efforts were ex-post characterized in this thesis as a "developmental university" approach, which elucidate somehow the path where the role of public universities can addressed in supporting emerging inclusive innovation systems. Additionally, open cluster dynamics promoted from public universities, have shown to be neutral arenas to generate shared agendas of collaboration, focused on university research efforts, as well as promoting non-linear interactions and facilitating trust building between university, government and socio-productive sectors. Therefore, in this context, it was possible to affirm that this kind of clusters can be potentially operative mechanisms to promote innovation and knowledge democratization for inclusive development ambitions.

The experiences shared in this study support the relevance of building co-evolutionary processes in Bolivia where the boundaries between science and society become increasingly transgressive. Co-evolutionary processes in transdisciplinary interaction, where science permeates society and society permeates science, are ideal conditions to facilitate both the development of useful knowledge. But it is extremely needed to orient more efforts and find synergies on the generation of absorptive capabilities for learning in the socio-productive sectors. This process must be supported by IPR and market regulations, which promote endogenous knowledge generation, diffusion as use for the domestic needs.

In the context of public universities in Latin America and particularly in Bolivia, coevolutionary process can also enhance the legitimacy of the university autonomous condition by creating open dialogue arenas for building non-isolated agendas of collaboration between the sectors.

## 4.3 Scientific Contributions and Originality

The publication of the paper "Bolivian Innovation Policies: Building an Inclusive Innovation System" in the Journal of Entrepreneurship and Innovation Management (JEIM), Volume 4, Issue 1 in June 2015. Furthermore, this thesis presents two unpublished original papers currently under evaluation in international scientific journals.

The author and the professional staff at UTT have developed institutional linking mechanisms, which have shown being relevant for the university research community at UMSS. As result, the first institutional innovation team of researches in the country was created. This team at UMSS discusses and participates in systemic innovation processes inspired by Mode 2 knowledge production and Triple Helix interaction structures in developmental university approaches.

The research is developing, in practice, the role of cluster development as an open university mechanism to promote inclusive innovation processes and the democratization of knowledge in the Cochabamba region.

## 4.4 Way Forward

Innovation systems dynamics are constantly evolving. Nevertheless, the relevance of innovation and learning in development processes are undeniable. Top-down strategies presented by the central government, started being implemented with many gaps in the process that still need to be filled. At the same time bottom-up initiatives presents useful insights that can be replicated in other regions in the country. Supporting programs need to be measured in terms of their impact, particularly in terms of their effectiveness for inclusive development.

The next step in the study is to perform deeper participatory action research, in order to understand actively the development of innovation and learning processes. Forthcoming studies aim to focus closely on the co-evolution processes between innovation policies, university efforts to contribute socio-economic development and cluster development effectiveness in the frameworks of innovation systems.

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