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A Holistic Model of Building Innovation Ecosystems

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Abstract: This paper provides an analysis in form of a systematisation of life cycle processes involved in deploying innovation ecosystems. The paper presents a general review of the current state of knowledge, and based on a systematic literature review illustrates the factors that influence the evolutionary creation of such ecosystems. Finally, we discuss open questions and future directions.

Keywords: innovation, ecosystem, process model

1. INTRODUCTION

Fostering innovation has become a mandated task on the agenda of most of governments, universities, companies, professionals and the civil society as a means to facilitate the coping mechanism of society in light of a number of economic, social and ecological issues (OECD, 2010; Carayannis, 2012). A set of issues has been pushing society to put more emphasis on innovation. This includes facing tougher competition in today's globalised market; boosting the economy and fostering new opportunities arising as a result of technological advances; improving the efficiency in the development of new products and industrial equipment; improving production and distribution processes; and all this having to deal with the increasing scarcity of natural resources and global warming, unemployment of young people, and the desire to better handle social inclusion (Mercier-Laurent, 2011; Jackson, 2011).

Regarding the mentioned motivations, innovation has enlarged its scope. From addressing product, processes, services and business improvements that underpin companies' continued competitiveness (Tidd *et al.,* 2001), to become the centerpiece of a socio-economic *development model* for cities and regions (e.g. Hwang *et al.*, 2012; Genome[1], 2012; Srinivas *et al.*, 2008). Innovation is more and more seen as a *global strategic means* and no longer only as a *local operational end* (OECD, 2010). Many frameworks have been devised worldwide to prop up this vision[2].

Nowadays *innovation ecosystems* are considered to be the most prominent type of 'environment' being built or nourished to cope with this broader vision (Jackson, 2011; Mercier-Laurent, 2011; Sloan, 2011; Olson *et al*., 2013). In order to understand how innovation ecosystems have been built or emerged, an analysis from a broader perspective is also necessary. This includes considering the 'canvas' of all the involved actors, their roles and inter-relationships; required infrastructures, policies and regulations; boosting mechanisms and sustainability approaches; culture values; the interconnections with external factors; among other aspects (Hwang *et al.,* 2012). This means analysing innovation ecosystems in a more systemic and holistic way, especially when compared to other less complex and more controlled environments, like technology parks, innovation habitats and virtual organisation breeding environments.

Despite the considerable efforts and investments that have been made worldwide to breed or boost innovation ecosystems, literature has reported that most of the attempts to that have either failed in achieving the envisaged innovation impact or their results are far less than expected (e.g. Jackson, 2011; Olson *et al*., 2013; Durst *et al*., 2013). According to the above literature, the reasons for such results are many and varied in nature. To mention just a few: inadequate local mindset for innovation; lack of actors' preparedness and suitable legal frameworks; insufficient cash flow throughout the whole innovation chain; the attempt for replicating 'Silicon Valley'-like ecosystems without understanding the necessary elements and the time required by them to flourish and evolve; low attractiveness, or insufficient infrastructure of cities; among many others. On the other hand, this does not mean these are mandated conditions for all successful ecosystems, or that they should be weighted in the same way when looking at a given region. They should rather be seen as good practices or desired conditions. There are examples worldwide showing that some factors may compensate the lack of others[3].

Building an ecosystem is a complex task. It involves coping with many hard tangible and intangible issues, of different nature, different levels and types of inter-dependences. When seen as a whole, this task comprises different and somehow independent but inter-related activities that need to be carefully performed. By *building* we mean the set of actions and steps involved in the establishment of an innovation ecosystem throughout its existence, being implicit or deliberate, emergent or planned, static or evolving, loose or tightly managed. The underlying assumption of this work is that, no matter how a given innovation ecosystem was established, a set of people took actions at certain moments ('stages') following some logical sequence, either towards building a whole ecosystem or possibly only related to some specific issue. As such, this can be observed and explicitly represented (even though the representation may be partial).

"There is a lack of global view even of the elements that constitute this view" (Mercier-Laurent, 2011). In fact, the

[1] Startup Ecosystem Report 2012 – Part One. Analysed and benchmarked top 20 worldwide innovation ecosystems and http://multisite-blog.digital.telefonica.com.s3.amazonaws.com/wp-content/uploads/2013/01/Startup-Eco_14012013.pdf

[2] e.g.http://www.industry.gov.au/science/policy/AustralianInnovationSystemReport/AISR2011/wp-content/uploads/2011/07/Figure-1.1_05-736x1024.jpg

[3] For example, Tel Aviv (Israel) is placed in a region having tough problems, but it is considered one of the 20 most successful innovation ecosystems[1].

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analysis of literature revealed a lack of consensus about the required building stages, the processes used or would make more sense to be involved in each stage, in what sequence, considering: enablers, their typical inter-relations and outcomes, who are the main actors most likely to be most involved in each stage, and the cultural and social phenomena behind all of this. Reports have pointed out that there is no single recipe for successfully building innovation ecosystems. Most of the consulted works in the literature are actually focused on some specific stage. For example, articles on how to prepare different actors given each of their particularities; on how to analyse a region to better identify its business vocation; or on how to conduct the innovation process itself inside the ecosystem. This limitation is also valid for some research projects devoted to innovation[4].

This paper presents a first attempt to systematise the phases and stages of ecosystem building, both more concretely and holistically, filling a gap in innovation research, contributing to the discussions of ecosystems' frameworks. The paper does not propose yet another approach for specific stages of development or a 'guide' to build innovation ecosystems. However, given a particular case, the model could be used by protagonist actors as a generic basis to assess what would be necessary when conceiving future ecosystems or intending to improve or transform an existing one.

The paper is structured as follows. Section 1 motivated the problem and depicted the research goal. Section 2 explains the research methodology. Section 3 discusses basic foundations of innovation ecosystems. Section 4 presents the identified ecosystem life cycle. Section 5 discusses open questions and challenges in the creation of innovation ecosystems. Section 6 provides some conclusions.

2. RESEARCH METHODOLOGY

This research aims at summarising and harmonising the findings of an extensive innovation literature about how existing innovation ecosystems have been created. The goal was to present a cohesive high level model of building an innovation ecosystem, and to learn from this synthesis.

This research qualifies as conceptual analytical work in Järvinen's taxonomy of research methods (Järvinen, 2004). We conducted a systematic literature review, analysed actions taken, lessons learned, and descriptions of practices written in individual reports about tens of existing ecosystems, as well as looked at roadmaps for future ones. Epistemologically, these findings represent regularities observed by a community of researchers studying innovation and that are here presented as 'processes'.

These processes were identified by a descriptive and *ex post facto* methodological procedure, combined with an inductive approach, trying to identify patterns of actions, relationships and common nature, further grouping and aggregating inter-related actions into *processes*, using a bottom-up approach.

In order to have a *starting* point for the identification of these processes and for their possible top-down presentation, we used concepts developed by the Collaborative Networks (CN) area (Camarinha-Matos *et al.,* 2007). CN offers useful foundations for analysing dynamic networks involving high collaboration among disparate actors, which are intrinsic characteristics of innovation ecosystems.

To exemplify the bottom-up approach: given a set of described actions (sometimes using different terminologies), if they were considered similar, e.g., being generally related to the education and empowerment of human actors, then we included these into the logical process called '*ecosystem preparedness building*' (see Fig 1). This in turn was made part of the larger process '*Project*', as an adaptation of the "Creation" phase in the classical CN life cycle.

Processes here are not to be seen as classical 'business processes', but as an interrelated set of life cycle processes. They are an 'engineering-like' expression and logical abstraction from a multitude of concrete actions (social phenomena) usually explained by social sciences. These processes represent the result of an analysis, intending to promote an understanding of the actions performed throughout the history of ecosystems building.

The ontological stance of these processes is important to consider so as not to misunderstand the results: processes *exist* as a phenomenon, they are being performed, but they are analysed and treated from the observer's point of view. The involved actors may not have (nor necessarily need) an explicit representation, or may not be fully *aware* of them within the entire innovation ecosystem life cycle.

This allows the inclusion of processes into our model that are deliberately and explicitly planned, structured, managed and controlled; and of emergent, organically developed processes; or anything in between. This is paramount from the utility point of view, because there may be actions that one can take to enable the emergence of necessary processes, even if managed and prescribed processes are out of the question.

Regarding the validity of the results of this paper, this research relies on secondary data sources, rather than direct experience with reality. Also, we had to be careful when interpreting the meaning of findings in our literature survey, as different authors use different conceptual frameworks and disparate terminology. We therefore used the language (terminology) of two relevant international standards (ISO15704 and ISO15288, Enterprise Architecture and Systems Engineering respectively) in an attempt to present a coherent model of the processes involved in conceiving, creating and sustaining an innovation ecosystem. To achieve this goal, as a research framework, we use the concepts of Enterprise Architecture frameworks, concentrating on three aspects: the *entities involved* (the innovation ecosystem as a system of systems); their *life cycle processes (phases)*; and the *stages of evolution* in time where these life cycle processes are instantiated. The outcome is a detailed descriptive model of major life cycle processes, expressed in a condensed and conceptually coherent way.

3. FOUNDATIONS OF INNOVATION ECOSYSTEMS

Literature presents many definitions for what innovation is. E.g., OECD defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 1997). Tidd *et al.* (2001) define innovation as "a process of turning opportunity into new ideas and of putting these into widely used practice".

In terms of innovation ecosystems, the many definitions also vary in vision, scope and detail: "economic agents and economic relations as well as the non-economic parts, such as

[4] For example, the European projects *BIVEE, ComVantage, IMAGINE, CoVES, Laboranova* and *PLENT* (Cordis, http://cordis.europa.eu/projects/home_en.html) tackled innovation at different perspectives and levels, using different models, basically supporting the development of *products* within the manufacturing sector. Their focus is essentially on ecosystem operation (see section 4.4.II), but not on how to build innovation ecosystems.

technology, institutions, sociological interactions and the culture" (Mercan *et al.*, 2011); "creation of nets that provide mechanisms for goal-focused creation of new goods and services to rapidly evolving market needs, with multiple, autonomous and independent institutions and dispersed individuals for parallel innovation" (Durst *et al.*, 2013).

Elements of an innovation ecosystem include (Hwang *et al.,* 2012; Durst *et al*., 2013; Mercier-Laurent, 2011; Jackson, 2011; Carayannis, 2012): *Actors* (all types of entities and their [social and economic] relations, playing various roles in and related to the innovation ecosystem); *Capital* (financial assets provided by some actors); *Infrastructure* (physical, technical conditions and general resources to support the ecosystem and the innovation developments "inside" of it); *Regulations* (laws and rules that frame the ecosystem functioning and innovation environment); *Knowledge* (existing supporting theoretical foundations, tacit and explicit, formal, informal and specialised knowledge that are used, generated (and eventually organised and managed), made available, and learned along the innovation value chain); *Ideas* (intentional thoughts that trigger innovation actions and around which the whole ecosystem works, also involving inventions and discoveries).

Three additional elements – but less tangible – impact the way the ecosystem operates: *interface, culture* and *architectural principles*. *Interface*: an ecosystem can be seen as an open environment composed of a collection of disparate entities organised in way to achieve economic and social operational and strategic goals. Each ecosystem's actor should have an "interface" (a channel) to interact with the other actors, including customers, stakeholders and civil society. This interaction should also consider the usual large heterogeneity of actors, so their cultures and idiosyncrasies.

Culture: this element has been considered nowadays as a key aspect, one of the most important ingredients for a successful innovation ecosystem (Hwang *et al.,* 2012; Mercier-Laurent, 2011; Olson et al., 2013[11]). It impacts the way each of the different ecosystem's actors performs, develops an innovation, solves conflicts and determines the rules to be used when they work together. Culture refers to the thoughts, customs and social behavior of a particular people or society, i.e. culture refers to the mindset of people and organisations that are combined to support and facilitate innovation initiatives and to solve related problems (Hwang *et al.,* 2012).

Architectural Principles: it refers to the way all mentioned ecosystems' elements are combined, orchestrated and the culture element is reflected upon them.

About the actors, the classical categorisation for them uses the triple, quadruple or quintuple helixes models (Carayannis *et al*., 2012). The innovation ecosystem's dynamics makes actors to assume multiple roles along the different stages of building the ecosystem and of developing of any particular innovation, also considering the eventual business models in place. Actors include (Carayannis *et al*., 2012; Durst *el al*., 2013; Hwang *et al.,* 2012): *government* (institutions that provide funding mechanisms and programs, regulations, policies and incentives); *universities* (educational and R&D institutions responsible for forming qualified people, boosting entrepreneurship and breeding future companies. They also include students and researchers); *industry* (companies and industrial associations that provide requirements, evaluate solutions, develop technologies and knowledge in their R&D departments as well as form qualified people via e.g. technical schools. They may also act as customers and funding entities); *supporting institutions* (private or public organisations and independent professionals who provide specialised assistance and knowledge to the other actors involved in given innovations); *entrepreneurs* (students, researchers, professionals and industry people who own an idea, discovery or invention [incremental or disruptive] and want to transform that into something useful and/or commercialisable. In general terms, they use to be the main type of actor who the innovation ecosystem is directed to); *financial system* (banks, governments, angel investors, virtual capitalists, and industries providing mechanisms to fund various steps of ecosystem building and innovation); *customers* (people, companies, universities, banks, etc., who participate and influence some stages of an innovation initiative and can even become end-users of its outcomes); and *civil society* (individuals, NGOs associations, who create societal and environmental demands and requirements which in turn can deeply affect businesses and impact the innovation development. They may also act as customers).

4. THE ECOSYSTEM LIFE CYCLE

Building an innovation ecosystem involves the consideration of numerous and evolving elements required for creating the conditions to nourish, flourish and sustain innovation. Hwang *et al*. (2012) metaphorically subdivide the building of an innovation ecosystem into three major phases: *seed* (general preparation of actors, infrastructures, etc.), *cultivate* (support the innovation environment's growth), and *nourish* (sustain the conditions for the environment to operate and evolve). Similarly, Kaplan (2012) sees that as *connect, inspire* and *transform* phases, highlighting the importance of creating a rich environment where people can get together to innovate.

No matter the metaphoric or more technical terminologies adopted, a number of authors use this notion of phases to explain how innovation ecosystems emerge or are created. Phases are decoupled, inter-related and happen in a continuous evolving feedback cycle when seen as a techno-social system. Decoupled, as they have their own goals, methodologies, policies, resources, actors-roles and activities; inter-related, as they have some degrees of dependence from on to another in terms of providing qualified inputs/conditions to the other phases; evolving, as they have their own maturing path and time.

Many authors emphasise that an innovation ecosystem essentially relies on collaboration among disparate and independent actors forming a network-like structure (e.g. Bernstein, 1998; Camarinha-Matos *et al*., 2007; Berasategi *et al.,* 2011). As explained in section 2, this work uses foundations of Collaborative Networks area as a general basis to express more concretely the identified process involved in the generic life cycle building of an ecosystem (Fig. 1).

Very broadly, it starts with an analysis about which kind of ecosystem is desired (*Analysis*); the ecosystem is further designed and partners are prepared taken this analysis into account (*Project*); this is transformed into real infrastructures and populated with real actors (*Deployment*). Assuming that initial conditions have been established in the previous phases, innovation initiatives can start to take place within the environment so developed (*Execution*). The ecosystem and its evolution can be managed (*Sustenance*). Finally, the ecosystem may either end its activities, or have its mission and profile radically changed, which can require going back to some of previous phases (*Conclusion*).

Each phase is taken as a process, and each one has subprocesses (e.g., *Project* consists of *ecosystem design* and *ecosystem preparation*) and activities (the set of actions performed within each subprocess). They mostly run in parallel as phases are decoupled. They are executed by some actors and may be managed by stakeholders (university, local government, civil association, etc.). In Figure 1, subprocesses' boxes are somehow blurred illustrating that subprocesses are not predefined and fixed in scope and sequence. Yet, that some of them or of activities may be not considered as relevant for a given ecosystem. Dashed arrows try to represent this variability but at the same time present the "typical" information flow observed among phases/process and subprocesses.

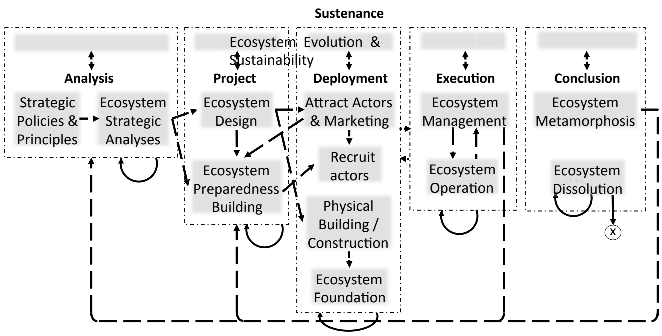

Fig. 1. Innovation Ecosystem Life Cycle

Phases are also self-evolving (circled arrows illustrate this feedback), repeated as the ecosystem goes through stages of development and growth in time. The necessary stages and dynamics of the ecosystem evolution depend on the different pace of actors' assimilation capacity, its level of harmonisation, culture, and on the availability and quality of the required means for the subprocesses at hand (Hwang *et al.*, 2012; Vicente-Molina *et al.*, 2013; Janaratne, 2014).

Subprocesses are not seen as discrete steps. For example, *recruiting actors* and *building actors' preparedness* are permanently running in an independent way to sustain new members to be always attracted for the ecosystem (and eventually formally recruited, trained and/or managed).

Several subprocesses' activities may be circularly dependent on one each other. The pace and the success of these activities may be impacted due to many factors, like the different maturity levels of involved actors, insufficient general infrastructure and resources, weak initial ecosystem strategy, changes in the coordination team (if any), and others. This turns the general process into a "zigzagging" through which the outcome is iteratively refined, but creating management complexity.

Subprocesses may go through *stages* of maturity of technical and management capabilities as well as may need very specific instantiations for the case. For example, *regulatory analysis* in one of the activities within the *Ecosystem Strategic Analyses* subprocess. But which and how existing regulations should be changed to leverage the tackled innovation environment? Which actors should be involved in this action? How long will this take, including political calendar? Can regulations be changed at once or should they be gradually modified? What is the impact of changes on the innovation process and which part of the life cycle will be affected? How does local culture impact the regulations deployment? How prepared current infrastructures are to respond to such new regulations? This example is only one amongst hundreds of others, making the building of an innovation ecosystem complex, time consuming, and eventually a continuous evolution process.

While governance issues may be handled as a (hard) programme management task delimitating rights and duties of all actors when performing their roles, the technical part of *what*, *how*, *when*, *with who* and *where* to do the actions in each subprocess cannot. According to Hwang *et al.* (2012), the right "seasoning" for a successful implementation of innovation ecosystems depends fundamentally on the right quality of ingredients and their right combination at the right time for every single innovation being handled. This demands experience and technical knowledge from the actors involved in each subprocesses' activity (Fransman, 2010), as they must develop adaptations to local conditions, culture and planned goals, considering the required and available investments.

The involvement of the actors in terms of intensity of participation, inter-relationships, and roles in each phase, subprocess and activities may also vary and can also present some overlapping. For example, the participation of supporting institutions' representatives might not be necessary in the *strategic policies definition*, but they use to be crucial in the *ecosystem operation* subprocess. Government is normally directly or indirectly involved in all subprocesses, but not necessary in all of their activities.

Innovation can be by of any type, originated within any subprocess and can be led by any actor type. For example, while plenty of e.g. novel products are being devised by manufacturers and entrepreneurs, other innovations can be triggered, e.g. by the bank sector to offer novel services to better support the actors recruiting subprocess; or by universities to provide on-demand courses based on novel business models; and so forth.

4.1 Analysis Phase

Take strategic decision of creating an innovation ecosystem in the given region. It is usually led by governments or universities. This phase has two main subprocesses.

I. Definition of Strategic Policies & Principles

Strategic discussions among government (local, regional or national), stakeholders and relevant decision-makers about the vision and the desired role of innovation ecosystem in a given area. This involves defining social objectives; macro objectives, mission and core values supported by risk and feasibility analysis; analysis of systemic cause-effect relationships, definition of scope and structural dimension (the consideration of already existing incubators, R&D centers and industrial initiatives); SWOT-like analyses; business *canvas* and general analysis of existing and desired conditions, and the conditions to bridge the gap and create a roadmap for change. Usually different dimensions (e.g. educational, infrastructural, technological, industrial and entrepreneurial) and levels are tackled for the particular case. The introduction of innovation-related initiatives should be gradually implemented – starting from primary school, which includes "mindset" aspects, like tolerance to diversity, creativity, curiosity, and how people deal with unsuccessful actions; or how local and regional government can work together to improve the image of the location in terms of social inequality so as to attract more talented people[5].

Basic output: the decision (or not) to implement the envisioned innovation ecosystem and initial roadmap.

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[5] e.g. http://www.ecosysteminsights.org/how-one-small-city-vcs/ about Helsinki city. There are many reports, white papers and blogs describing initiatives equivalent to this subprocess in several cities all over the world, like in Boston, Austin, Barcelona and London, just to mention few.

II. Ecosystem strategic analyses

Strategic discussions and decisions about how to implement the desired or general ecosystem, the steps and timing. Actions usually involved: deep analysis of local conditions, deployment models (e.g. centralised in a given city area; partially spread over different areas and institutions; or if it will be integrated to other ecosystems), the region's business vocation, innovation and entrepreneurship culture, actors to involve and their roles and competencies, policies for actors' preparedness, project planning of local resources, infra-structures, regulations and funding schema.

Regarding the deployment model, there are important factors: Porter (1998) and Gertler (2007) point out the pros of actors' physical proximity. Fitjar *et al.* (2011) highlight that a centralised approach has limitations regarding e.g. scale and partner complementarity. Hwang *et al*. (2012) advocate that widely distributed ecosystems have the potential to overcome local limitations and to expand the innovation impact. Innovation ecosystems projects may be created on top of an extant basis, encompassing R&D institutions, incubators, technology parks and industry clusters.

Basic output: localisation decision and deployment model, ecosystem requirement in terms of regulations, of general actors' preparedness and of basic infrastructures.

Consultants and R&D institutions[6] use to be the main actors helping governments or other organisations in this phase.

4.2 Project Phase

Design and take all steps to prepare the underlying conditions for building the ecosystem. This is done taking into account outputs of Phase 1. This phase has two main subprocesses.

I. Ecosystem Design

Define the ecosystem's "architecture", its components, types of actors, roles and relationships, infrastructure requirements, governance model, operating and business models, bylaws, code of ethics, incentives and mechanisms to attract actors.

Basic output: ecosystem mid and low level "specifications".

II. Ecosystem Preparedness

Define and plan (and milestones) actions related to preparing involved actors, infrastructures, laws and proper regulations to cope with the ecosystem's requirements and mid and low level specifications, along future stages of evolution.

Basic output: ecosystem's "environment" gradually prepared.

Consultants and R&D institutions are usually the main actors to assist the decision-makers involved in this phase.

4.3 Deployment Phase

Formally establish the designed ecosystem, transform specifications into infrastructures and populate with real actors. This phase has four main subprocesses.

I. Attract Actors & Marketing

Detailed design and execution of actions to publicise the ecosystem to attract qualified actors.

The rollout may be variable as it depends on available resources, prepared supporting actors and regulations, and local culture. This involves actions like offering dedicated innovation programs in universities, financial benefits for startups, incentives for boosting the creation of spin-offs, making university curricula flexible, innovation competitions and prizes, and city hall involvement in easing housing costs.

This subprocess gives feedback to the previous subprocesses, helping refine ecosystem preparedness directives. For example, in terms of comprehensive initiatives (of government, universities and private investors) to guide students in creating spin-offs, maturing ideas to attract funds for business development (via e.g. workshops, competitions and accelerators), to coach them and fora to meet investors. All this helps innovators to be incubated (or readily transformed in a startup and installed in some locations) and be coached again if the innovation outcomes succeed[7]. Initiatives like these have been also used as a mechanism to attract people to the ecosystem.

Basic output: attraction plan definition and execution.

II. Recruit Actors

Attract participants according to preparedness directives and rules. The way this can be carried out is variable, depending on many factors, in particular on the maturity level of innovation culture in the chosen region. For example, actors can be first pre-selected (based on e.g. technical competencies, ideas, reputation, social capital, collaboration history and trustworthiness) and then sent to targeted courses; or such courses can be openly offered; other courses can be suggested by mentors once they consider that the entrepreneurs' ideas have good business potential. There are areas where the system's behavior is "emerging and self-managed" without formal mechanisms for recruiting, since the involved actors respect a general code of ethics and bylaws of the leading institutions[8].

This kind of more formal recruiting does not apply to R&D institutions, banks and governments. This category of actors, crucial for innovation ecosystems, normally develops or receives external advisory to create specific conditions and services to support and help actors along an innovation.

This is all about not only attracting and recruiting actors, but also and very much importantly, keeping them integrated, permanently improved and evaluated, and aligned with the ecosystem's goals and regional strategic objectives.

Basic output: actors recruited and "ready" to start playing their roles.

III. Physical building construction

Make available suitable facilities to support the diverse types of actions required throughout the innovation life cycle, following the requirements and guidelines indicated in the design subprocess. Facilities can include meeting rooms, labs, common equipment, water, gas, electricity, furniture, air conditioning, communication infrastructures, restaurants and leisure areas, transport accesses, etc., and even some small housing built or leased. Depending on the deployment model, this can also involve joint involvement with the city council in planning new bus lines, bike lanes, etc.

Having a dedicated physical precinct specifically built to shelter innovation projects is not mandatory. Facilities can be housed or consider e.g. established parks, R&D institutes, incubators and private companies' labs, where the ecosystem can act as a "virtual entity" on top of existing infrastructure (this seems to be the most typical model). Facilities can be

[6] e.g. http://www.t2vc.com and MIT (http://ipc.mit.edu/).

[7] e.g. http://vms.mit.edu and http://www.endeavor.org (and its diverse branches in many countries).

[8] In Silicon Valley, for instance, there are daily reports that inform which actors have been acting improperly (Hwang *et al*., 2012).

very small and spread over some city areas, composed of some meeting rooms and basic staff. They may even not "exist" in a formal manner[9].

Basic output: facilities to "operate" the innovation process (gradually built) and be used by the ecosystem's actors.

IV. Ecosystem foundation

Official organisational foundation of the innovation ecosystem, when pertinent. Depending on the deployment model and taxation laws as well as legal incentive mechanisms, this can involve a legal or more formal establishment of the ecosystem. Other actions may include hiring administrative staff, creation of visual identity, etc.

Administrative staff can include very specialised people, like business brokers, mediators, network orchestrators, accountants, lawyers expert in IPR and technology transfer, patents, contracts, trading regulations, etc.. All this in turn can be offered "as a service" by specialised companies[10].

Basic output: ecosystem officially established.

Construction companies, senior R&D researchers, lawyers are usual main actors guiding decision-makers in this phase.

4.4 Execution Phase

This phase is responsible for managing the operation of the entire ecosystem. This phase has two main subprocesses.

I. Ecosystem Management

This includes management activities of the ecosystem as an system entity, and can cover two levels:

- The implementation of the ecosystem itself: depending on the devised strategy to build the ecosystem, this level can be responsible for managing all the building phases;
- The daily operation of the ecosystem once it has been launched. This involves the ecosystem management at operational level (personnel financial, organisational, technological, governance), including the "performance and behavioural" management of actors and hence the adding of new ones, their inclusion into the system and their exiting or exclusion from the system. This activity is also responsible for providing information for stakeholders to help monitoring ecosystem's results against the strategic objectives defined in the first phase.

Several authors stress the importance of using correct performance indicators as a tool for ecosystem management, and highlight the negative impact of incorrect indicators that threaten the ecosystem's sustainability. Negative impacts come from a myopic vision of some managers, who treat the innovation ecosystem (and the innovation development itself) as a traditional company. Devising adequate performance indicators to manage innovation is not an easy task and has been tackled by several authors (e.g. Birchall *et al.*, 2004).

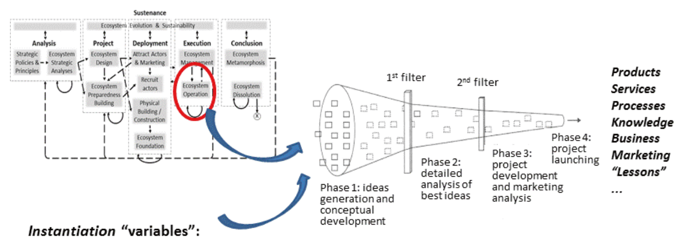
Basic output: management initiatives, creation of a suitable, friendly and trustworthy working "atmosphere", creation of management reports and performance indicators.

II. Ecosystem operation

This subprocess manages the aspects related to the innovation initiatives themselves carried out "inside" the ecosystem, their developments, problems, results and impacts.

The way this can be done depends on the ecosystem's size, sectorial scope, adopted governance model, bylaws, operating rules and principles. These are influenced by many factors, such as local culture, actors' trustworthiness and preparedness level for collaborating in open environments; legal framework and respect for IPR; funding and technological transfer schema, degree of involvement of private investors; exploitation plans; and innovation models (e.g. closed, open, network) and planned results.

Every innovation initiative can be developed in very different ways within an ecosystem. For example, in one given innovation initiative the closed and very linear model can be adopted, with a high care about IPR protection and ideas disclosure, very formal rules and tight monitoring. In another case, it can be treated as something unique and self-managed, so the innovation "path" is serendipitous and does not follow a predefined model; IPR protection is negotiable, and the level of idea disclosure is variable according to needs, rules are informal and loosely monitored. To be noted that an innovation initiative not necessarily aim to have a ready commercialisable outcome in its first development stage.



***Instantiation* "variables":**
Models: state gate, chain link, open innovation, networked innovation, "rainforest", ...
Approaches: co-creation, collaborative innovation, ...
Processes: *< how innovation is conducted >*
ICT: tools, platforms, environments, services, ...
Techniques: canvas, governmental/private/ hybrid Programs, coaching, acceleration, ...
Funding & mechanisms: angels, government, crowdsourcing, virtual capitalists, pay -forward...
Actors: *< who are involved along the innovation life cycle >*
Structure: spin-offs, startups, established companies, ...
Placement: incubators, companies, tec parks, universities, public labs, ...
Funnel picture 's source: Clark, K. B., and S. C. Wheelwright. *Managing New Product and Process Development: Text and Cases.* Free Press, NY, 1993.

Fig. 2. Innovation ecosystem and the innovation process

Literature and research projects[4] presents several models, methodologies, mechanisms and ICT platforms to support innovation. This means that an ecosystem should hold any instantiation of the innovation "framework". Figure 2 tries to illustrate a range of possibilities. For example, while a given initiative follows a funnel-like model, it is not necessarily a completely linear process. Actors may enter and leave throughout the process initially using an open network model, then later a closed one. The model can be formalised or informal; the process may have investors involved from the first or only in the second part of the funnel; entrepreneurs' business may be accelerated to refine the product's business plan so as moving the current implementation environment to a proprietary platform provided by a large ICT company, which in turn is interested to have some participation in a future launched company; this interest only has come up after having some partial prototype tested close to prosumers via a collaborative web-based tool regarding the innovation's development plan; this supporting tool (whose development was funded via a crowdsourcing scheme) was got from a university's spin-off thanks to fair technologic transfer mechanisms; the new company can start its activities in a given technology park due to a better legal support for adapting the envisaged product according to national regulations; etc.

Basic output: management initiatives; maintenance of the suitable, friendly and trustworthy working "atmosphere";

[9] In Silicon Valley, for example, people meet in cafes and further develop the ideas in more proper places (Hwang *et al*., 2012).
[10] For example, http://vms.mit.edu.

management reports and performance indicators at more individual levels; innovation outcomes (products, knowledge, newer ideas and models, "lessons learned", etc.); the management of these resulting assets from a knowledge management perspective.

In general terms, all actors use to get involved in this phase. Actually, this is the subprocess where the ecosystem runs at the full force and mostly shows its strength and vigour.

4.5 Conclusion Phase

This phase is basically responsible for handling issues that deeply impact the continuation of the ecosystem's life. This phase has two main subprocesses.

I. Ecosystem Metamorphosis

Occasionally the ecosystem's mission or profile must radically, creating the need for deeper reflections and hence big changes in the ecosystem (as a whole or in some parts of it). This may happen as a consequence of e.g. changes in regional strategic directions and policies, of internal or external socio/economic factors, or of lessons learned in the ecosystem operation.

Basic output: reflections and suggestions of new requirements for the "new version" of the ecosystem.

II. Ecosystem Decommission

This subprocess refers to handling issues related to the ecosystem closure - as whole or relevant parts of it - also considering eventual legal regulations. A number of more "drastic" factors can lead to this, like the ecosystem's outcomes are far below after some time; some crucial actors are no longer committed; different political priorities leading to e.g. too large cuts in government funds; IPR rules haven´t been respected so both entrepreneurs and industry no longer trust in the system; minimum infrastructures didn´t get ready within an acceptable time; and natural disasters.

Important to mention that a decommission does not mean ending the ecosystem overnight. Those drastic factors can impact the ecosystem at different levels so it (or part of it) may gradually vanish over years.

Basic output: final report with the analysis of the innovation ecosystem life cycle and the reasons and justifications about why the ecosystem is going to be decommissioned.

Ecosystem and regional stake-holders, lawyers, government and other decision-makers are usually the main actors involved in this phase.

4.6 Sustenance Phase

This phase is responsible for handling the future evolution and viability of the ecosystem, i.e. for managing the ecosystem's life cycle. This phase has one main subprocess, but which crosses, impacts and receives feedbacks from all the other subprocesses.

I. Ecosystem evolution and sustainability

It can be said that while the *ecosystem management* subprocess (4.4.I) handles the ecosystem at the *operation* management level and only focuses on the daily running of the ecosystem, this subprocess actually corresponds to *tactical and strategic* management levels that *all* phases (intrinsically or explicitly, informally or formally) have when performing their actions.

The actions to perform within this subprocess include minor or mid-level changes of the ecosystem, including policies, architecture, physical structure, governance rules and actors' roles, taking into account political directions and priorities, societal/actors feedbacks, business models and trends, etc. This subprocess also comprises situations of actors decommissioning as they may come and go throughout the ecosystem's life span.

Different management approaches and key performance indicators may be applied, depending on: the adopted deployment, governance and (eventual) business models; strategic goals and control mechanisms; ecosystem design; and actors' profile and their level of preparedness.

Basic output: permanent feedback about the ecosystem's status to relevant stakeholders and ecosystem managers.

Ecosystem stake-holders, government and other decision-makers are usually the main actors involved in this phase.

Having presented the life cycle and underlying vision, we define an innovation ecosystem as a strategic macro-level social actor that can support governments and institutions when conceiving their plans of social and economic development. It acts as a catalyzing environment that aligns independent actors, regulations and supporting elements to leverage actors playing their roles in an organised and collaborative way towards developing innovations. In more detailed terms, we defined it as an open, dynamic, sustainable and evolving networked business environment, which drives the transformation of ideas into valuable outcomes under possible and varied business models, supported by capital and by heterogeneous actor's knowledge and infrastructures, constrained by policies, regulations, governance and culture.

5. OUTLINE AND CHALLENGES

Literature discusses many cases on building ecosystems, and reasons for positive and negative results[11]. Negative reasons include (e.g. Lundvall *et al.*, 2002; Hwang *et al.,* 2012; Howells, 2005): inadequate local mindset for innovation; lack of actors' preparedness and suitable legal frameworks to work in a coordinated, convergent and trustful way; underestimation of the difficulties and time required for reaching the necessary level of preparedness; insufficient cash flow throughout the whole innovation chain; managing the ecosystem as a traditional company without understanding the intrinsic characteristics of innovation; endogenous intellectual environment with low diversity; attempting to replicate successful cases without understanding their unique environment; inadequate infrastructures and supporting institutions; low quality of life of cities; no comprehensive technology transfer mechanisms.

Lessons from successful initiatives include an environment with (e.g. Genome[1], 2012; Durst *et al.*, 2013; Hwang *et al.,* 2012): trustworthy and open; low bureaucracy and transaction costs; money flow along the entire innovation process; flexible innovation and business models; collaborative and sharable environment; fair business spirit; altruism, voluntarism, partnership and leadership; prepared supporting institutions and legal frameworks; clear and transparent operating rules; fair management of actors; respect for IPR and knowledge transfer schema; good integration with civil society; diversity of culture and thoughts; "acceptance" of failure as learning; and city infrastructure and social atmosphere.

[11] This includes an assessment presented by many ecosystems' "managers" during the special panel on innovation during the 2015 G20 Summit http://www.choosebrisbane.com.au/G20-Brisbane/Global-Cafe/Digital-Age

Those authors as well as Janaratne (2014), Mercan *et al.* (2011), Vicente-Molina *et al.* (2013) and Sloan (2011) also identify some open questions: How to prepare institutions and people for a new mindset? How to attract and retain talented people? How to nourish creativity in the local society? How to handle knowledge and technology transfer from R&D to the market? How to guarantee funds along the whole innovation process and ecosystem life cycle? How to drive universities, industries and governments to work in closer strategic alignment? How to identify, measure and manage innovation impact? How to better prepare students at the universities for innovation and entrepreneurship?

6. CONCLUSIONS

The article presented a first attempt to systematise the building of innovation ecosystems. The aim was to create a holistic view and demonstrate the complexity involved in that building process.

One of the conclusions reached after the literature review was that a successful innovation ecosystem is the result of a long evolution, and there is no single recipe that suits all cases. There exist several initiatives whose results are below what was initially envisaged. Reasons for this include the lack of proper adaptions of existing models to the local culture and environment; and a restricted view of the innovation process' nature, the types of expected impacts, and the time required for the ecosystem to mature. Besides that, each actor involved has its own individual 'system' and intrinsic particularities and related goals; i.e., the ecosystem is a system of systems. Therefore, one of the difficulties includes the design of a common framework through which heterogeneous actors can harmonise their interests and systems for innovation.

Practice documents emphasise that there is no straight-forward way to build an innovation ecosystem as it is necessary to prepare and to support the evolving process of actors and elements regarding local conditions, culture and strategic goals (if any). A sort of actions is hence performed along such building process. On the one hand, the so-developed set of life cycle processes as a model does not constitute a 'guide' to build innovation ecosystems. On the other hand, given a particular case, the model could be used by stakeholders as one basis to analyse what used to be done and considered when conceiving future ecosystems or intending to enhance and better sustain an existing one. Thanks to the holistic view upon the whole building process and its life cycle, a model like this can help stakeholders in better planning and management of time, resources allocation (human, financial, infrastructure, etc.), and the degree of complexity of actions in different stages of ecosystem building. This all can be helpful for predicting points of higher risks, and to prevent the whole system from achieving undesirable states.

This paper represents the first results of an ongoing research. Future research intends to develop a more formal model of the innovation ecosystem and the innovation process, which takes into account the mix of deliberate and emerging / distributed processes of ecosystem evolution; the formalisation of business models; and further refinements of the life cycle building processes via a mapping of the model against multiple case studies.

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