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From Ideas to Impact: Exploring the Role of Innovation in Knowledge Construction

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Abstract

In the knowledge economy, growth is triggered by research, but above all by the ability of an ecosystem of innovators and project developers to exploit this research by finding commercial applications for scientific and technical advances. Indeed, empirical studies by Aydalot (1986), Porter (1990), Ruffieux (1991), and Darchen & Tremblay (2008) have examined the notion of clusters as innovation networks exploring how to build and exploit relevant ideas and transform them into knowledge that can be applied in reality. The aim of our study is to explore theoretically the process of knowledge construction within society, including business. The fundamental question is as follows: How is the relevant knowledge generated by innovators built up in society? To answer this question, we carried out in-depth theoretical research based on a structured and sequenced literature review on the dynamics of knowledge production. A meticulous analysis of the information and theoretical models led us, on the one hand, to observe that knowledge occupies a very important place in the structuring of projects according to innovators, and, on the other hand, to reveal that the construction or production of dynamic knowledge is achieved through three stages: (1) knowledge economy, (2) company economy and (3) socio-ecological transition.

Keywords: knowledge economy, knowledge construction, innovators, economy of society and socio-ecological transition.

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1. Introduction

The future workforce landscape is ever more uncertain. With technologies playing a pervasive role in learning organizations, thus making skills-based education a pre-requisite, and affecting entire generations of learners, the need for disciplinary and transferable skills for job-ready.

Against a backdrop of intense rivalry between countries, we are witnessing a rethink of the competitive positioning of regions, which have to adapt to a globalisation that brings opportunities and added value. Indeed, empirical studies by (Aydalot, 1986; Porter, 1990; Ruffieux, 1991; Tremblay, 2008) have examined the notion of clusters as innovation networks, exploring how to build and exploit relevant ideas and transform them into knowledge that can be applied in reality. We can take the example of the most famous cluster, Silicon-Valley, as a high-tech production area operating in various value-added fields (bio-business, biotechnology, medicine, industry, advanced information systems, artificial intelligence, etc.), based on a networked innovation system, disseminating tacit knowledge, promoting learning and mutual adjustment between specialised knowledge producers in a node of related technologies (Saxenian, 2000). In fact, Silicon Valley has increased the likelihood of developing innovative ideas, processes and new products through the creation of new, exploitable knowledge. This knowledge production dynamic has enabled the cluster itself and Californian society (USA) to generate socio-economic benefits in terms of wealth, growth and development.

The success of any project is a fundamental point of every innovation policy, and the method of building high-performance knowledge where research leads to the creation of value is the philosopher's stone of all regional development policies. In fact, the dynamic of knowledge production by innovators is a spontaneous phenomenon that can be organised by understanding and identifying the mechanisms that generate it. This article proposes a theoretical model that includes the key elements in the composition of relevant knowledge.

Research always stems from the existence of a problem to be solved or clarified. A problem arises when we feel the need to close a conscious gap between what we know and what we should know. The main aim of this research is therefore to identify the mechanism that generates knowledge through the innovation activity of project leaders. Our objective is therefore to determine the process by which innovators or business opportunity providers develop knowledge that is both dynamic and stable. We have therefore formulated the following central problem:

How is the relevant knowledge generated by innovators built up in society?

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Is it a simple process of evolution in the number of projects or is it a dynamic of innovation making a qualitative leap towards new forms of relevant innovation and therefore towards new perspectives for technological development? In order to gain a better understanding of the driving forces behind the knowledge production process, we will use a methodological approach that relies mainly on a detailed, structured and chained analysis of the literature aimed at gathering and reinforcing existing theoretical and scientific debates in order to detect the dynamics of effective knowledge production, to present the hypothesis derived from the theoretical referents of our research proposals and finally to suggest a theoretical research model that explains the dynamics of innovation.

The first part of this paper aims to frame the concept of innovation and its dynamic process via an analysis of the scientific literature, in the second part we will present the methodological framework of our research work and in the final part we will simultaneously analyse and discuss the theoretical debates and models in order to identify elements of an answer to our central question.

2. The conceptual framework of innovation

2.1. The concept of innovation

Innovation has now become one of the keys to the competitiveness and development of every society. Innovation was defined by the economist Schumpeter in 1934 as the introduction onto the market of a new product and a new production method, the conquest of a new market, the use of new raw materials or the introduction of a new form of organisation (Schumpeter, 1934). For the author, innovation becomes the result of routine R&D work carried out in large industrial research laboratories. He considers (see figure 1) that it is teams with highly specialised skills carrying out highly routine work that are at the origin of innovation (Sander, 2005). Innovation is both a result (new product, new process, etc.) and the process followed to achieve that result (Fernez-Walch, 2006). Innovation as a result is modelled as a black box. The actual phenomenon of innovation is not explained because it takes place in the "box" between technical progress and the market.

The concepts of creativity, discovery, invention and innovation are often mistakenly confused, and it is important here to distinguish between them.

Creativity consists in bringing out new concepts or giving new meaning to facts that are already known (Wallisch, 2003). Creativity stems from divergent thinking, in the ability to reproduce new forms or to combine elements that are generally considered to be separate. Creativity, on

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the other hand, is defined as a dynamic of intuitive anticipation, imagination and the unconscious, which draws on various processes to bring new structures to light (Cortes Robles, 2006). Creativity can be seen as a way of solving problems, using intuition or combining ideas from very different areas of knowledge (González, 1981).

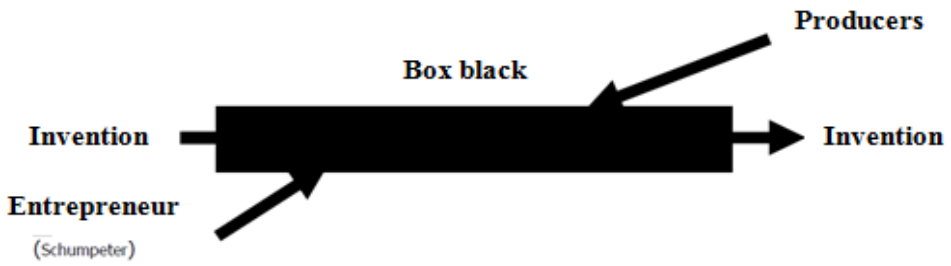

Figure 1: The black box model (innovation as a result).

Discovery is often defined as the action of finding what was unknown or ignored (Schmitt, 2012).

The OECD makes a distinction between invention and innovation. Invention represents one of the upstream phases of the innovation process, and bringing it to market in the form of a successful product will make it an innovation (OCDE, 1991). An invention, a new idea, a concept or the discovery of a product or process that has not been marketed are not innovations (OCDE, 1997).

2.2. Types of innovation

The Austrian economist Joseph Schumpeter (1934) distinguished five types of innovation: The creation of new products, the introduction of new methods of production, the creation of new forms of industrial organisation, the development of new resources for the supply of raw materials or other inputs, and the opening up of new markets (see figure 2). The Oslo Manual defines four types of innovation: product innovations, process innovations, marketing innovations and organisational innovations (Manuel d'Oslo, 1997).

According to the Oslo Manual, product innovation is characterised by the introduction of an innovative product, significant improvements in technical specifications or other functionalities, or the addition of an innovative supplementary service to an old service; process innovation is the implementation of a new or significantly improved production method; marketing innovation is the action of introducing significant changes in the following elements: design, packaging, placement, promotion or pricing of a product, while organisational

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innovation is the implementation of a new organisational method in the firm's practices, workplace organisation or external relations, for example.

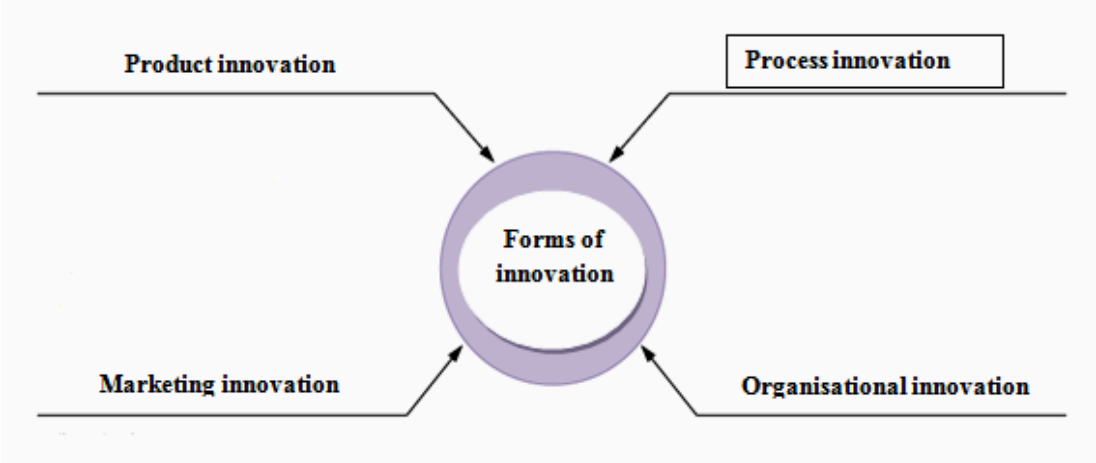

Figure 2: Forms of innovation, OECD

Schumpeter (1939) distinguishes between major (radical) and minor (incremental) innovations. An innovation is said to be radical when the technological characteristics or intended uses differ significantly from those produced previously. Such innovations may be based on new technologies, or on the combination of existing technologies in new applications. An incremental innovation, on the other hand, is one that improves the performance of an existing product or process (Manuel d'Oslo, 1997).

The object of innovation: this is the object developed by an individual innovator and placed on the market. It may be a material object, a service, a production process or a technology. It is the result of the innovation process. Consideration must be given to the specifications of the new product, the manufacturing processes and the life cycles of the product. This product is not static and unchanging, but can evolve thanks to new skills and new technologies in particular. The actions to be taken at this level must enable it to evolve. This involves adding new features (incremental innovations) or, if possible, proposing new products to replace it (radical innovations).

Product development must call on the company's current resources, skills and technologies, as well as new ones that will either be created within the company during the process, or obtained through acquisition.

2.3. Technological innovation

According to Khalil (2000), technology can be defined as "the knowledge, products, processes, tools, methods and systems used in the creation of goods or the provision of services". Technology is also defined as "theoretical and practical knowledge, skills and artefacts that can

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be used to develop products and services, as well as their production and distribution systems". Technology can be embodied in people, materials, cognitive and physical processes, plants, equipment and tools (Burgelman and Burgelman, 2006). As for Boly (2004), he presented technology as technical knowledge and related knowledge linked to industrialisation. According to N'doli Guillaume Assielou (2008), technological innovation is an innovation based on a new technology, or an innovation facilitated by the use of a new technology, or an innovation to which we have made technological improvements.

According to the definitions proposed by the Oslo Manual, technological product innovation means the development/marketing of a better performing product with the aim of providing the consumer with objectively new or improved services. Technological process innovation means the development/adoption of new or significantly improved production or distribution methods. It may involve changes affecting - separately or simultaneously - equipment, human resources or working methods. In relation to these definitions, Gaffard notes that a product innovation at firm level can constitute a process innovation at sector level, just as a process innovation for the firm can be a product innovation at sector level (Gaffard, J.L, 1990).

2.4. Innovation as a dynamic process

Innovation is both a result (new product, new process, etc.) and the process followed to achieve that result (Morel, 1998). A process can be broadly defined as a set of correlated or interactive activities that transform input elements into output elements. Thus, any activity managed in such a way as to enable the transformation of input elements into output elements by adding value to them can be considered as a process. Evolutionary approaches see innovation as a process dependent on a pathway along which knowledge and technology develop through the interaction between different actors and other factors.

According to the OECD (1997), innovation is an iterative process initiated by the perception of an opportunity in a new market and/or a new service for a technological invention and which leads to development and production tasks, resulting in a successful invention (Bescos and Mendoza, 1994). The innovation process includes the technological development of an invention, combined with its marketing, adoption and dissemination, right through to the end user. Khalil (2000) defined the process of technological innovation as a complex set of activities that transforms ideas and scientific knowledge into physical reality and real-world applications. It is a process that converts knowledge into useful products and services that will have a socio-economic impact. Morel (1998) speaks of a value creation process. Taravel supports these authors by asserting that innovation is closely linked to increasing the value of industrial

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products and services. But value is a function of time. The more it increases the intangible part of the product, the more it increases. Innovation is also described as a permanent and dynamic process in which innovators constantly develop their products and processes, their modes of reasoning and representation, and gather new knowledge to feed the process. This process is necessarily recursive, as past or current processes constantly enrich the company's future projects. According to N'doli Guillaume Assielou (2008), the authors summarise the process of innovation or knowledge creation in eight different conceptual points of view (from scientists and practitioners):

- Process of adding value to technical progress: transformation of technical progress into new technologies and skills, then their integration into a product that will be distributed on the market and bring economic value.
- The process of adopting something new: the mechanism by which an existing innovation becomes part of the culture of the group that adopts it.
- Whirlpool process: the creation of an object is a collective activity which continuously deforms the object as interests coalesce or disintegrate around it.
- Marketing process: a sequential series of stages from the search for new product ideas to the marketing of new products.
- Political process: a process involving players pursuing conflicting objectives, hoping for uncertain results and exercising power.
- Transformation of a technical system: gradual modification of the technical system over time in response to needs and new solutions.
- Project: life cycle broken down into phases: emergence, design, implementation and winding-up of the project.
- Learning process: the process of creating, capitalising on and disseminating knowledge and know-how within the organisation.
- Intentional process: players aim to develop their practices or meet latent needs. It is an intentional process of change through the introduction of something new in a context, which is perceived as such by the subjects, and which consists of the original arrangement of pre-existing elements. It is a finalised social action. Social because it is a collective action involving communication/collaboration between the players. Finalised in the dual sense that it is underpinned by the values of improvement and progress, and is geared towards action and the operational implementation of the ideas that led to its inception (Bary, 2002).

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2.5. Innovation process models

A vast body of literature exists on innovation processes (see figure 3), describing the management and phases of the process from idea to marketed product. Rothwell describes the evolution of innovation process models in five generations from the 1950s to 1990 (Rothwell, 1994). Fig.3 summarises these five generations of innovation process models, which have evolved from simple linear models to increasingly complex interactive models (Niek al, 2009). It is important to stress that progress from one model to another does not mean that the previous model is completely abandoned and replaced (Žižlavsk, 2013).

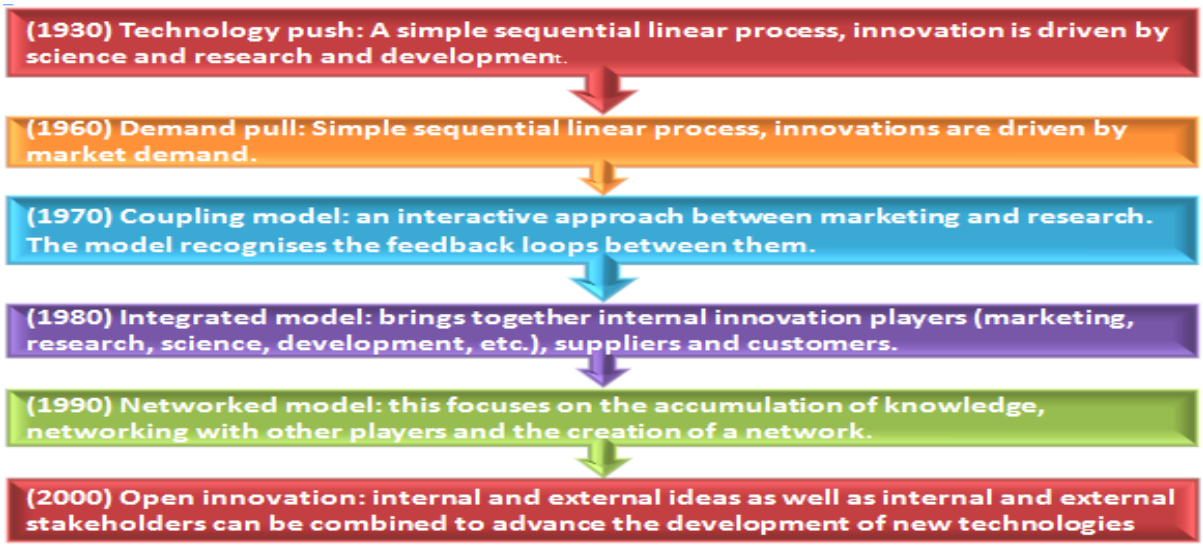

Figure 3: The evolution of the innovation process model from generation to generation.

- *The linear model of the innovation process*

In this model, the innovation process is a succession of obligatory and ordered steps. This is why it is called linear. The exit point of the previous step is the entry point of the next step. This mode of operation assumes a compartmentalized organization, a specialization of people and service activities. In addition, this model leaves no room for "feeds back", that is to say for possible returns between one stage and another. The sequences follow one another in a linear manner, prohibiting any feedback and recognizing no learning mechanism throughout the process (Chouteau and Vievard, 2007). Several derivative models inspired by the linear concept have appeared:

1) The first generation is Technology Push model: In this model, it is scientific discoveries and research that push entrepreneurs to find applications and therefore to innovate. Innovation then consists of giving a social use to the invention. As a result, innovations create market need. The "Push Technology model" is considered the first generation of the linear model. It was inspired by the economic work of Joseph Schumpeter and was

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developed during the late 1950s and mid-1960s. In this model technology is seen as the main driver of innovation (Hattori, 2012).

2) The second-generation Demand-pull model (Schmookler, 1966): In the demand-pull innovation model, innovations arise from perceived demand, which influences the direction and speed of technology development.
3) According to this vision, the biggest challenge is effective investment in marketing and identification of customer needs. The market becomes the new driver to guide research and development. This principle was initiated by Schmookler in 1966, for whom it is not science that pushes innovation but the market – in other words demand – which encourages and explains innovation. Market demands are taken into account by an entrepreneur, an inventor or even a company who seek innovative solutions to respond to them. This model seeks to know the needs of customers to satisfy them through innovation, at present we believe that the consumer is satisfied by the enormous existing offer, instead of looking for the needs of customers, marketing is supposed to imagine new needs, creates new offers, the consumer who has the means will only give in to this novelty following the strong marketing persuasion these days.
4) The Stage-Gate model (Cooper, 1988): It is considered a derived linear model, introduced by Robert G. Cooper with the aim of reducing production cost risks. Primarily used for project management, this model divides the product innovation process into five stages with defined gates acting as decision points between stages. At the end of each stage there is a stage gate, which consists of a phase review to assess whether the previous phase or stage has been successfully completed. The conditions for triggering an operational phase are, on the one hand, the end of the previous phase and, on the other hand, the decision to continue. If the project is reviewed positively, the work moves to the next phase. If not, the process stops in this phase until successfully completed.

With the evolution of society and the globalization of the economy, the linear concept has become old-fashioned, to the detriment of new models of innovation, more complex and more complete, better adapted to the economic situation.

- *Towards more complex models of the innovation process: We find in complex models of innovation:*
    1) The coupling model, (3rd generation model): A mix of previous approaches resulted in the 3rd generation coupling model where the Technology push and the Demand pull

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could fluctuate depending on the phases of the innovation process and coexist naturally (Rothwell, 1994). In the 1970s, this 3rd model spread with an interactive approach between customer needs and research.

Despite the sequential nature of the model, it establishes feedback loops between stages in order to adjust the product to market needs and modify the technological aspect, if necessary (Hattori, 2012). In this model, market needs and technology possibilities are key elements for developing innovation. Research and development and commercialization must be coupled in an efficient and balanced manner to create the most innovative product while reducing costs. According to this vision, the main challenge is inter-organizational marketing-research communication.

2) The linked chain model (Declan, 2009) or Kline model: also called the Kline model of innovation was introduced by Stephen J. Kline in 1985 and described in more detail by Kline and Rosenberg in 1986. The linked chain model attempts to describe the complexity of the innovation process. In the linked chain model, the market appears as an incentive for innovation.

Presented below, this model shows a central chain of innovation (represented by C) involving the identification of a potential market, followed by the conception and testing of the idea, leading to the market entry. At each stage in the development of the idea there are feedback loops (f) to describe the trial and error nature of the process. The most important source of feedback (F) is testing the idea in the market. Thus, the problem could be solved by reference to the existing stock of knowledge (arrow 1 at node K and arrow 2 at the back). For example, this could be achieved through reading scientific publications or attending conferences. If the problem cannot be solved within the current stock of knowledge, it may be necessary to undertake research (arrow 3 to R). The result of this search is so uncertain that the problem may be unsolvable (arrow 4 in the back is dotted). The model recognizes that existing technology or knowledge may not be sufficient to enable product and process development and meet the needs of the identified market (see figure 4).

A two-step process, indicated by the arrows marked K and R, is often necessary to overcome technological problems. First, a solution is sought from the existing stock of knowledge. If this fails, research is required to get a solution. This leads to an increase in the stock of knowledge subsequently transferred to the innovation process. Using the search function can be done without technical difficulties. Research enriches technological possibilities and the arrow labelled D represents this advanced link between new scientific knowledge and the innovation

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process. An important aspect of this model is the presence of the research function throughout the innovation process, unlike the linear model where research is found only upstream.

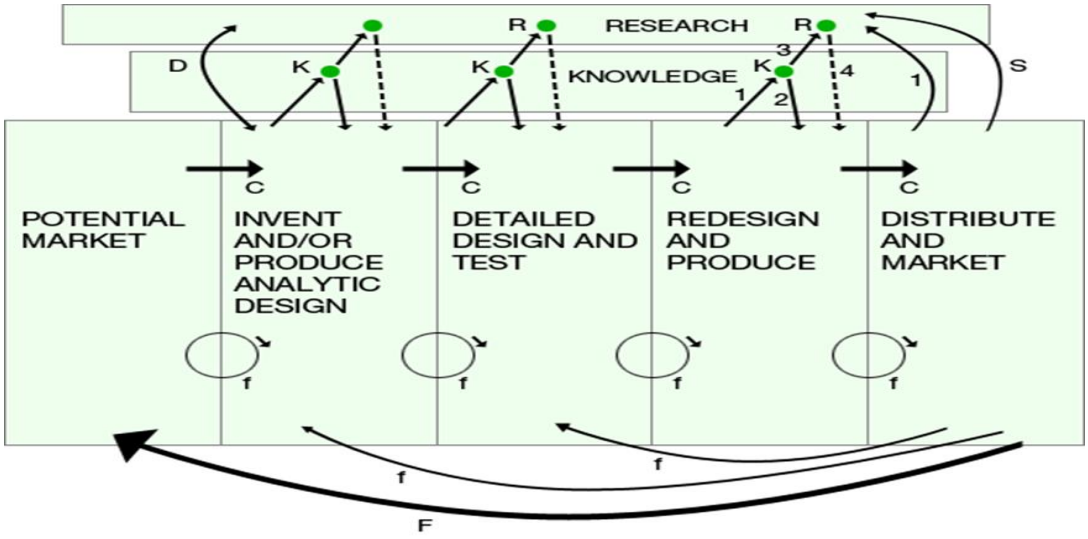

Figure 4: The linked chain model (S. Kline and N. Rosenberg, 1986).

3) The Integrated Model of Innovation (4th Generation Model): During the 1980s, the integrated model of innovation was developed to improve the lack of functional integration in linear models (Galanakis, 2006). This model highlights the importance of incorporating different departments of the organization during the development of a new product or service (parallel development). The step-by-step linear innovation process has been replaced by an integrated process where different stages of the development process occur at the same time. This approach considers the innovation process as a set of parallel activities integrated into organizational functions. This includes new strong interactions with other production players, upstream with key suppliers and downstream with key customers. The feedback loop and the sequential non-linear aspect allow the evolution of such a process while maintaining the characteristics of integration and the parallel state of progress of all stages.
4) Fifth generation networked models: The fifth-generation approach to innovation processes was brought about by time constraints. Being the leader in innovations on the market is insufficient; offering an innovative product in a short period of time represents a real competitive advantage (Rothwell, 1994). Companies have adopted a time-based strategy through the use of sophisticated electronic tools operating in real time to automate the innovation process and accelerate the speed and efficiency of new product development within of the innovation network including internal functions, suppliers, customers, partners and external collaborators (Hobday, 2005). Rothwell said: 5G

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represents the electronification of innovation (Rothwell, 1994). The models of the innovation process cited so far are mainly closed models where the entire development process took place exclusively within the company (See Fig. 5).

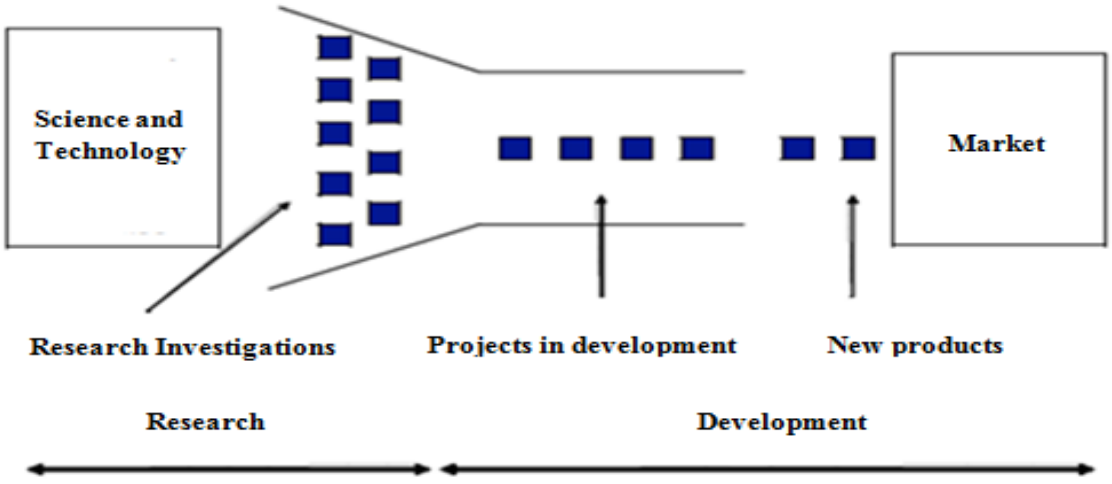

Figure 5: The closed innovation model.

In this model, research projects are initiated by the company itself based on an internal technology base. Some of these projects are cancelled and others are selected for development. Finally, some of them are chosen to be launched. This process is called “closed” because projects evolve internally throughout the process.

3. The methodological framework of the research

The approach we are going to follow is a structured analysis of the literature review, which covers both articles and theoretical models, in order to obtain a more exhaustive view. Indeed, the use of this type of analysis is considered a sine qua non for the development of a field of study and is thus an integral part of any research study (Easterby-Smith et al. 2002). Its aim is to help identify and organise the theoretical content of the field under study (McCutcheon and Meredith, 1993) and thus lead to the development of a theory. Reviews and models were selected according to their degree of relevance to the question posed. The concepts of innovation, knowledge and the triple helix were chosen as the relevant keywords for this study.

In order to better position our research work, we began with the conceptual framework of the research, and then we will propose our analysis model and its fundamental hypothesis, which will be analysed in the following section. In order to better conduct the study, we first chose a positivist posture associated with a hypothetical-deductive mode of reasoning that allows us to

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formulate the question and the hypotheses to be theoretically tested. In the light of the above, we want to test the theoretically anticipated hypothesis, which can be formulated as follows:

H1: The production of knowledge by the innovator ranges from the knowledge economy through the knowledge society to the socio-ecological transition.

This hypothesis must be confirmed or refuted by comparing theoretical models. Thus, our tested theoretical model can be presented as follows in figure 6.

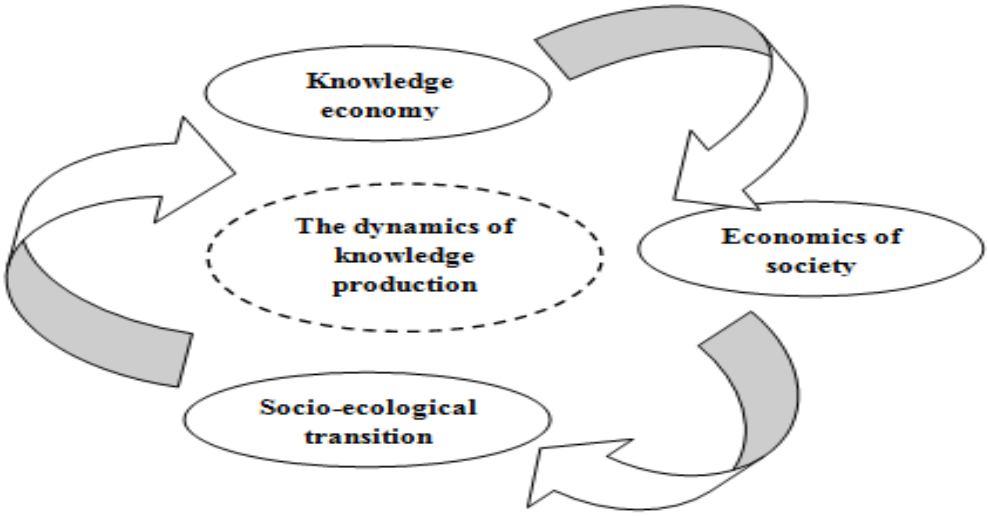

Figure 6: Methodological framework elaborated by the authors.

In what follows, we will simultaneously analyse and discuss the theoretical results, and then come up with some answers to the research hypothesis and the theoretical model.

4. Analysis of theoretical results and discussion

In what follows, we will analyse and describe the main debates and theoretical models addressing the phenomenon of the dynamics of knowledge production within society, including the firm.

4.1. From the New Knowledge Production model to the Quintuple Helix of innovation

In the process of developing the knowledge economy (Foray and Lundvall, 1997), three players play a major role in improving knowledge and transforming ideas into competitive products: universities, industry and government. Each of them working independently, industry produces and develops products, while the university creates the basis for innovation from its fundamental research programme. Collaboration between university and industry will create an economic model capable of reducing the time lag between scientific discovery, industrial innovation and production. Coordination is needed by a leading entity (the State) to maximise

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innovation capacity in a given geographical area. The authors seek to explain the changes underway in the dynamics of knowledge production by positing the existence of a new logic of dynamic interdependence between the three traditional poles of academia, industry and government (Shinn, 2022).

The New Production of Knowledge and the Triple Helix are two analytical currents in the sociology of innovation that have been the subject of debate on the changing landscape of the organisation of relations between science, industry and society to produce knowledge. The New Production of Knowledge, a book written by Michael Gibbons and others and published in 1994, argues that the way in which scientific knowledge, technological practices, industry, education and society as a whole are organised and function today contrasts sharply with the way in which they used to relate to each other. The '1' mode of knowledge production that prevailed until 1950 was characterised by a clear divide between academia and society. The academic world would be based on an autonomous university, independent scientific disciplines and specialities, and the possibility for scientists to decide what is and what is not science and truth. There seems to be no interaction here between the university and industry. Rather, the new mode of knowledge production heralds the disappearance of the traditional university, its independent scientific disciplines and its autonomy in research. Mode 2 would be characterised by a new interdisciplinarity, by the great mobility of temporary groups of experts organised around urgent problems, and by the primacy of economic and social problems in the decision to develop this or that sphere of knowledge Olosutean, 2011).

Gibbons' model thus postulates a mutation between two quite distinct eras, in which interactions between university and industry would have gone from nil to intense under the influence of numerous economic imperatives. The whole core of the new production of knowledge is to be found in this book, where statements are made about the end of universities and scientific disciplines, and about the increase in interdisciplinarity and research themes that are supposed to be economically and socially relevant.

The publication of a new volume in 2001 - Re-thinking Science - by three of the authors of the 1994 study (Nowotny, Gibbons and Scott) led to an examination of changes in the orientation of the new production of knowledge, with the authors speaking of a "new contract" between science and the rest of society. In their view, post-modern society is characterised by 'reverse communication', i.e. communication from society to the producers of knowledge, rather than the other way round. Society decides what happens to knowledge. Knowledge producers accept and follow. The authors use a new concept that they call socially robust knowledge. This

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concept refers to a tendency among scientists to formulate the questions raised by promising research in terms of the "technical innovations" that they might generate. It consists of a systematisation of research and knowledge invested with a mission and oriented towards application (Nowotny and al, 2006).

- *Definition of the triple Helix*

This way of conceiving a functional link between three spheres that were institutionally separate and whose interdependence was not clearly apparent until then has convinced international bodies (public authorities and Brazilian universities) and recognised organisations (National Science Foundation, CNRS, European Commission, etc.). Sociologists Etzkowitz and Leydesdorff were the first to evoke the concept of the triple helix as a genuine engine of growth. The three spheres - public (government), private (industry) and academic (university) - which used to operate at a greater distance in laissez-faire economies, are now increasingly intertwined in a spiral, with links between them emerging at various stages in the innovation process (Etzkowitz and Leydesdorff, 2000). In their overview of the triple helix published in Research Policy in February 2000, Etzkowitz and Leydesdorff present two new ideas: The traditional university is the cornerstone of the triple helix. The authors emphasise that discipline-based university departments are converging in new ways and that, while retaining traditional lines of research, they are also turning towards industrial research and intermediate forms of research.

Universities are thus generating a number of intermediary institutions that link them to economic and social interests. In this publication, the very mysterious core of the triple helix is finally identified. The recursive effect of the various inter-institutional links turns out to be infinite, since the said arrangements are subject to what the authors call endless transition (Shinn, 2002), with coevolutions occurring within and between the three strata in the form of several small changes that persist over time.

The triple helix approach emphasises historical continuity, with previous relationships continuing between university, industry and government, and new forms of relationship and institution being created. The triple helix is accompanied by a theoretical framework: self-organisation and coevolution. The basic statements of this theory are as follows (Humberto, 1980):

1) Under certain specific conditions, institutional and cognitive structures become ill-adapted to the situation and unstable.

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2) Several structures evolve together, and this co-evolution results in a new institutional and/or cognitive structure that is completely unprecedented in history.
3) Time plays a fundamental role in this dynamic.
4) Co-evolutions temporarily resolve problems of dysfunction in the complex structures of existing systems.
5) At a given moment, new strata of complexity are themselves accompanied by new dysfunctions (institutional and/or cognitive) and this gives rise to new cycles of coevolution.

Etzkowitz and Leydersdorff established three different generations of the triple helix (Fig. 7):

- Triple-helix I, in which the state brings together industry and academia to rule the relationship between them through legislation or directives.
- Triple helix II, in which the elements are strictly separate but linked by different channels of communication.
- Triple helix III, in which the three elements are blended and favour the emergence of tri-lateral networks and hybrid organisations.

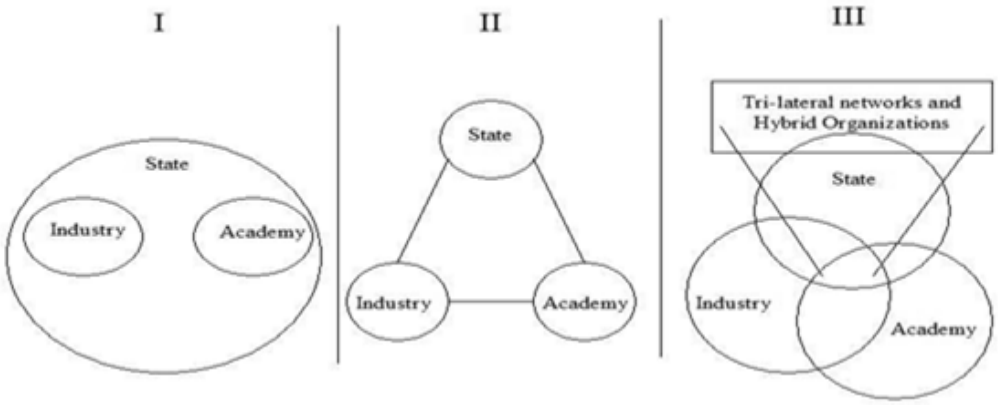

Figure 7: The three generations of the triple helix (Etzkowitz and Leydesdorff, 2000).

The configuration of the triple helix is characterised by the meeting at its centre of three major traditional poles, the appearance of hybrid organisms which combine the characteristics traditionally associated with one or other of the three poles concerned will optimise the objective of innovation (Etzkowitz and Leydesdorff, 2000). These three poles take the form of interlocking helices, forming a hybrid zone (see figure 8 below) with a particular role to play in terms of innovation.

The triple helix explicitly raises a number of urgent questions about government, academic and industrial policy. Here, the authors of the model are sometimes led to urge company directors,

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administrators and politicians to rethink their policies and decisions in response to changes in cognitive, technological, economic and international orientations (Shinn, 2002).

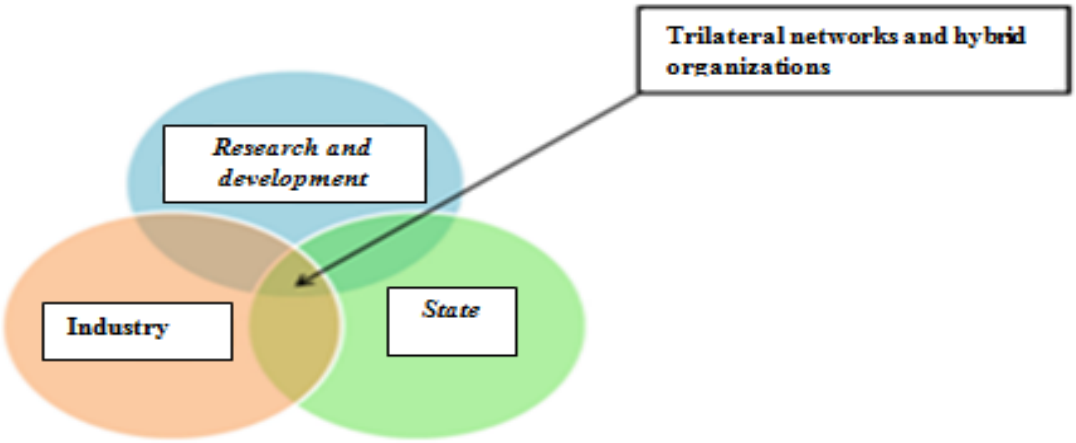

Figure 8: The triple helix model of innovation.

- *Analysis of the interweaving of the three spheres*

The Triple Helix advocates the advent of dynamic interdependence between the various spheres within a historical continuum. The authors of the Triple Helix postulate significant changes in the relationship between the academic, industrial and governmental spheres. The basic idea that underpins the operative nature of the concept is that network interactions generate mutual expectations between three institutional spheres: the university, local, national or supranational public government, and business (Etzkowitz, 1998). These expectations exert feedback effects on institutional arrangements.

Economic dynamics simultaneously induce institutional transformations within each institutional sphere. To facilitate structural adjustments, they can work to stimulate the development of networks across the institutional boundaries between the three spheres (Etzkowitz and Leydesdorff, 2000).

By analogy with DNA, the descriptive principle of the triple helix is as follows: each strand of the helix (the three institutions: business, government, university) has its own code of behaviour and communication between the strands takes place through their interface and by exchanging codes (the rules of behaviour of each institution).

The exchange of codes produces genetic mutation that constantly modifies both the surface and the internal structure of each strand. The model postulates that each traditional pole, in contact with the other poles within the new stratum of knowledge development, has the ability to

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remodel itself in order to continually integrate new elements of the external dynamic and to cope with certain internal events (Shinn, 2000).

Each helix is itself the site of constant transformation under the pressure of a perpetually changing environment. Market dynamics, like innovative dynamics, produce changes in the codes of communication between institutional spheres. It is these local translations at their interfaces that enable us to understand the mechanisms of adaptation in institutional arrangements. When two institutional dynamics tend to co-evolve into trajectories, a transitional regime emerges and institutions can flexibly assume the role of other partners. For example, industrial and academic players may modify their behaviour in order to adapt to the new requirements imposed by their interaction with other players.

The American concept of the entrepreneurial university, like the recent calls for scientists to create start-ups, bears witness to the interweaving of industry and research (Nieddu, 2002). In this way, universities are playing a major economic role because they are being asked to create an industrial context, they are developing entrepreneurial behaviours such as business start-ups, while firms are developing an academic dimension, sharing knowledge with each of the other spheres and training employees to higher levels of competence: Academic researchers become entrepreneurs and commercialise their own technology; entrepreneurs work in university laboratories or technology transfer offices, public sector researchers simultaneously work in private companies, academic and industrial researchers manage regional technology transfer agencies (Viale & Ghiglione, 1998). Local authorities are called upon to intervene at an increasingly detailed level, both in defining and steering scientific research programmes, and as public entrepreneurs in assembling the public and private resources needed for the emergence of new economic activities (Rallet, 1999).

The interweaving of spheres gives rise to three subsets (Nieddu, 2022): hybrid innovation agents within the university (such as the scientific interest group (GIS), the public interest group (GIP) and the university subsidiary), ‘innovation interfaces’ between industry and research (such as regional technology transfer agencies), and ‘innovation coordinators’ responsible for managing the passage of innovation between several institutions during its various phases.

The role of innovation coordinators is to promote a normative consensus, with the government defining an appropriate legislative framework to guide academic and industrial players towards greater integration (Carayannis and al, 2012). This is the role played respectively by the Ministries of Industry, Trade, Investment and the Digital Economy and the Ministry of Higher Education, Scientific Research and Executive Training.

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4.2. The Quadruple and Quintuple Helix model of innovation

There has been an expansion in the number of helixes capable of producing knowledge, and the authors speak in particular of the quadruple and quintuple helixes of innovation. This fourth helix is associated with public media, creative industries, culture, values, lifestyles, art, and perhaps also the notion of the creative class (Carayannis and al, 2009). The fourth helix integrates and combines two forms of capital: social capital (culture, tradition, values) and information capital through the media (news, communications, social networks. As for the quintuple helix, this is a five-helix model, where the environment and the natural environments of society and the economy represent the fifth helix (Carayannis and al, 2010).

The model proposes a response geared towards problem-solving and sustainable development. It emphasises the need for society and the economy to make a social-ecological transition in the 21st century; the Quintuple Helix is therefore ecologically sensitive. In this model, the natural environments of society and the economy should also be considered as drivers of knowledge production and innovation, thus defining opportunities for the knowledge economy. In 2009, (see figure 9) the European Commission identified the socio-ecological transition as a major challenge for the future development roadmap. The Quintuple Helix supports the creation of a win-win situation between ecology, knowledge and innovation.

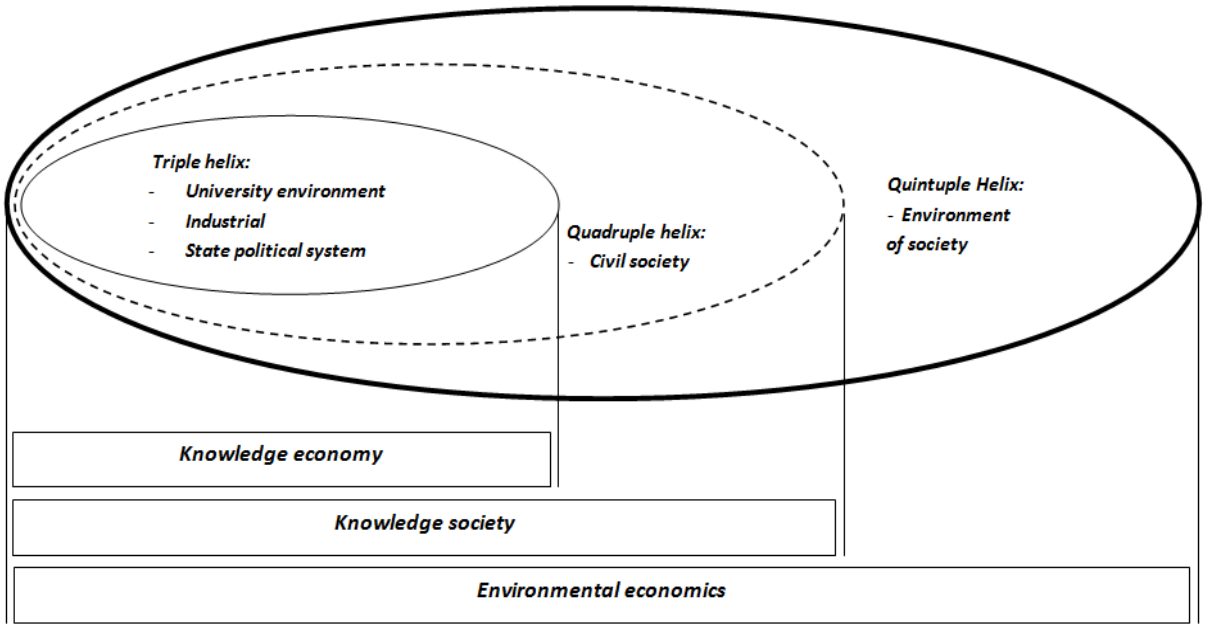

Figure 9: Knowledge production in the context of the knowledge economy, the knowledge society and society's natural environment (Quintuple helix model).

In light of the above, we were able to notice that the production of knowledge by the bearers of business ideas firstly begins a composition of the knowledge economy (also called the Triple Helix model), where there is a dynamic confrontation of an efficient and qualified university

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and training environment with an economic and industrial system of innovative companies and an adequate political system of the State, this automatically brings us to the Quadruple helix which comprises the knowledge society, c that is to say, its creative classes, its values, its culture and its vision in terms of creativity and innovation, to finally arrive at the Quintuple helix which contains the socio-ecological transition the exploitation and optimization of the natural environment of society.

This sequence, when it is favourable, healthy and dynamic, makes it possible to automatically trigger a real production of knowledge carrying added value in terms of growth and development of societies. Regarding the aforementioned theoretical models, we can confirm both our developed theoretical model and central hypothesis which says: *The production of knowledge by the innovator ranges from the knowledge economy through the knowledge society to the socio-ecological transition.*

Conclusion

The aim of our research was to contribute to the literature on the dynamics of knowledge production within society, including the firm, while at the same time offering a new theoretical perspective (which focuses on the conceptual framework of innovation as a key element in the construction of knowledge) and developing a specific analytical grid (that of the mechanisms of knowledge construction).

We carried out a more or less systematic analysis based on a discussion of the theoretical models developed in the subject in question. The intention was to demonstrate that the implementation of a relevant and effective innovation policy is often linked to a process of horizontal construction of knowledge through which a concrete project is built.

To create an innovative idea, the project initiator needs to have a well-adapted academic background, to be in contact with his environment (academic and industrial) and to make better use of his material and immaterial resources: the knowledge economy. Once the initiator has created an innovative idea, it needs to be confronted with society (the media, the creative classes, etc.): knowledge society, so that it can be transformed into reality while exploiting the natural environment: social and ecological transition, so as to ultimately obtain a project in action. In this respect, we can conclude that the construction of all knowledge must go through a knowledge economy, then a knowledge society and finally a rich natural environment.

Thus, in this study we wanted to synthesise and develop the literature review in order to better construct a theoretical model dealing with the path of knowledge formation from the knowledge

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economy to the social and ecological transition. The aim of our research is to highlight the importance of innovation as a result of a process of constructing knowledge in the development of society, and consequently, we can validate our main hypothesis cited above.

Empirical perspectives, with reference to successful international clusters operating in the fields of knowledge production and dynamics. In the future, we will carry out two mixed empirical studies (qualitative and quantitative). For the quantitative approach, we will aim to carry out a methodological approach based on a questionnaire administered and targeted at Moroccan clusters (by analysing the path of knowledge construction and its impact on the clusters themselves, and consequently on society, i.e. the host territory). On the other hand, we are going to carry out a qualitative methodological approach (intra and inter Moroccan cluster case studies) via a very in-depth interview guide, to zoom in deeply on the functioning of these clusters in terms of knowledge production, ICT, innovation dynamics and performance. We consider these approaches to be beneficial methodological contributions for future researchers. From a methodological point of view, we found it interesting to carry out this theoretical study in order to construct an idea of the emergence and development of knowledge. In the near future and from both a qualitative and quantitative point of view. As a result, we will begin a case study of Moroccan startups in order to better understand the path from the business idea to the creation of a project on the one hand, and on the other qualitative side, we will carry out a confirmatory study to verify the causal links contributing to the generation of knowledge within these startups. The dynamic dimension of the analysis highlights the importance of learning and interaction processes in the creation of specific resources at the origin of innovation.

In fact, our research study presents a limitation, despite a fairly abundant literature review on innovation and knowledge production, we reveal that there is a lack of empirical work that could play an important role in clarifying the subject dealt with, and this stems mainly from the complexity of the terms tackled, as a result of which we were confronted with the inadequacy of this type of work. Hence the need to test our proposed model empirically.

Broadly speaking, research in the field of innovation and knowledge is experiencing particular importance and crucial growth throughout the world. It is seen as a contributor to the resolution of social problems, a generator of economic wealth and a driving force behind the development of any territory.

Conflict of interests

We have no conflicts of interest to declare and no financial interest to report.

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