Innovation Systems in the Twenty-First Century: Toward the Emergence of "Democratic Competitiveness"

M. DEKKICHE *(mokhtar.dekkiche@univ-mosta.dz)*
Oran University, Algeria

Abstract:

The Twenty-First Century has been seeing a dramatic change at almost all levels. This was due to the spread and ramping of globalization fact. However, the main characteristics of the recent era is the growing importance of Information and Technology of Communication (ITC) which invades various aspect of life. Yet, according to Schwab (2015) a new industrial revolution (a forth one) is to be born in the near future, as the ultimate result of ITC pressure. This is true once we take in consideration that innovation and technology are changing the way supply and demand interact each other to generate new products. In an advanced stage their interaction creates what is known as the Quadruple Helix of innovation, in which not only supply side are called to produce, demand side are vividly welcomed to participate in the conception of new products. As a result competitiveness is said to be democratic as it receive the support of different actors including large portion of population and environment; the same as a president is elected a democratic country.

This paper shows that through the development of the innovation systems, since the nineties, there is a tendency to create competitive advantages, which receive the approval of various actors and lead to the emergence of "Democratic Competitiveness".

Keywords: Innovation System, Quadruple Helix

THE NATIONAL INNOVATION SYSTEMS:

diagnostic of existing definitions on National Innovation System (henceforth NIS) highlights its importance; in effect leading scholars all argue about the importance of institutions and their interactions. For Freeman (1995) the NIS refers to "*the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*, while Lundvall look at NIS as "*the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state"* (Lundvall, 1992); Nelson on the other hand define NIS as "*a set of institutions whose interactions determine the innovative performance ... of national firms" (*Nelson, *1993).* For others, NIS is a *"set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies*" (Metcalfe, S. 1995 as cited by (Niosi, 2002). According to these definitions, innovation is the matter of institutions. Their mode and their timing of interaction shape the systematic environment of the emergence, development, dissemination and transfer of new knowledge. Yet, some critics can be made. First: the epoch at which the concept emerged; indeed studies on NIS launched earlier in 1980s by the contribution of Freeman (Sharif, 2006, Freeman, 2004) then his printed work on Japan in 1987. It was followed by pioneering works of B.A. Lundvall (1992), R. Nelson (1993) and C. Edquist (1997). However, this era characterized by the victory of American mode of economic thought. Liberalism jointly with the spread of multinational firms are considered as the engine for economic leadership; on the other hand, the diffusion of silicon valley model in the United States announce the beginning of new era, that of chipset and digital technologies. The need for identifying the system that wraps the unprecedented jump between industries, authorities grew consequently. Second for the geographical location, a recent study by Teixeira (2014) shows that specialized journal, articles published and the most cited authors by the NIS literature belong to developed economies rendering thus the previous definitions partially relative. The third critic consists of author's background. For Sharif (2006) there are controversies among practitioners about the academic or policy-making origin of the term. Prominent leaders of NIS work at university, public and supranational institutions or both. This is why we believe that the articulation and the way the NIS is defined reflect author's

affiliation. In addition, no clear decision about author's first use of the term is done. Sharif (2006) concludes that NIS concept arose simultaneously in both field at the same time.

Yet, the ongoing use of the term will create some confusion in recent time. The reasons is that these definitions consider developed economies as referring point, while a projection attempt on developing economies may not match fully given the lack of clarity surrounding the system itself and its prominent components; this is due to the type and quality of rules in these areas. In our best knowledge, there are several studies which treat conveniences and efficiencies of the concept in developing world. Even results diverge from one study (or countries) to another, the evidence is that they use the same definition, while it is essential to updating them vis-à-vis time and location. Further, new thoughts emerged while others expand since 1990s; the globalization, which becomes a fact rather than a concept, has changed the ways of looking at and thinking of things. It was immediately accompanied with new concepts. The term «Governance», which is an economic synonym of "democracy, much more political concept" appears recurrently in non-governmental world institutions like OCED, WB, and WEF to designate the conduct of micro and macro policy of institutions at local, national or regional level. As such, governance measures the quality of democracy in a given economy in the sense that it quantifies some basic requirement. Both institutions classify developing world at the back of the list.

Looking at the previous definitions opens new windows for analysis. Reporting the word "national" renders the NIS concept less intuitive. A flexible use of the term "national" gives birth to two levels of analysis: the macro level, which refers to purely political meaning of boarders; and the micro level for referring to the type of systems.

Focusing on the macro level, innovation system can refers to local, regional, national or global meaning. The Local innovation system, the smallest system, denotes the concentration of firms and related non-market organizations that connect to generate new products in localized area. In that sense, it constitutes the backbone of industrial clusters. Regional innovation system, which refers to a meso-level of analysis, consists of a '*constellation of industrial clusters surrounded by innovation supporting organizations*'(Asheim and Coenen, 2005). The emergence of the term was developed to respond to the success of certain regions in developed world, especially the model of Silicon Valley in USA (Lundvall, 2009). However, we believe that the term conveys for countries with federal system ruling like Germany, Canada, Malaysia and India (in some extent, we can include France). The global

view of the system consists of harmonizing national innovation policies toward a global trend, generally under the framework of world institutions, OCED for instance.

The micro analysis level of innovation system gathers some intuitive concepts. The most reputed concept refer the sectoral innovation system. Malebra (2002) defines the concept as a set of agents carrying out market and non-market interactions for the creation, production and sale of new and established products for specific uses. To insure its vitality, heterogeneous interveners, with deferent background learning, interact through variety ways in market and non-market relations for a specific sector. A suitable example is the Agricultural innovation System. Under this concept, agricultural sector is seen as a network of multitude interactions from various actors whose main objective is to bring novel and useful technologies that affect positively the agricultural production (Kingiri, 2013). In a similar view, technological innovation system is regarded as a sector (a micro oriented variety of Sectoral Innovation System, if we use the proper words of Suurs (2009) since it refers to a network of interactions from active agents; these cooperation is reflected by the generation, diffusion and the use of a specific technology (Carlsson and Stankiewicz, 1991). A nanotechnology is a typical example. Developing a nanotechnology is not devoted to a specific sector; rather it is introduced in numerous key industries.

Later in the mid of nineties, a new stream of interest, complementary rather than rivalry, described the shift in academia and higher education philosophy. The central idea is that knowledge within academia follows new trend that is different from conventional one in prominent characteristics.

‘MODE2’ OF KNOWLEDGE PRODUCTION:

The immediate perception is the existence of ‘mode 1’. Also known as ‘*basic research*’, ‘mode 1’ knowledge production refers to the disconnection of research from real life concerns. University, as an ‘*Ivory Tower*’(Bok and Bok, 2009), produces knowledge in accordance to pre-defined rules which are strictly followed and revised by a cognitive community; the generated knowledge is strictly mono-discipline and responds to disciplinary interests. Hence knowledge with its generative researches never leave university. In addition, the application of research’s findings will be approved latter by other scientists of the same filed.

The changing environment of research process can be summarised, according to Gibbons et al (2003), to three elements:

- *The Determining of research Goals*
- *Engaged Research*
- *The accountability of Knowledge*

As a result of these elements, research (simultaneously knowledge) underwent a remarkable shift in term of studied problems, its quality and its definition (it does not regarded as public good). In an original work, Gibbons et al (1994) published a book whose core idea is to explain this transformation. The novelty is the introduction of 'Mode 2' term, which is based on interactiveness and distributiveness. In effect, 'Mode 2' differs in some attributes.

- The First attribute is the increasing aware that science does not take problem from nature then produces its application, in the sense that science itself seeks to retreat in the Ivory Tower; rather, it intertwines with society, economic and politics. That is to say, knowledge is only generated provided the inclusion of actors' interest; this means that problems are formulated earlier while communicating and dialoguing with different actors. So the first attribute concerns *'the context of application*'.

- The second attribute is '*transdisciplinarity*': in contrast to multi-disciplinarity, which necessitates a pre-existing disciplines and regenerates new disciplines, transdisciplinarity refers to the recruitment of a '*range of theoretical perspectives and practical methodologies*'(Hessels and Van Lente, 2008) to shape the group assent. Hence, heterogeneous skills and expertise, as well as the genius to manage theoretical and practical methodologies, condition the potential solution. This knowledge is said to be 'Tacit' that needs no theoretical aspects, i.e. embedded in the minds of individual researchers who work on the problem.

- As a consequence, it result that there is a great diversity of entities and types of knowledge; this is labelled "Heterogeneity *and Organisational diversity*': the third characteristic. University constitutes a fragment part of potential entities where knowledge, science and innovation is produced; non-academic organisation gain place in that market such as governmental agencies, industrial laboratories, consultancies, resulting in an interaction of different skills and competences linked by means of

formal and informal channels of communication. Therefore, a dynamic hybrid network is established within which a recombination of fields and areas leads to creating new forms of knowledge. Accordingly, organisational types change and vary in accordance to attacked problem and yield to a flexible team formation. Researchers can meet to tackle a specific problem, in a specific context of application, which disappear when solving the question, then work on different issue with totally different context of application. Such flexibility reinforce and contribute to creating highly valued competence.

- Another attribute of 'Mode 2' is the increasing responsibility of scientists about what they create, and awareness of the overall society of what is produced. A sort of a conversation between science and society governs the creation of knowledge. To be clear, there is a sensitivity for the impact of the final solution on society, in the sense that the solution has to incorporates public interests. This is due to the context of application in which the problem is defined according to actors' backgrounds. The forth attribute deals with '*accountability and reflexivity of science*'.

- Finally: '*Quality Control*'. Quality control concerns the peer-reviewers. Because the knowledge is defined and created in the context of application and includes overall society, reviews do not restricted to academia (and has to follows strictly codified criteria, predefined by the discipline, rather in encompasses broader range of political, societal, cultural and economic criteria; and good science cannot be measured by academic excellence, but judgements include the contribution to as well as the efficiency and usefulness of the overall solution.

It is clear that knowledge production under "Mode 2" is merely dynamic. While the solution is on progress, testing results are communicated instantaneously and may lead to the formation of a new problem, and so on. A fertilised system of knowledge generation, in the form of a complex matrix, appears. This system differs from NIS especially in the leading roles. Whilst firms conduct the system and possess the supremacy to innovate, "Mode 2" distributes this role between participants and even with the whole society. The context in which the problem is designed innovates and controls the quality of solutions. Herein each participant takes part to the solution and its efforts are less useful outside the system.

During the last twenty years, "Mode 2" thesis has received an enormous interest. Many studies are conducted to testify and/or validate its claim; however tow studies contain the question. Findings of a bibliometric study conducted by Martin (2011) witness a growing elements of interdisciplinarity as well as a significant shift of bibliometric research conducted in the context of application; also there are evidences of heterogeneous institutions. However, literature review, in a study by Hessels and Van Lente (2008), reports a list of critics classified into three categories, generally addressing the lack of evidence to endorse "Mode 2" attributes namely transdisciplinarity, quality control and reflexivity.

A clear image of what 'Mode 2' knowledge production is actively talking about was cleverly explained by *Etzcowitz* and *Leydesdorff* when formulating the 'Triple Helix' concept.

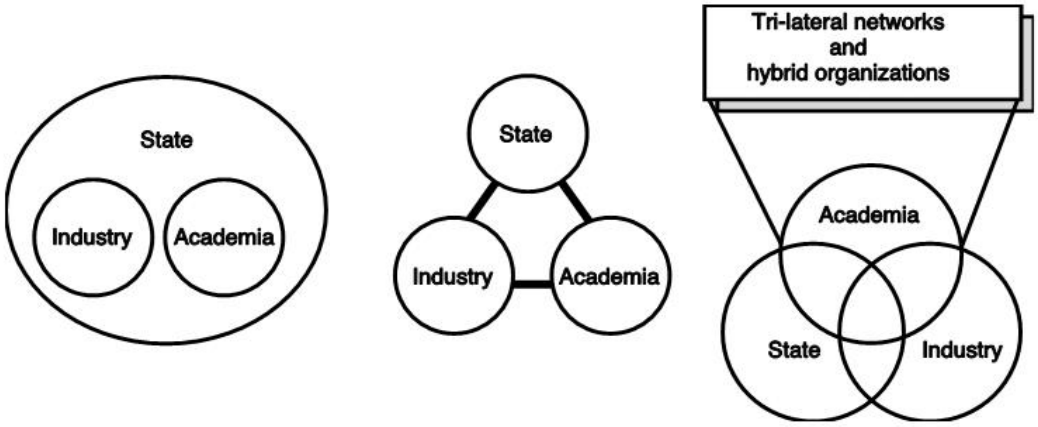
THE TRIPLE HELIX MODEL:

The Triple Helix approach represents a new stage of capitalism evolution; the model exposes the transition from the industrial economy toward the knowledge-based economy, in which entrepreneurial activities in terms of innovation uncommonly grew to foster competitiveness and economic development. Though it differs in that it stresses the historical continuity of collaboration among university, industry and government. From this point, one can define the Triple Helix as dynamic development, represented as a spiral model of innovation, which is based upon the range of agreements and partnership network amongst university, industry, government and leads to more institutional flexibility and emergence of hybrid organisations. According to Etzkowitz (2003) the final format of the Triple helix model is the outcome of two previous ones, which he labelled 'statist' and 'laissez-faire'(Triple Helix I and Triple Helix II.

The Statist model: under this configuration, the government takes the leading role in developing projects and providing resources; the government encompasses the industry and the university, which are considered as being subordinate entities or state-owned organisations (left side of the figure 1). Industry and university only receive support and guidance from the government which provides planning and exercises controlling and management activities. The type of organisation is basically hierarchic and centralised with the industry as national champion and university as teaching institutions; the government thus, determines which industry should be adopted and sustained while university has to

provide necessary trained workforce. The government organises technology projects and raises the level of research at universities to support national (regional) development.

-
-
-



- **Figure 1: The Triple Helix Configuration**

Source: (Etzkowitz, 2003).

The Laissez-faire model: under this configuration, a complete separation among institutional spheres takes place (middle side of the figure 1). the three elements operate independently as separate institutional spheres, by acting as competitive rather than cooperative in their relation with each other; this also hold for firms that operate solely both in R&D and product development. In this model, industry is considered as driving forces and the two other as supporting structures, and indirect interaction may exists in this model through an intermediary body.

The Hybrid model*:* this configuration reserves an equal importance to partners where university displaces military as leading sector (Etzkowitz, 2002). A more flexible overlapping system of mutual interaction with a specific organisational structure emerges to promote innovation. Each partner tries to enhance the performance of two others (right side of the figure 1) and at the same time gains values from them; thus there is a tendency to establish a common long term strategy of well-defined goals.

The implications of the Triple Helix can be listed in the following points: *First*, university receives an enhanced role translated by the adoption of new role beyond its traditional services of teaching and research. Modern universities tend to encompass ‘commercial taches’ namely through the capitalisation of research findings. According to (Ragna and

Etzkowitz. *Creative Reconstruction: A Triple Helix–Based Innovation Strategy in Central and Eastern Europe Countries*. In (Saad and Zawdie, 2011), pp 249-282) this new model which is transformed to 'an entrepreneurial activity' is the result of two revolutions: the first academic revolution led to the inclusion of research , in parallel to preserving and transmitting of knowledge. The second academic revolution designates the inclusion of a third mission that of economic and social development; the term of entrepreneurial university captures the idea that university commercialises the final results of its researches.

Second, each helix performs the mission of the others and takes their role. It does not mean that university become firms or act as governmental authority; rather it means that university for example develops capabilities to act as firms and firms improve their competences in providing reaching tasks. The idea is that each partner fulfil its mission and perform new tasks, generally considered as extreme to its original ones. That is, the government continues supplying rules and regulations that guarantee freedom, girths and duties of the society, while provides venture capital to help start new enterprises. Firms, the locus of production, still do offering goods and services in a competitive price and quality as their perform research activity. Yet, they conserve a great resource to offer training at higher standards and share knowledge by joint venture. The university act as industrial firm by promoting the creation of new firms and introduce the capitalisation of knowledge as an academic function. *Third*, the Triple Helix model is basically build upon the description of collaboration emerged after the breaking down boundary resistance and institutional rigidity of spheres, most involved in innovation. The principle requires the engagement of university, industry and authorities in flourishing discussion to enhance national (regional) economy and social well-being, through establishment of technology centre and development of growth agreement. In this context, the university undertakes the formation of students by providing training programs which correspond better to national (regional) needs. Firms, among them, try to find and found new supplier relationship and government (national/regional) creates stable environment. Then a network of relationship appears at the front: university-industry partnership; public-private cooperation arise. Further, bilateral interaction among university-government; university-industry and government-industry increase remarkably. *Fourth*, the inevitable result of university-industry-government rapprochement is the adoption of a 'hybrid structure' both as organisational and institutional. In terms of 'Mode 2' a context of application determines the framework of innovation policy by defining the problem from multiple views. The final agreement considers, implicitly, the adoption of unique structure to activate the innovation

policy; this includes the organisational aspects as well institutional ones. The hybrid structure in terms of the Triple helix constitutes the ultimate goal of the model. It is located at the centre of the interaction; the hybrid organisation necessitates colossal efforts from the three partners. Their initial bilateral rapprochement facilitates the framing of broader arrangement to overpass boundaries and institutional[1] bottlenecks of hybrid. Therefore, three types of hybrid structures appear; hybrid structure which relates university with industry; hybrid structure that gather university and government and hybrid structure of government-industry relation. Each partner within the structure fulfils specific considerations and responds to an agreed policy as it conserves an independent identity and boundary autonomy. In an advanced stage, the success of the hybrid organisations encourages the fusion for a unique body of triadic parties, in which innovation policy and programs even their execution, is an outcome of interaction rather than a dictation from a dominant party or an external body. The final hybrid structure or the Triple Helix organisation still conserves a core identity of parties; however less attention is devoted to boundary separation. Further, entrepreneurial activities multiple their existence and take new forms such as entrepreneurial university or entrepreneurial government.

The Triple Helix emerges when university, industry and government establish a reciprocal relationship with each other. Yet, this statement should be treated by caution. Indeed, establishing interaction among them does not necessary lead to the emergence of Triple helix as it is conventionally described. University, industry and government may interact closely but negatively; the figure 2 presents two types of Triple Helix.

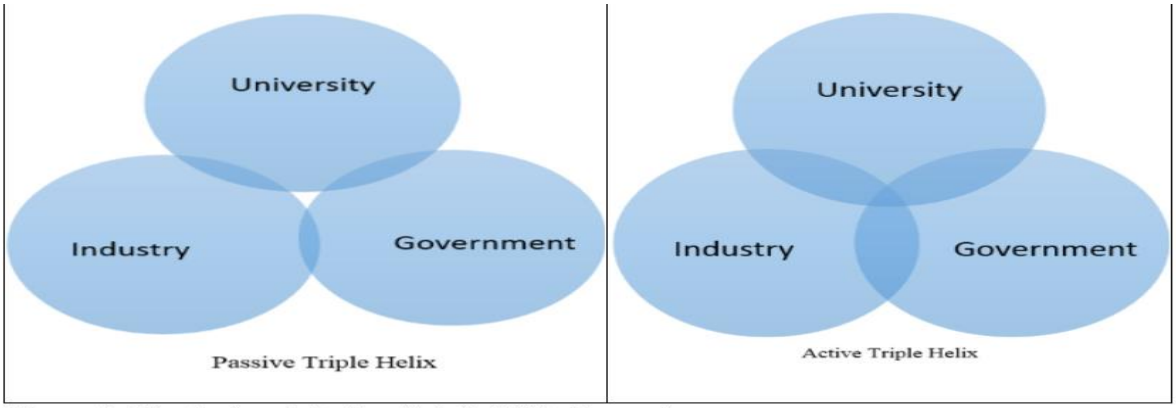


Figure 2: Neutral and Active Triple Helix Format

Source: adapted from Hossain et al (2012)

However, it is convenient to notice that triple helix model has received some critics and limitations:

First, the triple helix model has some level of abstraction namely "actors" which are introduced without decent analysis (Cooke, 2005, Tuunainen, 2005). Then, the model fails to recognise the national settings that have influences on university, industry and government; this claim can be seen when analysing innovation systems among nations. Third, the model ignores people from the scene. Lastly, Tuunainen (2002) argues that the triple helix approach provides weak justifications when explaining university-industry collaboration.
The extensions that the triple helix has submitted result in the adoption of a fourth helix, then the emergence of a fifth one. In what follow we addresses these two points.

BEYOND THE TRIPLE HELIX:

Examining the third critics reveals that the triple helix model omits people from the picture. Pillay (2005) stresses the necessity of social cohesion for both industry and societies to achieve economic and social development. That is to say that any study must include or may take into consideration civil society as a *key variable* in the conclusion of results. Further, global integration, challenges and issues that arise exert pressures on innovation and knowledge creation.

Carayannis and Campbell (2009) stresses the necessity to add a fourth strand within the innovation system to understand the rise of the knowledge societies in the twenty first century. The new strand refers to civil society (the public) and is placed at the heart of the model. The public under the quadruple helix not only own but participate in the design of innovation process. Their quality as "innovation users" gives them the right to be involved throughout the production process. In addition, the quadruple helix model considers civil society as innovative partner and knowledge producer in line with academia, industry and government. Citizens have the power to propose solution, ideas, or new type of innovation for other strands, which are invited to support then exploit the citizen-based innovations. However, civil society opinion's is highly influenced by media and/or culture. Indeed, two passages in (Carayannis and Campbell 2009) states the following "…*media reality overlaps with political and social reality; perception of politics primarily through the media; and the laws of the media system determining political actions and strategies …*" *"…On the other*

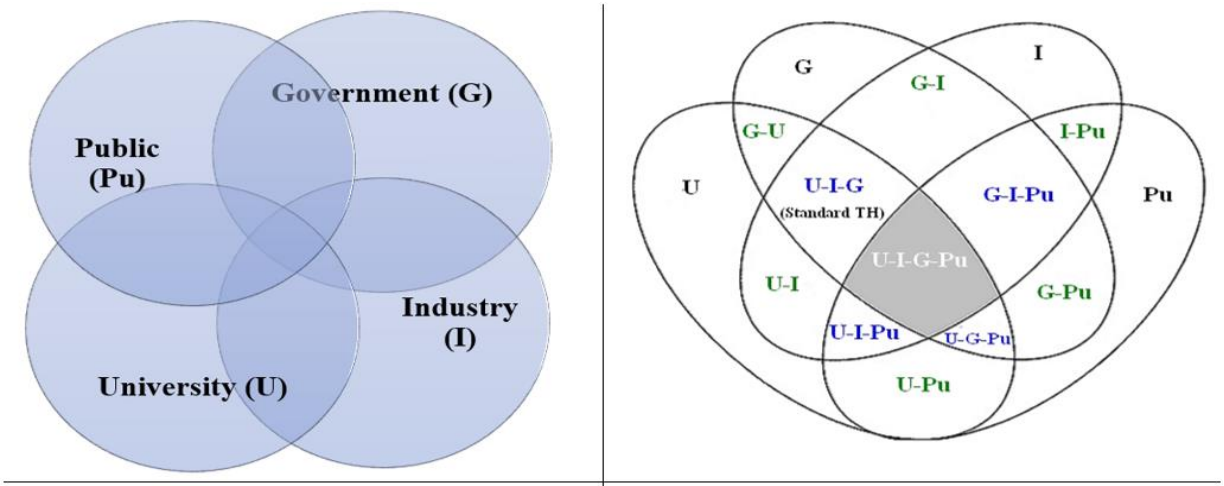
*hand, the public is also influenced by culture and values…"*in this regard, Ivanova (2014) stresses on the role of media and consider it as the fourth pillar. According to her the innovation activity is performed in an external space of consumers, which requires the setting of a mechanism to guarantee a stream of communication between university-industry-government and consumer, and maintain a favourable conditions for the growth of innovations among consumers. The required infrastructure is declined to design all mean of mass media. Throughout her study, Ivanova demonstrates how *huge hum* (infrastructure technologies) is now shaping public awareness and consumer consciousness to the extent that the modern economy is characterised by the standardisation of production in individual consumption. Accordingly, extending the standard Triple Helix model to a Quadruple Helix must include the media and results for new interactive areas of commercial advertising, public provision of information and usage of communication by the government. Other new area on the form of Triple Helix emerged within the Quadruple Helix model, namely media-industry-government; media-industry-university and media-university-government. Finally, a unique hybrid organisation of four strands appears at the core of the model as shown in figure *3.b*. panel a gives an introductory presentation of the Quadruple Helix model. Therefore, four circles are putted on contact with minimum interaction and unique hybrid contact at the centre. Panel '*b*' is more inclusive; the four circles are in advanced, dynamic relations with nine primary contact: six as double helices and three as triple helix) and one sophisticated relation at the core (note that many figures are presented to show the Quadruple Helix concept. All of them agree about the positive interactions of the spheres in contrast with the Triple Helix were a neutral model can exist. This result is one powerful point of the Quadruple helix model when studying innovation system with regard to producers-users aspects).

Yet, even there is a wide convention about adding a fourth helice, there is a debate about its nature. Media cannot be considered as the ultimate delegate of civil society; the voice and the influence of the public can also be channelled by the power of Non-Governmental Organisations (NGOs) (Heng et al., 2012). These authors consider that the power of the public is well expressed when it is unified under the umbrella of NGOs whose role is to defend social objectives rather than completing political or economic goals. The influence of NGOs came from their right to organise sanction, boycott or embargo. Further, NGOs can provide information and establish a link between other strands. Apart from these roles,

NGOs, the well-established and the best reputed help firms achieving their social programs and provide information for market capitalisation.

One important point, even result, when adding civil society or the public which are formulised under "media" or "NGOs" is the introduction of the term "*Governance of Innovation*" and "*Knowledge Democracy*". Indeed, the complexity of the model that result by adding new helices makes additional pressure about sharing and diffusing tasks or results instantaneously and among participants equally. Carayannis and Campbell (2009) refer to the term "Knowledge Democracy" because the innovation program or the knowledge adopted is mandated by the majority, i.e. recognising the concept of pluralism in a society and the respect of other opinion which lead to an unbiased decisions as they are ligitimated by the majority.

The complexity of the environment on which innovation is produced, renders the understanding of innovation system more ambiguous. The adoption of Global Innovation System, as a result of Globalisation stream, adds new variables to the process of innovation/knowledge creation; using *Etzkowitz and Leydesdorff*'s term, additional helices are needed to conceptualise the new interval of innovation. Indeed, one challenge that arise world consciousness is the question of climate change and ecological awareness; accordingly novel terminology emerged namely "*the Green Economy"* and *"Naturally-Friend Activities"*. *Carayannis and Campbell* in an advanced proposal introduce environment issue as an imperative factor for innovation the same as industry, university or civil society; therefore the Quintuple Helix model contextualises the Triple Helix and embeds the Quadruple Helix by extending the architecture of innovation to the global ecology. Further, the Quintuple Helix model can be seen as a framework for trans-disciplinary analysis of sustainable development and social ecology (Carayannis et al., 2012). This can bring a full analytical comprehension of how innovation is produced when social sciences, social science, humanities, politics and economics are oriented toward a unified objective of prosperity and protection. The Figure 3 conceptualises the Quintuple Helix model.



a. Standard presentation b. Interactive presentation

Source: panel "a" adapted from (Carayannis 2013). panel "b" adapted from (Ivanova 2014)

Figure 3: the Quadruple Helix model of innovation

As for Quadruple helix, adding new helices generates additional interactions. We can see that the Triple Helix consists the platform for the Quintuple Helix. In addition to the standard Triple Helix model advanced by *Etzkowitz and Leydesdorff*. In each of them environmental issues constitute the core of discussions and programs. For instance any rapprochement between university and industrial sector should consider climate change as departure point for researches; this is because environment prevention became an important asset for corporations and a key variable of academic researches. Hence any scientific advancement must be in favour of environment. Further the concept of competitiveness may see a drastic deviation to designate *environmental competitiveness* where an economy is considered as competitive if its activities are harmless vis-à-vis the environment. Therefore, Government will favour those industries and researches which fit better to the environmental criterion.

On the other hand, the Quintuple Helix model facilitates the emergence of new interactions in form of Quadruple Helix; this refers, in addition to the model advanced by *Carayannis and Campbell*. The multiplication of such four length interactions lead us to invent a new term, that of "*Democracy of Competitiveness*".

The competitiveness within economic thought has been used to designate the product side; that is to say that a firm, a sector, an industry or even a country is competitive if its production costs are relatively or absolutely less than its rivals. However, with the coming of the Quadruple helix view of the twenty-first century and the rise of environmental issue advanced by the Quintuple helix, the production process does not concern firms only; civil society can participate vividly in the setting of product characteristics which reflect their

preferences and thus, the product contains user side since its elaboration. This cooperation between producer-user sides at the earlier stage of production, under the framework of government and enforcement of research institutions, will orient efforts to reduce costs and create advantage in selected industries. We notice that the selection represents both participation and acceptance of all actors and includes both side of production in contrast to the traditional view; therefore, the competitiveness is rather "*democratic*".

The democracy of competitiveness is well presented in the Quintuple Helix; the rise of green economy and naturally friend products reflects the influence and the weight of "*the public"*- represented as NGOs and Media- in the selection of actions, products and innovation programs that take in consideration the protection of environment. This vision is far away from the purely industrial approach of competitiveness. That is to say industries and production sectors that are designated to exports reflect the convention of different actors in an economy, including non-market performers and respond to global queries.

CONCLUSION:

The innovation system has been seeing a rapid changes. At the turning of the last century, different approaches emerged. All these changes resulted when university adopted new role with additional missions. However, five stages can be distinguished. At the beginning, and for a long period of time, the dominant model of knowledge creation consists of "Mode 1" when university transmits divine knowledge and undertakes the mission to illuminating people about religion. In an advanced stage, a Humboldian university model was born. In this station, questioning and observing phenomena constitutes the engine for knowledge advancement. Yet, the interwoven events at global level during the twentieth century contributed to the adoption of collaborative thought. The Triple Helix model on innovation, belonging to this stream consists of establishing partnership between three main blocs of knowledge production which are university, industry and government. This view has gained acceptance of wider range of academic, practitioners and policy-makers. In addition a fourth approach of innovation system resulted to include user-side. The Triple Helix according to this view represents a half part model of innovation. This is because innovation ideas are primarily inspired or influenced by consumer and users; accordingly adding "civil society" to the model brings further understanding to the process of knowledge creation. Finally, the rise of global warming and the green activity practices calls for the inclusion of environment as a fifth partner, thus the emergence of the Quintuple approach of innovation system. We notice

that the last two models include the concept of “Democracy”. While the Quadruple helix enforces the democracy of knowledge, the Quintuple Helix model facilitates the rise of “*the democracy of competitiveness*”.

REFERENCES

ASHEIM, B. T. & COENEN, L. 2005. Knowledge bases and regional innovation systems: Comparing Nordic clusters. *Research policy,* 34**,** 1173-1190.

BOK, D. C. & BOK, D. C. 2009. *Beyond the ivory tower: Social responsibilities of the modern university*, Harvard University Press.

CARAYANNIS, E. G., BARTH, T. D. & CAMPBELL, D. F. 2012. The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship,* 1**,** 1-12.

CARAYANNIS, E. G. & CAMPBELL, D. F. 2009. 'Mode 3'and'Quadruple Helix': toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management,* 46**,** 201-234.

CARLSSON, B. & STANKIEWICZ, R. 1991. On the nature, function and composition of technological systems. *Journal of evolutionary economics,* 1**,** 93-118.

COOKE, P. 2005. Regionally asymmetric knowledge capabilities and open innovation: Exploring ‘Globalisation 2’—A new model of industry organisation. *Research policy,* 34**,** 1128-1149.

ETZKOWITZ, H. 2002. *The triple helix of university-industry-government: implications for policy and evaluation*, Swedish Institute for Studies in Education and Research.

ETZKOWITZ, H. 2003. Innovation in innovation: The triple helix of university-industry-government relations. *Social science information,* 42**,** 293-337.

FREEMAN, C. 1995. The ‘National System of Innovation’in historical perspective. *Cambridge Journal of economics,* 19**,** 5-24.

FREEMAN, C. 2004. Technological infrastructure and international competitiveness. *Industrial and Corporate Change,* 13**,** 541-569.

GIBBONS, M., LIMOGES, C., NOWOTNY, H., SCHWARTZMAN, S., SCOTT, P. & TROW, M. 1994. *The new production of knowledge: The dynamics of science and research in contemporary societies*, Sage.

HENG, L. H., OTHMAN, N. F. M., RASLI, A. M. & IQBAL, M. J. 2012. Fourth Pillar in the Transformation of Production Economy to Knowledge Economy. *Procedia - Social and Behavioral Sciences,* 40**,** 530-536.

HESSELS, L. K. & VAN LENTE, H. 2008. Re-thinking new knowledge production: A literature review and a research agenda. *Research policy,* 37**,** 740-760.

IVANOVA, I. 2014. Quadruple Helix Systems and Symmetry: a Step Towards Helix Innovation System Classification. *Journal of the Knowledge Economy,* 5**,** 357-369.

KINGIRI, A. N. 2013. A Review of Innovation Systems Framework as a Tool for Gendering Agricultural Innovations: Exploring Gender Learning and System Empowerment. *The Journal of Agricultural Education and Extension,* 19**,** 521-541.

LUNDVALL, B.-Å. 1992. *National systems of innovation : towards a theory of innovation and interactive learning*, London, Pinter.

LUNDVALL, B.-A. K. 2009. *Handbook of innovation systems and developing countries : building domestic capabilities in a global setting,* Cheltenham, Glos, UK ; Northamption, MA, USA, Edward Elgar.

MALERBA, F. 2002. Sectoral systems of innovation and production. *Research policy,* 31**,** 247-264.

MARTIN, B. R. 2011. What can bibliometrics tell us about changes in the mode of knowledge production? *Prometheus,* 29**,** 455-479.

NELSON, R. R. 1993. National innovation systems: a comparative analysis. *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*.

NIOSI, J. 2002. National systems of innovations are "x-efficient"(and x-effective): Why some are slow learners. *Research policy,* 31**,** 291-302.

NOWOTNY, H., SCOTT, P. & GIBBONS, M. 2003. Introduction:Mode 2'revisited: The new production of knowledge. *Minerva,* 41**,** 179-194.

PILLAY, H. 2005. 6 Knowledge and social capital. *TEAM LinG***,** 80.

SAAD, M. & ZAWDIE, G. 2011. *Theory and practice of the triple helix system in developing countries : issues and challenges,* New York, Routledge.

SCHWAB, K. 2015. *Are you ready for the technological revolution?* [Online]. Available: http://www.weforum.org/agenda/2015/02/are-you-ready-for-the-technological-revolution [Accessed 19-02 2015].

SHARIF, N. 2006. Emergence and development of the National Innovation Systems concept. *Research Policy,* 35**,** 745-766.

SUURS, R. A. 2009. Motors of sustainable innovation: Towards a theory on the dynamics of technological innovation systems.

TEIXEIRA, A. A. C. 2014. Evolution, roots and influence of the literature on National Systems of Innovation: a bibliometric account. *Cambridge Journal of Economics,* 38**,** 181-214.

TUUNAINEN, J. 2002. A Critical Comment Based on a Case Study. *Science Studies,* 15**,** 36-58.

TUUNAINEN, J. 2005. Hybrid practices? Contributions to the debate on the mutation of science and university. *Higher Education,* 50**,** 275-298.