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Matching Technological Bid in Smart Cities Initiatives: A Case Study of Innovation Fairs at Research Institute in Brazil

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Abstract: The main objective of this work was to present a general framework of the technology roadmap from a central competence of Nuclear and Energy Research Institute from Brazil. The approach provides a structured to strength the join to market mechanism design to survive in complex environment trends to shape the future. The technological innovation impact measures depend from (1) quality of diversified technology knowledge and (2) quality of diversified country industry knowledge. From this big view picture, the Technology Transfer Office took these two general dimensions of impact into account and divided them into four (4) sub-categories that explain potential benefits and performance results in areas such as: a) Current Projects and Programs, b) Patents, c) Education and Teaching and d) Scientific Publications. The sampling contemplated the big picture of performance related in National Management Information System and a repository proper in response to institutional performance growth and plans, programs and projects associated in Innovation key indicators and policy disclosure. The taxonomy to roadmapping innovation impact measure was centered in terms in two potential fields to shape the future: i) Nuclear Research Reactors and/or ii) Nanotechnology.

Key words: research reactors; innovation trajectories; insertion areas; technology and innovation management roadmap; nanotechnology social economic networks

JEL codes: O1, O2

1. Introduction

Many countries have developed standardization of roadmaps in various areas reported in intelligent systems, identifying significant opportunities and challenges associated with standardization in complex areas (OECD, 1997; 2002; 2005). To roadmapping from a central competence of Nuclear and Energy Research Institute in numbers is an inspirational approach engine and large influence in cultural and Institutional policymaking in Science, Technology and Innovation (S&T&I).

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To learn the demand for solutions from big cities and improve the possibilities of creative solutions to the urban problems are one of goals from R&D Institute (Coase, 1960; Batty et al., 2009). A combined relational and cultural approach to the Transnational Nuclear and Energy Research Institute and the most representative academic institution of Brazil, University of São Paulo (USP), and other arrangements and possible formats on beginners, start-ups, spin-offs, business incubators, focusing on alignments and construction of cooperation network to the demand of smarts cities.

Based on this work it's possible to express and establish a sustainable normative culture in innovation. Learning the city and social networks should be possible to determine arrangements and formats for innovation, like technology transfer, matching mechanisms and technological routes.

The object of the case study was the Nuclear and Energy Research Institute (IPEN-CNEN/SP) is held at São Paulo, Capital, one of the 10 biggest cities of the globe with high density on population and market demand for a response to urban growth and regional plans associated. The Nuclear and Energy Research Institute is an autarchy linked to the Secretariat of Economic Development, Science, Technology and Innovation of the Government of the State of Sao Paulo and managed technically and administratively by the National Energy Commission (CNEN), an agency of the Ministry of Science, Technology and Innovation (MCTI) of the Federal Government.

The fields of Research Reactors and/or Nanotechnology at Nuclear and Energy Research Institute (IPEN-CNEN/SP) evidence the key technologies in convergence in the initial stage, whose economy is heavy based on natural resource and a potential emerging park (Allen et al., 2000; Rocco et al., 2011; Ayhan et al., 2017; Blind et al., 2009; Daim et al., 2008).

The Nuclear and Energy Research Institute (IPEN-CNEN/SP) are Among University of São Paulo the research and development and are strongly associate with the dimensional to educational and teaching in areas that matches every eleven (11) research centers of Nuclear and Energy Institute such as: 1) Biotechnology Center, 2) Fuel Cells and Hydrogen, 3) Materials Science and Technology, 4) Nuclear Fuel Center, 5) Nuclear Engineering Center, 6) Laser Center and Applications, 7) Radiation Metrology Center, 8) Center for Chemistry and Environment, 9) Radiopharmacy Center, 10) Research Reactor Center, 11) Radiation Technology Center.

This paper contributes to introducing reforms both through changes in public academic system and instruments for research funding. The National Intelligent Innovation System presents the possibility to improve policymaking process toward general and integrated conceptual framework on the role of different types of standards in the research processes and technology life cycle. The research reactors and/or nanotechnology, however, it is a central competence and was the purpose of its foundation and regarding as a core business of the future key technologies, especially in convergence stage to response smart cities solutions to development countries.

To aggregate and to deliver value in National Intelligent Innovation System, plans, strategies and Policies must be relating to Intellectual Property, building symmetry and isometry to policy disclosure to boost reach and internationalization prestige. Those fields depend very much on the development of corresponding standards, which clarify not only terminology, measuring and testing methods, but also regulate safety, security and specify interfaces, to bases the next generation of technology in a sustainable economic networking (Hazelkorn et al., 2017; OCDE, 2005; OCDE, 2015; WIPO, 2017).

For this study all the data collected came from the Nuclear and Energy Research Institute, with longitudinal analyses, analyzing data from 2012 to 2016. It was used the SIGEPI — Management and Information System, it establishes the programming and counts the performance of the activities-ends in the three finalistic functions, namely: Research & Development & Engineering, Products & Services and Teaching. Also having the Institutional Director Plan as a source of information. At senior working level to gather information to respond to the question in the audit system, in response with interviews. In advance, the roadmapping was carried out in upper level to Superintendent to advance. This paper has been produced as part of an applied research project.

Patents have been presents as a core of an output in innovation system (Stav, 2016). Otherwise, Innovation indicators presents reflections on limitations and potentialities on quality, symmetry and isometry of information among networking (Hoffman, 2006; Hoffman, 2007; Ho, et al., 2017.) This paper spreading the boarding of Innovation assessment converting intangible assets into tangible outcomes (Kaplan et al., 2003), abroad the overview perspective into four distinctive categories like a) Human Resources, b) Teach and Education, c) Products & Services, d) Scientific Technological Research.

Questions that motivated this work shapes and sizes changed drastically over time. These changes are mainly due to the transformations in the social, technological, economic, environmental, political and vale system (OECD, 2002; Narasawa et al., 2009). Regarding the future, between a "complex irregular warfare" (Hoffman, 2006, 2007), auditing mechanism and tools is useful to provide a clean comprehensive strategy and the link with objectives of the system delivery (Viotti, 2007; WIPO, 2017). Such data and analyses are a precondition for defining realistically attainable economic and development objectives to suitable safe and security technological absorption.

Therefore, the present study aims to create a specific roadmap to the Manager of Technology Transference Office to better understanding the phenomes of innovation dynamic marketing, explore, share thru networking and boost an integrated view of institutional performance growth and plans, programs and projects associated in Innovation key indicators and policy disclosure. The future in advance is expecting to investigating innovations in nuclear reactors and/or nanotechnology to build-to-suit new perspectives to technologically qualified bid purpose and new opportunities for R&D, collaborations and future foresight studies applied to gauge smart cities solutions within the context of a developing country.

The multiple aspects of key variables involved in systemic analysis surely require a strong culture in quality, but sometimes simple straightforward rules of thumb that used to guide Science and Technology in the past in linear model (Lazega et al., 2017). Identifying disruptive technology and surviving in disruptive markets is not easy but roadmaps can help for policy makers, technology and innovation management, industry, leaders and researchers (Phaal, et al., 2004a, 2004b, 2009).

Universities and Public Research institutions occupied the center stage of The Science, Innovation and Technological. It's a is a presence preceptor of high-quality knowledge and technologies (Decter, et al., 2007; Dube et al., 2011). The innovation and technology impact pool perspective in Research Reactors is a natural consequence of investments in Research and Development (R&D), between and among Universities and Public Research Institutions and multiple benefits arising from results, towards Awards in Science and Policy disclosure.

The roadmapping approach provided integration through Science, Technology and Innovation (S,T&I) and Institutional Stagey and Business Model. The benefits bring together past and lead with integrated of technology, product and commercial perspectives, including internal and external sources, hence provides integrated a stakeholder's link (Phaal et al., 2004a, 2004b, 2009).

The geographical localization and graphical form of the roadmap is a powerful communication mechanism; however, it can present information in a highly synthesizes and condensed form to strengthen link between Science, Technology and Innovation (S,T&I) and Smart Cities Solution.

The central competence framework aimed at advancing knowledge necessary that would eventually lead to innovation trajectories and with strong security and safe cultural insertion gauge to country succeed in international competition through innovation and growth, high-quality products and services, and research and education areas. The unique strengthen link can be matched from the S,T&I policy in term “technology transfer” in capacity building from push or/and pull innovation models.

2. Methodology

The methodology applied to the present study consists of three main stages. The first stage looks on and identify the central competence business of Nuclear and Energy Research Institute and the methodology to assessment the strategies of innovation impact and reach. From this big view picture, the workgroup presented a general framework for the technology roadmap for the centre of competence of nuclear and energy research. Because of foundation historic, research reactor field remain sixty year of experience and nanotechnology emerge as a potential field among all research centres of Nuclear and Energy Research Institute. It was understanding as a cross-sectional area and potential to shape the future in biotechnology, chemistry, food and agriculture, health, environment, social, economics, informatics, entertainment and arts.

Similar work to customize roadmap was found in Germany, Turkey, EUA and in the International Energy Agency. Blind and Gauch (2008) applied a customized roadmapping in nanoscience and nanotechnology in Germany, they affirmed that the market success of nanotechnology applications depends very much on the development of corresponding standards. European and international standardization organizations have launched first initiatives into a leading position in standardization initiatives, which pave the way for future commercialization of nanotechnology and also the basis for the next generation of research activities.

Tugrul et al. (2007) seeking alternative energy sources, they implemented a technology planning for roadmapping future technology portfolios for the government sector of EUA. They found challenges into networking thru chain to delivery service when they defined “Technology Gap Analysis” tracking the transmission, renewables and energy efficiency to those that are implementing the technology planning process for the first time. Identify key candidates, evaluation, allocation of resources to the R&D — Research & Development programs are fundamentals to have the planning implemented at federal agency.

Ayhan et al. (2017) on marketing focus, developed a roadmap study for the Turkish defense industry to address new demands and provide further opportunities of potential application of nanotechnologies. They also use bibliometric analysis aim to identify the trends to reveal the commercialization.

The second stage, to assessment quality of strategy innovation, the authors mention that these fields would be analyzed under 4 subcategories to converting intangible assets into tangible outcomes:

A = Human Resources: includes government officials versus fellows and trainees, participants from other institutions and volunteers.

B = Teacher & Education: includes the amount of economic fund and number of conclude projects of Mastering and doctoral students.

C = Products & Services: includes the sum of economic fund and the number of all institutional projects and programs under development.

D = Scientific & Technological: is includes the sum of patents, technological products, scientific publication in own database in the online library of the Nuclear and Energy Research Institute.

Bibliometric methods have contributed to science and technology studies for decades, it allows finding hidden patterns by classifying information, including counting simple document word frequency analysis, co-join word analysis, collaboration analysis and involving the construction of the roadmap for the Nuclear and Energy Research Institute.

The sampling was provided by a Nuclear and Energy Research Institute and was based in data collected from 2012 to 2016 and contained multiple activities reported in the Institute Director Plan, and was related as: i) Engineering of Reactors and Energy Systems, ii) Experimental nuclear and condensed matter, iii) Activation analysis with neutrons, iv) Operation and use of Research Reactors.

To complete the sample, the data collection on Nanotechnology occurred from in labeled activities on nanotechnology. The taxonomy rooted "Nano" was the central term. Were identified co-join nanotechnology, nanoparticles, nano particulate, nanostructures, nanotubes, nano compounds, nanomaterial and among others. The root "nano" was widely applied to address the sum of distinctive categories to mapping independent variables of impact technology innovation.

Finally, the third stage was characterized by the roadmap construction at Nuclear and Energy Research Institute Level to explore applications, development and audited tool. To the standard approach focused on firm level contributed with an integrated vision with the organizational matrix boosting an integrated view of institutional performance growth and plans, programs and projects associated in Innovation key indicators and policy disclosure. The systematic plan and strategy thru distinctive research centers in synergy with marketing activities.

The unique strengthen link can be matched from the Science, Technology and Innovation (S,T&I) policy in term "technology transfer" in capacity building from push or/and pull innovation models in trends of complex environments. The lean strategy deployment be-duty bound to align Institutional link to both pull and push innovation roadmapping management system to accurate reality on time. This work is under development, in the initial stage, the complete datamining compilation regarding in the last 60 years of production. The vision pictured were taylor-made-design to a better comprehension of how the many variables are linked together and how we optimize this relation to have better measurement of innovation social impact.

The methodology was guided by the OECD (2005; 2015) and in an analysis of indicators of innovation and public policy development of National Innovation System (NIS). Also, guidelines from NSF — National Science Foundation (2018) and Pannano (2017), (1st Pan-American Congress of Nanotechnology Fundamentals and Applications to Shape the Future) was used as a milestone for standardization in applying a structure of roadmaps to exploring, communicating, building relationships, evolving multiples networks and development markets, products and technologies over time. Parallel, happed the 60th years of IEA-R1 60Y Workshop where were addressed the challenges and potential field of research reactors (IEA-R1 60Y, 2018).

The innovation pool perspective in Nuclear and Energy Research Institute is a natural consequence of investments in Research and Development (R&D), between and among Universities and Public Research Institutions and multiple benefits arising from results, towards Awards in Science and Policy disclosure.

Units

N: it was applied to present the total sum/quantity/frequency to address simple integer number in independent categories variable. In the categories Patents and Scientific Publication, the result integer over sixty (60) years.

E: In the categories of Projects and programs and categories of Education and teaching the result integer current active, enable us to address past and future performance.

U$: it was used to standardization monetary in American dollars.

3. Results and Discussion

From the research in institute database, with keywords that was rooted "nano", was possible to compile the Table 1.

Table 1 Innovation Impact Nanotechnology Approach

Currents Projects and Programs	E	U$ ~
Institutional and collaborative	160	39.544.735
Nano rooted title projects and programs	14	1.049.113
Patents	**N**	**Collaboration Patents**
Total Patents	127	18
Nano rooted patents title	21	11

Currents Education and Teaching	E	U$ ~
Post-graduated students projects	440	1.295.585
Nano rooted title Post-graduated students projects	56	169.697
Scientific Publications		**N**
Total Publication		23.734
Nano rooted field Publication on title		41

Where N is the total sum of specific quantity applied in categories of Patents and Scientific Publication. E is the number of Projects and programs and categories of Education and teaching under development in 2017, enabling us to address past and future performance. U$: it was used to standardization monetary in American dollar in order to compare different periods of time to overcome national economic instability.

In Table 2 we preset the data compilation for both nuclear reactors:

Table 2 Innovation Impact Research Reactors Approach

A) HUMAN RESOURCES	2012	2013	2014	2015	2016
Total Nuclear and Energy Research Institute (CNEN-IPEN-SP) and Pars	399	407	614	651	497
Pars on Collaborations and Cooperation	85	87	152	171	121
B) TEACH & EDUCATION	**2012**	**2013**	**2014**	**2015**	**2016**
Guidance and completed projects (IC, Masters, Doctorate and Postdoc)	88	90	103	89	83
Fund to students by Government (U$)x1,000	341	352	359	305	319
C) PRODUCTS & SERVICES	**2012**	**2013**	**2014**	**2015**	**2016**
Revenues (U$) x1,000	33	13	138	143	139
Industry Customers	51	36	24	34	32
D) Scientific & Technological Research Reactors	**2012**	**2013**	**2014**	**2015**	**2016**
Scientific publications x 10	14.6	14.6	14.6	14.6	14.6
Projects and Programs in Collaboration	24	27	1	1	6
Technological products	0	17	10	6	0
Patents	2	0	0	0	2

For better understanding, we also preset the data for Table 1 in Figure 1.

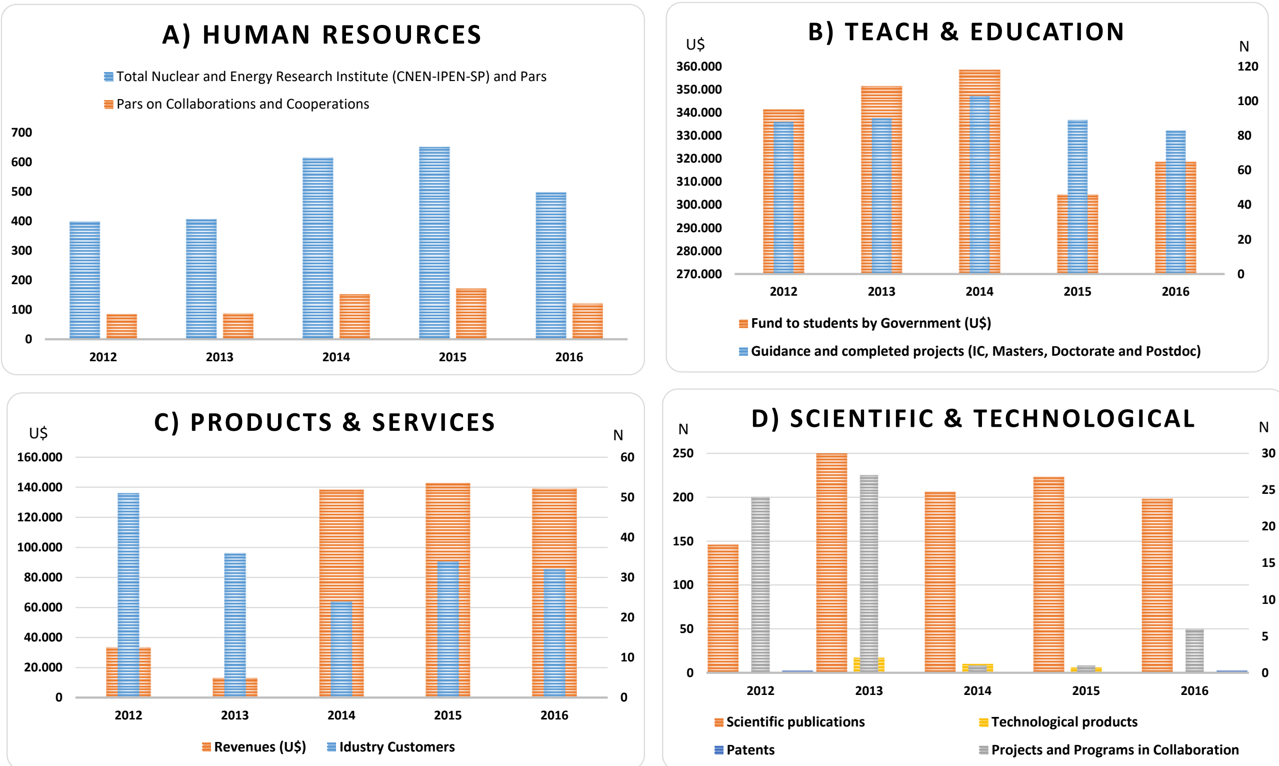

Figure 1 Innovation Impact Research Reactors Approach

We can see from Figure 1(a) that human resource is decreasing in last 2 years, but the collaborations are growing to overcome this very high lever human resource. In another hand we can highlight form Figure 1(b) that the completed projects from students has a little increase, even the total fund decrease. The Figure 1(c) shows how import is the service to society because the main products and services from our nuclear reactor are related to radio pharmacy production to nuclear medicine utility. The scientific and technological production Figure 1(d) are directly related to Figure 1(b) in number of scientific publications and scientific collaborations.

Universities and Public Research institutions occupied the center stage of The Science, Innovation and Technological in Research Reactors. The innovation and technology impact pool perspective in Research Reactors is a natural consequence of investments in Research and Development (R&D), between and among Universities and Public Research Institutions and multiple benefits arising from results, towards Awards in Science and Policy disclosure.

Research Reactor in numbers is an inspirational approach engine and large influence in cultural and Institutional policymaking in Science, Technology and Innovation (S,T&I). The unique strengthen link can be matched from the S,T&I Policy in term of "technology transfer" in capacity building from push or/and pull innovation models.

The roadmapping in Nanotechnology approach provided integration through Science, Technology and Innovation (S,T&I) and Institutional Stagey and Business Model in create synergy and integration fields in science and environments social and economic networks. Identifying disruptive technology and surviving in disruptive markets is not easy but roadmaps can help for policy makers, technology and innovation management, industry, leaders and researchers.

The geographical localization implies a mimetic mechanism to build-to-suit capabilities and empowerment flow to share people, information and knowledge. As so as the social networks build a strengthen link between Science, Technology and Innovation (S&T&I) and Smart Cities Solution to shape the future needs.

The solutions by market-driven provide improvement at total quality managing front-to-end of technology transfer. Though roadmapping is one of the most widely used tools as predictive exercise, supporting systematic planning and standardized strategy development.

4. Conclusion

The central competence framework from roadmapping manual costuming aimed at advancing knowledge necessary that would eventually lead to innovation trajectories and with strong security cultural insertion gauge to country succeed in international competition through innovation and economic growth, high-quality products and services, and research and education. The approach provides a structured to strength the link to market mechanism design to survive in complex environment trends.

Technology transfer is an important axis, both in the domestic market and in export. Business combinations can meet different objectives between supply and demand. The unique combinations strengthen the link between different segments of niches and segments society. The technological potential of new specific projects in advance can be matched from the S&T police in state capabilities and institutional arrangements and formats to long-term duration.

The workgroup faces challenges to enlace integration Institutional vision of distinctive technologies core of eleven (11) centers to evidenced two potential fields. To shape a better future, the roadmapping is a power tool to start an establishment of an integrated innovation culture and could be useful in frontiers in contextual area to boost Science and Research and, align strategy, leadership and plan business. For other side, increases the Government's responsibility for directing and supporting R&D in the sense of developing not only technological competences, but also marketing competences. It is to the extent of strengthening the institutional role, broadening the mission and vision of business.

This work is under development, in your initial stage. The complete data compilation in the last 60 years will afford to forward an integrated vision among the Nuclear and Energy Research Institute and its Stakeholders. Provides a better comprehension of how the many variables are liked together and how we optimize this relation to have better innovation social impact in applying roadmaps to exploring, communicating, building relationships, evolving multiples networks and development markets, products and technologies over time.

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