SOME VIEWPOINTS ON SCIENCE AND TECHNOLOGY REFORM: ISSUES TO BE CONSIDERED WHEN MAKING SCIENCE AND TECHNOLOGY POLICY

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Abstract:

Science and technology (S&T) always plays an important role in and is a driving force of socio-economic development of each country or each region, especially in the presently default knowledge economy. By a synthesis approach, this article presented views or management models of S&T which had been drawn from research findings by organizations and experts worldwide. Discussions and proposals in this article relating to S&T research highlighted the role of basic research in promoting the world knowledge economy and expected that it would create a platform to facilitate the determination of direction and identification of issues need to be considered when making reform of S&T policy in Vietnam, which was found still limited in the context of international integration.

Keywords: *S&T policy; Science, technology and innovation (STI); Basic research.*

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1. Introduction

In the trend of mankind development, in general and the knowledge economy, in particular, most of the nations in the world have put high interest and attention in increased labor productivity through STI development. Accordingly, the competitiveness of a country is directly dependent on innovation capacity and the ability of exploitation of enterprises' research results for production and social development. In this context, the development of policies for STI plays an important role.

In Vietnam, the capacity of STI was still low and the national innovation system was still limited. Research and development (R&D) was still a complementary activity implemented in enterprises and government agencies[2]. These limitations were also reflected in the ranking table of global competitiveness in 2015, where Vietnam ranked 56th out of 140 countries *(VEF[3], 2015)*. Recently, in the Bloomberg ranking of 50 countries

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[2] Evaluation report on STI in Vietnam by OECD (provided by World Bank in 2014)

[3] VEF: Vietnam Education Foundation, http://www.vef.gov/index_vn.php

considered as the most innovative nations in the world in 2015, Vietnam was not present in the list, and in the Global Competitiveness Report 2015-2016.

In recent years, Vietnam has worked hard in S&T development in order to enhance national position. However, in the context of international integration, there is a need to increase competitiveness of knowledge economy, whereby some important factors were considered as barriers to the development of STI. These factors should be addressed in the near future. So this will need to have specific provisions from STI policies to match properly with the socio-economic development.

During the past, some experts expressed their views at many different angles on the role of STI policy for socio-economic development. In this article, the author provides an overview of some viewpoints to serve as the basis for analysis of factors affecting the process of formulation of STI policy in order to promote this activity for socio-economic development in Vietnam.

2. Significance of STI policy for socio-economic development

In terms of the viewpoint on innovation system[4], *David P. and P. Dasgupta (1994)* said that the modern knowledge economy had three key growth objectives:

- Increasing labor productivity, promoted growth;
- Enhancing research capacity;
- Promoting the establishment of funding models in the form of public research funds.

In which models of public research funds were formed on the basis of:

- Risk taking and sharing when funding for scientific research activities;
- Development of knowledge for communities, raising people's awareness;
- Promoting the combination of research and the need of society.

Sharing with that same perspective, *Syanbola et al (2014)* analyzed relevant issues of STI policy in relation to the application of scientific research results. The authors reviewed the issues in view of the tripartite model[5] (Triple Helix) which set out three key questions:

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[4] Freeman. (1987) *Innovation System is a network of organizations in the public sector and private sector whose activities and interactions initiate, import and dissemination of new technologies*.

[5] Triple Helix "the tripartite model of partners", namely Enterprises - the business community or the owner of innovation; Research institutes and universities – the knowledge producing institutions, backstopping for

- How to have a good policy for STI development to facilitate the human and material resources development for socio-economic development?
- How to develop STI policy appropriate with national conditions and make confirmed the major role of STI in national socio-economic development?
- How can develop STI policy consistent with the national priority programs and be also effective measures to create scientific, technological, innovative products based on knowledge, ideas and strategies for sustainable development?

The Millennium Development Goals at the World Summit on Sustainable Development, the new partners for Africa development and report by a number of experts with an international consensus on the reference frame for S&T plan in Africa. Scholars have examined the applicability of researches under this frame through their transparency, accountability and fairness. In which, it included good governance and success indicators of the latest efforts to develop and implement STI policy.

In view of innovation system, some other scholars also had given the same opinion such as:

Bo Carlsson et al (2002) introduced the concept of technological innovation system, in which the author described the components of this system including the interactive actors in a specific technology at infrastructure of a particular organization related to the creation, dissemination and use of technology (*Carlsson và Stankiewicz, tr. 49*).

While some other experts *like Michael Gibbons et al (1994)* emphasized on social benefits and knowledge production institutions at the micro level which need a specific historical context, the viewpoint of tripartite partners was concerned on aspects of how to convert academic knowledge into practical applications for economic benefits. The view of tripartite partners showed the role of each party to play, in which enterprises were key players in STI as they were implementation agent of innovation, while the State was responsible for creating an enabling environment where innovative products by scientists were closely guarded, so scientists could fully be assured with doing research and disseminating widely their creative ideas to the public. Again, it could be confirmed that the individual relationship and independent role could not be maintained its optimal role in promoting the tripartite model of the *Triple Helix*.

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innovation process with new knowledge and ideas; and Government/State authorities supporting for innovation process through state funding or technical support.

Padilla-Pérez, R. and Gaudin, Y. (2014) provided other examples relating to STI policy in practice, i.e, important issues need to be early identified (priority) during developing S&T plans as the development of S&T would bring what a nation expected to achieve. Latin American countries used to seek to develop projects integrated from foreign direct investment sources, technology transfer and import substitution was undertaken. The group of these countries also made comment on possible policies immediately created after the testing phase and during the belt tightening due to debt crisis. The view of this group was shown in their national system under innovative approach and it was said: "The government plays a central role in the innovation system through two main activities

Firstly, actions towards new knowledge dissemination through public research centers, universities and businesses.

Second, actions towards adjustment of laws, regulations, policies to support STI activities, including provision of funding*" (p.750*).

From the above perspectives, the study team found that the formulation of STI policy based on the starting point of assessing relationships affected the tripartite relationship (enterprise - research institutions/universities - Government/State) by policies, at the same time, pointed out the importance of identifying prioritized research issues in S&T relevant to the social needs and context of each country.

Unlike the views on giving priority for basic research, *Gibbons et al (1994)* mentioned a lot to research management. He and his colleagues showed a change in the production of interdisciplinary knowledge, two modes of knowledge production mentioned by Gibbons et al were, as follows:

Table 1: Characteristics of new knowledge production by Gibbons et. al (1994)

	Mode 1	**Mode 2**
Entities of knowledge production	Universities, research institutes, enterprises and national laboratories...	Centers, networks, projects with participation of actors from various organizations such as universities, firms, public sectors/areas.
Knowledge creation structure	Monophyletic	Interdisciplinary/interference areas, multidisciplinary or interdisciplinary
Resources (Source of problem formulation)	Researchers	Researchers collaborating with other stakeholders
Quality control	Independent evaluation	Peer review combined with other practices such as assessment of impact on and benefit of the parties concerned.

Both modes of new knowledge production have prevailed in scientific research and are mutually dependent. The legitimacy of STI policy is now based on a number of assumptions such as the need to adjust governance issues of scientific research to promote the accountability of science to society and the active participation of scientists. However, mode 2 showed a clear trend of transformation of new knowledge of scientific research, and it had much influence on policymaking community worldwide for STI. However, deeper arguments were indicated in the document "*Production of new knowledge*" where included all the parties involved in the formulation and survey of research questions collected from other studies and policy making parameters.

Besides the above arguments, *Triple Helix* by outlining the views of *Etzkowitz Leydesdorff* and *Henry (1998)* made the comment that, models of knowledge-based innovation was really emerging in most developing economies in the Organization for Economic Co-operation and Development *(OECD)*. *Triple Helix* considered that the interaction between elements of knowledge with social benefits was important and confirmed that the interaction did not derive from the separation of academic science areas in the face of current social context.

By the end of 1980s, there is some gradual change in parameters of the concept to legitimize or justify the approach of STI policy. The key issue was the switch from a linear policy approach to logic thinking (the first generation of science policy was based on the assumption thinking by dividing sciences to produce knowledge and the application of knowledge was for enterprises in society). Some countries kept this view because they thought moving from a linear approach in most countries was only a formality rather than reality (linear model supports two approaches of STI policy, whereby technology and innovation policy was separated from science and research policy).

Thus, viewpoints on knowledge production have exposed the idea that in order to renew policies, it should start from adjustment of the scientific research management, as the process of scientific research is the process of direct new knowledge production, the motive force for innovation. The process of producing new knowledge actually is the nature of basic research in science.

3. Some issues related policy

3.1. Setting priorities for STI development

In reality, policy makers must take into consideration those issues to be given priority to select specific outputs, choose which type of research

focused in the development strategy. However, there has not been more in-depth studies on this issue, except within some sectors. Priority setting is not fixed, but it needs the connection between the priorities established with the policy objectives and the evaluation of the outcome. This indicated that there was little research or policy efforts conducted to set priorities in recent times. Setting priorities was one of the important tasks of STI policy. Setting priority is a decisive factor in determining the expected outcomes, possible tools, instruments and funding methods to be used.

In the past two decades, OECD countries were increasingly interested in this issue to assess scientific research, but so far, there has only been a few of priorities set out. The most recently recognized priority setting was the advancement of the *Lund* list in global challenges which was lately integrated into the *Horizon 2020* program. Horizon 2020 was a program of successful research topics and actions by the Seventh Framework Program of the European Union for research and innovation. Accordingly, it provided the classification method for different models of setting priorities for research and innovation. The authors had identified the following priority setting:

- Increased the profit in public investment in research;
- Increased the relevance of research with socio-economic objectives (competitiveness, growth, welfare, etc.);
- Linkage between research with long-term goals of society.

Considering this perspective, priority setting became a resource allocation issue and the development of tools, funding modalities to administer the factors in the system to ensure that the results achieved as expected. *Das Gupta and David* (2004) had identified 5 key questions should be answered when dealing with priorities setting, namely:

- What are the priorities of public investment?
- How to make the S&T development prioritized?
- What mechanism to be used to set priorities?
- How is the decision making process?
- Who are the stakeholders involved?

These questions will help establish an applicable classification to determine the investment priorities for S&T, independently on the development situation of the country. Accordingly, the authors showed the effort to set priorities in accordance with the output published from a number of different countries in the OECD bloc.

Besides, there ware opinions that, priority setting can be used to avoid wasting in research spending. This lesson was drawn from the health sector, where priority setting was used quite popular. *Iain Chalmers et al (2014),* who presented a classification table of research purposes, which pure basic research (to expand knowledge), pure applied research (to immediately increase the application of research results and policy decisions into practice), and use that as motivation (inspired use) for basic research (both expanded knowledge and increased application).

The problem was identified by Chalmers et al, i.e basic research traditionally received the lion share of research funding, but its contribution to health improvement or creating motivation for basic research was less than applied research. The authors showed how to avoid wasteful spending in research, as follows:

- Make more investment in scientific research;
- Ask donors to provide a systematic overview of what has been known and the previously funded projects to determine the new investment;
- Develop those programs that help figure out the best potential scientists and be proactively implementable;
- Promote interdisciplinary research work.

Although these results were found by the authors from the health sector database, the parameters outlined here can be applied to general policy on STI.

One of the basic results of STI policy is providing knowledge to improve policies in other areas. The integration of concerns at macro-level like health care equality with other sectors to determine priority setting. Accordingly, *Henry Etzkowitz and Loet Leydesdorff (1998)* gave a detailed overview of the inputs necessary to establish such priorities. The arguments presented by these authors have demonstrated two important issues: first, the importance of setting priorities for developing countries; second, the possibility of cooperation among countries to improve the quality of these issues.

An example of a well-known method for setting priorities: surveying and forecast mapping. Survey was received attention because it was conducted by the European Science Foundation and was different from the standard survey method which applied for identify priorities for scientific development rather than for technology. Survey was to create the effects of decisions today to get a better future, for example for technology development, for society or for science. European Science Foundation

proposed that the survey methodology also can be applicable to science development to optimize research funding or conduct strategic recruitment. Surveying sciences can be applied to select strategic areas for investment strategy of the country or of public research institutes. This report also provides a series of minimum conditions to conduct a survey of sciences and some key differences between survey on S&T areas. *Marie L. Garcia and Olin H. Bray (1997)* not only focused on forecast mapping technology but also provided an example of how this technology was used in business environment. The techniques of setting priorities such as survey and forecast mapping (road-mapping) were widely used in business environment and were implemented by companies, e.g *Shell and British Petroleum*. According to the authors, the forecast mapping technology was the most useful in situations where "decision on technology investment is made not in a linear manner". This can happen as a result of competitive technologies or where it is not clear to pursue or do replacement (e.g, to improve existing technology or to replace with a new technology), or undertake necessary cooperation to develop or acquire technologies.

Forecast mapping technology is used to facilitate the technology planning and application at sectoral level, e.g the transformation or development of technology in transport, agriculture, energy sectors, etc. Garcia and Bray provided an overview of the participatory process in forecast mapping technology from the identification of technology or technological change alternatives, assessment of current situation. Trend of forecast mapping is realized for each technology. For example, if an energy Enterprise X invests in free-carbon technologies and decides to use forecasts mapping technology for this issue, then it will need to create a roadmap for each potential technology that needs to consider. Therefore, forecast mapping technology requires significant knowledge about selection of alternative technologies or access to information sources such as universities or national laboratories.

Thus, as experts pointed out that to build STI policy, it needed to set out priorities, priority setting was conducted through the knowledge on the S&T system. Through survey and S&T forecast mapping, policy makers would have an accurate assessment of the need for S&T development appropriate for specific socio-economic context of each country.

3.2. In terms of funding tools and methods

Study on funding tools and methods showed it was considered as a key issue to steer the research in the donor driven direction. One of the most popular trends of STI policy today is the transition from *block allocation of funding* to competition based allocation between organizations and

individuals. This change has been proven by a scientific basis as how much a business spends money and it thus requires more effort to ensure accountability to the community. Moving to competitive allocation is also a part of the overall change towards putting science into the national framework of competition, whereby universities are under the global ranking and increased scientific workforce competitiveness among OECD countries. While there are many benefits obtained from this approach, the other factors depend on the nature of S&T system, but the two issues are invariant. Competition based allocation requires more knowledge and more costly than block funding for organizations. The evaluation of aid effectiveness in scientific research has consolidated scientific basis for the allocation of resources for scientific community. The criteria used to evaluate research performance usually include total published works, the impact of research on socio-economic development.

Diana Hicks (2012) touched upon the dealing with funding and research methods issues. In her paper, Hicks focused on the evaluation of the efficiency of national funding for research based on effective funding for university research. The paper presented an overview of the approach at national level for funding research projects based on efficiency calculations. Hicks defined a performance-based funding system was the one should be assessed through peer-review. A research assessment must be done in early stage (*expost*). Review of proposals for funding research projects or programs never includes post evaluations (*exante*) (tr. 252).

Jacob, M. and Meek L. (2013) showed an overview of funding tools and methods for research. In which, financing tools were arranged to allocate research funds to groups, individuals and organizations, the arrangement was actual in accordance with practical funding instruments. Therefore, a project was a funding instrument, but it should comply with rules and procedures governed by donors and their advice on what funding methods can be used. The rationale for this was because there was only a limited number of tools available for research funding, while the financing method was important for the strategic development and management of research funding as they determined the management cost and allocation of funds. Through funding methods, donors can communicate and manage in more updated way to promote the output of a specific system.

Sarah C. (2005) and Heinze T. (2008) provided an example in Brazil, when putting the question of how to solve difficult problems when developing STI strategy in developing countries, for instance, connecting research with local issues and how local scientists handle with technologies. Sa C. described sectoral funding and analyzed the difficulties encountered in the cooperation between universities and businesses.

In India, scholars found that the main objective of S&T policy was to promote excellence research centers. This concern has been perceived by OECD countries to consider as how to promote/support this kind of research centers.

Heinze T. put forward the idea of research fund and analyzed the context of funding research projects. Thereby, risky projects was identified due to the two following causes:

- The project is not feasible due to low allocated funds and short-term investments;
- The bias existed when reviewing the proposal (inaccurate evaluation mechanism may increase risks to the project).

Heinze T. (2008) pointed out that the selection of programs for funding was a breakthrough step. He noticed, long-term funding mechanisms were more favorable for interdisciplinary or explorative research. Heinze also assumed that donors should boldly propose to develop funding tools and methods for diversified researches appropriate with research groups or projects.

From the above points of view, it could understand that to have good projects, it should have appropriate funding tools and methods. Through these tools and methods, the selection of policy evaluation face two main challenges in respect of research funding, namely: *(i) creating tools and methods that support good combination of applied research and explorative research; (ii) finding ways to conduct simulation studies of existing problems in society but still limited in science.*

3.3. Globalization and international cooperation issue

When observing at STI policy in the current global context, it can be noticed that globalization and international cooperation issue is one of the top priorities of most countries. Two issues of concern include the movement of students and high-skilled labor resources, and the coordination of donor agencies in research and development cooperation.

One of the main trends of contemporary STI policy is the increasing level of international cooperation. Globalization is always an important issue of higher education with research focus on the trend of recent innovation, as the movement of scientific manpower is inevitable for every country under the increasingly stronger integration with the world. Many national research councils are teaming up in research such as the European Research Area, abbreviated as ERANETs), or the creation and innovation program called "Joint Programming Initiatives". However, the current research cooperation is a major challenge for many developing countries, so it should have a

research strategy done to quickly achieve as highest benefits as possible. *Pastries Boekholt et al. (2009)* and colleagues pointed out a comprehensive overview of the process of international cooperation in research. Research cooperation is classified into two types: wide and narrow STI cooperation. Broad STI co-operation is meant to increase the amount of foreign investment into a country by many different ways to achieve major intended objectives. Narrow STI cooperation is meant to make investment for specific goals, such as promoting or attracting international academic scientists; enhancing the effectiveness of science and strengthening the realization of the set objectives.

According to *Jacob M. and Meek L. (2012)* said that one of the ways used by countries to deal with the pressure of globalization was to promote policies for higher education and research, emphasize the issue of scientific workforce movement. The authors provided an overview based on the analysis of scientists through policy instruments to promote capacity building and international approaching. Movement of scientific personnel was the combined trend when scientific human resources were identified as scarce and tended to concentrate in major centers. *Heitor et al (2014),* defended the view that it should give priority to attract highly qualified scientific manpower and place in important positions in economic development as this development was dependent on the attraction of highly qualified scientists.

Heitor et al (2014) also stressed that countries need to focus on and select "what priority action and to take appropriate decision" so as to increase the use of investments for education, there should be policies to attract scientists to foster and promote talents. Many developing countries were warned that investing in higher education and scientific research, but there was a tendency of highly qualified scientists remained in large institutions of some Westen countries. The controversy stemmed from the data in Portugal, when Heitor and colleagues said that it could retain talents in the country if a long-term strategy and investment was selected for sustainable science. Investment portfolios are diversified by funding instruments and investments in research, at the same time, it confirmed the role of funding and financing methods indicators nationwide.

Jonkers, K. and R. Tijssen (2008) provided an analysis of the relationship between human movement in science and international cooperation by investigation focused on Chinese scientists living in US. Jonkers and Tijssen provided actual data to demonstrate the changes outlined in the *Jacob M. and Meek L. (2012)* when assessing the need for a strategy to ensure the return of the scientists and the readiness to participate in international cooperation network.

Thus, the factor of globalization and STI policy indicated two key elements, i.e globalization and international cooperation. These issues should be taken into account by STI policy with a view to promoting and sustaining research capacity in research community in each country. The attention to globalization and international cooperation is a matter of confirming the potential of STI in each country.

4. Conclusions

Based on the analysis of the viewpoints of some experts, this study showed three important elements for policymaking of STI, including:

- Setting policy priorities for scientific research in connection with economic development and social needs;
- The formulation of policies for reform of S&T management should be considered based on the linkage of scientists, research institutions and enterprises in the innovation system, at the same time, placing the emphasis on research cooperation under global integration context;
- There should be a reasonable choice of funding tools and modalities to be appropriate to each research model.

The overview and analysis in this article will contribute to support the development of policies for reform of S&T management in the near future in Vietnam./.

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