

INTERNATIONAL EXPERIENCE OF LINKING BETWEEN RESEARCH, EDUCATION AND INNOVATION IN RESEARCH AND DEVELOPMENT ORGANIZATIONS

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Abstract:

Meeting new requirements, research and development (R&D) organizations in countries worldwide had made every effort to find out solutions and take appropriate actions to promote the internal linkage among research, training and innovation in their organizations. Since this was by nature, an internal arrangement, the establishment and maintenance of such a linkage had a number of fundamental advantages relating to management; setting development goals; formulating regimes and policies for the use of human and physical resources; building the confidence in internal workforce. This article introduced some experiences in promoting the link of research, training and innovation by three major R&D organizations in the world, i.e Max Planck Institute and Fraunhofer Institute (Germany), Institut Pasteur (France). On that basis, it provided with some recommendations for Vietnam in promoting the linkage among research, training and innovation in public R&D organizations.

Keywords: *R&D organization; Link of research, training and innovation; International experience.*

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1. Various theoretical arguments on the linkage among research, training and innovation in R&D organizations

1.1. Linkage of research, training and innovation in R&D institutions to meet the new requirements

The linkage of research, training and innovation in R&D organizations refers to the coordination and interaction among three activities in an R&D organization. This interaction on the one hand, enables R&D organizations to work and make three types of activity, i.e knowledge creation (research); knowledge dissemination (training); and knowledge application (innovation) integrated, on the other. The nature of linkage of research, training and innovation in R&D organizations is the change of the way of creating and

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using knowledge. Previously, knowledge creation, dissemination and application used to take place in an one and sequential way, but now it enables R&D organizations to realize continuous knowledge creation, dissemination and application in practice; these activities are interactive, interconnected with each other and provide necessary supportive conditions for each other's development. The link of research, training and innovation in R&D organization not only fills the gap among these three operations in terms of closer space, but also enjoys unified objectives and management modality, through which knowledge is converted into material resources for the development of R&D organizations themselves and more broadly, for the society. This process happens in a continuous and systematic manner.

In general, the link of research, training and innovation in R&D organizations has received interest and attention in order to meet the new requirements, namely:

- *First*, the legitimate demand of the society for the contribution of R&D organizations to prove the value of the people's tax money. Research result of R&D organizations is not only reflected in the increased knowledge for society, but also more importantly, it must be introduced into production, thereby it creates new products (goods and services); or assists in training of highly qualified human resources capable of detecting and solving problems posed by practice;
- *Second*, the tendency of government policies to reduce subsidies, increase autonomy and self-responsibility for R&D organizations. Governments no longer provide generous, unconditional funding for research, they only share a part of operational budget of public R&D organizations, and the rest shall be secured by R&D institutions from the private sector. This trend requires and allows R&D organizations to be more proactive to establish and develop effectively internal and external relations;
- *Third*, now it is emerging new models of linkage among research, training and innovation. Linear model expressed by direct move from research to training, or from research to innovation. This model has disadvantage of not reflecting the importance of the strong interaction between these activities, leading to mistakes in the state policies or wrong behavior of individual R&D organization. From this circumstance, it appeared the nonlinear model which emphasized the interaction, interrelation, and provided complementary conditions for development of respective research, training and innovation. This new model requires R&D organizations to redesign appropriately their mutual links;

- *Finally*, the link of research, training and innovation also enables R&D organizations to improve the effectiveness of all three operations. This is considered as an important measure to enhance the status and reputation of R&D organizations, therefore it gives new opportunities, new partnership for the organizations with outsider entities (especially with those in industrial areas).

The link between research, training and innovation in R&D organizations exposed several fundamental advantages, namely (i) Unified management in internal R&D organization; (ii) Objectives of individual operation are consistent to the overall development goals of the organization; (iii) Unified labour regimes and policies for the workforce, except specific working characteristics of each operation, so the workforce is easy to transfer or coordinate; (iv) Easy coordination of the use of working facilities, equipment; and (v) Easily set up and develop links with outsiders by having existed confidence, interference within internal activities of the workforce.

1.2. Content of the linkage of research, training and innovation in R&D organizations

R&D organizations have a mission to create new knowledge, therefore, the organization's main activity is doing research. Training and innovation appear to meet new requirements, these two operations provide the basis for development and maintenance of research activities. The link among research, training and innovation in R&D organizations is associated with ongoing changes and is significant to meet the new demand. Three operations: research, training and innovation in R&D institutions have intertwined relationships and extremely closely connected. The following analysis will clarify the content of this linkage.

1.2.1. Link between research and training

In R&D organizations there is postgraduate education, specialized training as well as fields of research. The result of the training depends largely on results from research activities.

Research results form the basis of training curriculum and are used to clarify, update, modify the content/curriculum of training. Through the training, researchers in R&D organizations help post-graduate students (Master and PhD students) understand how a research result was generated. The process of preparing teaching materials also helps researchers reveal the knowledge gaps that need to be filled up. Comments, feedbacks, questions, opinions of students may make new ideas appear for researchers. Information and experience acquired by researchers in teaching process in the classroom can

help them perform better research; Teaching helps researchers develop skills useful for research, including those of counseling, monitoring and analyzing other people's understanding and feedback (*Nick Feamster, 2013*).

In many countries, the type of R&D organization combined with training exists to best promote the benefits that joint research and training bring about. Through training activities, R&D organizations can attract more funding from the interest of different donors; participating in training will generate more income and thus can in return serve for research activities. Close link between research and training will enable R&D organizations to have optimal use of resources for both activities which have a lot of things in common. R&D combined training organizations, researchers not only concentrate on the implementation of research projects, but also on teaching. And so, the development and implementation of research programs and projects in R&D organizations have different objectives, such as creating new knowledge to associate with innovation or attach to training.

R&D organizations in the world always consider that post-graduate students are integral part of their manpower as this is the in-situ source of additional research forces for R&D organization. In many cases, lack of post-graduate students, research tasks of professional researchers found difficult to achieve the desired results. The involvement of students will make researchers increase their capacity to carry out major research projects with high performance or have the opportunity to work with research programs requiring higher intellectuality. In contrast, for students, through participation in research tasks, they can have opportunity to update their wealth of knowledge, furthermore, it is important for them to better familiar with the research profession, getting more motivation to research work (*Hoang Van Tuyen, 2012*). Linking research and training is also an effective method to create research teams in R&D organization, including long experienced researchers and young scientists.

1.2.2. Link between research and innovation

The formation and development of innovation activities in R&D organization is a necessity in order to address the internal problems of the organization and provide support for external businesses. Linking research with innovation is the way to facilitate researchers in R&D organizations to expand their operations, demonstrate their dynamism and increase their income. While research combined with training is an issue of priority, innovation is the third key operation that R&D organizations must focus on. In this article, the link between research and innovation in R&D organizations is reviewed in the two forms, as follows:

- *First*, R&D organizations establish spin-off enterprises to realize production of products come out from the research results. This is a specific feature of the link between research and innovation in R&D organizations, and it becomes a suitable solution allowing researchers on the one hand, keep their intellectual property, and on the other hand still gain economic profits from research results, and R&D organizations are also entitled to enjoy long-term benefits. Spin-off businesses are partners of R&D organizations, the two sides will support each other in research and innovation. R&D organizations contribute to establish spin-off businesses, sharing profits with researchers when undertaking production. Researchers who established spin-off businesses should be released from the R&D organization to start-up the business and replaced by young researchers. Therefore, by this way, R&D organizations can not only have the research results materialized, but also have S&T personnel mobility from research to industry;
- *Second*, R&D organizations join/support the innovation activities of enterprises through research contracts. In this modality, R&D organization is a very important source of innovative ideas, scientific platform and technological solutions; and enterprise is subject for funding, initiating research questions and keeping the intellectual property rights. In fact, there appears more joint research projects between R&D institutions and businesses, the two sides cooperate closely with each other through different stages from project formulation, implementation to evaluation of project results. R&D organizations obtain basic benefits when having research collaboration with businesses, namely: (i) Reducing the government's support for research; (ii) Making full use of the organization's equipment; and (iii) Getting economic benefits for R&D organization (*Albert Barber, 1985*).

1.2.3. Link between training and innovation

At R&D combined with training organizations, when a training program developed and implemented in association with innovation-oriented purposes (i.e establishing and developing innovative capacity for students), it will certainly create attractiveness for learners, and more importantly is the formation of research teams capable of addressing practical issues. In the course of the training, participants are mobilized to take part in research projects that R&D organizations have cooperation with enterprises, this participation is under the supervision of researchers (also are their mentors). Through it, students can get access to practical problems needed to resolve, they also have a favorable environment to develop, test their innovative ideas. Therefore, students play a more active role in learning and are

encouraged by their mentors for join creative efforts when engaging in innovation with businesses.

The link between training and innovation opens a huge employment opportunity for students; forming a number of scholarship programs and improving entrepreneurship spirit for young scientist teams in the future; content, training curriculum are regularly updated with more vivid evidence-based innovation practices from businesses. The link between training and innovation facilitates R&D organizations to receive larger funds from industry (even sometimes greater than funding from the state) and to be used as part of revolving fund for training activities. The link between training and innovation on the one hand contributes to improve the content of training so as that it be attached to practical needs, and on the other hand to help R&D organizations create a highly qualified team with performance-oriented knowledge and skills, “friendly”, adaptive market to any circumstances.

1.3. Forms of link between research, training and innovation in R&D organizations

The above analysis showed the content of the linkage between research, training and innovation in R&D organization was very rich, diverse, and expressed in many different forms:

- Unity in the formulation of program, contents of all three kinds of operation, i.e research, training and innovation towards mutual, complementary support each other;
- Common use of human resources for all three operations: research, training and innovation;
- Unity in using the research results, namely those used for agreed specific purposes, such as for training and establishment of spin-off enterprises or participation in/support for innovation activities of enterprises;
- Providing material conditions for mutual development, namely the common use of facilities, equipment in the implementation of research, training and innovation activities. In addition, funds generated from one operation can be back used for other activities is also an important form of link between research, training and innovation in R&D organizations.

2. Some international experiences on the link between research, training and innovation in R&D organizations

2.1. Max Planck Institute

Max Planck Institute (MPG) was founded in 1948 (formerly it was the Kaiser Wilhelm Society, founded in 1911). MPG consists of 83 member research institutions, centers. The institute is a world leader in scientific research and it ranks the third on technology research according to the ranking of the prestigious journal Times Higher Education. MPG mission is a research organization in the field of basic science, however, it does not mean that in MPG there is no link between research, training and innovation. In contrary, the case of MPG shows that even a purely basic research organization still can promote link between research, training and innovation in their own ways, specifically:

- From a basic scientific research organization, not influenced by any political orientation or business, MPG for the last two decades started paying stronger attention to qualitative research towards innovation and encouraging the entrepreneurial spirit among researchers. In the research findings of MPG, there was a significant number of new technologies, these technologies can directly or indirectly create products (goods and services) available in the market for profits to offset risks and make reinvestment enhance research capacity. The success of MPG was recognized by the fact that a number of spin-off businesses had established by MPG from their research results. From 1990 to the end of 2014, 114 spin-off enterprises were established by MPG². From an organization 100% dependent on state financing for research, MPG has so far been in autonomy of about 20% of research funding;
- In order to facilitate the creation of spin-off businesses and the connection with the industrial sector, in 1970, the Max Planck Innovation (in 2006 renamed as Garching Innovation New) was set up by MPG. The mission of this company was to promote technology transfer, support for institutions on the issue of legal protection for industrial property, business plan development and other necessary conditions for the establishment of spin-off businesses from research results³. Max Planck Innovation has become a powerful arm of MPG in the link between research and innovation;
- In the trend of combination of basic and applied research under certain objectives, MPG took initiative to form innovation driven research programs based on joint research with the Fraunhofer Institute; and has carried out many collaborative research projects in a number of scientific areas such as computer science, materials science, renewable energy, nano and biotechnology;

² https://www.mpg.de/913658/technology_transfer

³ <https://www.mpg.de/913507/Max-Planck-Innovation>

- At present, in MPG there are nearly 5,000 graduate students being trained. They are regarded as an integral part of research forces of MPG. These graduate students are attracted to take part in the MPG research programs under the guidance of professors. Since 2005, the MPG has established the Max Planck Fellowship Program, this allows professors to lead a group working at MPG institute for a period of 5 years. Training program for post-graduate students was led by scientists of the MPG and typically are multidisciplinary to help the exchange of knowledge and research results of different scientific subjects. MPG provides the best material conditions for fellows to complete their doctoral dissertation, from access to information to doing experimental studies in the most modern laboratories of MPG;
- To implement training programs, MPG in association with some universities established international Max Planck research institutions (IMPRS). IMPRS is actually a combination of programs of one or more institutes of MPG with an university, providing scholarships for doctoral training program, normally within 3 years (not all institutes have this IMPRS). Approximately half of the number of scholarships of a IMPRS each year is for international students. Up to their choice, PhD students can work at a research group at MPG institute, or at universities having association with the institute in the IMPRS⁴. The learning and working environment of IMPRS is fully satisfactory and very modern, providing the most favorable conditions for fellows to complete their doctoral dissertation at MPG;
- To promote MPG (as well as other research organizations) to pay more attention to the link between research, training and innovation, German government has taken several measures. Through the Joint Initiative for Research and Innovation, the federal government (along with state governments) had awarded research institutes, including MPG, with autonomy on finance, planning and increased main funding up to at least 3%/year (ended in 2010). In return, MPG must commit itself to improve the quality, efficiency and capacity of research projects, promote the link between research with training and innovation. More importantly, they must closely associate with enterprises through collaborative research projects on innovation (*NASATI, 2010*).

2.2. Fraunhofer Institute

Fraunhofer Institute (FHG), an applied research organization in Germany and the largest research organization in Europe, was founded in 1949 in

⁴ <https://www.mpg.de/en/imprs>

Bavaria. Currently, FHG is composed of 67 member research institutes and units. Unlike MPG, an organization that focuses on basic research, FHG is an organization of industry-oriented research, in favor of applied research. Therefore, FHG has many more advantages than MPG in the development of relations and links between research, training and innovation. At FHG, innovation is a key activity which receives due attention to become a motivation force for research and training. Income from innovative activity not only helps FHG reduce government assistance, make full use of its equipment, but also bring many economic benefits to the organization. FHG is considered very dynamic and flexible when developing links between research, training and innovation, specifically:

- FHG especially focuses on encouraging entrepreneurial spirit of researchers. So far, researchers of FHG have set up more than 150 spin-off enterprises⁵. To facilitate the establishment of such businesses, FHG created a Venture Promotion Advisory Group to review, evaluate production ideas, research results, assess the conditions relating to establishment of spin-off businesses; securing investment sources, assessing the value of new technologies; consulting for business plan; securing legal aspects for new technology acquired by institutes establishing spin-off business; review potential contribution of FHG to participate in spin-off enterprises. The objective of FHG is to obtain maximum exploitation of the benefits that spin-off businesses may bring about. Spin-off businesses are partners of FHG, the two sides will support each other in research and production; FHG makes financial contribution for the establishment of spin-off businesses, and together with researchers shares the profits from production;
- This activity is considered as the backbone of FHG, which is to support innovation activities of businesses through research contracts. FHG is an important factor to promote industrial innovation in Germany. Along with businesses, FHG develops and optimizes new technologies and production processes, including the production of prototype and mass production. Through research contract, FHG has become a supplier of new technologies and know-how, especially for small and medium enterprises without having a R&D department itself. FHG encourages researchers to stand on "two legs", i.e. one in laboratory, and the other in factory, and must always be flexible, responsive in seeking funding from industrial sector. Currently, the revenue from research contracts of FHG is always accounted for over 60% of its annual research budget, for example, in 2014, the research budget of FHG was 1.9 billion Euros, out

⁵ <http://www.fraunhoferventure.de/en/press.html>

of which 29% came from federal government, 6% from state government, and 65% from research contracts (*Fraunhofer, 2014*);

- At present, out of 23,000 employees of FHG, 25% are post-graduate students (master and PhD students). FHG uses students as formal research force, they are placed in research programs, projects under the guidance and supervision of professors, and well paid of remuneration. FHG cooperates with universities to train post-graduate students, and support for research students to develop their working teams by allowing them to use physical conditions, equipment of FHG to conduct research;
- With a view to promoting FHG activities, and support for the development of links between research, training and innovation, each year the German government always maintains a stable research funding for FHG (about 35%). FHG uses that funding to conduct preparatory research and the results of these researches are then the basis for developing and establishing further connections.

2.3. Pasteur Institute

Pasteur Institute (Institut Pasteur) is a private non-profit research organization founded in 1887 in France thanks to the contribution of sponsors around the world. The Institute's mission is to help prevent and treat diseases, primarily infectious diseases, through scientific research, teaching and public health interventions/initiatives. Currently, the Institute has 120 research units, 30 research institutes abroad. Different from MPG and FHG, the Pasteur Institute is a research organization with the combination of basic research and applied research for public health objectives. Nevertheless, the Institute is very interested in the link between research, training and innovation in order to make full use of and promote the benefits of this linkage brings about, namely:

- Pasteur Institute always encourages entrepreneurship spirit of researchers, promotes the establishment of spin-off businesses from laboratories. Since 2000 up to now, 25 spin-off businesses have been created (in the fields of diagnostics, vaccines and treatment, viruses, biotechnology, genetics, pharmaceutical biology, immunology, microbiology,...). The Institute maintains close ties with their spin-off businesses and continues to increase the value towards promoting spin-off businesses be connected to industry. The Institute is not a long-term shareholder and wishes to have its capital escaped from existing spin-off businesses within a period of 6-8 years so as to re-invest in other spin-off businesses⁶;

⁶ <http://www.pasteur.fr/en/industrial-partnerships/entrepreneurship/institut-pasteur-and-entrepreneurship>

- In Pasteur Institute, the content of post-graduate training program is developed in relation with practical problems solving in the health sector. The emphasis on practical aspects have attracted students and researchers who want to expand professional knowledge or improve the level of their degree. Training curriculum of the Institute always has been implemented in collaboration with universities such as Paris Descartes, Pierre et Marie Curie, Paris Diderot, Paris Sud;
- Each year, the Pasteur Institute enrolls about 500 post-graduate students from 60 countries around the world. They are considered as an integral part of manpower of the Institute and arranged to participate in research programs, projects and be well paid. In addition, post-graduate students can also attend all scientific conferences of the Pasteur Institute, where they listen to and discuss with scientists from the world about the result of latest researches related to public health;
- Pasteur Institute has 120 laboratories, of which many are modern facilities with close links with the universities for postgraduate training. The fellows are allowed to use these modern laboratories to implement and complete their thesis⁷.

3. Lessons learnt for Vietnam

The link between research, training and innovation in R&D organizations has a very important significance, allowing R&D organizations to make full use of existing resources, while meeting the objective requirements set out. To promote the link between research, training and innovation in R&D organizations, Vietnam should take various appropriate solutions by learning from international experiences.

The issue of promoting links between research, training and innovation in R&D organizations in Vietnam has been discussed quite a lot on forums. However, there exist two biggest barriers to the establishment and development of this link, e.g (i) the demand of linkage between research, training and innovation in Vietnam R&D organizations is not so high due to subsidy mechanism of the state has existed for a long time; and (ii) Limited capacity in establishing links between research, training and innovation of R&D organizations due to lack of quality research force in terms of appropriate science and technology knowledge, facilities, equipment and information. However, international experience indicates that it is quite possible for the establishment and development of links between research, training and innovation in R&D organizations of Vietnam:

⁷ <http://www.pasteur.fr/en/teaching/doctoral-programs/pasteur-paris-university-international-doctoral-program/overview>

- *First*, the state should keep a stable level of investment, or increase the financial investment for research in R&D organizations to create valuable research results serving as "seed money" to set up links between research, training and innovation. However, this investment should not be made equally, it requires specific criteria, i.e be performance based and actual need associated, dependent on capacity of R&D organizations. First of all, priority should be given to R&D organizations working in priority technology areas of the country, including: Information Technology and Communication; Biotechnology; New materials technology; mechatronics-automation technology; Environmental technology⁸.

Along with investment, the lessons learnt from MPG and FHG showed that the state should provide R&D organizations with autonomy in R&D finance and planning, and set up a mechanism to ensure the commitment of R&D organizations to increase the quality, efficiency and research capacity in the establishment and development of links between research, training and innovation;

- *Second*, for R&D organizations with postgraduate training, they should be involved in research programs and projects of R&D organizations. Experience of the three large organizations MPG, FHG and Pasteur Institute showed that postgraduate students should be an integrated part, of the formal research study forces, and be well remunerated in turn of the value they contributed to the R&D organization. This was not only a solution for R&D organizations to settle down the problem of research manpower shortage, but more importantly to give students the opportunity to work and exchange ideas and research results with scientists in many different scientific areas;
- *Third*, in order to implement postgraduate training programs, R&D organizations need to have close link with universities. Practices from MPG, FHG and Pasteur Institute showed that, through joint training with universities, R&D organizations could make full use of specific advantages of the resources of both sides, and more importantly the students can work with many scientists to exchange knowledge and results of different scientific researches;
- *Fourth*, to facilitate the introduction of spin-off businesses from research findings, R&D organizations need to create a specialized unit (departments, center...) to receive and evaluate the ideas from industry and R&D

⁸ The technology sector priorities identified in Decision No. 418/QĐ-TTg dated 11th April 2012 of the Prime Minister "approving the strategy development of science and technology for 2011-2020".

activities, support for identification and formulation of investment projects, find interested investors, and providing legal supports;

- *Finally*, for a purely basic scientific research organization, it can still set up and develop links between research, training and innovation. MPG's case demonstrated clearly this possibility. First, researchers instead of focusing on the issues of their own interest, they should pay stronger attention to innovation-oriented researches. At the same time, they should expand partnership with applied research institutions. In this relationship, basic scientific research institutions can bring the full wing of their strengths of theoretical issues, while applied research institutions can focused on practical issues. In the end, benefits from research results can be shared and enjoyed by both parties./.

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