AWARENESS OF SCIENCE AND TECHNOLOGY ROLES TOWARDS SOCIO-ECONOMIC DEVELOPMENT

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Abstract:

Intuitive awareness of science and technology (S&T) roles towards production appeared early. Tough binding of S&T and production was emphasized in many economic doctrines. Up to now, the practical awareness of this issue, however, remains limited in many aspects. There exist many reasons to explain the fact why the awareness of S&T roles towards socio-economic development is a long and complicated process. Namely, S&T makes impacts not only directly to actual production processes but also indirectly to global aspects of production activities; there are so many components of production activities falling under impacts from S&T such as labors, production means and materials. Impacts from S&T may be strong but unequally dispatched and it is also difficult to evaluate impacts/contributions of S&T to economic activities. There exists certain gaps between S&T research and application activities and between the rightness and usefulness in scientific research. There are also difficulties in S&T development management. International experience shows that there are concrete solutions to settle difficulties and pro-actively to promote the awareness of S&T roles towards socio-economic development.

Keywords: *Science-technology roles; Socio-economic development; Production activities.*

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1. Awareness of science and technology roles towards socio-economic development passes a long and complicated process of development

The intuitive awareness of S&T roles towards production appeared early. The clearest evidence of that come from Greek myths about gods of techniques (who created techniques and transferred them to the human), namely Athena is the Goddess of cultivation, Hephaistos is the God of metallurgical techniques and use of fire for ceramic techniques. However, by the XVI-th Century, there appeared the deep and science-based understanding of the S&T roles. Francis Bacon (1561 - 1626) was the first philosopher who realized that S&T can change the whole world and he was the man who supported investment projects for science. His concepts on the S&T roles (typically expressed in his work *Novum Organum* - 1620) made

great influences in research practice. The slogan "Knowledge is Power and Power is Knowledge" inspired many generations[1].

The next figures were René Descartes with "Thesis on methods" (1637), John Locke with "Thesis on the human knowledge" (1689) and Immanuel Kant with "Critics for pure reasoning" (1781) and others.

The binding of S&T and production was emphasized in many economic doctrines such as the growth model by Kaldor which considers that the economic growth depends on technical progress or technological level, or the two sectors models (agriculture and industry) of economic development by Lewis and Harry T. Oshima. The authors paid great attentions on better labors and higher productivity which can be enhanced by investment and S&T. The model by Solow made accents on factors of technology and labor development in sustainable way. The neo-classic model supposed that it is possible to base the explaination of social production, growth rate and difference between developed countries and developing countries on studies of "basic elements" including resources, technologies and development priorities.

Many other concepts were developed to reflect the binding of S&T and production. Some of them were selected to establish Technology-based Development Principles which was proposed for the first time in the 40th annual meeting of UN ESCAP, April 1984. The Resolution of the meeting emphasized that the technological progress is the most important element for economic growth. The technology development was considered as the most important background for socio-economic development.

Together with the right and proper evaluation of S&T roles towards socio-economic development, there exist other visions which ignore or doubt, under-evaluate or over-evaluate the S&T roles.

Jean Rousseau (1712 - 1778), the same time as Bacon, was famous with his thesis written in 1750 where he confirmed that progresses in science and arts do not bring useful benefits to the human society. He even considered that the modern technologies are not good for the human kind. Adam Smith in his economic doctrine emphasized the value of labors and other economic factors and reserved the secondary roles for technical progress. Even, Frederic Taylor (1856 - 1915), the author of the famous Taylor's methods, did not pay attentions to S&T applications when talking about functions of enterprise management. In his concepts for management, enterprises need to turn integrated attentions to the following functions: technical aspects for production functions, transaction skills for commercial

[1] Bacon, indeed, was not the first author to note that the advantages of the science can produce for the human society. But, before him, no one was so eager to propagate largely these ideas. Bacon was excellent in his writing skills and very famous as politician. The Bacon's concepts for the S&T roles produced great influences.

functions, fund search and management for financial functions, protection of assets and human resources for security functions, asset inventory, control and costs for accounting functions and administration skills for enterprise management functions.

Many economic growth doctrines can be listed which ignored S&T factors such as the models by David Ricardo, Harrod-Domar and others. The typical model was presented in the concepts by Malthus in 1798 in his work about demography. In that work, he noted his top concerns for the biggest problem the human society has to face: "The demographic power is clearly stronger than the power which created the life in our Earth". Here, he ignored the capacities to use S&T achievements to produce goods to meet human needs.

The doubt about the S&T capacities to make contributions to socio-economic development was also seen in many new research results. In 1856, a newspaper stated that the voice cannot be transmitted along a wire and, even if it can be done, it cannot produce any practical value. Less than one decade later, the telephone appeared in Bell's laboratory and was applied largely. Similarly, on the day Wright brothers made a take-off, newspapers refused to make comments because the editors could not believe that can be done. Even when Wright brothers made the first flight, Smithsonian Institute, a famous research center, fired Prof. Langley because he dared to propose the research to make motorised flying equipment. Even Rutherford, a famous atomic researcher, declared that it is impossible to release the atomic energy. But, 9 years later, the world saw the atomic bomb explosion.

Other examples can be added. Namely, today no one can deny the advantages of use of wireless, lamps, cars, computers and many other things. But before their appearance and introduction to use, there were so many wrong assessments about their roles and importance. For case of railway, for example, in 1832, Arago condemned it because "the air compression in tunnels is very harmful for lungs of passengers". For case of electrical generators, experts assigned by Napoléon III had "scientifically" proved that the generator created by Zenobe Gramme never can operate. For case of electrical bulbs invented by Edison in 1878, a committee of British Congress stated: "It is also good for our over-ocean friends but it is not enough to attract attentions of the scientific circle or practical minded people". Henry Morton, Chairman of Stevens Technology Institute, simply noted: "We are all familiar with heavy failures of terrible inventions". For case of alternative current, Thomas Edison stated in 1889: "The use of alternative current is a time consuming practice. No one will use this invention". For case of microprocessors (which are used in so many

equipment and devices), an IBM engineer made a note in 1968: "What this invention is good for?" For case of data transmitting equipment, Dennis Gabor, British physicist, noted in 1962: "The document transmission is theoretically possible but the equipment required for realization is too expensive then is not realistic in practice". For case of cars, *Literary Digest* Magazine made a comment in 1899: "This horse-free transport means is a luxury good of elite circles. Even with the prices to be reduced in the future time, the car can never get popularly used as bikes". Some newspapers added: "Nothing can be more stupid than to believe that something can substitute the horse coaches". For case of the wireless, Lee DeForest, American inventor, author of vacuum bulbs, noted in 1926: "This invention is absolutely feasible theoretically and technically but is utopic commercially. It is a time wasting invention".

Another trend of concepts acknowledging the power of S&T considering that the S&T potentials are already exhausted presents a vision of limited history of S&T development. In 1865, the Director of American Invention Agency had resigned and declared: "I have no reason to stay. There is nothing for invention". By the end of the XIX Century, Lord Kenvin, a very highly respected and erudite scientist, declared that the science boat has arrived a quite wharf and all the most basic problems had been solved. In the new century, it has to complete only remaining details and to enhance the exactitude level. If there remain some tiny clouds, however, which may turbid the blue sky of science; there could be only some studies needed for radiation and interpretation of Michelson experiments".

In his work "The End of Science" published in 1996, John Horgan stated: "All the biggest discoveries of the human kind were already made and the end of science is not far". John Von Neumann, mathematician, stated in 1949: "We have arrived the limit of inventions possible for computers".

We can see an indirect indication of the limit of S&T development through the name, very suggestive and prideful, of a research program proposed in 1980s by Japanese scientists to study the human brain which is "Program on the human border". Some Japanese scientists called it as the last black box of the human.

Another yet concept is to over-evaluate the S&T power which create unreal illusions. Many expectations for contributions of science to economic development were based on alchemy in old times. There are some technologies which were forecast but did not appear yet. For example, Denis Gabor, in 1970, had made a report of points of view by experts saying that the first demonstration of controlled nuclear fusion would occur by 1980, but after that time nothing happened as forecast.

2. Reasons of limited awareness of S&T roles towards socio-economic development

There are many ways to explain why the awareness of S&T roles towards socio-economic development is a long and complicated process. Among them, the main reasons can be listed as follows.

First, S&T has direct and indirect impacts to actual production activities. S&T contributions to production usually last for long time. Short term contributions are lower in values than long term ones. For example, recent calculations showed that the 1% increased expenses for R&D of Singapore would make 0,020% for GDP growth rate for short terms (1 year) and 0,052% GDP for long terms (3 years) [5].

S&T development requires a long vision investment while the actual trends in practice (pressures from willing and competitions) want to get fast benefits. This leads to different situations, even in leading developed countries. In the US, R&D expenses reduce in economic recession time and increase in economic explosion time. In Europe and Japan, the picture is not seen like that. For US enterprises, the cut-down of R&D expenses is a technique to maintain benefits in reduced turn-over times. In Europe and Japan, R&D expenses do not suffer cut-down because they see them as power sources for long term competition.

It is lucky that the history development trends are not oriented to increase the contribution of S&T for production but also to enhance direct and short term benefits (such as IP rights, shortened time gap between research and production, tough connection of basic research and application development and etc.). These trends enhance practical values of S&T for production.

Second, there are direct impacts but also indirect ones which come through various production factors such as labors and production means. The higher influences from and the dependence on other factors partially would reduce the S&T roles. It usually happens in the human history that the "real holders" hide the real driving forces, particularly in the case of appearance of intermediate factors in economic activities where trade activities are good examples for that.

Third, S&T impacts may be strong but unequally dispatched. The limited propagation leads to a low sensibility of connections between S&T and production. We have no way to see well the S&T roles where it is not present. From another side, the limited propagation of S&T roles can be taken to lower the power and the necessity of connections between S&T and production.

Fourth, there are certain difficulties in evaluation/calculation of impacts/contributions of S&T to economic activities. One can see highly

impressive figures presenting the contribution of S&T to economic development. Some of them may sound like: "By end of the XX Century, a half of GDP growth and 85% of increase of income per capita come from application and use of S&T research" [6] or "Contributions of technological advances to economic growth in 1950-1985 period of France, Germany, Japan, UK and US were 76%, 78%, 55%, 73%, 49% respectively"[2]. Many efforts have been made for calculation of contributions of S&T to economic development by the governments of many countries[3]. In practice, however, the calculation and evaluation of contributions of S&T to economic development cannot be seen easily as convincing and face certain obstacles as acknowledged by scientific communities[4].

The S&T contributions still have to find a shelter under common denominator of TFP. The reflection of difficulties in quantification of knowledge and efforts for evaluation of global impacts of knowledge are usually conducted in indirect way. There is an obvious acceptance of the fact that the knowledge can partially interpreted the growth without being capable to explain it as whole because of accumulation of tacit and well identified factors such as labors or capitals. The growth is not taken into calculation because these factors - the remaining part - are assigned to *the growth in their own productivity*. It means that the other factors are used in another astute way, through knowledge. This remaining part is called somewhere as the remaining part of Solow, after the name of economist Robert M. Solow who first started this approach by 1950s. The notions which can be measured by this approach are conventionally called as TFP. Some researchers call the remaining part of Solow as a gauge of our knowledge because they stand for the things we cannot calculate.

Fifth, there is a phase gap between S&T research and application, between the rightness and the usefulness in scientific research. The typical case is the fact we usually pretend that Einstein theory is basically "more right"

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[2] M.J. Boskin, L.J. Lan. (1992). *Technologies and the riches of nations*. California.

[3] The US is the first country to conduct the S&T evaluation. The work of S&T evaluation has become institutionized activities which are developed and completed with enriched and diversified contents. This type of works is compulsory for all investment projects. Actually, in the US there are some evaluation organizations such as Science Implementation Management Consulting Company (MSD), World Technology Evaluation Center (WTEC), Congress Service Group (CRS), US Auditing Agency (GAO) and others. Since the middle of 1980s, Canadian Federal Government required to carry out the evaluation of Government key programs including S&T ones to support the decision of program adjustment, strategic planning works and interpretation of effective use of public funds.

[4] As example, a macro economy book of Harvard University (US) recorded: "Our knowledge of economic growth should not be complete without understanding the impacts of individual decisions and public policies towards technological progress. It is one of the biggest challenges for economists today". (N. Gregory Mankiw, 1997, *Macro Economy*. Hanoi, Statistics Publishing House and National Economy University, p. 85). A report by World Bank recorded: "Research on knowledge for development is a new field and here are many works to do. For example, there are actual discussions how to measure knowledge. Without having standard gauges, we cannot identify if the gaps in knowledge extend or shrink" (World Bank, "*Report on World Development Status: Knowledge for Development*". Hanoi, *National Politics* Publishing House, p. 30).

than Newton theory. But, in fact, Einstein theory produces less influence than Newton theory does because Newton theory established the background for modern S&T. Almost all the modern technologies are based on the concepts of Newton theory but not the ones of Einstein theory.

The practice here showed that the scientific concepts taken to be right have lower chances for application, and inversely. This paradox contributes to block the acceptance of tough connection between S&T and protection.

Sixth, there are difficulties in S&T development management. Forecasting of S&T development trends remains a difficult work. Even the rules governing the science progress is permanently changing. By middle of the XVIII Century, the science progress was taken as the source and driving forces for evolution and improvement of the human kind. Then, philosophers, scientists and social reformers held the view that the concept of social progress is the logical extension and globalization of the concepts of science progress. Since the second half of the XVIII Century, the capitalist concepts on social progress was formed, prevailed and held the dominating position in mindset. According to that, the concept about the integration of science progress, as organic component of the whole process, into the social progress was taken as a logical development. Sine end of the XIX Century, the theoretical concepts of problems of science progress changed in a basic way. In the XX Century, many capitalist authors followed a new way. In the new concepts, they started to search the rules of science progress outside the connections towards the evolution of social life. It was not taken as an organic component of the world history but as the rules of an autonomous and self-close world and of automatic rules and self-existence of scientific creativities (logical or psychological rules, biological or mathematical rules, and even metaphysical rules). There, maybe, exist some mutual interactions of science rules with social rules but, in fact, they are basically strange to and independent from the later.

There exist many examples which demonstrate some limitations of S&T development forecast techniques. In 1937, the American Academy of Sciences made public the report on technological trends and socio-economic development. But the report could not forecast the appearance of antibiotics, radar, atomic energy, jet planes and many others. In 1963, Rand Corporation, a council of famous scientists, was established. It made a global picture of the world since the middle of 1980s. Rand Corporation forecasted the appearance of automatic translating machines by 1978, the control of nuclear fusion by 1985, the large use of home robots by 1988 and etc.

Regarding the management models, there exist many reasoning concepts for connections between S&T and production. But they are low effective

and demonstrate some embarrassment. Practice shows that the study of contributions of S&T for production can be completely resolved if it gets bound to management initiatives and to promotion of influences of S&T towards socio-economic development. This is similar to the situation in old times when the question "What is the source of human knowledge?" was put down. When philosophers tried to describe the basic nature of the world, Descartes (1596 - 1650) had confirmed that such a question cannot get the adequate answer without binding it to the question "How can I know it?" By another way, the distance between the knowledge and the mastering of that puts the awareness of the knowledge itself under influences.

The reasons show more clearly the features of the awareness of S&T roles. It is a process of objective and subjective nature at the same time. The more the S&T development is strong, the more the practical impacts of S&T towards socio-economic development are seen. And then, the later offers better conditions for a higher awareness of S&T roles. From another side, the right and unified evaluation of S&T roles depends on actual approaches, convincing scientific analysis, patient and large scaled communication activities of these roles.

3. Pro-active promotion of the awareness of S&T roles towards socio-economic development

S&T research and application activities are found under considerable impacts from the awareness of S&T roles towards socio-economic development. The awareness decides the social behaviours of budget allocations for S&T development and S&T investment rate by enterprises. It also decides the scale and the self-consciousness of S&T research and application activities.

The social awareness of S&T roles is recorded in practice. In Malaysia, the success of binding S&T with socio-economic development on basis of national policies can be interpreted in many ways. One of the leading and important reasons is found as the consensus and supports the Government can get from the whole society. Thailand also deeply realizes that the low social awareness of S&T roles cause obstacles to the country's socio-economic development. Namely, one of the six focused problems noted in the National Strategies for S&T of Thailand (2004-2013) is: "The population does not have the full awareness of the importance of S&T, proper knowledge and right understanding of S&T roles. All of these lead to the lack of supports reserved for innovations and S&T development". The Philippines Government, when evaluating actual situations to define the backgrounds for development orientation in the S&T Vision, 2000-2020 periods, emphasizes: "For many Philippines, S&T remains a far standing or mysterious issue but not an important part of daily activities or an element

of their own existence". In a study conducted in 2012, Battele and R&D Magazine recorded also: "The understanding of S&T topics by population remains one of the three key aspects which cause the most impacts to R&D activities of all the nations and particularly for certain leading countries such as France, Russia, Korea, UK and US"[5].

With this high level of complexity and importance, the awareness of S&T roles towards socio-economic development is really a problem attracting our attentions. The pro-active activities to enhance the social awareness for S&T have concerns of both practical and systematic natures. Malaysia, when building and implementing its programs to enhance the social awareness, understands well the S&T values for the country's existence. It is a very important move to establish the environment for creativity, innovations and trade of technologies. The Government's specific measures oriented to promote a culture to glorify science and to innovate technology trades were implemented through 5 regional S&T centers. Activities of these centers enhanced the awareness and the understanding of S&T roles by population. The S&T culture was introduced in the education system and mass media for better communication and larger escalation of S&T programs. It is also an effective solution to encourage the success of creation, design, manufacture and application of numerous S&T research projects of Malaysia.

The Philippines conducted programs to popularize S&T. Typical activities include S&T information propagation in popular language, study of social aspects of S&T, promotion of innovation culture, enhancement of awareness and education of important value of S&T for decision makers, encouragement of healthy competition for S&T achievements, deliverance of awards and prizes for outstanding S&T researches and achievements.

Chinese State Council declared the Action Plan for Science Knowledge to enhance the national awareness, 2006-2020 period. Though activities of S&T education, communication and propagation, the objectives are defined as: by 2010, scientific knowledge of Chinese people would be at the level of developed countries at the end of 1980s; by 2020 China would have explosive activities in S&T education, communication and propagation.

Japan, during the period of acceleration to catch up the development of advanced counties, established S&T propagation organizations to escalate scientific knowledge. They were aware that the activeness and sustainability in promotion of the awareness of S&T roles by population would be bound with their deep understanding of S&T. Japan had

[5] Battele and R&D Magazine. International Monetary Fund. World Bank. CIA World Factbook

announced the White Pages for Science and Technology[6]. As measures to remove the inferiority in S&T understanding, the Science Museum was built and opened for large public. In this museum, the creative works and experiments were conducted to demonstrate advanced technologies. Here, visitors can have exchanges of knowledge and ideas with famous scientists during presentation of S&T topics.

In Vietnam, the enhancement of the awareness of S&T roles has gained attentions in many Party and State documents. In practice, however, the awareness is still limited and causes obstacles to S&T development and application.

Recently, the Strategies for S&T Development, 2011-2020 periods (promulgated with the Prime Minister's Decision No. 418/QD-TTg dated 11th April 2012) indicated: "The promotion of propaganda to enhance the social awareness towards the S&T roles is defined as one of the six important solutions for the country's S&T development. Law on S&T (encoded as Law 29/2013/QH13) provided many practical measures such as the indication of S&T Day (Article 7), measures of State investment and investment encouragement for development of S&T communication and knowledge propagation activities (Item 1, Article 48), set up and implementation of annual plans, five year plans for communication and knowledge propagation activities, tax reductions for supports and investment by organizations, enterprises and individuals for S&T activities (Item 3. Article 48). Certain new initiatives and measures could be found as needed, but these regulations if implemented well would offer a new advance in the awareness for S&T roles towards the country's socio-economic development.

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6. National Center of S&T Information. (2008) *Competing capacities of the US in S&T fields*. Bulletin of Science-Technics-Economy. No. 1/2008, p. 7.

[6] For the first time, the National Agency of S&T Information has issued the White Pages for Science and Technology in 1958 and the second time was in 1962. The Pages were made public every year since 1964. The White Pages for Science-Technology is the annual report on the status, orientations and policies for S&T development by the Government.