Technology Foresight and Its Implementation Strategy

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***Abstract*—This paper studies technology foresight activity, its implication for knowledge society, and its implementation strategy. Technology foresight can be approached from a national as well as a corporate (organizational) level. This paper studies the concept of technology foresight, technology foresight tools, and analyzes the case studies pertaining to technology foresight and its implementation strategies. First, on a national level, foresight activity in the United Kingdom, Japan, and Korea was analyzed. In particular, technology foresight activity and emerging technology 21 in Korea were analyzed in-depth. Second, foresight activity of IBM and Corning was analyzed at a corporate level. The implementation strategies for technology foresight can be carried out in the following manner: first, by strengthening the relationship between technology foresight and innovation system; second, by making a linkage between technology foresight and a technology roadmap for strengthening the execution; and third, by encouraging the participation of citizens in foresight activity.**

***Index Terms*—Technology foresight, implementation strategy, innovation system, technology roadmap.**

I. Introduction

This paper studies technology foresight activity in the 21st knowledge society. One of the most important issues in our society is technological innovation [1]-[3]. A desirable future in a knowledge society can be achieved by technological innovation [3], [4]. In science fiction (SF) movies and novels depicting future scenarios, there are both desirable as well as negative effects of science and technology (S&T). Desirable futures can be achieved by maximizing desirable aspects of S&T and minimizing its negative aspects [4].

This paper first analyzes the technology foresight activity at a national level. As a case study, national level technology foresights were analyzed for the United States, United Kingdom, Japan, and Korea. Subsequently, technology foresights of IBM and Corning were analyzed. Nowadays, in addition to the importance of foresight at the national and corporate level, there is a growing importance of future preparedness elsewhere. Therefore, this paper studies foresight, future preparedness, and implementation strategies for technology foresight.

II. Technology Foresight

Technology foresight does not only pertain to the future and future imagination. There is confusion between foresight, prediction, and foresee. The European Foundation for the Improvement of Living and Working Conditions defines foresight as a "*systematic, participatory process that involves gathering intelligence and building visions for the medium-to-long-term future, aimed at informing present-day decisions and mobilizing joint actions*" [4]. This definition of foresight can be approached and achieved in three ways [4], namely, via future studies, networking, and planning like Fig. 1. [4].

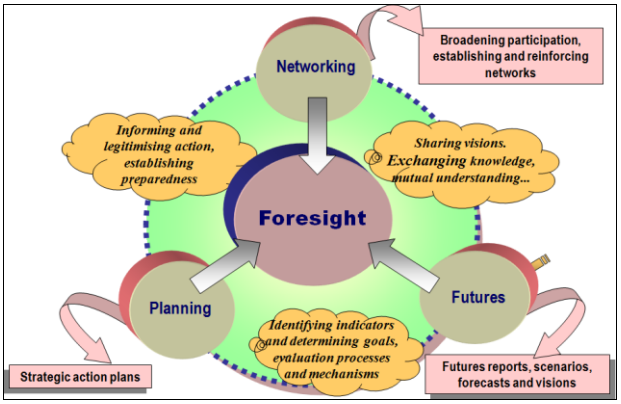

Fig. 1. Foresight's triple base. Source: [4] HKSF – Handbook of Knowledge Society Foresight (2002), PREST & FFRC for European Foundation for the Improvement of Living and Working Conditions.

First, foresight is based on future studies such as future reports, scenarios, and vision statements. In order to enable future studies, nowadays there are several reports, books, as well as SF movies providing an insight into future trends [4]. Second, foresight is also based on networking and participation. By utilizing this networking among technology experts and citizens and by employing surveys and Delphi methods, we can anticipate and imagine the future [4], [5]. Online Delphi and survey methods were used to accomplish efficient networking. Third, foresight can be achieved by systematic and strategic planning [4].

III. Relationship between Foresight and Future Preparedness

With the growing importance of future studies, there is considerable foresight activity both at the national as well as corporate levels. In addition to foresight, there is also a growing importance of future preparation for a desirable future; this concept of future preparation is called future preparedness [6]. Future preparedness activity references are as follows: State of Future Index (SOFI) by the United Nations Millennium Project, World Competitiveness Yearbook (WCY) by IMD, and Composite S&T Index (COSTII) by KISTEP [6]. In 2014, the new concept of future prepared index was introduced, and called FIRST-REAP by

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KISTEP.[1] FIRST refers to the Future Index of Research in S&T, and REAP refers to Resources, Environment, Activity, and Performance [6]. In the area of REAP, the management of FIRST is needed for future preparation [6]. This concept of FIRST-REAP includes the present competitiveness and capability building for future preparation.

IV. Technology Foresight Case Study

A. Technology Foresight at the National Level

First, this paper analyzes technology foresight at the national level. Technology foresight can serve as a control tower for the national innovation system [7]. Technology exploration is made possible by technology foresight. Technology foresight can direct the national R&D system for innovation in the long term [7]. In this respect, many nations such as the United States, United Kingdom, Japan, and Korea conducted national foresight activities.

1) The United States' technology foresight

An in-depth analysis of The Global Technology Revolution 2020 was published by Research and Development Corporation (RAND). The Global Technology Revolution 2020 contains the trends of global technology development and national emerging technology.[2] The National Intelligence Council (NIC) publishes the World Foresight Report such as Mapping the Global Future, 2025, 2030 [8]. This report contains information regarding the megatrends of the world economy, world governance, and world issues [8].

2) The United Kingdom's technology foresight

The United Kingdom designated three or four important foresight areas and conducted foresight activities in selected areas. [3] For example, brain science, new diseases, and intelligent building systems were selected as technology foresight areas.

3) Japan's technology foresight

Japan's technology foresight was conducted by the National Institute of Science and Technology (NISTEP).[4] Technology foresight influences Japan's Basic Science and Technology Plan. Japan's technology foresight includes the needs analysis of society and economy, Delphi surveys to determine the timing of the technology development, technology realization time, and the importance of technology. In addition to this quantitative analysis, a scenario analysis for emerging areas was conducted for a desirable future. In this manner, Japan's technology foresight was conducted using several methods such as a needs analysis of society and economy, Delphi surveys, and scenario analysis like Fig. 2.

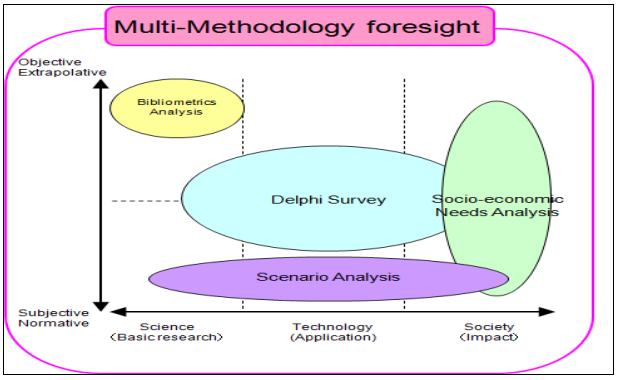

Fig. 2. Japan Technology Foresight Methods, Source: [9] Park, B.W. (2005), Futures and Technology Foresight, KISTEP.

4) Korea's technology foresight

In Korea, technology foresight was conducted by S&T law every five years on a regular basis [9], [10].[5] First, future society' needs were identified and the analysis of major issues conducted. Second, technology development and Delphi analysis for future societal needs and issues were conducted. Third, a scenario analysis for future social system changes was made like Fig. 3 [10], [11]. In Korea, in addition to technology foresight activity, national emerging technology selection activity was also conducted regularly. For example, in 2006, based on their technology foresight activity, National Emerging Technologies 21 was selected [12]. [6] National Emerging Technologies 21 stands for the promotion of economic values, public safety, and welfare of the people [12]. Moreover, KISTEP selects ten emerging technologies annually.

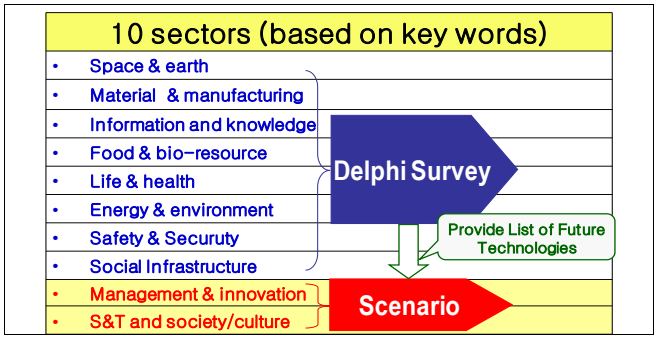

Fig. 3. Korea technology foresight methods, source: [9] Park, B.W (2005), futures and technology foresight, KISTEP.

B. Technology Foresight at the Corporate Level

There is a growing importance in technology foresight and technology intelligence at the corporate level because technology cycles are getting shortened and new technology emerges frequently [2] [13] [14]. Because organizations adapting to a new technology environment survive, issues pertaining to technology choice are very important for both chief executive officers (CEOs) and chief technology officers (CTOs). Global corporations such as IBM, Corning, and Samsung recognize the importance of technology foresight at the corporate level, and conduct technology foresight activities in their own way.

[1] I participated in the project entitled "A study on the methodology for the measurement of National Future Index of Research in Science and Technology (FIRST)" Na S.H. (2015), KISTEP, as an advisor committee member in 2015.

[2] http://www.rand.org/pubs/monograph_reports/MR1307.html

[3] https://www.gov.uk/government/collections/foresight-projects

[4] http://www.nistep.go.jp/en/?page_id=56

[5] http://www.kistep.re.kr/c1/sub2_2.jsp

[6] I participated in the project "National Emerging Technologies 21" as a KISTEP steering committee key member in 2005

1) IBM's technology foresight

IBM, the leader in change and innovation, publishes the reports Global Innovation Outlook (GIO) and Global Technology Outlook (GTO), which contain information regarding the megatrends of society beyond corporate boundaries and technology issues [15]. In particular, GIO deals with the healthcare industry, e-government, and change of work and work-life [15]. In addition to internal IBM experts, various external experts participate in IBM's technology foresight activity. Therefore, IBM's foresight perspective is beyond the organization and towards a global innovation outlook [15]. With its technology foresight and intelligence capability, IBM has been trying to adapt themselves to a new environment—from an analog environment to a digital, ubiquitous one. IBM have innovated to drive themselves from a main-frame computer and consulting company, to a business solution company, which deals and defines business problems as well as provides complete hardware and business service solutions.

TABLE I: COMPARISON OF THE CHARACTERISTICS OF TECHNOLOGY FORESIGHT

Foresight level	Nation/ Corporation	Characteristics of Technology Foresight
National level	The United States	The Global Technology Revolution 2020 contains the trends of global technology development and national emerging technology
	The United Kingdom	The United Kingdom designated three to four important foresight areas and conducted this foresight activity in selective areas
	Japan	Japan's technology foresight was conducted using multiple methods such as needs analysis of the society and economy, Delphi surveys, and scenario analysis
	Korea	Korea's technology foresight was conducted using multiple methods such as the analysis of future society needs and major issues, Delphi analysis for future societal needs, and scenario analysis for future social system change In addition to technology foresight activity, national emerging technology selection activity was also conducted regularly.
Corporate level	IBM	IBM publishes GIO and GTO. GIO and GTO contain information regarding megatrends of society beyond corporate boundaries and technology issues
	Corning	Corning always focuses on future technology exploration and uses a technology roadmap for future preparation

2) Corning's technology foresight

Corning also prepares for the future continuously with diverse technology foresights. Corning always focuses on future technology exploration and uses a technology roadmap for future preparation.[7] In Corning's You-Tube channel, there are various Corning future technology solutions and future insights. Corning's business areas are liquid-crystal-displays (LCD), optical fibers, optical devices, and bio-related areas. With the vision and scenario of future technology, Corning prepares for the future.

V. TECHNOLOGY FORESIGHT AND ITS IMPLEMENTATION STRATEGY

This paper examines technology foresight activity at the national and corporate levels. With respect to national foresight, the cases of the United States, United Kingdom, Japan, and Korea were analyzed. With respect to corporate foresight, the cases of IBM and Corning cases were analyzed. Through these analyses, technology foresight strategy can be implemented as follows: first, by strengthening the relationship between technology foresight and innovation systems; second, by establishing a linkage between technology foresight and a technology roadmap in order to strengthen execution; third, by encouraging the participation of citizens in foresight activity.

The first technology foresight implementation strategy is strengthening the relationship between technology foresight and innovation. When technology foresight can direct the national R&D system, the National Innovation System (NIS) will lead to a desirable future [7]. The regional innovation system needs regional technology foresight at a regional level. In addition to national and regional levels, the corporate organization innovation system should be closely connected with the corporate foresight activity. For example, IBM publishes GIO regularly, and the organization innovates continuously based on these corporate foresight activities.

The second technology foresight implementation strategy is making a linkage between technology foresight and a technology roadmap for strengthening execution. A desirable future with various future technologies can be achieved through technology development and R&D programs[16] [17]. The future scenario can be connected via a technology development roadmap [18]. With this roadmap, technology development is possible in proper development stages for a desirable future scenario [18]. For this reason, technology foresight, particularly the future technology scenario, and technology roadmap can be closely linked and managed organically. For example, in Korea, after the technology foresight activity, the National Emerging Technologies 21 project, which can be competitive in the 21st century, was selected. After that, a national "total roadmap" was drawn up, which contains all the information regarding technology resources and roadmaps in Korea.

The third technology foresight implementation strategy is that of encouraging the participation of citizens in foresight activity. Foresight involves future planning, future studies, and networking [4]. Nowadays in networking, in addition to expert networking, citizen networking is very important, suggesting that citizen participation is necessary for foresight activity. In order to maximize the positive effect and minimize

[7] http://www.corning.com/worldwide/en/innovation/corning-emerging-innovations.html

the negative effect of S&T, citizen participation is necessary in the process of technology foresight activity. Therefore, citizens' participation is increased in the area of identification and analysis of the needs of society, the economy, and technology assessment in technology foresight activity. With the active participation of citizens, positive and desirable futures can be drawn.

VI. Conclusion

This paper studies technology foresight in the 21st knowledge economy. There will tend to be a growing importance of technology foresight in advanced knowledge societies [4]. Through technology foresight and intelligence activities, nations and organizations can adapt to new technology environments and sustain their competitiveness. Innovation in nations and organizations is very important; however, innovation without foresight is like a ship without a compass. Therefore, this paper examines the concept of technology foresight, future preparedness, foresight cases at the national and corporate level, and its implementation strategy. Technology foresight implementation strategy can be conducted in the following manner; first, by strengthening the relationship between technology foresight and innovation systems; second, by making a linkage between technology foresight and technology roadmap for strengthening execution; third, by encouraging the participation of citizens in foresight activity. This paper deals with very broad areas, from foresight concepts to national and corporate foresight activity. Related foresight studies in specific areas can be anticipated.

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