Foresight in Strategic Planning and Technology Foresight in Kazakhstan: making Decisions about Long-term Investment in Science, International Experience.

Shevchenko, Yelena and Stukach, Victor

Head of Strategic Planning and Analytics Department of Science Fund (Astana, Republic of Kazakhstan), Department of Management and Marketing of the State Educational Establishment of the Omsk State Agriculture University

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Foresight in Strategic Planning and Technology Foresight in Kazakhstan: Making Decisions about long-term Investment in Science, International Experience

Yelena V. Shevchenko[1*], Victor F. Stukach[2]

[1]*Candidate of Science Economics, Head of Strategic Planning and Analytics Department of Science Fund (Astana, Republic of Kazakhstan,* <yelenashevchenko@gmail.com>

[2]*Doctor of Economics, Professor of the Department of Management and Marketing of the State Educational Establishment of the Omsk State University, Russian Federation Omsk, Russian*

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Abstract: *Development of the national science, technology and innovation (STI) strategy is a complicated process associated with a high level of uncertainty. Establishment of efficient framework for STI policy planning in Kazakhstan is an essential element of the sustainable policy planning system. From a perspective of future management, foresight provides a basis for decision-making process by identifying key areas for a long-term investments and assessing long-term perspectives of science, technology, economy and society. Foresight allows setting up future priorities by focusing on different aspects of anticipated changes. The main purpose of this paper is to investigate the role of foresight in the decision-making process and to elaborate recommendations on effective integration of national foresight results into the process of STI policy planning in Kazakhstan.*

Keywords: *foresight, forecast, future studies, government policies, STI priorities, strategic policy planning, emerging issue analysis, priority setting, S&T program planning, strategic planning system, International Experience foresight.*

Форсайт в области стратегического планирования и технологического прогнозирования в Казахстане: принятие решений о долгосрочных инвестициях в науку, международный опыт.

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Елена В. Шевченко1, Виктор Ф. Стукач2

1.Кандидат экономических наук, научный фонд стратегического планирования и анализа Республики Казахстан (Астана, Республика Казахстан) <yelenashevchenko@gmail.com>

2.Доктор экономических наук, профессор кафедры менеджмента и маркетинга Федерального государственного образовательного учреждения высшего образования «Омский государственный университет имени П.А. Столыпина», Омск, Россия, vic.econ@mail.ru,

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Аннотация: *Разработка национальной стратегии в области науки, технологий и инноваций (ИППП) представляет собой сложный процесс, связанный с высоким уровнем неопределенности. Установление эффективных рамок планирования политики в области ИППП в Казахстане является важным элементом системы устойчивого планирования политики. С точки зрения будущего управления прогнозирование создает основу для процесса принятия решений путем определения ключевых областей для долгосрочных инвестиций и оценки долгосрочных перспектив науки, техники, экономики и общества. Форсайт позволяет настраивать будущие приоритеты, сосредотачиваясь на разных аспектах ожидаемых изменений. Основная цель настоящего документа - изучить роль предвидения в процессе принятия решений и выработать рекомендации по эффективной интеграции результатов национального прогнозирования в процесс планирования политики в области ИППП в Казахстане.*

Ключевые слова*: предвидение, прогноз, будущие исследования, государственная политика, приоритеты ИППП ,стратегическое планирование политики, анализ возникающих проблем, установление приоритетов, планирование программ S & T, система стратегического планирования, международный опыт Форсайта.*

INTRODUCTION

Innovations have become a key driver of global economic development and remains at the forefront of a technological breakthrough. Developed countries increasingly concentrate their efforts on research and development (R&D) in those segments that in the next decades will determine megatrends of technological and social progress.

However, it is difficult to predict future with a high degree of reliability and in this regard; foresight can be used as a systematic approach for identification of national priorities.

Foresight is a systematic, participatory, and future-intelligence-gathering and medium to long-term vision building process aimed at present-day decisions and mobilization of joint actions. Foresight brings together key agents of change and various sources of knowledge in order to develop strategic visions and anticipatory intelligenc[1]. **(Practical Guide to Regional Foresight European Communities, 2001).** A prerequisite for a successful foresight is an existence of developed civil society. Foresight requires an active participation of all stakeholders based on the exchange of views among different actors aimed to reach consensus on the topic under investigation. At the same time foresight is not aimed at providing an accurate prediction of the future but allowing to design alternative scenarios of possible futures and to elaborate policies and strategies to achieve "the desired scenario". Implementation of "the desired scenario" depends on the decisions taken at the present because choices that made today will affect the level of development in the future. In this regard, foresight serves as a tool for mobilization of all actors of the national innovation system in the process of long- term vision-building with the purpose of transforming innovation system in desirable directions.

Foresight is used in different contexts (national, regional, organizational) to anticipate changes and create a basis for elaboration responses to them [1-3]. Foresight on the national level helps to identify key scientific and technological areas that ensure sustainable development in the future. Thus, foresight can be viewed as a systematic attempt to observe the long-term future of STI and identify emerging technologies that will probably provide the greatest economic and social benefits.

In terms of STI development, "technology foresight can be regarded as the most upstream element of the technology innovation process. It provides inputs for the formulation of technology policies and strategies that guide development of the technological infrastructure. In addition technology foresight provides support to innovation, and incentives and assistance to enterprises in the domain of technology management and technology transfer, leading to enhanced competitiveness and growth"[2]*(UNIDO Technology Foresight Manual. United Nations Industrial Development Organization. Vienna. 2005. Vol. 1. P.)*

The results of foresight activities provide evidence-based recommendations for decision-making process. Challenge of the foresight relates to the translation of its results into concrete decisions for policy-making, because policy-makers usually deal with short-term urgencies and foresight has a long-term focus [4].

This article considers different aspects of effective integration of foresight results into the process of STI policy planning in Kazakhstan that can help to manage uncertainties and ensure policy alignment with the future needs of society.

Literature review – foresight cases of Singapore and south Korea

Foresight for STI policy planning – case of Singapore

Foresight seeks to foster economic impact by enhancing the network between industry, academia, government and the society. The results of such networking activities under the umbrella of foresight should be considered at the stage of strategic policy elaboration.

Among the emerging economies Singapore and South Korea represent good examples of integration of foresight results into strategic planning process on the national level at the stage of policy planning and implementation. Singapore and South Korea were chosen because both countries implemented the results of foresight exercises into the national policy planning process and experienced fast technological development.

Integration of foresight results into STI policy is still a challengeable issue for many countries. The ability to effectively exploit results of foresight is hampered by the limitations of governance systems to take into account the complexity in the definition of public policies. In such a context, foresight needs to be more thoroughly integrated into the policy making process to be effective [5].

In Singapore in 2005 year was initiated Program of risks assessment and horizontal scanning. This Program implemented under the principle of cooperation and collaboration between all governments institutions that were obliged to conduct risk assessment and horizontal scanning in a strong collaboration [6]. The Risk Assessment and Horizon Scanning system was designed to network multiple agencies together and provide advanced data analytics [7]. Foresight exercises in Singapore provide a basis that helps the Singapore government to navigate emerging strategic challenges and harness potential opportunities. Foresight and future analysis are widely used in Singapore. To conduct the foresight and implement the results in the strategic planning process, special centers under the government institutions were set up. The Risk Assessment and Horizon Scanning Programme (RAHS) set up in 2004 to complement scenario planning. RAHS scans the horizon for weak signals of potential future shocks, and detects emergent threats and opportunities through a suite of technology-based methods and software [3] . In 2010 year, the Center of Strategic Analysis of the Future was established with a mandate to coordinate national foresight activities, elaborate, implement national policies and strategies and develop foresight capacities in the country.

National foresight in Singapore includes government-wide information network, a technology oriented research and a public outreach program. In this regard RAHS Programme helps to improve knowledge and information sharing process and together with foresight exercise become an essential part of strategic planning process [8].

Foresight for STI policy planning – case of South Korea

Integration of S&T foresight in the national policy planning process promoted fast STI development in South Korea. Foresight activities conducted in South Korea are qualitatively different from the linear forecasting models that were broadly used by government of many countries in 1950-1960 years. In contrast to previously used forecasting methods aimed at identifying the unique direction for the future

development, foresight in Korea was used for elaboration of alternative scenarios of possible futures. Scenario building process was based on analysis of trends and different factors that can influence the path of the future, investigation of treats, opportunities, needs, challenges and risks the society may face in the long-term and followed by designing of recommendations to address future challenges.

Foresight in South Korea focused on matching future needs of the society with appropriate technological developments.

Foresight in Korea is not based on extrapolation of the existing model of development. It is based on the recognition of high uncertainty of the future and identifying possible directions for the future development as well as designing specific policies and strategies to achieve the desired vision of the future. In South Korea foresight has a central role in formulation of S&T policies and strategies.

The experience of South Korea provides an example of effective implementation of national foresight results. The initiator of the national foresight is Korean government. Foresight exercises are carried out with an active participation of public, private sector and representatives of the society.

There are two government agencies responsible for implementation of foresight exercises in the country: Korea Institute of Science and Technology Evaluation and Planning (KISTEP) and Korea Institute for Advancement of Technology (KIAT). KISTEP manage national S&T foresights in Korea and link the results of the national foresight to STI policy of the country. KISTEP in foresight focuses on long-run S&T priorities setting. The same time KIAT is focused on foresight for elaboration of technology development roadmaps in short and medium run [9].

Among the most successful national foresights in South Korea should be noted foresight activities conducted before the implementation of Highly Advanced National Project (HAN Project) in 1992 year. The HAN Project was aimed at lifting Korea's technological capability to the level of G-7 countries by 2020 year. [11]. It was a large-scale and long-term R&D project, designed as an inter-ministerial program under the National R&D program framework. The HAN Project was aimed at developing strategic industrial technologies in order to make Korea more self-reliant in science and technology (S&T). The HAN Project was broadly composed of two categories:

- Product technology development focused on technologies that develop specific products, particularly high-tech products in which Korea had potential to compete with the advanced countries by the early 21st century. They were new agro- chemicals, ISDN, HDTV, ASIC, flat panel displays, bio-medicals, micro-machine, next- generation vehicles, and express railways; and
- Fundamental technology development emphasized core technologies that were indispensable for continued economic growth and high quality of life, e.g. next-generation semiconductors, advanced materials, advanced manufacturing systems, new functional biomaterials, environment technology, new energy, next-generation nuclear reactors, advanced superconduction TOKAMAK, and human sensibility ergonomics [10].

This project was developed for the period of 1992-2001 years, as a large-scale inter-ministerial R&D project under co-funding mechanism between government and business sector (the total amount of funding for project was about $3.2 billion) [10]. This initiative was designed to promote joint R&D with participation of universities, companies from various sectors of the economy and public research institutions. The HAN project was not limited to the anticipation of possible futures but to elaboration of concrete measures and designing of initiatives to respond to the identified challenges, problems and long-

term needs.

The HAN project represented a shared vision of six ministries about the path of national R&D development in South Korea. Implementation of the foresight outputs into the policy-planning process allows Korea to make a transition from vertically oriented S&T management system to horizontal system [11].

Foresight exercises conducted in South Korea helped to improve communications between public institutions involved in the strategic planning process. It provided a clear identification of the priorities for the future technological development and estimated budget for the National R&D programs. Development of expert networks and establishment of the National Science and Technology Information System (NTIS) allowed gathering decentralized S&T information for the decision-making process. It also helped to build a consensus among all key actors and increase a number of joint R&D projects, especially in terms of interactions between science and industry.

NATIONAL FORESIGHT EXERCISES IN KAZAKHSTAN

Scope and design of the National foresight in Kazakhstan

To identify National STI priorities in Kazakhstan two National Science and Technology (S&T) Foresights were conducted.

The First National S&T Foresight had a time horizon until 2020 year and was hold in 2011-2012 years under the initiative of the Ministry of Investments and Development of the Republic of Kazakhstan (MOID). The First Foresight produced the list of strategic technologies (75 key technologies in 8 priority sectors). Based on foresight results the Government of Kazakhstan approved priorities for the allocation of innovation grants. During the period of 2013-2014 years, innovation grants provided by the MOID in compliance with the list of strategic technologies resulted from the First National S&T Foresight. To support the development of strategic technologies MOID also launched an initiative to set up

Targeted Technology Programs with an aim to mobilize all stakeholders and increase cooperation between science and industry. Targeted Technology Programs were designed based on the results of the foresight in the format of the “Triple Helix Model” which requires government-science-industry collaboration.

In 2013-1014 years the Second S&T Foresight "System analysis and S&T Foresight" was initiated by the Ministry of Education and Science of the Republic of Kazakhstan (MES). Time horizon of the foresight was set up until 2030 year. The main purpose was to identify key products and services, promising technologies and R&D topics that could become engines for the rapid economic growth and could be considered as a basis for a long-term research and innovation development. Identification of priority areas for S&T development in Kazakhstan was based on the assessment of socio-economic impact of promising technologies, as well as assessment of resources and technological capacities of the country.

The Second Foresight was aimed at providing a framework for strategic thinking process on the possible options for STI development in Kazakhstan based on identification of key trends, opportunities and risks, as well as on the assessment of existing competencies in the world and in the Republic of Kazakhstan.

Analytical framework and methods

Methodology for the National foresight exercises in Kazakhstan was designed in cooperation with the Korea Institute of Science and Technology Evaluation and Planning (KISTEP). Methodology applied for the Second National S&T foresight included such methods as: expert panels; analysis of future trends, needs and opportunities for S&T development; patent and bibliometric analysis; STEEPV analysis; analysis of acting STI policies and programs; analysis of domestic competencies and resources; scenario writing exercises; expert surveys (including experts from industry, research institutions and academy); technology analysis; identification of key products and services, strategic technologies and key R&D topics; road mapping activities.

Expert panels consisted of the leading experts in eight strategic sectors: National Health; Secure, Clean and Efficient Energy; Biotechnology; New Materials; Environment and Natural Resources; Mechanical Engineering; Information and Communication Technologies; Sustainable development of Agriculture. In order to achieve consensus between all stakeholders (research, academia, industry, public bodies) results of the Foresight were discussed on the roundtables and seminars and posted on the organizer's website.

Activities of expert groups were aimed at provision of basics for strategic understanding of the options of further development consistent with key trends, factors and possible risks. The works performed were based on generation of scenario for development of science and technology in Kazakhstan. Experts work included the analysis of scientific and technical information, analytical reviews of leading national and international research organizations, analytical reviews of industrial development, bibliometric and patent analysis.

Foresight provided a framework for integration of industrial and STI policies by identification of key products and services for the country and linking them with strategic technologies, which should be developed in Kazakhstan to produce that products and services. The same logic was implied for identification of key R&D topics. Key R&D topics were identified in conformity with strategic technologies that should be developed to produce key products and services.

List of key R&D topics was used as a basis for roadmapping activities. Implementation of the roadmaps was suggested to be performed in the following stages: operational plan (until 2018), strategic plan (until 2020) and long-term vision (until 2030). For the each stage of the roadmap, special performance indicators were defined. Afterward, cross-sectoral discussions of expert groups were initiated to identify interdisciplinary crosscutting research topics. Cross- sectoral meetings resulted in interdisciplinary National R&D programs. This approach allowed determination of new technological solutions on the intersection of the adjacent scientific areas.

The following mega-trends of scientific and technological development were marked out in the results of the foresight:

- enhancement of convergence of technologies;
- enhancementof diffusion of modern high technologies into medium-tech sectors;
- growing value of multidisciplinary approach in R&D;
- Increase in impact of new technologies on management and business organization, which facilitate the development of flexible network structures.

DISCUSSION

Foresight on the country level helps to improve policy-planning process by making it more transparent through the engagement of all interested parties and ensuring their commitment to policies and programs, which are based on the results of foresight. In addition, foresight raises an awareness of participants about possible directions of STI development in the future, risks they may face and opportunities that should not be missed.

Fig-1: Interests of different actors in the results of foresight

Participation in foresight representatives from industry, science, government enables to raise the level of mutual understanding among key stakeholders and ensure more comprehensive and interdisciplinary nature of work. Involvement in national foresight exercises all main stakeholders will help to ensure their commitment to policies and strategies elaborated on the results of foresight.

Activities conducted during foresight exercise can be divided into two categories: future study (investigation and anticipation) and foresight. Future study allows considering and analyzing possible, probable, plausible and preferable options of future. Foresight aims at building consensus between different actors and elaboration of recommendations, policies and strategies based on the results obtained at the stage of future study. Foresight helps decision-makers to investigate possible alternatives by thinking beyond the ordinary perception of reality. A high level of uncertainty and variety of alternatives require involvement of all stakeholders into strategic planning process.

Foresight allows anticipating future needs and possible changes and elaboration a set of actions and strategies to cope with future challenges. Results of the national foresight can be effectively used for the development of long-term policies and strategies, and should be disseminated among the society. To increase the effectiveness of the strategic planning process the results of foresight should be disseminated among all institutions responsible for implementation of STI policy in the country.

A high degree of decentralization and fragmentation of information databases negatively affects strategic planning process and S&T policy management in Kazakhstan. The lack of the dialogue and coordination between ministries, eventually, leads to a low efficiency of implemented programs and

projects. National S&T foresight can be used as a platform for coordination of inter-ministerial strategies and programs in Kazakhstan.

The results of foresight can be used for the development of long-term and medium-term policies and strategies as well as short-term plans and programs (less than 5 years). Foresight findings should be incorporated into the process of policies and strategies elaboration to ensure the greater cooperation across the innovation system [12;16].

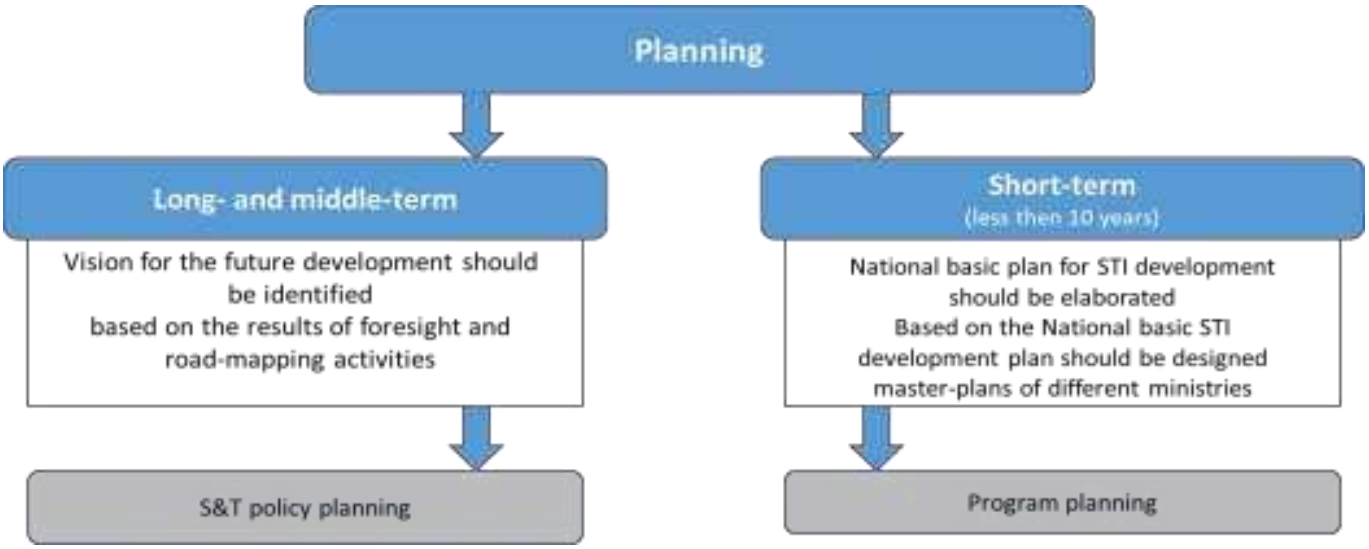

Fig-2: National S&T planning process

Long-term planning includes elaboration of STI development strategy (vision of STI development) based on the results of scenario planning, priority setting and roadmapping activities. National S&T Plan should be elaborated in consistence with a long-term vision of STI development. Master plans of ministries and agencies should be designed according to the National S&T Plan.

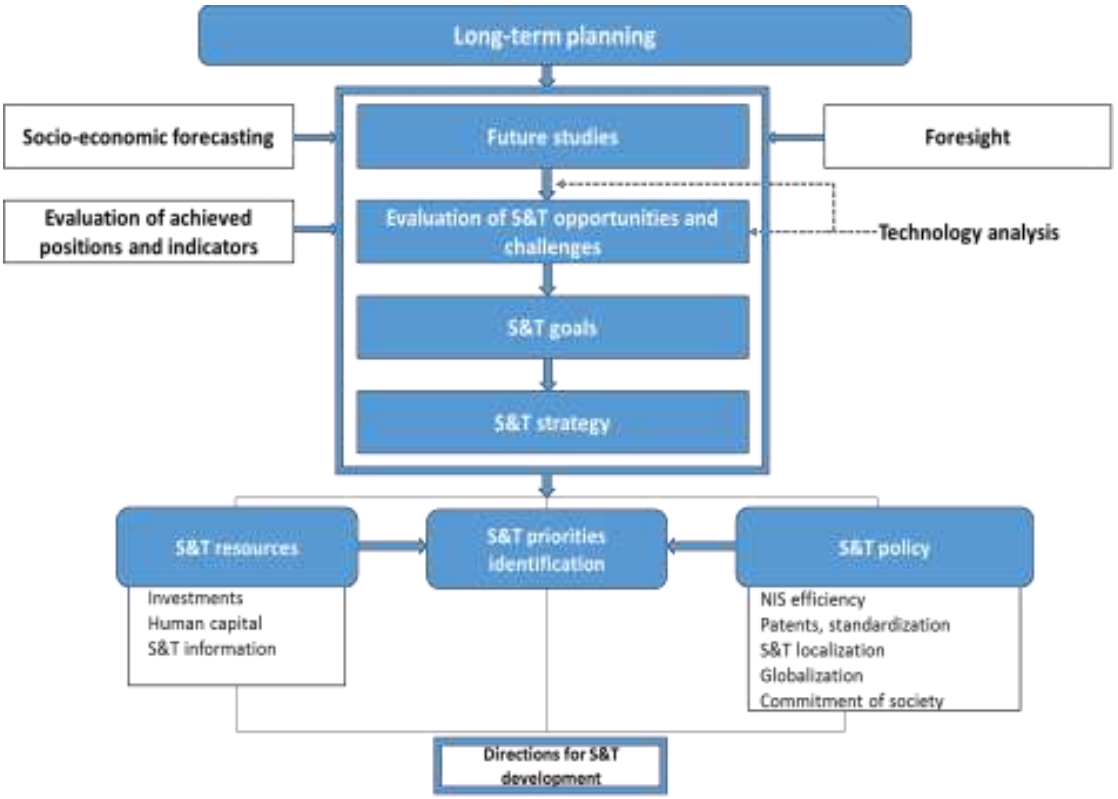

Fig-3: S&T policy planning

Strategic areas for S&T development should be identified based on the foresight results. Insertion of foresight results into the National S&T Plan will ensure better commitment of all interested parties in implementation of proposed actions. To fulfill strategic tasks, national R&D programs should be designed.National R&D programs include specific R&D projects aimed to develop strategic technologies. The portfolio of national-level R&D programs and projects should have a problem-oriented nature.

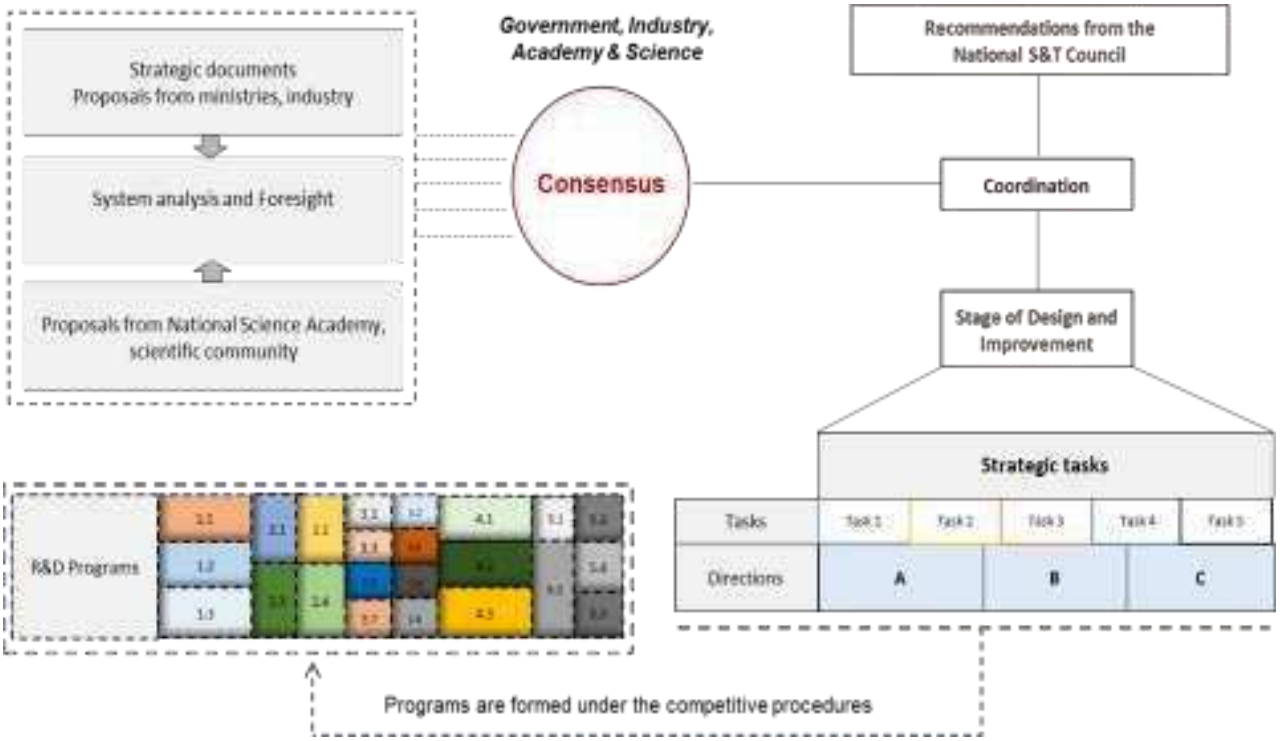

Fig-4: S&T priorities setting on the national level

Different ministries can implement national R&D programs, but it is necessary to avoid a duplication of investments. This issue can be resolved by means of effective system of national R&D management and coordination. Figure 5 shows inter-ministerial process of National R&D programs development. This approach helps to eliminate duplication of government investments in S&T based on inter-ministerial coordination of National R&D programs in accordance with the National S&T Plan.

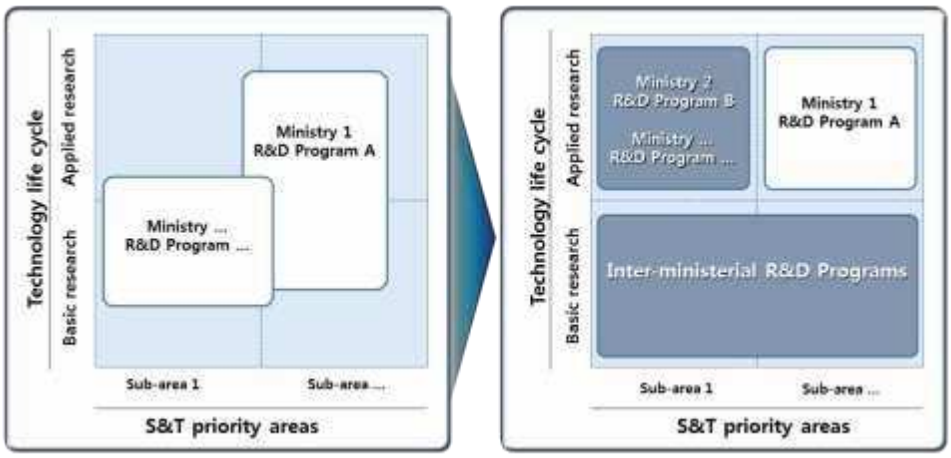

Fig-5: Process of National R&D programs development on the country level

Different ministries and agencies are engaged in the management of STI development on various stages of R&D process (from the stage of basic science to the stage of commercialization). All these ministries and agencies should maintain an internal coherence of S&T master plans, R&D programs and projects to the main goals of the National STI policies and strategies.

For example, the National S&T Basic Plan in South Korea is designed based on the results of the National foresight exercise. National S&T Basic Plan sets national S&T priorities and master plans of different ministries are designed in accordance to the National S&T Basic Plan. National R&D programs are designed with an aim to develop key technologies identified by the National foresight exercise. National R&D programs consist of specific R&D projects. Development and monitoring of such projects is carried out by sectoral ministries with involvement of highly qualified experts who might be representatives of interested business, scientific and academic community. Ministries that involved in STI management process are responsible for R&D roadmapping activities. R&D roadmaps are designed to improve strategic capabilities and efficiency of public R&D investments from a long- term perspective. To consolidate all roadmapping efforts on the country level and to provide a unified direction to all medium-term public research programs a single R&D Total Roadmap was designed in Korea in 2006. R&D Total Roadmap included medium and long-term R&D strategies for public R&D investment portfolios. This allows to improve coordination and coherence among different ministries and agencies that involved in R&D planning and STI policy implementation.

National R&D programs are diversified and belong to different sectors. The whole process of strategic planning on the national level should be based on principles of planning-implementation-evaluation and inter-sectoral coordination to prevent duplication of public investments in R&D.

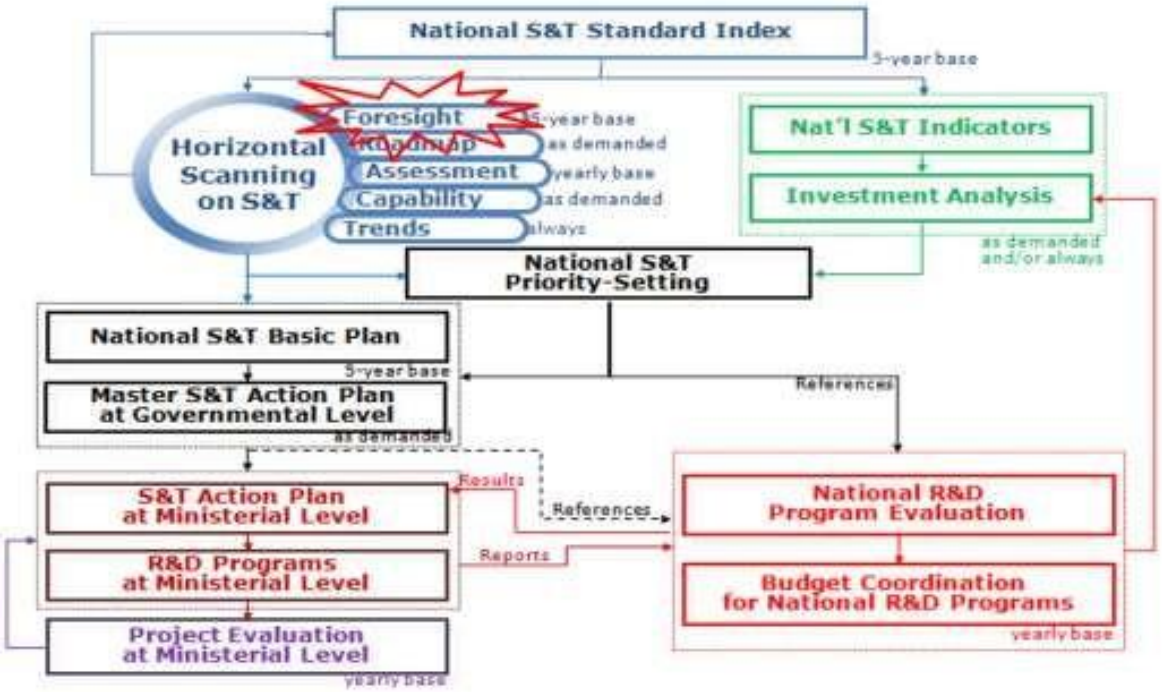

Fig-6: Strategic planning system of South Korea [4][i]). ***Source: Korea Institute of Science and Technology Evaluation and Planning***

CONCLUSION

The experience of Singapore, South Korea and the Republic of Kazakhstan proves that to ensure better coordination and commitment of different stakeholders in implementation of STI policy and strategies they should be designed on the results of the national foresight exercise.

Kazakhstan as a developing country has faced with a number of problems related to the fragmentation of national innovation system, weak links between institutions involved in STI policy implementation, problems in S&T priorities identification and evaluation of the efficiency of implemented strategies and programs. In this regard, national foresight can be considered as a tool for mobilization of all main stakeholders and building mutual consensus and commitment to the proposed policy and strategies.

Problems in implementation of policies and strategies often relates to the lack of stakeholders commitment to act according to the approved policies and strategies. In this regard foresight should be focused on "action" and should be linked to the decision-making system [14]. To ensure greater efficiency the national strategic planning process should be based on the following principles:

- *Focus on improving the competitive advantage of the country;*
- *Planning process should be transparent, unbiased, and objective;*
- *Planning process should be based on active participation of all stakeholders;*
- *Highly qualified and competent experts should be involved in the planning process; and*
- *Policies and programs should contain plan of actions including schedule, resources required for implementation, participants, milestones, target indicators, etc.*
- *In foresight exercises, issues related to sharing and implementation of foresight results shouldn't be underestimated. Organizers of foresight should clearly identify who will be the main "client" and will take a responsibility to implement obtained results.*

Based on the experience of South Korea and Kazakhstan in implementation of foresight projects the following ways of enhancing an effectiveness of national foresight exercises can be recommended:

- *Dissemination of the main ideas and techniques of foresight among the expert community, highlighting advantages and opportunities offered by conducting foresight exercises. It will help to develop competences in the field of foresight and to improve the culture of strategic planning in the country;*

- *Involvement of all stakeholders (including government institutions, academic, scientific and business community) in foresight and planning activities. Development of expert network will provide an integrated and interdisciplinary nature of work. In addition, active participation of all major actors in foresight exercises will ensure greater transparency, better understanding, acceptance and commitment to the results. It will also help to improve the efficiency of integration of the foresight results into strategic planning process;*
- *Interdisciplinary approach to expert groups composition;*
- *Ensuring inter-ministerial collaboration at all stages (at the stage of foresight exercises and at the stages of planning and implementation of obtained results) to ensure information sharing, transparency, equal consideration of different stakeholders positions and opinions, consistency of policies and programs and commitment to their implementation;*
- *Alignments of S&T master plans of different ministries horizontally and vertically with the national S&T plan based with the results of the national S&T foresight. To improve STI policy coherence two main aspects of STI management should be considered: 1) horizontal coordination of STI policies across different ministries and 2) vertical coordination of governance arrangements related to research and R&D commercialization. Policies and programs should have overall coherence otherwise there is a risk of their ineffective implementation.*
- *Targeted dissemination of foresight results among the society to create a shared vision concerning long-term developments within science, technology, innovation and society as a whole and to facilitate all interested parties to act accordingly to the designed policies and strategies.*

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Yelena V. Shevchenko[1*], Victor F. Stukach[2]

[1]*Candidate of Science Economics, Head of Strategic Planning and Analytics Department of Science Fund (Astana, Republic of Kazakhstan,*
yelenashevchenko@gmail.com

[2]*Doctor of Economics, Professor of the Department of Management and Marketing of the State Educational Establishment of the Omsk State University, Honored Worker of the Higher School of the Russian Federation Omsk, Russian.*
vic.econ@mail.ru

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Форсайт в области стратегического планирования и технологического прогнозирования в Казахстане: принятие решений о долгосрочных инвестициях в науку, международный опыт.

Елена В. Шевченко1, Виктор Ф. Стукач2

1.Кандидат экономических наук, научный фонд стратегического планирования и анализа Республики Казахстан (Астана, Республика Казахстан) <yelenashevchenko@gmail.com>

2.Доктор экономических наук, профессор кафедры менеджмента и маркетинга Федерального государственного образовательного учреждения высшего образования «Омский государственный университет имени П.А. Столыпина», Омск, Россия, vic.econ@mail.ru,

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