NATIONAL RESEARCH UNIVERSITY
HIGHER SCHOOL OF ECONOMICS

Ozcan Saritas, Derrick Ababio Anim

THE LAST AND NEXT 10 YEARS OF FORESIGHT

BASIC RESEARCH PROGRAM
WORKING PAPERS

SERIES: SCIENCE, TECHNOLOGY AND INNOVATION

WP BRP 77/STI/2017

Ozcan Saritas[1], *Derrick Ababio Anim*[2]

THE LAST AND NEXT 10 YEARS OF FORESIGHT[3]

This study investigates trends in Foresight and establishes how the changing global landscape has affected the Foresight activities over the last decade. The strategies these countries have adopted to counter the effects and make the best of these changes have also been examined. Key issues discussed in the paper cover the drivers of the trends in the past and next decade and their future implications for Foresight. The study identifies trends in Foresight through case studies. Five leading countries in Foresight have been selected for analysis including Finland, the UK, Germany, Japan and Russia. A set of indicators have been designed for the purpose of benchmarking national Foresight activities of these five countries. Among the indicators are: the contextual landscape, scope of the exercise, regularity of using Foresight for policy formulation, funding mechanisms, scale of participation as well as use and implementation. The results of the study show that, Foresight activities have changed in content, context and process over the last ten years. First, Foresight has moved from large scale national activities and become narrower in scope with attempts to focus on specific grand challenges, sectors or technologies. Second, in the quest to provide a broader picture of the social environment within which the results of the study will be implemented in order to ensure robust STI policy, Foresight exercises have become more extensive by involving more social stakeholders and expert consultations. Also, technological applications have shortened the entire Foresight process as new tools have been created for gathering and processing data, eliciting opinions, and disseminating them widely. This is a result of more intensive use of technologies and electronic platforms for the purpose of Foresight studies. Recent Foresight literature lacks a comprehensive overview of the changing landscape of policy making, motivations for organizing Foresight activities and processes of implementing Foresight. The present study aims to fill this gap with a holistic analysis of the context, content and process of Foresight activities in the past 10 years, and discusses possible transformations in the next 10 years.

Keywords: Foresight, science and technology, science technology and innovation policy

JEL Classification: Z

[1] Institute for Statistical Studies and Economics of Knowledge, National Research University Higher School of Economics, osaritas@hse.ru (corresponding author)

[2] Institute for Statistical Studies and Economics of Knowledge, National Research University Higher School of Economics, animkderrick@gmail.com

[3] This paper was prepared within the framework of the Basic Research Program at the National Research University HSE and was supported within the framework of the subsidy granted to the HSE by the Government of the Russian Federation for the implementation of the Global Competitiveness Program.

1. Introduction

Foresight has been used as an instrument associated to Science, Technology and Innovation (STI) policy making for several decades now. During this time various definitions have been suggested for Foresight emphasizing its long term orientation, participatory nature, priority setting characteristics and orientation towards recommendations for the future of society and economy (Saritas, 2006). Miles and Keenan, (2002) define Foresight as "*the application of systemic, participatory, future-intelligence-gathering and medium to long-term vision building process to informing present-day decisions and mobilizing joint actions*" (p. XI). From the definition, firstly Foresight is not a technique but a process. The activities take place over an extended period of time which span months and mostly years (Miles et al., 2016). The process acts as an avenue which draws participants from a wide range of stakeholder groups (scientific community, NGOs, government, Industry etc.) to deliberate on important issues in the growing STI portfolio. The idea of creating the future must be systematic and captioned Foresight. Also, the medium to long term dimension of the definition means that, the exercise must have a longer-term time horizon, which goes beyond planning time spans to cover longer term uncertainty, across five or more years, depending on the scope and focus of the Foresight exercise. Foresight usually has a broad aim of selecting priorities to focus limited resources on through research and development (Martin and Johnston, 1999). A clear example of the use of Foresight to set priorities is earlier Japanese Delphi exercises, where Foresight methods were applied to identify priority areas for science and technology. Foresight is also used to reform as well as inform policy and strategy at all levels of governance (Gavigan et al., 2001). Began largely with a 'one-size-fits-all approach' to solving problems, over time Foresight activities have been more and more customized according to their contexts and contents (i.e. scope), and became increasingly evidence-based, creative and participatory. This has created an awareness and given Foresight a role in the design of customized policies at the supranational, national, regional, sectoral or local (Georghiou and Harper, 2011).

Governments around the world especially catching up countries are increasingly recognizing the need to incorporate Foresight into their national development plans in order to shape future developments (Magariños, 2005). The changing effects of grand challenges and uncertainty associated with global changes have propelled Foresight to the forefront of strategic planning tools of governments at the national and regional levels for establishing priorities for

STI. Major challenges of society such as food security, soil and water conservation, natural resources, poverty, energy production, nuclear proliferation, climate change, etc. are overarching challenges that transcends the borders of individual countries and thus affect humanity as a whole. These challenges have created varying opportunities and damaging effects on countries leading to the adoption of different methods and approaches to tackling these problems.

Building on the recent trends on Foresight, the present study first provides an overview of the recent Foresight experience. Besides undertaking an overall discussion, five cases are presented selected Foresight the countries, which indicated a high level of commitment in recent decades. The analysis of selected countries indicate that their attitudes for Foresight have evolved across time in a fast changing, uncertain and sometimes unstable world. Although this uncertainty has made some countries be more reluctant in undertaking Foresight exercises with a short-term orientation, the others considered that Foresight might open new horizons in crisis times. A benchmark of case studies will elaborate these different responses. The study will conclude with an overall discussion on the future of Foresight in the next decade to come.

2. An overview of the past Foresight experience

Up until the early 2000s, five generations of Foresight were observed (Georghiou, 2008). This categorization has been represented by Jemala (2010). The first generation emerged from the mid-twentieth century out of technology forecasting activities driven mainly by internal technology dynamics. The second generation of Foresight, which was observed mainly during the 1980s, focused both on technologies and markets. These two drivers were closely related as technological developments were carried out as a result of the influences of the forces of demand and supply (markets) as well as its contribution. Coming to the 1990s, the third generation emerged with the need to consider social trends as well as alternative institutional arrangements in order to deal with the issues raised. During the late 1990s and early 2000s, Foresight programmes in the fourth generation were characterized by their distributed role in the innovation system. Foresight exercises were undertaken and sponsored by multiple organizations in accordance with their specific needs. Increasingly from the early 2000s up to the present, the fifth generation of Foresight has been characterized by a mix of Foresight programmes, which are spread across various sites and combined with strategic decision-making elements. From the

2010s, Systemic Foresight approaches have been introduced, based on the principles of systems thinking (Saritas, 2013).

Foresight activities continues to evolve with ever changing contexts, new and emerging areas of focus, and novel technologies, which offer new methodological possibilities through the use of computers and information technologies.

3. Last ten years of Foresight

As Foresight contributes to the evolution of the world, it also needs to adapt itself to these changes. Technology Assessment, Technology Foresight, Long Range Planning, Technology Forecasting, Futures etc. have been among the list of interchangeably used terms for Foresight over years (Pouris and Raphasha, 2015). Although the terms have varied across time, Foresight represents the art and science of anticipating and designing the future (Loveridge, 2009). is based on the fact that the future is still under construction and can be influenced, discovered and created (Cuhls, 2003). In the last decade, Foresight adapted to the changes in a number of ways to allow governments and organizations construct visions, policies and strategies for the future.

Among the changes observed are the The trajectory of Foresight as one of the main methods in the STI policy toolkit, are in recent years undergoing changes in methodology development. The changes have been influenced by the growth in technologies in information and communication and tools which are easily available online (Daheim and Hirsch, 2016). The demand for Foresight as an information tool for STI policy makers has increased rapidly in recent years and has been adopted in certain countries as "the solution", thereby propelling it to the center of discussion to address the most important challenges in STI policies.

According to Daheim and Hirsch (2016), changes that have taken place in the methods applied to Foresight can be attributed to the following drivers: Firstly, there have been changes in demand in the use of Foresight for science, technology and innovation policy. Secondly, the advent of technological innovations such as improvements made on information technology has ensured advancement in the area of text mining as well as clustering for conducting scanning exercises. These changes have been captured and discussed by various scholars under different labels such as "networked Foresight," "experiential Foresight," "5th generation Foresight," "Foresight 2.0" (Hines and Gold, 2013; Prime Minister's Office, 2014; Saritas and Burmaoglu, 2015); Van der Duin et. al., 2014). Issues raised by these scholars under these new labels and

terminologies include: putting the "intelligence of the crowd" to use when coming up with insights for long-term research, thus scenarios sources from the crowd; Foresight supported IT tools; the use of design and visualization of fiction in "gamification" or "experiential Foresight" as novel means of generating knowledge and communicating results.

There has also been the introduction and use of new terminologies such as 'open science', 'open Foresight', 'networked science', and 'citizen science' which highlights further ambition for research and innovation (Daheim and Uerz, 2008; Dufva and Ahlqvist, 2015). One of the challenges of Foresight is ensuring the participation of a broad number of people with limited resources (Dufva and Ahlqvist, 2015). These new terminologies call for the broadening of the number of participants in Foresight and other decision making areas such as corporate Foresight. From the perspective of broader participation, policy-making moves beyond governance and takes into consideration of the joint impact of both the private and public decision-making on issues affecting society. This trend involves the practice in which a broad number of participants are allowed to collaborate and contribute to the generation of data and information, laboratory notes as well as other research processes for the Foresight study. This trend is driven by changing landscape of knowledge production. Knowledge production systems are becoming multidisciplinary, fusion of fields and heterogeneous, thereby emphasizing the need for communication, networking, partnership and collaboration among actors (European Commission, 2009).

There has been an increase in the use of different Foresight instruments to carry out these exercises. The proliferation of data of all sorts has led to the widespread introduction of advanced tools to help process, mine, compare, organize, search, display as well as interpret many forms of data (Ahlqvist, 2015; Geoghiou, et. al. 2008). This trend can be attributed to the multidisciplinary nature Foresight activities in S&T have taken. Data gathered from Japan's Delphi surveys were used by various stakeholders from diverse policy making levels. However, the surveys only had 'supply' orientation, ignoring the demand side. This approach was criticized and new instruments have been adopted to broaden the entire approach (Kuniko et. al., 2012). This development has led to the production of large amounts of data which requires an increase in communication among stakeholders.

In 2013, the Finnish government launched a project to create a Foresight model which is aimed at building a national approach to Foresight in order to improve the country's competitive

edge (Prime Minister's Office Reports, 2014). This is a trend in recent years and is driven by an increase need for cooperation and shared processes between actors, expedition of the implementation of Foresight results, expedition of information dissemination, from the strategy stage to the practice stage. Also, as a result of growing globalization in the midst of economic competition has made innovation and resource allocation in S&T important. Thus, there is a need to focus available national resources on more strategic options. Countries are developing and focusing their S&T Foresight efforts to tackle the S&T grand challenges (European Commission, 2009). Japan, for instance have conducted Foresight exercises that have focused on green innovation. This dimension of Foresight is directed to providing solutions to the S&T grand challenge of climate change and also foster research in the area renewable energy (Kuniko et al., 2012).

National Foresight activities to set S&T priorities have become more complex both in scope and design. The growing popularity of Foresight has seen the development of more rapid processes such as "Mini-Foresight" which can be conducted using simple and effective 24-hour scenario workshops. This development was driven by the need to learn and gain better understanding of the dynamics of Foresight in addition to the growing confidence in the use of Foresight frameworks and methodology (Miles et al., 2008). The effect of such development was that Foresight was overloaded with many objectives leading to the collapse of many National Foresight activities as a result of the weight of the different expectations. This is exemplified in the previous UK and German Foresight activities.

Recently, Saritas et al. (2017) have suggested a "dynamic and adaptive Foresight" and demonstrated this concept with the use of scenarios. The idea of growing complexity, rapid changing environments and as a result increasing uncertainty require more contingent pathways towards the scenarios of the future.

4. The way forward with Foresight

To explore the way forward in Foresight, it is important to understand how the contexts, contents and processes of organizing and implementing Foresight have been changing. An analysis of context, content and process, and how these affect the Foresight activity has been demonstrated by Saritas et al. (2007) both theoretically and with a case study. The current

analysis builds on this logic of 'contextual analysis'. For this purpose, first, the factors, which are likely to shape the future of Foresight are discussed in the next section.

Understanding global trends and their impacts on Foresight

Global changes also known as "mega trends[4]" are having strong impact on Society, Technology, Economy, Environment, Politics, and Values (STEEPV). Such a STEEPV framework is useful to capture and understand the broad range of interacting and interconnected systems. These large scale global changes allow us to put into perspective some elements of the likely medium-to-long term future with implications for Foresight in the way of scoping the activity and developing novel methodology and processes in line with these changing contexts and contents.

According to OECD (2016) social changes such as population changes, society, inequality and wellbeing will have lasting impact on humanity. The world's population is expected to peak 10 billion by 2050. Global population growth will put immense pressure on natural resources. Family and household structures are also experiencing immense changes especially in OECD countries where there is an increase in one-person households as well as couples without children. About 90% of urban growth is occurring in Africa and Asia. Improved access to basic amenities such as electricity, water and sanitation are some of the benefits urbanization will have on society. The treatment of infectious diseases in the developing countries are being compromised as a result of the growing resistance to antibacterial. Also, the mass migration of displaced people from war torn areas is causing social and political tension on the countries they are coming from and the countries they are moving to.

Under Technological trends, Digitalization plays a unique role. Production and service provision are gradually becoming digitalized leading to highly integrated and efficient production and delivery processes. Digital technologies are impacting societies and economies by slashing computing and equipment cost. The global digitalization has led to an increase in development that are open sourced leading to the creation of more employment (OECD, 2016).

On the demand side production, population growth, higher incomes, sustained demand for bio-fuel, changing diets and urbanization are causing changes in consumption in developing

[4] Mega trends are large-scale trends that are slow to form but tend to have lasting influence on humanity. They come in the form of social, economic, political environmental as well as technological changes (OECD, 2016).

economies. The supply side is seeing slowdown in global agricultural production growth to 1.5% (Boubaker, 2014; International Monetary Fund (IMF), 2015). China's decreased consumption and the global increase in the production of commodities such as shale oil in the US has caused a significant drop in price of commodities. This has the potential of making commodity exporters to diversify their exports and local economies. There has also been changes in accounting and regulation standards which has increased following the economic crisis of 2008 (Tysiac, 2016).

Under environmental trends, the growing world population in addition to economic growth has placed natural resources under immense pressure. Energy consumption has risen steeply, causing further changes in the climate. In poor and highly populated countries, the threat on biodiversity is increasing. This trend is driven by technological innovations, which are adopted around the world.

The role of governments is gradually changing. This change, fueled by globalization is shaping the global political landscape. The decline in public confidence in government, in addition to the transition to a more polarized world are leading to growing instability. The shift in global powers towards the east and south is empowering new players such as megacities, non-state and states actors are driving and facilitating globalization (OECD, 2016). These and a number of other trends shape the context of STI policy and how these policies are formulated. As discussed above, Foresight has been a popular instrument for formulating STI policies and strategies. A number of countries have adopted Foresight and undertaken activities at different levels of governance including national, regional, corporate, and sometimes at the international level. Particularly national Foresight cases have been illustrative on how governments looked in to the future, prioritized areas for STI and allocated funding. Recent developments in the global landscape, changing trends and transforming society, economy and policy created different reactions against Foresight by the STI policy makers of various leading economies in the world. In order to demonstrate this five cases have been selected from the countries, which have led to the formulation of STI policies using Foresight. Recent developments have indicated that the attitudes of these countries against Foresight have varied considerably. The following case analyses describe how these variations have emerged and discuss some of the underlying reasons.

5. Foresight Cases

Five Foresight cases have been selected for comprasion, including Finland, The United Kingdom, Germany, Japan and Russia. Among the indicators for comparion are: (i) the contextual landscape of the Foresight programme, (ii) scope and coverage of Foresight exercises, (iii) regularity of undertaking Foresight activities for policy formulation, (iv) funding mechanisms, (v) scale of participation, and (vi) the use and implementation of results.

Finland

Finland has built a strong ecosystem of Foresight, where Foresight functions are distributed among many actors which are public, private, international, governmental, non-governmental or a combination of any of these types. The function and networks of the various actors are sometimes overlapping, making the system more complex. The Finnish Foresight system is characterized by a bottom-up and inclusive approach to involve and penetrate the society on board with important stakeholders such as ministerial officials, national funding agencies, corporate organizations, universities and sectors researchers, and other decision makers. Multiple government departments have their in-house dedicated Foresight capacity. The cities gather and provide the information to the regional centers, which provide that information to the ministries and the ministries to the prime ministry. This approach ensures the flow of up dated information at all times making it one of the most efficient systems in the world (Kaivo-oja et al., 2002). The outstanding qualities of Finland in Foresight can be attributed to visionary politics and their well-established national Foresight system.

The Finnish government prepares and releases one future report[5] per every four-year electoral period. This means that every time a new government is elected, it writes it programme for its term. The highly political report specifies the government's programme and issues to be covered in the future. The preparation of the document is coordinated by the Prime Minister's Office and is closely supervised by a ministerial group. The preparation of the report spans a period of two years with the participation of all stakeholders. The government of Finland began preparing reports on its future since the 1990s.

[5] Finnish government report contains the position of the government with regards to the desired future and the measures required to achieve those future and expresses political will.

Appropriations and personnel resources are allocated by the government for the entire duration of the preparatory work. The appropriations also include a modest budget to be used to cover other expenses incurred during the planning process. Forward looking activities and research in Finland are also funded through national funding agencies such as Sitra, Tekes etc. Finland provides access to competed funding by promoting open science and capacity building by developing and creating environments that stimulates research.

The scale of participation of Foresight activities in Finland in the past decade has been both extensive and inclusive which highly depends on the nature of the topic or issue to be addressed. A large number of citizens are invited to participate through online surveys known as Mini-Foresight when the issue to be addressed is one of social interest e.g. the wellbeing and sustainable growth Foresight exercise. On the other hand, when the issues to be addressed concerns national security, the scale of participation is limited to a few experts and are only opened to a limited stakeholder participation through workshops. A wide variety of actors play roles in the Foresight activities of Finland. Preparatory work, idea formulation and preparation of initial drafts of the Foresight exercises are done by an expert group. Ministerial working groups then provide support and political guidance throughout all the stages of the exercises. The Foresight exercise for Long-term Climate and Energy, for instance, involved a wide range of stakeholders and citizens in the process with the aim of gathering lead contribution to the content of the final report, test the ideas that had been drafted during the preparation process, encourage discussion on the themes covered by the exercise as well as sensitizing the actors on climate protection efforts.

Finland is considered as one of the leading countries in the design and implementation of STI policies. The proliferation of information and their management no longer guarantees success. Hence, information is gained through processes of mutual sharing and discussion which provide new perspectives on to the issues at hand. Finnish organizations are, in many respects, the leading producers and users of Foresight output with fragmented and scattered nature of these data. Foresight data exist in a variety of forms which includes speculative (visionary data) or data gathered on probable scenarios (Prime Minister's Office Reports, 2014). New approaches such as the cooperative Foresight approach have been introduced to ease the use of Foresight results. The cooperative Foresight approach looks beyond creating mutual understanding. It looks at the shared processes used in data generation. Usually, the implementation of government Foresight

goes beyond the government's four-year term making the implementation binding on the next government. In the case of a change of government before the report is completely implemented, the report is carried forward for the new administration to complete.

The United Kingdom

The United Kingdom is among the forerunners of countries to conduct "fully-fledged" Foresight at the national level. It has made efforts to embed Foresight into its government through the use of central Foresight agencies (Miles & Keenan, 2003). The UK started the countries' first Foresight programme in the early 1990s (Saritas & Oner, 2004). The UK Foresight programme is now in its third cycle..

Since the first cycle, the Foresight Programme has experienced revisions in its organization, intensity, context and issues addressed. The current round is a government led rolling Foresight programme with an in-depth science-based, strategic and future oriented projects which involves the private sector, non-government organisations (voluntary sector) and other agencies to provide and implement effective strategies for the future. These programmes have moved from broadly scoped priorities and networking for a better design of STI policy to a narrowly-scoped distributed projects of multiple initiatives in order to create more awareness while building a more general Foresight culture in the process, through science-based programs which are aimed at improving policy-making ability in dealing with STI related issues.

The third Foresight cycle is aimed at increasing the UK's exploitation of science. Two Foresight projects were run at any time in this cycle. In the last decade, a total of eighteen Foresight projects have been carried out at the national level in the UK. Each project last between twelve to eighteen months through implementation and completion. One interesting fact about these projects is that, they are not launched until a major stakeholder agrees to champion and see to its implementation. The most recent projects under implementation are: (i) Future of mobility, and (ii) Future of the sea.

Foresight projects in the UK have a long time been funded through government ministries such as Department for Environment, Food and Rural Affairs (DEFRA), Ministry of Health (MoH) etc. This has remained the same in the last decade. Non-governmental organizations and charities also play an important role by providing funding to research in the public sector in order to influence the research strategies. Competitive schemes are also used as

sources of funding to promote research in the UK. Other financing and tax schemes such as the *Faraday Partnership Programme*[6] are used to promote research interaction between science, technology and engineering based industries (UK Science Partnerships, 2016). Research Base Funders, a forum of governmental and non-governmental research sponsors who do not aim at commercially exploit results of research also support Foresight activities. Their aim is to find strategies which have collective impacts on sustainability, health and outputs.

The networking element of the third Foresight cycle has been drastically reduced as compared to the previous Foresight cycles. The cycle has a narrower perspective as it has moved from setting priorities across all sectors of the economy to focusing on specific technological areas which holds the most potential. Foresight project teams' work with experts, academics and government departments in order to identify emerging areas of science like is likely to influence policy. However, the number of actors involved is relatively limited in the third Foresight cycle. A general dialogue is maintained between STI policy makers and the industry. This serves as the basis for an intensive and better working relationship. In the third Foresight cycle, industry associations are proactive in all the phases of the policy cycle through their own proposals, policy statements conferences and through other communication channels

In the last decade, a wide network of committees, advisory groups and councils at the government, departmental and parliamentary levels have been used by the Department of Business, Innovation and Skills (BIS) to implement the results of Foresight projects. The implementation of the set priorities and results of the various Foresight projects are supported by research councils through R&D programmes, projects and other support tools.

One of the new and innovative ways the UK implements its Foresight results in the area of STI is through the Catapult programme. The Catapult programme was established by Innovate UK, formerly the Technology Strategy Board, a non-departmental public agency, which reports to the Department for Business, Energy and Industrial Strategy (BEIS). The programme consists of a network of world-leading centres in the area of STI, which are designed to drive future economic growth. These centers specialize in transforming high potential ideas which are sometimes identified through Foresight exercises into new products and services[7].

[6] Faraday Partnership consist of alliance between research and technology organisations, professional institutions, universities, firms and trade associations who are dedicated to improve competitiveness through R&D, exploitation of new areas of S&T.
[7] https://catapult.org.uk/about-us/about-catapult/

Results of Foresight exercises are also implemented through joint activities between the public and the private sectors in the form of partnership between government department and charities, which provide funding for various regional initiatives.

Germany

The innovation system of Germany is characterized by a balanced structure between modernism and traditionalism. STI policies and institutions in Germany have been shaped through historical processes. R&D institutions, the German educational system, industrial associations as well as its political and regulatory system have their foundations on governing rules that have been shaped over considerable number of years. For instance, the then "Kaiser Wilhelm Gesellschaft", now Max Planck society was founded in 1911 has been carrying out cutting edge research till date (LI and LIU, 2015). The Federal Ministry of Education and Research (BMBF) of Germany is the official Foresight agency of the government. It operates in consultation with the approaches and programmes that are carried out at the sub-national level by 'Länder'(Dreyer & Stang, 2013).

Regarding Foresight, the BMBF has been the key player. The Foresight process implemented by the Federal Ministry of Research and Education (BMBF) is carried out in a cyclical manner and in a number of phases, which include the search and analysis of information, transfer of the information and preparation for the next cycle of activities.

The scope and coverage of the programme is determined by the Federal Parliament (Deutscher Bundestag) or by the Federal government. The parliamentary committee on Education, Research and Technology Assessment then invites expert advice from various stakeholders concerning the issues to be tackled.

At the governmental level, the BMBF conducts ad-hoc expert studies and workshops to identify and evaluate all possible topics. Foresight Studies, conferences and other instruments are used to stimulate the debate around the topics and also to create awareness. The responsible ministries, mostly the BMBF formulates, research topics based on the inputs gathered (Federal Ministry for Education and Research, 2016). In order to facilitate the smooth implementation of the strategy through dialogue between the stakeholders involved, the German government established two platforms. The platforms were particularly important to the success of the strategy because they established cooperation links between innovation works of the various

stakeholders. The participants of the project included the BMBF and representatives of industrial and science sectors.

All the Foresight activities that were carried out in the "Futur" project were specifically selected and funded by one of the departments of the BMBF (European Commission, 2007). Several new funding instruments have been introduced by the Federal Government to help promote and implement the high technology strategy at the municipal, national and European levels. These new funding mechanisms are allocated to specific technological areas. Some of these new funding instruments include "Energy Storage Funding Initiative", "Sustainable Electrical Grids funding initiative," "medical-technology funding initiative," "ICT for electro-mobility funding programme" (The Federal Government, 2014)

The responsibilities of implementing the results of Foresight activities are split between Ministries of Science also known as known as the Ministry of Cultural Affairs and the Ministry of Economy or its equivalent. Although differences exist between the various states (Lander) and the level at which they formulate their own STI policies and allocate funding, the design, evaluation and implementation of their STI policies follow similar patterns which are influenced by the national STI policy. Since 2010, Germany has been implementing structured Foresight in a four-year cycle with two interconnected stages. During these stages, development prospects in STI are analyzed using research on prospective products, global trends, etc. Expert-based procedures applied by both international and local experts are used. The results of the Foresight exercises are used by the Ministry of Economic affairs and Energy, Ministry of Education and Research as well as other agencies to prepare various strategic documents and initiatives. At the regional levels, the results are utilized by companies, ministries and other stakeholders to support their R&D activities.

Japan

Japan has been conducting Foresight exercises on key scientific and technological domains since 1971. The country has been a leader in S&T Foresight surveys by the use of the Delphi method, which has been adopted by a number of countries in the early 1990s. In Japan, large national Foresight exercises are undertaken every five years. Each round of Foresight gathers new

information to update insights that have been gathered from previous exercises. The basic plan serves as the blueprint upon which the main S&T Foresight studies are based.

Over time, the Japanese Foresight exercises have been richer in their methodological composition. For instance, from the 8th round of the programme, Foresight methodology involved new methods like horizon scanning (Saritas and Miles, 2012), and scenarios (Saritas and Aylen, 2010). The Delphi method of the 9th S&T Foresight exercise used cross-sectional panels consisting of scientific and technological frontiers distinguishing it from previous studies. These panels covered the themes of "security", "safety", "international collaboration" and "international competition". Experts from research organizations, natural sciences, humanities and social sciences were involved in the ponels. They extensively discussed the future targets and contribution of S&T in each domain. In the end, twelve interdisciplinary panels, composed of 135 experts took part in setting up the framework required for subsequent discussion (NISTEP REPORT No.140, 2010). The Foresight exercises took consideration the ideas of external experts through S&T Expert Network which is operated by the Science and Technology Foresight Center. In total of 5000 experts participated in the recently ended 10th S&T Foresight exercise of Japan. The Japanese national foresight activities are gradually placing more emphasis on the societal and economic demand surrounding the implementation of the results in the field of science and technology. For the first time in the history of the exercise, the topic of social ethics was included. The results of the Foresight activities are made available to all interested parties including companies and students to be used as inputs to policy-making and general information. Japan's long experience in Foresight, qualifies the undertaking body, NISTEP, to evaluate the predictions of the earlier Foresight exercises. The evaluation of earlier Foresight activities indicates that Japan has reached over 60% of realization rate of earlier predictions (Yokoo and Okuwada, 2012).

Russia

Russia has accumulated considerable experience in conducting Foresight projects in the last couple of decades (Gokhberg et al., 2017). These Foresight activities mainly aimed at generating a list of priority areas and critical technologies which are consistently revised over the years. The priority areas are thematic areas with the greatest capability of contributing to increasing the

countries competiveness. The critical technologies on the other hand are technology related thematic areas selected across industry and possess the potential for innovative applications while improving the country's competitiveness. Russian presidential decree No Pr-843 made on April 21, 2006 approved a new list of S&T priorities after extensive discussion and endorsement from relevant ministries. The latest set of priorities were approved on July 7, 2011 by a presidential decree No 899, identifying eight priority areas and 27 critical technologies (President of the Russsian Federation, 2011).

Over the last decade, the number of Future oriented studies has increased exponentially in Russia. This can be attributed to the adoption of the First fully-fledged Foresight in 2004, which was based on international methodologies. The Russian government has initiated many Future-oriented activities and constantly reviews the priority areas and critical technologies aimed at long-term development of innovation. The S&T priorities approved by the Russian President in 2006 were used as the basis for creating the National S&T programme. The decree also established that the S&T priorities will be updated regularly- every four years. The aim of the revision is to consider key technologies with the potential of delivering practical results within a 10-year period.

Foresight results have been used to formulate large-scale innovative projects which are funded through private-public partnership programmes. Federal goal-oriented programmes such as the "research and development in S&T priority areas: 2007 – 2013." Russia also provides priority funding to top level international and Russian experts conducting Foresight exercises within the national S&T programmes.

One of the implementation tools adopted by the Russian government is the National Technology Initiative (NTI). The project seeks to provide system solutions required to adequately define key technologies, while creating new markets likely to propel Russia to world leadership by 2035. NTI is one of the key future oriented task instituted by the Russian President on December 4, 2014 in an address to the Federal Assembly (Agency For Strategic Initiatives, 2014). The project will provide changes in the rules and regulations, measures necessary for the effective development of human resources and funding or compensation mechanisms.

6. Comparison of the Cases

The Foresight activities of the countries analyzed above show various levels of intensity. Although each of them has indicated considerable commitment for Foresight activities up until the 2010s, their attitudes have varied significantly since then. Countries with stable economic and political conditions continue their commitment for Foresight activities. Among the programmes compared, Finnish Foresight programme can be considered as the most institutionalized. The programme is well integrated into the governance structures of the country at different levels from the national government, to companies as well as large research institutions and research funding bodies. Well set up and well embedded Foresight programme is represented in the parliament with the "Committee for the Future", which was established in 1993, and is considered to be the first futures committee in the world.

Similarly, as the longest running Foresight programme in the world, Japanese Foresight has been stable almost all the time since the first implementation in the early 1970s. There have been changes in the content and processes in parallel with new and emerging science and technology areas as well as new methods for Foresight.. For instance, the Japanese activities have moved from a single to multi-method approach, and are now also scoped to cover societal issues along with science and technology areas. Given the fact that the evaluations of earlier rounds of Foresight indicates high success rates, it is expected that the commitment for Foresight is going to be at a steady level with further improvements in methodology and scope.

Germany is one of the countries, which has moved from large scale national Foresight activities. Foresight exercises are organized around the key emerging technology fields. The BMBF still plays an instrumental role for coordinating Foresight activities. Recent Foresight activities focused more on monitoring social and technology trends as well as challenges. Several volumes of reports are published and disseminated on a regular basis, which gives a stability to the on-going Foresight efforts.

When began, the UK Foresight programme was one of largest national initiatives and inspired a number of other countries in undertaking . The Foresight activities in the UK has declined in intensity in the last decade. Foresight activities in the UK has reduced in intensity and have become narrower and more demand oriented. At the level of national government Foresight has already been reduced to a minimum level with no strong public appearance. The dedicated

website for Foresight has been abandoned, and been replaced by a few pages under the Government website. The pages were last updated in May 2016.

Among the countries analyzed, Russia has indicated an increasing intensity in Foresight activities. Opposite to the UK programme, under crisis and strict sanctions Russia considered Foresight as a strategic instrument for formulating long-term priorities and policies. Foresight studies at different levels of governance from federal to regional and sectoral to corporate levels indicate a coherent and complementary ecosystem. Strategies particularly for substituting imported technologies and goods appear to be successful, which help to increase the commitment for Foresight activities.

7. What is on the agenda for the next ten years?

Foresight activities largely started and diffused across countries globally through "bandwagon" and "millennium" effects (Keenan, 2009). The activities in the past decade indicated that Foresight is now much more customized and absorbed by national and regional governments as well as corporations. The tools and methods have been richer and much more sophisticated through the use of new technologies (Saritas and Burmaoglu, 2015). Looking into the future of Foresight, it can be said that the activity will adapt itself into changing contexts, emerging new areas, and will improve its methodological toolbox through the use of new technologies and participatory methods.

The dynamic changes in the world bring challenges for undertaking long-term Foresight activities. Global economic fluctuations, increasing conflicts, mass immigration and all the other factors brought disruptive effects on long-term policies. Therefore, there is an increasing need for making Foresight more adaptive and dynamic into fast-changing contexts. Saritas et al. (2017) gives an example of developing a new scenario approach, which brings together multiple time horizons and multiple paths for achieving or avoiding future scenarios. In order to remain relevant and acclaimed Foresight approaches need to mediate this emerging 'tension' between long and short terms.

In parallel to the changing contexts, the scope and coverage of Foresight activities are also changing and evolving. Moving from heavily technology oriented activities with the recent more social-orientation, the activities of the next decade are expected to evolve into more trans-

and anti-disciplinary domains. This new focus will provide a platform for a wide vaiety of scientific disciplines, multiple levels of governance as well as all innovators from the individual to institutional levels.

One of the most noteworthy improvements in Foresight is the fact that the activity is continuously drawing more and more on emerging technologies of information and communication. Among those, Big Data appears to be very promising in terms of using more and real-time evidence for Foresight. New sources of information beyond textual data including visual as well as sensor data increase the quality and quantity of input. Similarly new ways of analyzing and visualizing data provides opportunities for making more sense of interpretation and use. Some examples of using Big Data for identifying trends are provided by (Saritas and Burmaoglu (2016) and Burmaoglu and Saritas (2017) Futhermore, the technologies like Blockchain, have the potentials to increase participation and provide more transparency for the Foresight process. The potentials provided by increased computer power, semantic analysis, and cloud based technologies are expected to take Foresight to next levels.

References

Agency For Strategic Initiatives. (2014). National Technology Initiative. Retrieved March 2, 2017, from https://asi.ru/eng/nti/

Ahlqvist, T. (2015). *Foresight activities in Finland: actors, relations, and impacts on policy making*. Tokyo, Japan.

Boubaker, B.-B. (2014). *Food Commodity Markets: Global Trends and Emerging Issues*.

Burmaoglu, S. and Saritas, O. (2017). Changing characteristics of warfare and the future of Military R&D, Technological Forecasting and Social Change, vol. 116, pp. 151-161.

Cuhls, K. (2003). From forecasting to foresight processes – new participative foresight activities in Germany. *Journal of Forecasting*, *22*(3), 93–111.

Daheim, C., & Uerz, G. (2008). Corporate foresight in Europe: from trend based logics to open foresight. *Technology Analysis and Strategic Management*, *20*(3), 321–336.

Dreyer, I., & Stang, G. (2013). Foresight in governments–practices and trends around the world. *European Union Institute for Security Studies, YES*.

Dufva, M., & Ahlqvist, T. (2015). Developing a service model for systems-oriented foresight. In *The ISPIM Innovation Summit* (pp. 1–12). Brisbane.

European Commission. (2007). Futur - the German Research Dialogue. Retrieved March 29, 2017, from http://www.bmbf.de/futur/en/index.htm

European Commission. (2009). *Collection of EFMN Briefs, Part 2*. Brussels: European Commission.

Federal Ministry for Education and Research. (2016). Federal Ministry for Education and Research (BMBF). Retrieved February 10, 2017, from http://www.bmbf.de

Future of Facebook. (2011). Project information and videos from the Future of Facebook project.

Gavigan et. al. (2001). FOREN Guide – Foresight for Regional Development Network – A Practical Guide to Regional Foresight. In *FOREN Guide – Foresight for Regional Development Network – A Practical Guide to Regional Foresigh*. Brussels: European Commission.

Georghiou, L. (2001). Third generation foresight, integrating the socio-economic dimension. *The Approach to and Potential for New Technology Foresight, Proceedings of the International Conference on Technology Foresight, Tokyo, Mar*.

Gokhberg, L., Sokolov, A. & Chulok, A. (2017). Russian S&T Foresight: identifying new drivers of growth, *Foresight*, vol. 19, issue 5, pp. 441-456.

Harper, L. G. & J. C. (2011). From priority-setting to articulation of demand: Foresight for research and innovation policy and strategy. *Futures*, *43*(3), 243–251. https://doi.org/10.1016/j.futures.2010.11.003

Hines, A., & Gold, J. (2013). Professionalizing foresight: Why do it, where it stands, and what needs to be done. *Journal of Futures Studies*, *17*(4), 35–54.

International Monetary Fund (IMF). (2015). *Commodity Special feature from World Economic Outlook*.

Jemala, M. (2010). Evolution of foresight in the global historical context. *Foresight*, *12*(4), 65–81. https://doi.org/10.1108/14636681011063004

Kaivo- oja, J., Marttinen, J., & Varelius, J. (2002). Basic conceptions and visions of the regional foresight system in Finland. *Foresight*, *4*(6), 34–45. https://doi.org/10.1108/14636680210453470

Keenan, M. (2009). Technology Foresight: International Experience. *Foresight-Russia*, *3*(3), 60–67.

Kehl, W. (2013). Shaping Tomorrow. Retrieved February 22, 2017, from https://shapingtomorrowblog.wordpress.com/2013/10/05/strategic-foresight-as-knowledge-management/

Kuniko, U., Yohiko, Y., & Hiroshi, N. (2012). S&T policy and foresight investigation - impacts in Japan. *Foresight*, *14*(1), 15–25. https://doi.org/http://dx.doi.org/10.1108/14636681211210332

Li, Z., & Liu, L. (2015). *Comparison of the Innovation Systems in China and Germany "*

Magariños, C. A. (2005). *Economic development and UN reform: towards a common agenda for action ; a proposal in the context of the millennium development goals*. Vienna: United Nations Industrial Development Organization.

Loveridge, D. (2009). Foresight: The Art and Science of Anticipating the Future, Routledge, New York, Oxon.

Martin, B. R., & Johnston, R. (1999). Technology Foresight for Wiring Up the National Innovation System-Experiences in Britain, Australia, and New Zealand. *Technological Forecasting and Social Change*, *60*(1), 37–54. https://doi.org/10.1016/S0040-1625(98)00022-5

Miles, I., Harper, C. J., Georghiou, L., Keenan, M., & Popper, R. (2008). *The Handbook of Technology Foresight: Concepts and Practice*. (L. Geoghiou, J. H. Cassingena, M. Keenan, I. Miles, & R. Popper, Eds.). UK: Edward Elgar Publishing Limited.

Miles, I. & Keenan, M. (2002), Practical Guide to Regional Foresight in the UK, European Communities, Luxembourg.

Miles, I.& Keenan, M. (2003). Ten Years of Foresight in the UK. In *documento presentado en la segunda conferencia internacional sobre prospectiva tecnológica, Tokio* (Vol. 27).

Miles, I., Saritas, O., and Sokolov, A. (2016). *Foresight for Science, Technology and Innovation*. Springer International Publishing, Switzerland. https://doi.org/10.1007/978-3-319-32574-3

NISTEP REPORT No.140. (2010). *The 9th Science and Technology Foresight*. Tokyo. Retrieved from http://data.nistep.go.jp/dspace/bitstream/11035/693/3/NISTEP-NR140-SummaryE.pdf

OECD. (2016). *OECD Science, Technology and Innovation Outlook 2016*. Paris: OECD Publishing.

Pouris, A., & Raphasha, P. (2015). Priorities Setting with Foresight in South Africa, *9*(3), 66–79. https://doi.org/10.17323/1995-459x.2015.3.66.79

President of the Russsian Federation. (2011, June 7). List of critical technologies of the Russian Federation. *Kremlin News*. Moscow. Retrieved from http://news.kremlin.ru/ref_notes/988

Prime Minister's Office reports. (2014). *Finlands government´s work & report on the future*. Helsinki. Retrieved from http://www.mittnorden.net/download/18.3b49e5551455d3734f4317/1400239365622/rosenström.pdf

Prime Minister's Office Reports. (2014). *Cooperative and Continuos foresight: A proposal for a national foresight approach*. Helsinki.

Saritas, O. (2006). Systems Thinking for Foresight, Ph.D. Thesis, University of Manchester, UK.

Saritas, O. (2013). Systemic Foresight Methodology, in *Science, Technology and Innovation Policy for the Future: Potentials and Limits of Foresight Studies*, D. Meissner, L. Gokhberg, and A. Sokolov and eds. Springer Verlag, Berlin, pp.83-117.

Saritas, O. & Oner, M.A. (2004). Systemic analysis of UK foresight results: joint application of integrated management model and roadmapping, *Technological Forecasting and Social Change*, vol. 76, issue 1, pp. 27-65.

Saritas, O., Taymaz, E.& Tumer, T. (2007). Vision 2023: Turkey's national Technology Foresight Program: A contextualist analysis and discussion, *Technological Forecasting and Social Change*, vol. 79, issue 3, pp. 509-529.

Saritas, O. & Aylen, J. (2010). Using scenarios for roadmapping: The case of clean production, *Technological Forecasting and Social Change*, vol. 77, issue 7, pp. 1061-1075.

Saritas, O. and Miles, I. (2012). Scan-4-Light: a Searchlight function horizon scanning and trend monitoring project, *Foresight*, vol. 14, issue 6, pp. 489-510.

Saritas, O. & Burmaoglu, S. (2015). The Evolution of the use of foresight methods: A scientometric analysis og global FTA research output, *Scientometrics*, vol. 105, issue 1, pp. 497-508.

Saritas, O. & Burmaoglu, S. (2016). Future of sustainable military operations under emerging energy and security considerations, Technological Forecasting and Social Change, vol. 102, pp. 331-343.

Saritas, O., Dranev, Y. & Chulok, A. (2017). A dynamic and adaptive scenario approach for formulating science & technology policy, *Foresight*, vol. 19, issue 5, pp. 473-490.

The Federal Government. (2014). *The new High-Tech Strategy Innovations for Germany*. Berlin. Retrieved from https://www.bmbf.de/pub/HTS_Broschuere_eng.pdf

Tysiac K. (2016). 6 global economic trends you can't ignore. Retrieved June 29, 2017, from http://www.cgma.org/magazine/2016/oct/global-economic-trends.html

UK Science Partnerships. (2016). Faraday Partnership Programme. Retrieved March 28, 2017, from http://www.faradaypartnerships.org.uk/

Van der Duin, P., Heger, T., & Schlesinger, M. D. (2014). Towards networked foresight? Exploring the use of futures research in innovation networks. *Futures*, vol. 59, pp. 62–78.

Yokoo, Y. & Okuwada, K. (2012). Validity of foresight derived from the evaluation of past activities in Japan, *International Journal of Foresight and Innovation Policy*, vol. 8, issue 4, pp. 296-310.

Ozcan Saritas
Institute for Statistical Studies and Economics of Knowledge, National Research University Higher School of Economics, osaritas@hse.ru (corresponding author)

Derrick Ababio Anim
Institute for Statistical Studies and Economics of Knowledge, National Research University Higher School of Economics, animkderrick@gmail.com