Technological Forecasting & Social Change xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

The role of corporate foresight and technology roadmapping in companies' innovation development: The case of Russian state-owned enterprises

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A R T I C L E I N F O

Article history:
Received 6 July 2015
Received in revised form 13 November 2015
Accepted 17 November 2015
Available online xxxx

Keywords:
State-owned enterprises
Corporate foresight
Technology roadmaps
Innovation strategies
Innovation management

A B S T R A C T

In recent decades, the attention of researchers and policymakers has turned to state-owned enterprises (SOEs), in particular the role they play in science, technology and innovation and the methods they use to implement innovation strategies. In this paper, we look at Russian state-owned companies and their development plans, as well as the management tools they employ to forecast and prioritize technologies. Although most Russian SOEs rarely implement corporate foresight and technology roadmapping, certain successful cases are presented and discussed in the paper. Based on these case studies, we suggest a common structure of a technology roadmap that is suitable for SOEs.

1. Introduction

In today's rapidly changing world, innovation is one of the major factors determining national competitiveness (OECD, 2015a). In developed economies, the business enterprise sector is a catalyst of innovation, and a major source of research and development (R&D) funding.[1] While the importance of small firms in innovating, creating jobs, and contributing to national economic growth is indisputable (Audretsch, 2009; OECD, 2012; Siegel et al., 2003), large-scale implementation of technological innovations can hardly occur without diverse efforts of large corporations. The total amount of R&D investments of 2500 of the world's largest companies constitutes more than 90% of the total expenditure on R&D financed by the business sector worldwide (Hernández et al., 2014). Furthermore, this sector definitively leads patent activity: in 2010, it accounted for about 83% of all patent applications (WIPO, 2011).

Considering how important large enterprises are for long-term national competitiveness, such entities inevitably draw governments' attention in a variety of forms. Thus, even in developed economies where corporations are largely private, the latter still consult and maintain dialogue with the state regarding issues such as corporate social responsibility, ecological development, and energy consumption. In the developing world (including Russia) large companies are often state-owned and make up a substantial proportion of GDP, employment, and market capitalization (OECD, 2014). While state ownership often 'naturally' exists in such sectors as utilities and infrastructure (e.g. transport and telecommunications or energy), it may also dominate in high-tech areas, such as aerospace, shipbuilding, and automotive industries, particularly if they make up some of a military–industrial complex. Many SOEs become either monopolies in their respective fields or diversified industrial groups, whose activities (including R&D and innovation) are totally or partially funded and controlled by the government (World Bank, 2010).

Although the management and innovation literatures have shed little light on innovation in SOEs, in recent decades the role of the state and SOEs in taking on high-risk innovative projects has been reconsidered (Mazzucato, 2013; Tõnurist, 2015). This may be attributed to the rapid and innovative growth of SOEs in China (Nolan and Xiaoqiang, 1999; Girma et al., 2009) and, to a lesser degree, in other countries (Baliga and Santalainen, 2006), including some European economies (i.e. Antonelli et al., 2014).

Innovation in the Russian Federation has been stagnating in the last decade. The proportion of enterprises engaged in technological innovation has not increased beyond 10% since 2000, while the share of innovative products in industrial turnover remained between 4 and 6% in 2000–2011 (HSE, 2015).

Due to this, for the last several years the Russian Government has been trying to improve this situation (Gokhberg and Kuznetsova, 2011). In 2011, Russia adopted its national level Strategy of Innovative Development, which included many mechanisms and tools to stimulate innovation at federal and regional levels. Within a short time, high-level strategic documents in science, technology, and innovation (STI) were developed including a Fundamentals of Science and Technology (S&T)

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[1] The sector accounts for about 60% of R&D spending in OECD countries on average, and remains the largest source of R&D financing in major STI-driven economies such as USA, Japan, Germany, France, and UK. For more information, see (OECD, 2015b).

http://dx.doi.org/10.1016/j.techfore.2015.11.018
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Policy, a Federal Law on Strategic Planning in the Russian Federation, and S&T Foresight 2030. The government established key elements of STI infrastructure, such as engineering, prototyping, industrial design centres, and centres for technology transfer, as well as a system of development institutions to provide financial support to companies at all stages of the innovation cycle. The newer government initiatives include both the creation of 35 technology platforms (Proskuryakova et al., 2014) and the establishment of 25 innovative regional clusters (Kutsenko, 2015). Moreover, a set of technology roadmaps was designed to support new industrial sectors including biotech, composite materials, photonics, engineering, and industrial design. These various initiatives encourage stronger interaction among different actors of the national innovation system.

One of the recent government STI policy tools is innovation development programmes (IDPs) of SOEs. According to the President's instruction, 47 largest Russian SOEs have been obliged to develop IDPs since 2011. In 2012, their number increased to 60. The share of SOEs implementing IDPs in Russian GDP is about 20% (Gershman, 2013). Among this group of companies are such giants as Gazprom, Rosatom, Rosneft, Rostech, Russian Railways, and United Aviation Corporation, many of whom already possess a large S&T base inherited from Soviet times.

The innovation strategies were developed in accordance with official governmental recommendations. Most of them are focused on the following strategic areas: new product development, modernization of equipment, commercialization of technologies, cooperation with universities, R&D institutions and SMEs, participation in Russian technology platforms, and international collaboration. SOEs from the approved list prepare annual progress reports on the implementation of innovation strategies for the government review.

Russia's Strategy of Innovative Development adopted by the government in 2011 stipulated that the IDPs of the largest SOEs should become a major trigger for technology and innovation development of the country. Their plans should be linked to high-level strategic documents defining the country's overall STI development including the above-mentioned sectoral technology roadmaps and S&T Foresight 2030. This might be achieved by implementing foresight and technology roadmapping techniques at a corporate level. Thus, it is interesting to look more closely at SOEs' innovation plans, specifically with regard to their strategic planning tools. Do these huge companies really use them to develop and implement innovation strategies? Are there any successful cases which could serve as an example for other countries faced with similar problems?

The structure of the paper is as follows. After reviewing the relevant literature and outlining our methodology, we analyse how the surveyed group of Russian SOEs that are implementing IDPs deal with corporate foresight and technology roadmapping. We provide several case studies showing best practice. Next, we suggest a structure of technology roadmaps that contains all the necessary pillars for successfully developing and implementing an IDP. Finally, we discuss the further evolution of government requirements that attempt to strengthen SOEs' strategic S&T planning competencies.

2. Literature review

In general, corporate foresight involves research undertaken by companies to study emerging markets and trends, identify weak signals, and formulate corporate strategies and innovation policies to prepare for an uncertain future (Horton, 1999; Becker, 2002; Müller, 2008). This type of future-oriented study indicates a dynamic capability to make structural and cultural changes in the organization to re-adapt to imminent needs (Rohrbeck, 2011). With the help of corporate foresight, private companies and SOEs understand those complex forces that drive changes in the decision-making process and strategy development, and encourage research for innovation in a company (von der Gracht et al., 2010; Battistella, 2014). Rapid social and economic changes often result in problems of capacity building for corporations. Therefore, future orientation paired with strong foresight that is based on flexible and adaptable systems, is the key to success (Hines, 2003; Ratcliffe, 2006).

Large companies use foresight for various purposes. Becker (2002) defines two types of drivers for corporate foresight activities: those that are essential to a company's' business operation and inherently demand a long-term orientation (i.e. in industries with long product cycles or high development costs); and, those that act as preventive measures to better deal with uncertainties in the business environment. Further, foresight activities can be categorized in terms of their intermediate functions and impacts: anticipatory intelligence (informing and warning), priority-setting (establishing guidelines for the corporate strategy), determining priorities (identifying the most desirable R&D areas), strategy formulation, and innovation catalysing (stimulating and supporting innovation processes). The companies studied by Becker mostly used foresight for one of the purposes mentioned. However, a few of them – namely Decathlon, Volvo, and IBM – employed foresight tools for a broad range of tasks, from intelligence gathering to strategy development (Becker, 2002). In a more recent study of 44 large European companies, Müller (2008) asserts that corporate foresight can achieve ‘hard’ objectives: it can support strategic decision making, improve long-term planning, enable an early warning system as an engine for issue management, refine the innovation process, and enhance the speed of reaction to environmental change. Within the foresight process, more than half the companies regularly implemented such measures to generate medium/long-term future perspectives (92.5%), identify and analyse environmental trends and issues (75%), anticipate future application contexts of products/services (72.5%), interpret trends, issues, and future perspectives (62.5%), and communicate/transfer the foresight results and insights (55%) (Müller, 2008). Rohrbeck and Gemünden (2011) analyse 19 case studies and 107 interviews and identify three generic roles of corporate foresight, namely strategist, initiator, and opponent roles. In the first role, corporate foresight guides innovation activities by developing a vision, providing strategic direction, combining opinions, assessing and repositioning innovation portfolios, and identifying new business models of competitors. In the initiator role, corporate foresight fosters innovation initiatives by defining new customer needs, technologies, and product concepts of competitors. Finally, in the opponent role, corporate foresight encourages the innovators to create better and more successful innovations by challenging basic assumptions, creating state-of-the-art current R&D projects, and scanning for disruptions that could endanger current and future innovations (Rohrbeck and Gemünden, 2011).

Corporate foresight enables us to use a wide range of approaches and methods (for example, about 50 different foresight methods have been identified: see Popper, 2012). It may be also combined with other techniques sometimes considered as alternatives — competitive intelligence (Muller, 2005), benchmarking, and business analytics (Calof et al., 2015). Corporate foresight tools and techniques, applicable for both private and state-owned companies, can be classified in different ways. Essentially, the methods employed are quantitative (e.g. cross-impact analysis, correlation analysis), qualitative (e.g. brainstorming, scenarios), and synthetic (e.g. bibliometrics, roadmapping) (Becker, 2002; Popper, 2008). Phillips et al. (2005) distinguish nine families of foresight methods: expert opinions, scenarios, modelling and simulations, monitoring and prospecting, trend analysis, statistical methods, creativity, descriptive and matrix methods, and evaluation methods. In turn, Rohrbeck and Gemünden (2006) delimit the methods of strategic (corporate) foresight according to areas in which these methods are applied. Researchers have identified market-oriented, technology-oriented, and integrated methods. The latter are considered a powerful tool that overcomes the barriers between both the fields of market and technology, and among strategic, tactical, and operational planning (Rohrbeck and Gemünden, 2006). The most popular integrated methods are roadmaps and scenarios (Rohrbeck et al., 2007).

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Further, according to a study of corporate foresight in Europe, the most popular and regularly used methods are trend analysis, analysis of media publications, scenarios, roadmapping, as well as participation methods (Daheim and Uerz, 2008).

In particular, roadmaps represent a key element in the innovative toolset of many corporations. For the last two decades, researchers have been reviewing the roadmapping process. Phaal et al. (2001) define this process as a highly effective method for supporting technology management and planning, especially when it comes to studying the dynamic interaction between company resources and goals, and environmental changes. In addition, roadmapping is a management tool in the areas of product development and R&D (Vishnevskiy et al., 2015; Clayton, 2009). It includes a variety of information exchange processes among stakeholders (Yasunaga et al., 2009; Clayton, 2008). There are two main approaches towards using roadmapping in the foresight studies: technology push ('bottom up') and market pull ('top down') (Brem and Voigt, 2009). The first stream presupposes market demand as a driver for R&D and identifying technologies (Holmes and Ferrill, 2005; Albright and Kappel, 2003; Lee et al., 2009a). The second approach considers technological backlogs as a major factor for elaborating innovative products that determines the market needs that can be satisfied by new technologies (Lichtenthaler, 2008; Lee et al., 2009b). In practice, Lucent Technologies, Philips, BP, LG, Samsung, etc. applied roadmaps as a core element of foresight. Motorola, which became a leader in the use of roadmaps, developed them in order to forecast market and technological changes, as well as to solve customer problems and improve productivity (Willyard and McClees, 1987; Major et al., 1998; Richey and Grinell, 2004; Goenaga and Phaal, 2009). Nokia actively used roadmaps to plan the development of their product range and to determine its competitive position in emerging markets (Vecchiato, 2012).

3. Methodology

We base our analysis on several sources. The first is a survey of the Russian SOEs that have implemented IDPs. The survey was conducted as part of a project on the best practices of innovation management in Russian SOEs funded by the Russian Venture Company. The questionnaire had four major blocks consisting of 50 multiple choice questions: planning of innovation activities, organizational structures for innovation, control and motivation of innovation activities within the company, and interaction with external organizations in STI. The results for certain survey questions (those which concern planning of science and technology, market priorities, STI goals and documents regulating innovation-related activities of Russian SOEs) provide us with some of the empirical evidence discussed in this paper.

The questionnaire was sent to all 60 state-owned companies (in accordance with a list approved by the government), accompanied with an official letter of support from the Ministry of Economic Development of the Russian Federation. We received completed questionnaires from 32 SOEs, eleven of them representing the military–industrial complex. Civil SOEs were large companies from the mining and energy sectors (Gazpromneft, Alrosa, Rusgidro, Inter RAO, Rosseti), automobile and transportation (Avtovaz, Aeroflot, Sovcomflot, Russian Railways, Transneft, Avtodor), and telecommunications (Rostelecom, Russian Post, Russian Television and Radio Broadcasting Network). The survey sample is representative and characterized by the following figures as of 2013 (according to the Ministry of Economic Development of the Russian Federation):

- total number of employees is more than 2.3 million people (1.9 million excluding military-industrial complex);
- total sales is more than 3.8 trillion roubles (about 200 billion current PPP US dollars);
- innovation expenditures within the IDPs equaled 379 billion roubles (20.6 billion current PPP US dollars);
- R&D expenditures constituted 76 billion roubles (4.1 billion current PPP US dollars).

The second source of data is interviews with 11 SOEs' managers responsible for innovation development undertaken in 2014. The interview guide included questions such as: role of innovation in company's strategy, innovation manager's functions, innovation processes, collaboration with external organizations, best management practices including technology foresight and roadmapping. The interviews were conducted in Russian and lasted between 30 and 45 min.

Third, we refer to SOEs' innovation development programmes and reports on their implementation. These documents are available online on companies' websites. In addition, we analysed governmental methodologies and guidelines for designing and monitoring IDPs.

Based on the interviews we conducted and publicly available information on IDPs, we present three cases of large Russian SOEs – Rosatom, Gazprom and Aeroflot – which use corporate foresight and roadmapping tools within their innovation strategies. The three SOEs represent different sectors of the economy — atomic energy, oil and gas sectors, and aviation. For this reason, the paper should be of interest for a wide range of readers.

Finally, following the IDPs' contents and structure, the findings from our interviews, and our case studies, we exemplify our paper with an illustration of a technology roadmap which could serve as a strategic management tool for SOEs implementing innovation strategies.

4. Findings

Tools such as corporate foresight and technology roadmapping have proven themselves useful for decision making in business diversification, entering new markets, or developing and implementing new technologies. However, our analysis shows that for most Russian SOEs, the use of these instruments to coordinate product and technology development is uncommon. Only a few companies in our sample report having used a technology roadmap (i.e. Rosatom, Gazprom). Some of them are only planning to design it, but have not yet implemented it in practice.

The problem manifests itself most explicitly in companies that conventionally depend on public procurement (e.g. in defence, aerospace, and shipbuilding industries). Here, the state establishes technology priorities for them. Limited profitability of government purchases leads to scarcity of financial resources needed for enhancing S&T capacities of a company or implementing new technologies. Insufficient experience of operating in a volatile market environment also results in the predominance of short-termism in planning and high-risk aversion by senior managers in many Russian SOEs.

The respondents from infrastructure, mining, and service sectors say that the 'bottom up' approach dominates planning procedures and portfolio-building of innovative projects; i.e., new projects and ideas come from production units and subsidiaries (functional customers). Then they are collected, evaluated, and funded in accordance with the given annual budget. Implementing a joint project that involves several departments thus remains a complicated task, since production divisions usually link problem-oriented themes directly to their own current needs. An innovation-related unit here serves as a focal point, collecting and examining applications under the supervision of relevant expert bodies. In line with this, representatives of Russian SOEs generally confirm their inability to develop and implement long-term and concerted action plans, even when supported by top-management. A 'top-down' process of initiating and implementing complex projects, coupled with collecting ideas from the bottom, therefore demand the ability to provide adequate strategic intelligence support based on continuous market and technology monitoring and the analysis of best international practices (Gershman et al., 2015). Under these circumstances, the need to implement IDPs becomes one of the main incentives for the Russian SOEs to perform corporate foresight studies.

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Fig. 1. Main market priorities of Russian SOEs (percentage of respondents picking each option out of the total number of respondents).

The results of the survey show that Russian SOEs are almost equally inclined towards providing traditional and innovative products and services inside the country (Fig. 1). One of the possible explanations could be that due to various reasons (worn-out equipment, ageing staff, lack of coordination among companies' divisions), the priority for many of the Russian corporations remains strengthening the effectiveness of 'traditional' business processes. Moreover, more than 40% of companies are committed to public procurement while only 28.1% are interested in non-state consumers. This indicates that the overall structure of the Russian economy is dominated strongly by the public sector (Liuhto and Vahtra, 2009; Shprenger, 2010) which may also serve as a disincentive in the implementation of corporate foresight tools in some SOEs. Exploring foreign markets with new or traditional products is considered a top-level priority by roughly 25–35% of companies, as this potential remains unrealized due to lack of stimulus or infrastructure. This paper argues that an absence of stimuli is likely to hinder the comprehensive use of technology roadmaps.

Another question in our survey concerned the STI goals of Russian SOEs (Fig. 2). In line with companies' market priorities, almost 94% of respondents consider the upgrading of production facilities as a priority STI objective. For nearly 80% of SOEs, one of the top STI priorities is the improvement of staff skills.[2]

R&D-related activities focus mostly on improving business processes (69% of answers) rather than on market demands (34.4%), thus reflecting a 'conservative' product line approach among many Russian SOEs. Finally, only around half of the surveyed companies target providing innovative products and services. This perhaps explains why corporate foresight and technology roadmapping are not popular within this type of Russian enterprises.

As earlier mentioned, each SOE on the government-approved list had to develop an IDP. However, a quarter of these companies still do not have a detailed implementation plan. A minority (40.6%) has a list of long-term technology priorities, which are to be one of the main outcomes of corporate foresight and technology roadmapping (Fig. 3).

Nevertheless, there are few examples of Russian SOEs that demonstrate intensive use of corporate foresight tools in developing their innovation strategies. These would be internationally recognized companies such as the State Corporation 'Rosatom', joint stock company (JSC) 'Gazprom,' and JSC 'Aeroflot'.

5. Case study 1: Rosatom

JSC 'Rosatom' is one of the most prominent cases of Russian SOEs practising long-term forecasting and foresight-studies at the corporate level. Just before developing its IDP in 2010–2011, the corporation analysed trends in the global energy industry and other spheres of the company's activity. Further it benchmarked global leaders in the energy and nuclear fields. As a result, it has identified future energy markets, strategies of the leading companies in the specified fields, and analysed its own strengths and weaknesses. Ultimately, Rosatom approved three priorities of innovative development: modernization for traditional (energy) markets; new products, technologies and services for traditional (energy) markets; and, new products, technologies, and services for non-energy markets (Fig. 4).

A broader vision of future S&T trends helps the company to define specific goals and plans for upcoming ambitious projects. An example of this is the award-winning 'Proryv' ('The Breakthrough') project.[3] The project facilitates the development of a new generation of nuclear technologies based on closed nuclear fuel cycle with fast neutron reactors. It integrates several innovative nuclear technology related projects and unites over 40,000 specialists from different fields and organizations. The key instrument in managing such a complex undertaking is an integrated technology roadmap with thousands of tasks and events. High-level targets were set by the Federal Targeted Programme 'Nuclear Energy Technologies of The Next Generation,' the company's R&D programmes, and project documentation. The special project management group oversees the list of expected results and controls implementation processes. The map of key events guides R&D groups working on particular sub-projects, which also work with smaller-scale roadmaps within the project's larger integrated technology roadmap. The latter is updated continually through monthly monitoring.

6. Case study 2: Gazprom

One of the world's leading oil and gas producers, Gazprom bases its technology priorities on the net present value (NPV) assessment, which involves the following steps. First, the company assesses the possibilities of improving each business process by implementing the best available technologies via a set of technological and economic indicators

[2] The two options, however, are interrelated since new equipment usually needs specially trained workers.

[3] http://pmolimp.ru/files/content/403/pasport-luchshej-praktiki-kp-2-kalendarno-setevoe-planirovanie-rosatom-pdf.pdf (in Russian).

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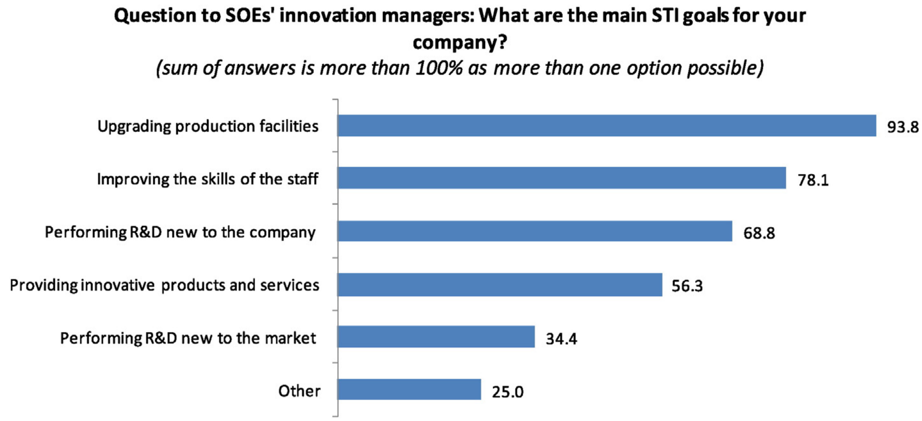

Fig. 2. Main STI goals of Russian SOEs' (percentage of respondents picking each option out of the total number of respondents).

(TEI). Then the estimated values are computed into the model of the company's long-term development, in order to calculate (by changing the values of TEI) the forecasted impact of innovative technologies on each business process. On the one hand, this enables the company to analyse the relation between technological changes and the NPV of each business process; on the other hand, it helps to identify technology fields with the highest investment returns. Finally, integral efficiency indicators for each technology priority are set, and based on expert assessments key innovative technologies with particular performance indicators are identified (Fig. 5).

The method described above has its own pros and cons. On the one hand, economic efficiency and applicability of R&D results may fit better with the company's current demands. However, on the other hand, this approach does not allow investment in risky yet potentially breakthrough long-term projects. Such a 'cautious' strategy, if employed solely, could thus weaken the competitiveness of the company in the long run. However, according to data on public procurement, Gazprom has recently commissioned a foresight study of its innovative development faced with possible changes in the hydrocarbon production industry and the social and economic system as a whole. In the course of the project, the company would obtain the methodology for forecasting and prioritizing long-term S&T development. Another major task is to develop a roadmap for one of the selected technology areas.

7. Case study 3: Aeroflot

JSC 'Aeroflot' was also one of the first companies to develop a technology roadmap as part of the Russian government's initiative. According to the Adviser to the Director who is responsible for innovative development, Aeroflot's IDP aims to address key challenges facing the air transportation industry such as increased security, energy efficiency, environmental impact, and the quality of on-board services. To identify ways to achieve these goals, the company has developed a roadmap. This roadmap combines both market pull and technology push approaches (Vishnevskiy et al., 2015). Its central element is a forecast for the development and introduction of innovative solutions, which is linked both to the implementation of the company's priorities and the need to respond to industry-wide challenges. Within the framework of the technology roadmap, Aeroflot tried to evaluate its competitive position in all major markets, and worked to elaborate innovative ways of strengthening its position. The respondent also mentions that besides being a useful communication tool within the company, technology roadmaps also promote interaction with the external environment. For example, after announcing the need for developing a new generation anti-icing fluid as one of the company's priorities (mentioned in the IDP), researchers from Kazan National Technological University independently conducted research and suggested a solution to the problem which perfectly matched Aeroflot's needs.

8. Discussion

The IDPs cover a broad range of measures related to innovation, such as technology audit, benchmarking and implementation of cutting-edge technologies, improvement of business processes, and strengthening cooperation with different domestic and foreign actors (Fig. 6). To align all the corresponding tasks and issues, it is imperative to use technology roadmaps that present the whole picture of SOEs' innovation development comprehensively and in a format amenable to decision making (Karasev et al., 2014).

A properly designed technology roadmap reflects the main aspects of IDPs through six major layers within a time-scale (Fig. 7):

1. *Goals and challenges*: This layer includes global and domestic challenges that companies face as well as current and future

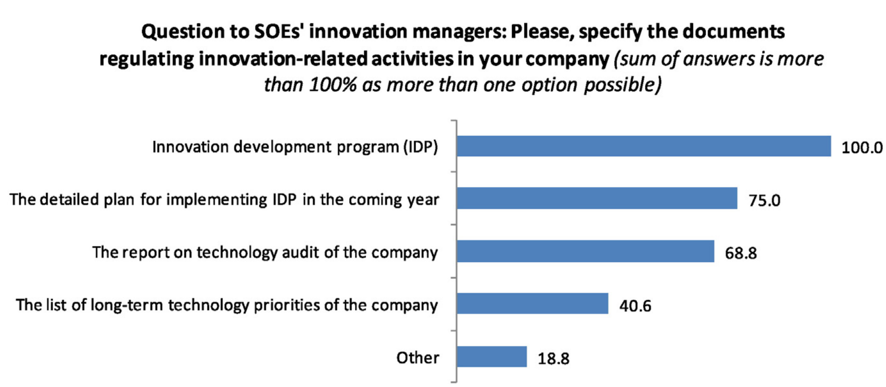

Fig. 3. Documents regulating innovation-related activities of Russian SOEs (percentage of respondents picking each option out of the total number of respondents).

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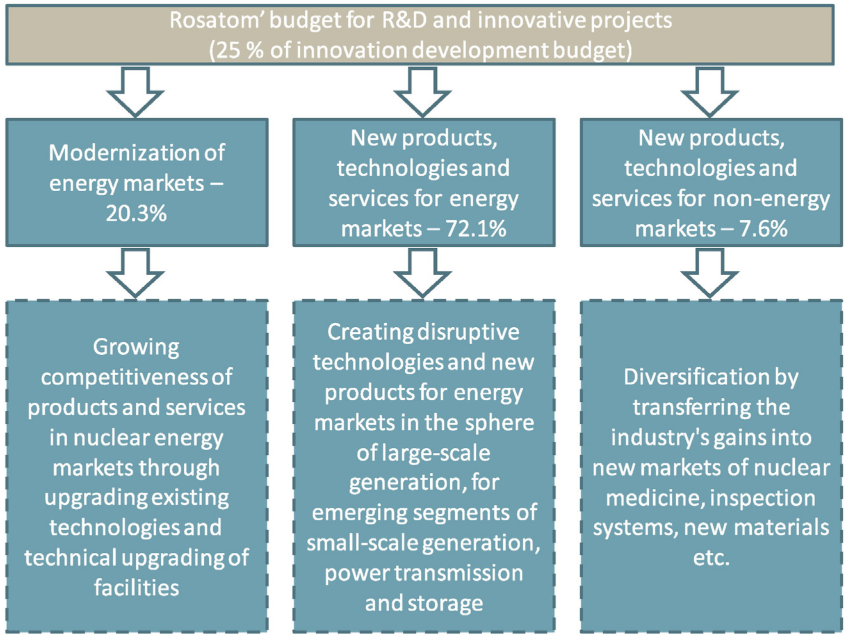

Fig. 4. Rosatom' innovation funding priorities based on corporate foresight: 2011–2020. Source: Innovation development programme of Rosatom. http://www.rosatom.ru/resources/25232a804a57ef1198719e13c5b23fe1/innov_pasport_2020.pdf.

trends which encourage setting a system of short-, mid- and long-term goals.

2. *Innovation activities*: It comprises a company's plans in the fields of technology, development of business processes, and cooperation with the external environment. Further, each area is divided into a number of sub-areas (e.g. cooperation with universities, industrial clusters, technological platforms, SMEs etc.).
3. *Markets*: Here, a technology roadmap provides scenarios of domestic and international market developments, forecasts competitors' development, and suggests strategy for each segment.
4. *Key performance indicators (KPIs)*: For each aspect mentioned in layer 2, special KPIs are suggested. A system of general KPIs would present economic indicators like energy efficiency and labour productivity.
5. *Financing*: A special layer is devoted to the financial aspects of implementing IDPs based on the scenario approach.
6. *Risk analysis*: Identification of major risks is crucial for successfully implementing the innovation activities of SOEs.

Technology roadmaps can serve as a basis for SOEs' decision-making processes, addressing such questions as the development of new technologies, the main areas of investment, and the ways of expanding cooperation among different actors (Vishnevskiy et al., 2015; Khripunova et al., 2014). The fact that technology roadmaps are public documents which can be used by a number of stakeholders mean that they are a powerful tool for government STI policy that positively contributes to improvements in national competitiveness (Kindras et al., 2014; Karasev and Vishnevskiy, 2013).

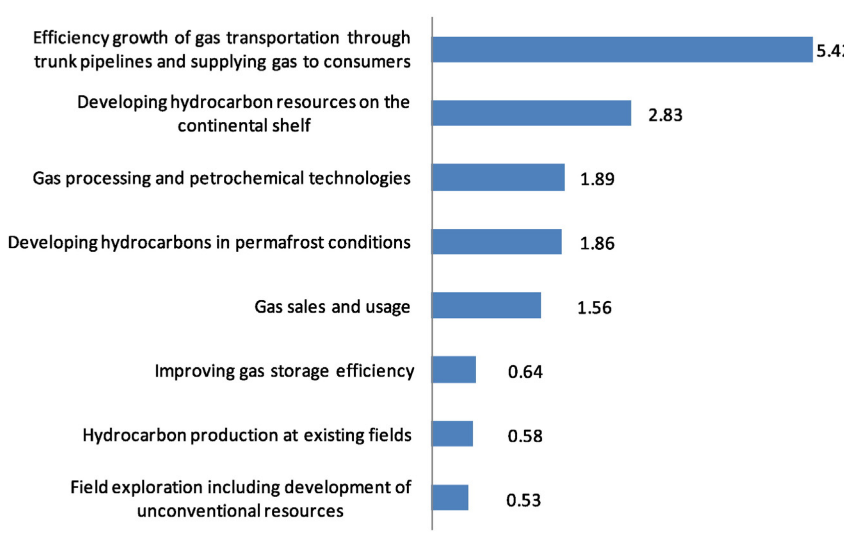

Fig. 5. Technology priorities of Gazprom by NPV: 2011 (USD billion). Source: Innovation development programme of Gazprom. http://www.gazprom.ru/f/posts/97/653302/programma-razvitia.pdf.

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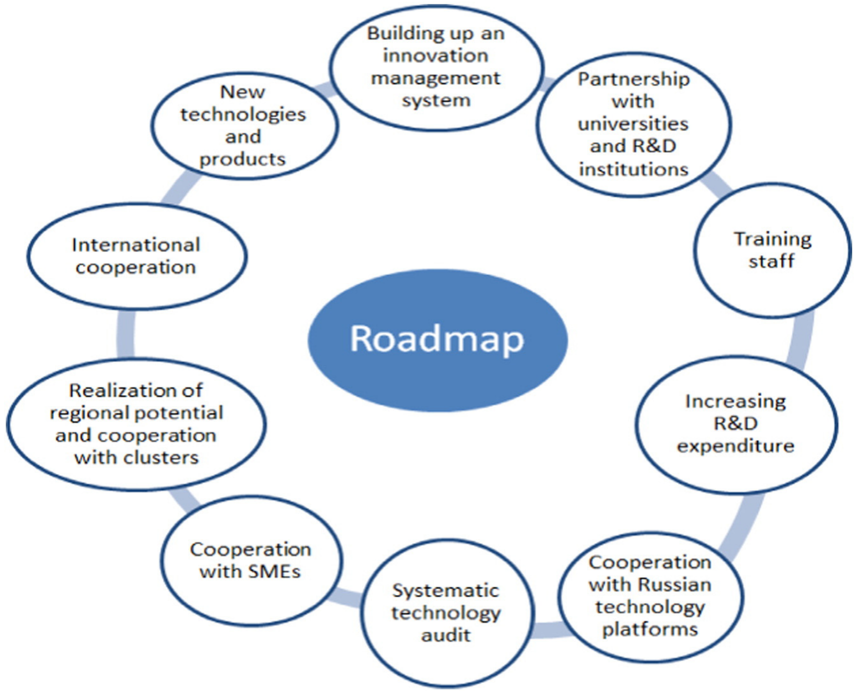

Fig. 6. Issues addressed in the innovation development programmes of SOEs.

9. Conclusions

In this paper, we looked at the use of corporate foresight and technology roadmapping tools by the largest Russian SOEs. In most of them, the system of long-term technology planning does not exist explicitly, due to various reasons. The main factor affecting such planning is non-innovative market priorities and STI goals of the surveyed companies whose current concerns are that of modernization and of selling traditional and innovative products inside Russia. Other obstacles include a commitment to public procurement and SOEs' management structure, which is unsuitable for long-term technology planning.

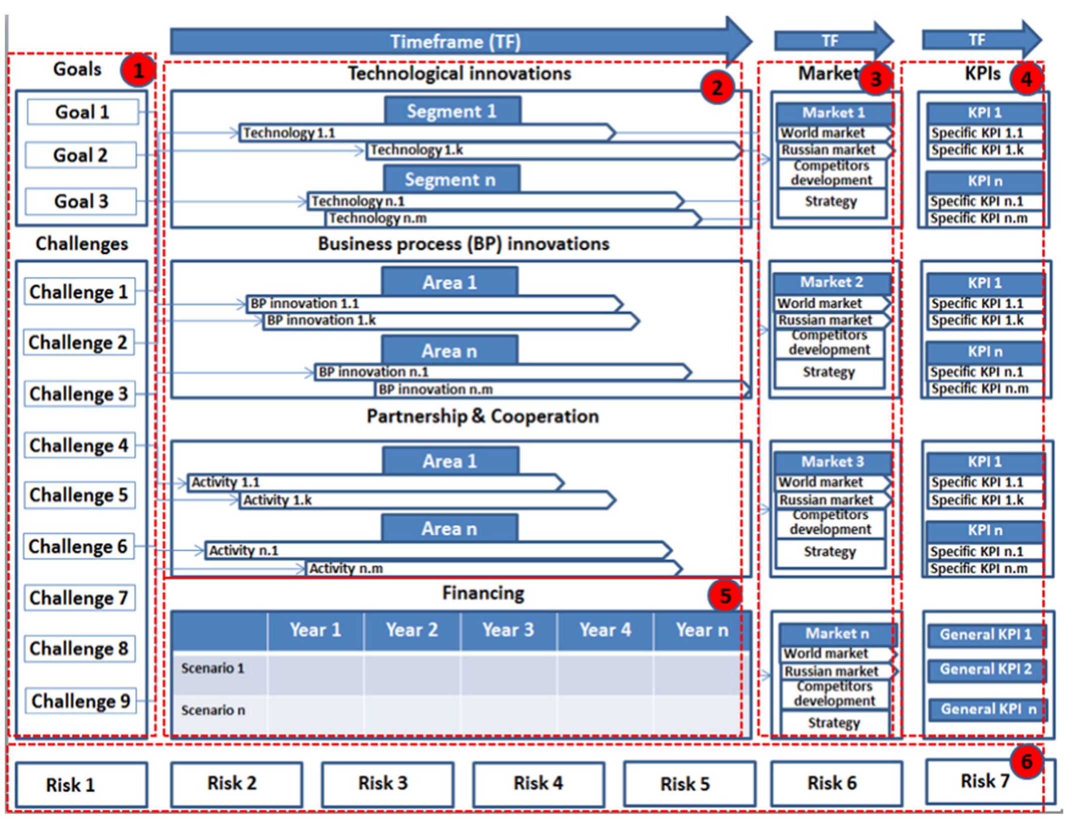

Fig. 7. Basic scheme of technology roadmap for SOEs.

Please cite this article as: Gershman, M., et al., The role of corporate foresight and technology roadmapping in companies' innovation development: The case of Russian state-owned..., Technol. Forecast. Soc. Change (2015), http://dx.doi.org/10.1016/j.techfore.2015.11.018

This paper has described several examples of best practices, particularly the cases of Rosatom, Gazprom, and Aeroflot. The first two of these companies have a long tradition of technology forecasting and have a large S&T base, including a number of branch R&D organizations. Technology roadmapping is used largely when dealing with large-scale projects and preparing forecasts of the future value of technologies. Aeroflot, which is different in terms of structure and traditions, is still very receptive to new management practices, and – to date – its specifically developed roadmap guides most of the company's innovations.

Based on these case studies, we suggest a common structure of a technology roadmap suitable for SOEs. The proposed model corresponds to the renewed Government recommendations elaborated in 2015 when the second stage of implementation of IDPs began. These new guidelines are based on the experiences gained during 2011–2014. The focus of the government is now on strengthening strategic planning alongside designing and implementing innovation strategies. The SOEs should now attempt a transition from bottom-up planning (when the programme rests upon suggestions from the divisions of companies) to top-down planning based on long-term priorities. This transition requires regular strategic analysis in the field of innovation, technology monitoring, foresight, and benchmarking.

In the opinion of the government, because SOEs are major actors in the economy (in terms of their investments and contributions to GDP), their implementation of innovation development programmes may boost technology development in certain sectors. Thus, smart allocation of resources in different technology fields can be achieved by developing strategic marketing and S&T foresight exercises which, in turn, will determine priority setting, top-down planning of innovative development, and stronger involvement of SOEs in government strategic planning.

According to the new government recommendations, SOEs should also consider the opportunities of development in and the use of such technologies as additive technologies, modelling and managing complex systems, robotics, energy saving technologies, new materials development, photonics, medical and biotechnologies, and mining and refining technologies.

Closer collaboration of SOEs with 'sectoral' ministries and agencies, which develop S&T forecasts and set technology priorities in different sectors of the economy, may have synergistic effects. Thus, technology roadmaps can play a crucial role in achieving such effects as they facilitate not only companies' internal operations but also their effective cooperation with the external environment.

Acknowledgements

The authors are grateful to Imogen Wade for editing and proofreading assistance.

The article was prepared within the framework of the Basic Research Programme at the National Research University Higher School of Economics (HSE) and supported by a subsidy granted to the HSE by the Government of the Russian Federation for the Implementation of the Global Competitiveness Programme.

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