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ASSESSMENT OF DEMAND AND SUPPLY OF SCIENTIFIC AND TECHNICAL INFORMATION IN THE CONTEXT OF FORECASTING TECHNOLOGICAL TRENDS

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Abstract

Each year, an increasing number of countries base their innovation development strategies on forecasts of scientific and technological development. There are numerous methods for forecasting technological trends, with the STI proposal being a key indicator. This article presents an improved methodology for forecasting technological trends, which includes an analysis of not only the supply of STI but also the demand for it.

In particular, it is proposed to supplement the method based on the analysis of the STI proposal with statistics on the volume of STI user requests on the Internet and in scientific and technical libraries for the necessary keywords related to the object under study.

By comparing the dynamics of STI data in Belarus with current global trends, it is possible to assess the interests of the domestic scientific community in various areas of research and identify the most significant of them. Studying the dynamics, structure and territoriality of demand for STI and comparing these data with the STI supply makes it possible to assess the degree of satisfaction of needs in STI. Based on the STI supply, specialists can draw conclusions about the possible emergence of new technologies and product groups in a certain forecast period.

The results of such analysis can be used to more accurately predict technological trends.

Keywords: methodology, forecasting technology trends, state system of scientific and technical information, scientific and technical information.

ОЦЕНКА СПРОСА И ПРЕДЛОЖЕНИЯ НАУЧНО-ТЕХНИЧЕСКОЙ ИНФОРМАЦИИ В КОНТЕКСТЕ ПРОГНОЗИРОВАНИЯ ТЕХНОЛОГИЧЕСКИХ ТРЕНДОВ

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Реферат

Ежегодно все большее число стран, основываясь на прогнозах научно-технологического развития, выстраивают свою стратегию инновационного развития. Существует множество методов прогнозирования технологических тенденций, основным показателем которых выступают предложения НТИ. В статье представлена усовершенствованная методика прогнозирования технологических тенденций, включающая анализ не только предложения НТИ, но и спроса на нее.

В частности, предлагается дополнить метод, основанный на анализе предложения НТИ, статистикой объемов запросов НТИ пользователей в Интернете и в научно-технические библиотеки по необходимым ключевым словам, относящимся к исследуемому объекту.

Сопоставляя динамику данных по НТИ в Беларуси с актуальными мировыми тенденциями, можно оценить интересы отечественного научного сообщества к различным направлениям исследований, выделить наиболее значимые из них. Изучение динамики, структуры и территориальности спроса на НТИ и сопоставление этих данных с предложением НТИ дают возможность оценивать степень удовлетворенности потребностей в НТИ. Исходя из предложения НТИ, специалисты могут делать выводы о возможном появлении в определенном прогнозном периоде новых технологий и товарных групп.

Результаты такого анализа могут быть использованы для более обоснованного прогнозирования технологических тенденций.

Ключевые слова: методология, прогнозирование технологических тенденций, государственная система научно-технической информации, научно-техническая информация.

Introduction

Due to the increasing role of innovations in the development of national economies [1, 2, 3], the demand for forecasts of innovative and scientific-technological development as a tool of strategic management is growing [4]. Such forecasts allow identifying trends in the development of technologies, assessing the prospects for the emergence of new markets, and also exploring production and personnel capabilities and challenges. The obtained forecasting results help to determine priority areas of technological development, develop scenarios for economic growth and optimize investment risks [5].

As world practice shows, developing and especially developed countries regularly design forecasts of scientific and technological development. In the Russian Federation, since 2013, forecasts of scientific and technological development have also been developed on a regular basis, the latest of which was the Forecast of Scientific and Technological Development of the Russian Federation until 2030. In the Republic of Belarus, a Comprehensive Forecast of Scientific and Technological Progress of Belarus for 2026–2030 and for the period until 2045 (hereinafter – CF STP 2045) has been developed.

One of the common methods used to forecast technological trends is based on studying the dynamics and structure of scientific publications and registered patents, i.e. on the analysis of the STI proposal both on a global scale and by comparing this data for individual countries [6, 7, 8]. By comparing the dynamics of data in Belarus with the corresponding global trends, it is possible to assess the interest of the domestic scientific community in various areas of research and identify the most relevant ones. Based on the STI proposal, specialists can draw conclusions about the possible emergence of new technologies and product groups in a certain forecast period.

The purpose of this study is to improve the methodology for forecasting technological trends by including not only an analysis of the supply of STI, but also an analysis of the demand for STI.

1. Analysis of the dynamics of the STI proposal in the CF STP 2045

The method of forecasting technological trends based on the STI proposal (hereinafter referred to as the STI proposal method) was used along with other methods in the development of the Comprehensive Forecast of Scientific and Technological Progress of the Republic of Belarus for 2026–2030 and for the period until 2045 [9].

The CF STP 2045 presents a list of forecasting objects, which are understood as innovative goods, product groups and technologies.

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For each forecasting object, the values of parameter groups were determined: global trends in publications and patents; world market capacity; the state of the infrastructure of the Republic of Belarus. The first two groups of parameters characterized the demand for the forecasting object in the forecast period, the third group of parameters – the feasibility of the forecasting object in the forecast period.

Global trends in publications and patents for each forecast object were assessed based on an analysis of scientific publications in foreign sources and patents in foreign patent databases. For this purpose, the number of foreign publications and international patents for the previous 5 years was determined for each forecast object.

The group of parameters characterizing the feasibility of the object also included such parameters as the domestic scientific publications and patents in bibliographic and patent registers, databases and other STI resources.

As an example, Figures 1–4 shows data on the forecasting object "System for assessing transport flow parameters based on processing navigation data on vehicle movement" (hereinafter referred to as the "Assessment system...") from the CF STP 2025, which was implemented in 2018 [10], the methodology of which will make it possible to determine the capacity of the road network, the efficiency of using the existing network, the volume and structure of transport demand.

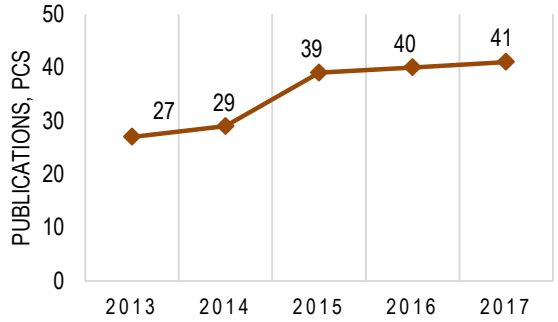

Figure 1 – Dynamics of international publications on the forecast object "Assessment system…"

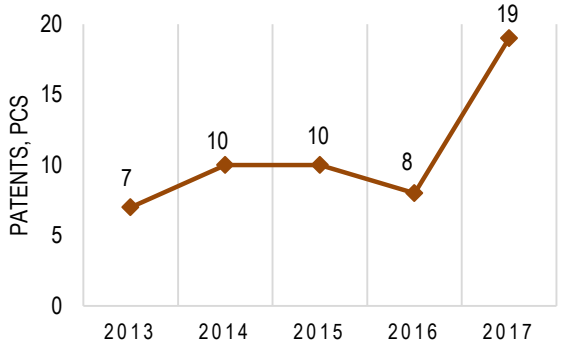

Figure 2 – Dynamics of international patenting for the forecast object "Assessment system…"

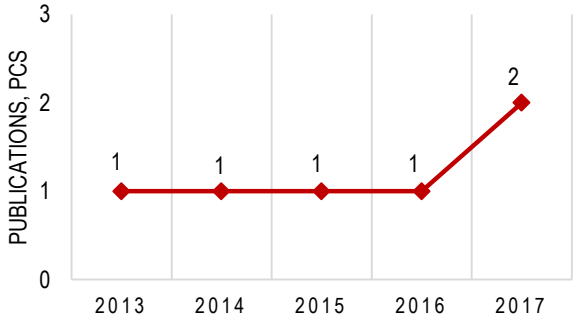

Figure 3 – Dynamics of publications in the Republic of Belarus for the forecast object "Assessment system…"

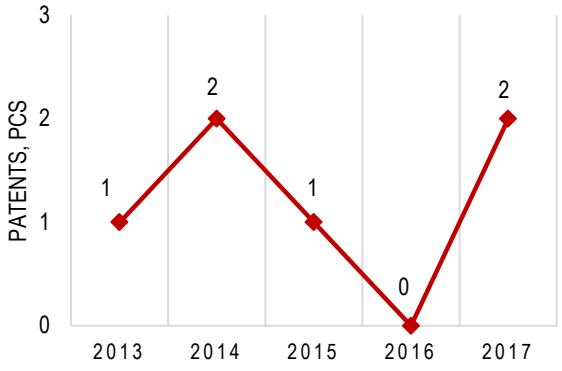

Figure 4 – Dynamics of patenhting in te Republic of Belarus for the forecast object "Assessment system…"

Figures 1–2 show that the activity in international publications and patents increases annually in relation to the forecasting object under consideration. In turn, Figures 3–4 show low activity in the field of publications and patents in the Republic of Belarus. It can be concluded that there is high interest in the forecasting object in the international scientific community and that this object has great prospects as an innovative product. From the graphs in Figures 3–4 it follows that the reserve in the country is low, and taking into account global prospects, it is worth assessing the possibility and feasibility of research in this direction.

2. Analysis of the dynamics of demand for STI

It is necessary to distinguish between the demand for STI and the supply of STI. As already stated above, the supply of STI is understood as published scientific works and registered patents both in paper and electronic form. The demand for STI is understood as a set of search queries aimed at finding scientific and technical information (search among STI offers). Accordingly, the demand for STI can serve as an indicator of the demand for certain areas of STI.

In the forecasting method described above, based on studying the STI supply, the basis for further forecasting is the already created and publicly available STI (STI supply). However, modern information technologies allow not only to analyze the STI already available in the public domain (i.e., the STI supply), but also to study the volumes of search queries for STI in various categories, made both in global and local networks (i.e., the demand for STI). Studying the dynamics, structure, and territoriality of STI demand and comparing this data with the STI supply makes it possible to assess the degree of satisfaction of STI needs. The results of such an analysis can be used for more substantiated forecasting of technological trends.

Demand for STI can be tracked in various ways and by various organizations or individuals (individually). To perform a semantic search for data on the number of requests, it is necessary to define the keywords of the area of interest. Data on the number of queries is searched for on the internet using various specialized program that show user query activity: *Google trends, Google Analytics, Google Ads, Keyword Tool, Key Collector, Wordstat* and etc.

These software resources allow you to see the demand of Internet users for STI by specified keywords. They display statistics: on the dynamics, structure and territoriality of demand. It is necessary to mention a particular feature of these systems: they do not include information on the dynamics of queries made before 2004.

The methodology outlined above should also be supplemented with statistics on user queries to scientific and technical libraries for the necessary keywords related to the studied STI object.

As an example, Figure 5 provides data on the STI object "Artificial Intelligence" (hereinafter referred to as AI). The given figure shows the dynamics of publications of scientific articles and registration of patents as a percentage of the base year 2004 for the period 2004–2022. It also shows the dynamics of Internet user requests for this STI object as a percentage of the base year 2004.

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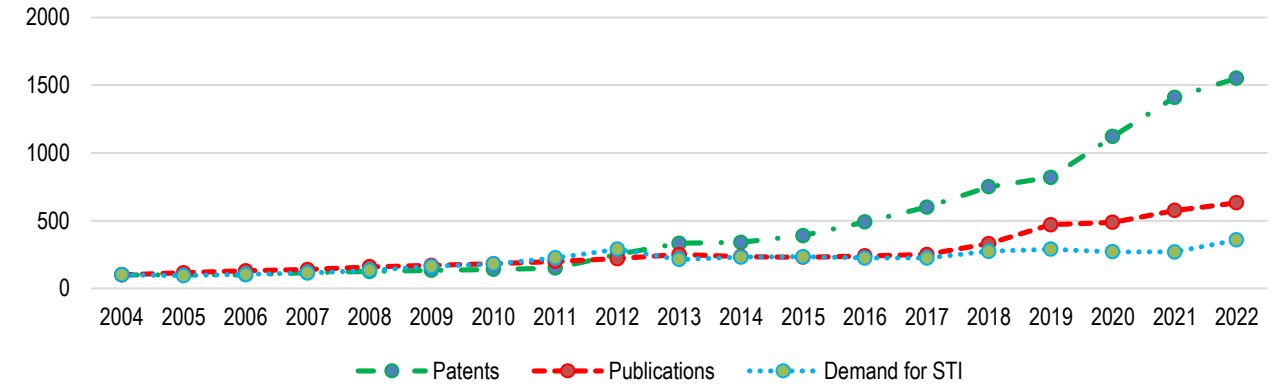
а) In the period 2004–2022.



б) In the period 2009–2014.

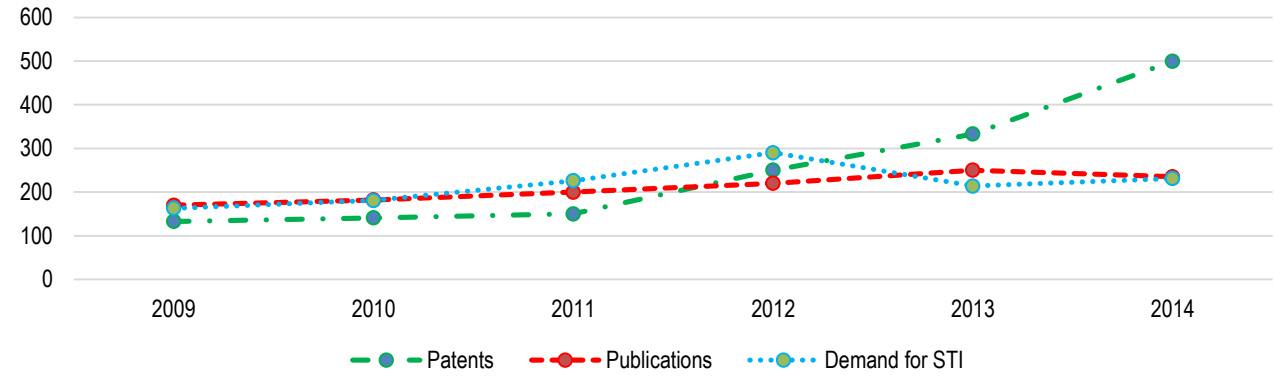


Figure 5 – Dynamics of STI demand for the STI object "*Artificial Intelligence*" [11]

From Figure 5 it is evident that the growth rate of demand for STI and the supply of STI for the STI object under consideration practically repeat each other's dynamics with a supply lag of an average of 1 year.

This situation can be explained as follows: To research a given topic or develop a new project, a scientific team needs to explore a specific area, which consequently leads to an increase in demand for STI. The next stage involves preparing a scientific paper and submitting it for publication (or preparing a patent application). Occasionally, there may be a surge in demand for STI, which is driven by a new discovery or a change in approach within the research area. Figure 6 shows a surge in user queries related to the STI object "Artificial Intelligence."

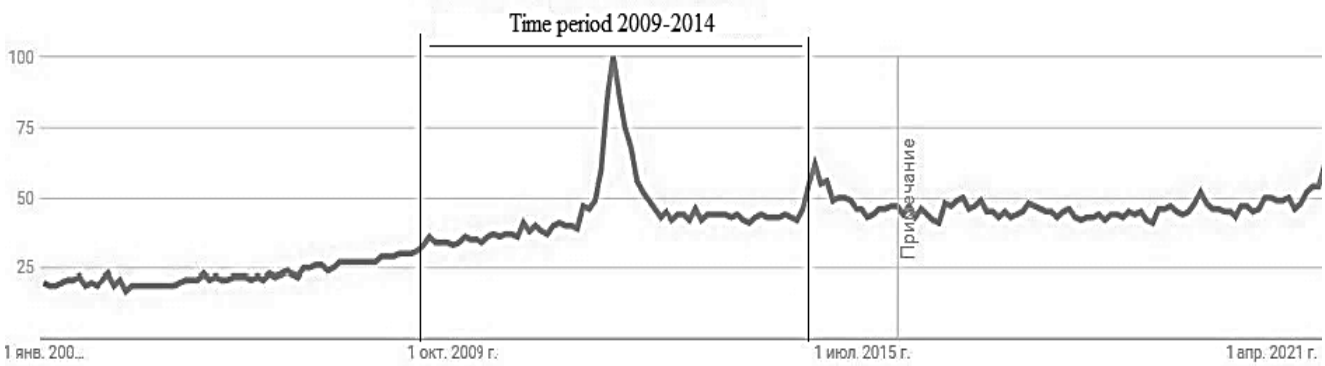


Figure 6 – Activity graph for the STI object "*Artificial Intelligence*" in the period 2004–2021, displayed in the *Google trends* [12]

A surge in STI queries is noted starting in 2010. This increase is linked to the growth in computer processing power, which enabled the combination of Big Data with Deep Learning methods based on artificial neural networks. Subsequently, this led to the successful application of artificial intelligence in many fields (such as speech and image recognition, natural language understanding, autonomous vehicles, etc.), which, in turn, marked a resurgence of AI [13].

Similarly, we can consider the demand for STI in the area of Big Data.

Figure 7 shows the growth of activity in the mentioned object since 2011, which is caused by the trend related to the analysis of big data by scientific universities within the framework of scientific and statistical research. By early 2012, the volume of data had grown to massive scales, creating a need for its systematization and practical application.

From 2014 onwards, leading global universities specializing in applied engineering and IT disciplines began to focus on Big Data. Subsequently, IT corporations such as Microsoft, IBM, Oracle, and EMC, followed by Google, Apple, Facebook, and Amazon, became involved in data collection and analysis. Today, large industry companies and government agencies utilize Big Data.

The demand for the STI object "Big Data" can be examined not only on a global scale but also within individual countries.

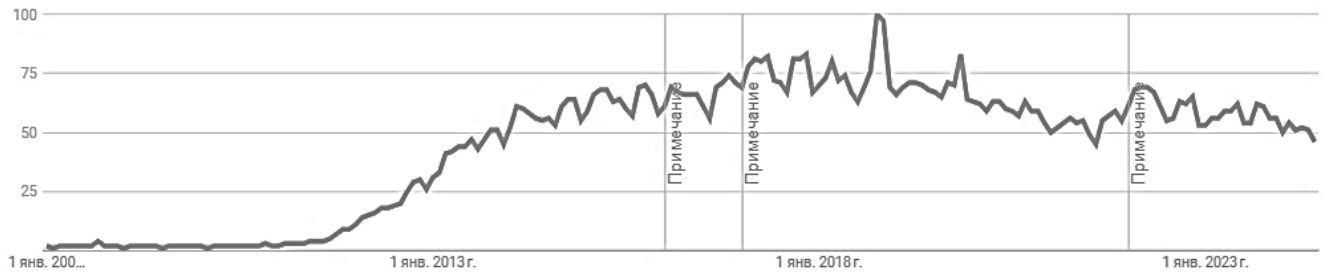


Figure 7 – Activity graph for the STI object "Big Data" in the period 2008–2024, displayed in the *Google trends* [12]

The dynamics of STI queries in the Russian Federation clearly show a surge in interest in the research object (Figure 8). This is evident, as in 2019, 68 % of organizations tested the implementation of Big Data analysis tools, which is recognized as the most frequently adopted technology in Russian companies [14].

It is also useful to compare the demand for STI across different countries and then rank them, which involves identifying potentially developed countries and those developing in various research areas.

When comparing the demand for STI related to Big Data in South Korea (Figure 9) and the Russian Federation (Figure 8), it is noticeable that the surge in South Korea occurred in 2017, while in Russia, it was at the end of 2019. The difference in the timing of the demand surge for the research object allows us to infer which country is potentially developed and which is developing in this direction.

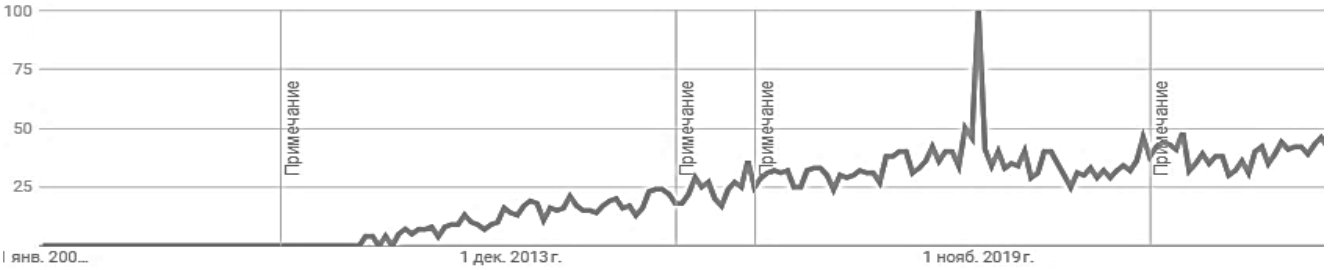


Figure 8 – Graph of activity in the Russian Federation for the STI object *"Big Data"* in the period 2008–2024, displayed in the *Google trends* program [12]

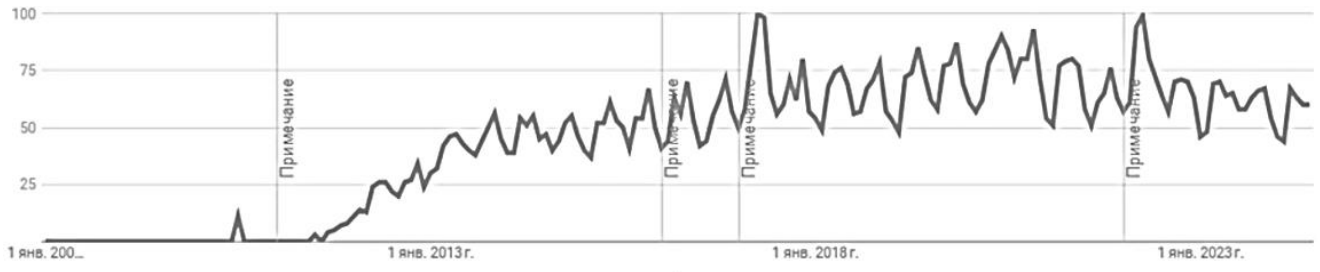


Figure 9 – Graph of activity in the Republic of Korea for the STI object "*Big Data*" in the period 2008–2024, displayed in the *Google trends* program [12]

3. Collection and analysis of data on supply and demand of STI in the State System of Scientific and Technical Information of the Republic of Belarus

As is well known, the vast amount of scientific and technical documentation generates enormous information flows, which are increasing annually. Consequently, there is a growing need for the development of effective STI monitoring systems. For example, a large amount of new digital information is created globally each year [15]: in 2018 alone, approximately 33 zettabytes (10^{21} bytes) were generated, and between 2020 and 2021, humanity produced more information than in all of previous history. Furthermore, the volume of generated information is expected to continue increasing each year. According to forecasts, by 2025, the annual global volume of generated information may reach 175 zettabytes (Figure 10) [15].

The above information indicates colossal information flows that require study. For these purposes, specialized systems have been created and are successfully operating in a number of technologically advanced countries. The Republic of Belarus is no exception.

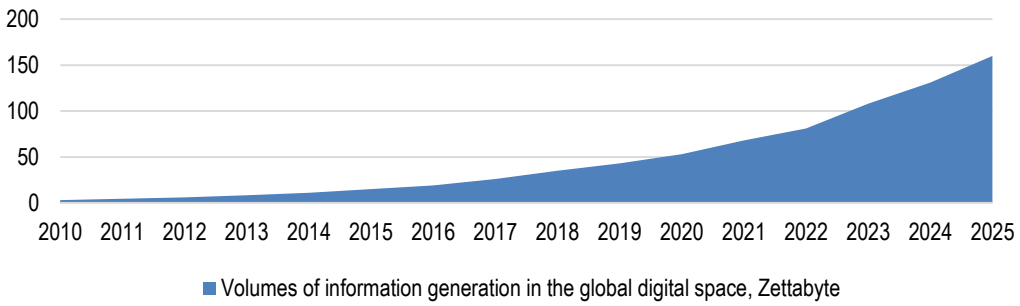


Figure 10 – Dynamics of generation of new information in the global digital space (2010–2025)

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Currently, Belarus has a functioning State System of Scientific and Technical Information (SSTI), which includes: republican information centers; library infrastructure; industry-specific STI centers and services; regional STI centers; a system for publishing and distributing scientific and technical literature; and an information and telecommunication infrastructure. The primary tasks of these components are the collection, storage, and dissemination of STI [16, 17, 18, 19].

Empowering the SSTI of the Republic of Belarus with the capability to analyze the dynamics and structure of the demand for and supply of scientific and technical information will allow to use this data in forecasting scientific and technological progress. Analyzing STI demand will enable the comparison of STI demand with its supply and facilitate the early identification of emerging technological trends.

It would also be beneficial to develop an information system that automatically tracks surges in demand for STI to identify new technological trends at their formative stage. This would allow for the anticipation of technological trends approximately one year earlier compared to the analysis of STI supply alone.

The obtained data can also be utilized by research organizations when forming prospective research and development plans, where labor savings can be achieved by reducing research work on less promising areas [20, 21].

Conclusion

Each year, an increasing number of countries conduct forecasts of scientific and technological development to determine priority areas for national economic development scenarios and to optimize and reduce investment risks. The Republic of Belarus is no exception.

In our country, forecasting methods based on the analysis of the STI supply are used. This method was used in the Comprehensive Forecast of Scientific and Technological Progress of Belarus for 2026–2030 and up to 2045. It is based on studying the dynamics and structure of scientific publications and registered patents both globally and by comparing this data across countries, which allows to identify global development trends. The domestic scientific publications and patents is another important parameter used in this method to assess the feasibility of a forecasting object**.**

The method based on STI supply analysis can be supplemented with statistics on STI query volumes from users on the internet and in scientific and technical libraries using relevant keywords related to the research object. Studying the dynamics, structure, and territorial distribution of STI demand and comparing this data with the STI supply makes it possible to assess the extent to which STI needs are being met. The results of such analysis can be used for more substantiated forecasting of technological trends.

Given the functions and tasks, as well as the departmental structure, it is advisable to assign the responsibilities for monitoring and analysing STI demand to the State System of Scientific and Technical Information (SSTI).

This innovation will improve the efficiency and accuracy of forecasts of scientific and technological progress conducted in the Republic of Belarus.

References

1. Gurskij, V. L. Formirovanie edinogo nauchno-tekhnologicheskogo prostranstva Soyuznogo gosudarstva: potencial uchastnikov, mekhanizmy, perspektivy / V. L. Gurskij, E. V. Presnyakova, M. B. Petrov // Ekonomicheskaya nauka segodnya : sb. nauch. st. / Belorus. nac. tekhn. un-t. – Minsk, 2022. – Vyp. 16. – S. 141–152.
2. Guc, YU. V. Sfera nauki v kontekste formirovaniya intellektual'nogo kapitala / YU. V. Guc, A. V. Bondar' // Nauch. tr. / Belorus. gos. ekon. un-t. – Minsk, 2021. – Vyp. 14. – S. 115–122.
3. ZHukovskaya, O. YU. Sushchnost', formirovanie i osobennosti ocenki nacional'nyh innovacionnyh ekosistem / O. YU. ZHukovskaya // Nauka i innovacii. – 2022. – № 8. – S. 51–56.
4. SHumilin, A. G. O perspektivah nauchno-tekhnicheskogo i innovacionnogo razvitiya Respubliki Belarus' (sostoyanie, problemy, puti resheniya) / A. G. SHumilin // Sistema «nauka – tekhnologii – innovacii»: metodologiya, opyt, perspektivy : materialy Mezhdunar. nauch.-prakt. konf., Minsk, 1 dek. 2016 g. / Centr sistem. analiza i strateg. issled. NAN Belarusi ; redkol.: V. V. Goncharov (otv. red.) [i dr.]. – Minsk, 2016. – S. 4–12.
5. Solodovnikov, S. YU. Modernizaciya belorusskoj ekonomiki i ekonomika riskov: aktual'nye problemy i perspektivy / S. YU. Solodovnikov, T. V. Sergievich, YU. V. Meleshko. – Minsk : Belorus. nac. tekhn. un-t, 2019. – 491 s.
6. Zianchuk, M. Foresighting technological and innovative development of Belarus / M. Zianchuk, I. Saltanova // MEST Journal. – 2020. – № 2 (8). – P. 192–199. – DOI: 10.12709/mest.08.08.02.22.
7. Zianchuk, M. Uneven development of production innovations and consumer innovations and its conse-quences for economic growth / M. Zianchuk // Vestnik of Brest State Technical University. – 2023. – No. 3(132). – P. 99–102.
8. SHlychkov, S. V. Metodologicheskie osnovy razrabotki Kompleksnogo prognoza nauchno-tekhnicheskogo progressa Respubliki Belarus' / S. V. SHlychkov, N. F. Zen'chuk, I. V. Saltanova // Novosti nauki i tekhnologij. – 2018. – № 4 (47). – S. 10–18.
9. Gosudarstvennoe uchrezhdeniya Belorusskiy institut sistemnogo analiza i informatsionnogo obespecheniya nauchno-tekhnicheskoy sfery. – URL: http://www.belisa.org.by/ru/KPNTP (data obrashcheniya: 25.07.2024).
10. Kompleksnyj prognoz nauchno-tekhnicheskogo progressa Respubliki Belarus' na 2021–2025 gg. i na period do 2040 g. / pod red. A. G. SHumilina. – Minsk : GU «BelISA», 2019. – 750 s.
11. Elsevier. – URL: https://www.elsevier.com/?a=823654 (data obrashcheniya: 15.09.2022).
12. Trends.google. – URL: https://trends.google.ru/trends/explore?date=all&q=AI (data obrashcheniya: 15.09.2023).
13. United Nations Educational, Scientific and Cultural Organization. – URL: https://ru.unesco.org/courier/2018-3/iskusstvennyy-intellekt-mezhdu-mifom-i-realnostyu (data obrashcheniya: 15.09.2023).
14. DELOVOY PROFIL [site]. – URL: https://delprof.ru (data obrashcheniya: 08.07. 2024).
15. Reinsel, D. The digitization of the world from edge to core: an IDC white paper – #US44413318 / D. Reinsel, J. Gantz, J. Rydning // Seagate. – URL: https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf (data obrashcheniya: 14.12.2023).
16. Makarevich, S. V. Improving SSTI for innovative economic development: experience of Belarus / S. V. Makarevich // Management, Economics, Education, Science & Society Technologies. – № 2020. – № 2 (8). – P. 130–136.
17. Kosovskij, A. A. Razvitie gosudarstvennoj sistemy nauchno-tekhnicheskoj informacii Respubliki Belarus' / A. A. Kosovskij // Razvitie informatizacii i gosudarstvennoj sistemy nauchno-tekhnicheskoj informacii : RINTI – 2018 : XVII Mezhdunar. konf., Minsk, 20 sent. 2018 g. : doklady / Ob"ed. in-t problem informatiki NAN Belarusi ; nauch. red.: A. V. Tuzikov, R. B. Grigyanec, V. N. Vengerov. – Minsk, 2018. – S. 6–9.
18. Makarevich, S. Rol' gosudarstvennyh resursov nauchno-tekhnicheskoj informacii v usloviyah formirovaniya innovacionnoj ekonomiki / S. V. Makarevich // Sistema «Nauka – tekhnologii – innovacii» : metodologiya, opyt, perspektivy» : materialy Mezhdunar. nauch.-prakt. konf., Minsk, 23–24 sent. 2021 g. / Centr sistemnogo analiza i strategicheskih issledovanij NAN Belarusi. – Minsk, 2021.– S. 299–302.
19. Ugrinovich, E. V. Preodolenie negativnyh trendov, ugroz i riskov v processe formirovaniya mezhdunarodnoj informacionnoj infrastruktury nauki i obrazovaniya / E. V. Ugrinovich, D. V. Mun, D. V. Popeta // Sistema «nauka – tekhnologii – innovacii»: metodologiya, opyt, perspektivy : materialy Mezhdunar. nauch.-prakt. konf., Minsk, 26–27 okt. 2017 g. / Centr sistem. analiza i strateg. issled. NAN Belarusi ; redkol.: V. V. Goncharov (otv. red.) [i dr.]. – Minsk, 2017. – S. 54–64.
20. Bajnev, V. F. Poleznostnyj metod analiza nauchno-tekhnicheskoj deyatel'nosti / V. F. Bajnev, S. V. Makarevich // Ekonomicheskaya nauka segodnya : sb. nauch. st. / Belorus. nac. tekhn. un-t. – Minsk, 2023. – Vyp. 17. – S. 41–50.
21. Bajnev, V. F. Resursno-poleznostnyj podhod k obespecheniyu tekhnologicheskoj bezopasnosti Respubliki Belarus' / V. F. Bajnev, S. V. Makarevich // Nauka i innovacii. – 2023. – № 5. – S. 27–32.

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