

COMMON STI PRIORITIES FOR A GROUP OF COUNTRIES: THE BRICS CASE

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Abstract

The identification of common science, technology and innovation (STI) priorities for a group of countries is a complex task since it has to meet national priorities and socio-economic peculiarities and should be presented in several dimensions. The article describes results of the study aimed at identification of the overall system of STI priorities of the BRICS countries, it used a comprehensive system of foresight methods, including the analysis of relevant national strategic documents, the survey and consultations with leading experts from the BRICS countries, big data analysis, bibliometric and patent analysis. Based on the results of this analysis, a consolidated list of 14 national STI priorities for the BRICS countries has been developed, which were further subdivided in 74 detailed thematic areas. They have a wide range of practical applications and create an opportunity to realize competitive advantages (territory, available resources, S&T capacities, etc.). Finally, this study provides the proposals on the mechanisms for implementing priorities, including a draft programme and a road map for STI co-operation.

Keywords: common STI priorities; international STI cooperation; BRICS.

Introduction

During the last decades, research and development (R&D) activities have been increasingly characterised by a larger scale, interdisciplinary nature, global coverage and a greater role in innovation development. Despite the substantial growth of R&D expenditures in developing countries, none of them can conduct comprehensive research across the full range of subject areas. Accordingly, valid priority setting in the science, technology and innovation (STI) becomes particularly important (which affect scientific and socio-economic development paths alike) both at the national level and within the supranational alliances in order to join efforts and complement each other's strengths. Therefore, building a common system of STI cooperation priorities for a group of countries is becoming an increasingly relevant objective.

This requires establishing a reliable information basis for shaping a common agenda, based on comprehensive analysis of the countries' S&T capacities and socio-economic objectives. It implies advancing the existing approaches to priority setting, and adapting them to identify common areas where joining various countries' forces could, among other things, produce significant synergies.

The paper proposes a number of methodological solutions for setting common S&T development priorities for the case of BRICS countries, taking into account each member state's strengths, and drafting a common S&T agenda, which would be relevant to all of them.

Priority setting principles and selection criteria

Setting common STI development priorities for a group of countries is a complex methodological task, which requires designing a specific approach taking into account each participant's interests and abilities, to identify R&D areas whose accelerated development could be achieved due to synergies produced by joining various countries' resources. Development of a common system of priorities implies broad complementarity, which would help to meet current S&T challenges, and overcome the existing barriers by strengthening exchanges and cooperation between the participating countries, making full use of their potential, experience, and best practices.

Approaches based on Foresight methodology currently play the main role in setting STI development priorities on the national and international levels, while the priorities tend to be primarily oriented towards dealing with strategic national or global problems (see Gokhberg et al., 2016). Such priorities are set in the framework of designing long-term strategies for sustainable socio-economic development of specific countries, and major supranational alliances, based on multi-lateral assessment and optimisation of their possible contribution to sustainable socio-economic development, and competitiveness. In recent years, such approaches were commonly applied in many countries and, to a less extent, in international alliances.

Methodology of, and mechanisms for setting and implementing international-level priorities are constantly being improved and developed in order to meet new challenges reflecting global development trends. Studies aimed at assessing STI development prospects, designing approaches to priority setting, and implementing relevant strategies also play a major role in the OECD's activities (OECD 2010; 2012).

A significant contribution to development of approaches to common priority setting was made by the European Union in the scope of designing and implementing a series of framework research, technological development, demonstration, and innovation activities programmes (BILAT-USA, 2010). Since 1 January 2014, the European Union is implementing a new framework programme, Horizon 2020¹. Priority is given to high-performance technologies including environmental, nano-, bio-, and information technologies oriented towards solving key socio-economic problems (such as development of green energy, transport, climate change, and ageing population). The programme's priorities were set on the basis of the results of broad (and focused) Foresight projects covering more important S&T development areas, in specific European countries and on the EU level generally². The EU also carried out foresight projects aimed to identify STI cooperation priorities with other countries (see, for example, Guy, 2007 and Haegeman et al., 2015).

At the same time, EU represents a single economic space with a common financial system, which makes the process of selecting priorities more understandable. In the case of the alliance of individual countries, which do not have such complex interrelations, special methodology should be identified moving on to the forefront of their cooperation agenda (see BRICS, 2015, 2017).

Approaches based on Foresight methodology play a major role in STI priority setting activities in all BRICS countries (see Shashnov, Poznyak, 2011; Chan, Daim, 2012; Sokolov, Chulok, 2016; Cagnin, 2014; Li, 2009; Pouris, Raphasha, 2015). The selected priorities are oriented towards dealing with strategic socio-economic and S&T development issues. Relevant stakeholders are

¹ See more details on: http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020

² See more details on <http://ec.europa.eu/research/foresight/index.cfm> and <http://www.foresight-platform.eu>

involved in priority setting to make sure these issues are adequately covered, including public authorities, businesses, and the academic community.

Broad circle of experts also participate in priority setting, actively applying various quantitative and qualitative analytical techniques. Application of the abovementioned approaches results in lists of priority areas and critical technologies, and long-term S&T development foresight reports.

This strategic focus was also applied to design methodologies for building and testing a system of common S&T development priorities for a group of countries, using the BRICS (Brazil, Russia, India, China, and South Africa) as a case. The objective was to design a *common system of thematic and functional priorities* oriented towards dealing with key socio-economic development issues, relevant to all countries in the group (Georghiou and Harper, 2011).

Thematic priorities are S&T fields investing in which could make a biggest contribution to solving major social and economic problems in the medium to long term. In this respect thematic priorities are frequently set in the form of national-level critical technologies lists, but such lists may also be prepared for specific industries, subject areas, and regions while functional priorities are activities (policy areas) whose objectives include further development and improvement of the R&D sphere and the innovation system aiming at identifying the national innovation system's "problem areas" and relevant policy tools, e.g. accelerated development of universities' R&D potential; upgrading research personnel, etc.

The proposed methodological approaches allow identifying common S&T areas whose development would make the biggest contribution to accomplishing the BRICS countries' major STI objectives. This, in turn, implies identifying areas where countries – potential partners have not only a significant S&T potential, but also economic interest in cooperation. Those are the areas where joining forces can be expected to produce substantial synergies.

The building a common system of S&T development priorities for a group of countries (common priority system) should on the one side be oriented towards accomplishing the countries' more important common socio-economic development objectives and their competitive advantages (such as S&T potential, available resources, completed R&D groundwork, etc.), and on the other side take into account major global STI development trends. Priorities should be selected as a limited number of first-order S&T areas to concentrate the available resources on for common time horizon, typically 10 years. Efficient STI policy tools should support priorities implementation. These principles are applied by using a system of criteria to select common priorities. The more important of them include the following:

- priority areas' relevance, in particular:
 - potential to make a major contribution to the country's economic growth (increased competitiveness in domestic and international markets, relevance for numerous industries and interdisciplinary S&T areas, potential to create new high-tech jobs, etc.);
 - potential to make a contribution to solving social problems;
 - potential to make a contribution to achieving technological security;
- scope for priority areas' implementation, in particular:
 - availability of financial resources;
 - human resources;
 - availability of S&T groundwork results;

- availability of relevant production facilities and equipment.

This approach implies the need to develop a methodology, which would integrate goals and objectives set in the official international and national documents adopted by the countries – members of the group with assessment of their S&T capacities and opinions of expert communities in all relevant countries.

The applied methodology

In line with the above principles and criteria for developing a shared methodology for setting common S&T development priorities for the BRICS countries, tools best suited for accomplishing this objective were selected out of the broad range of available quantitative, qualitative, and mixed Foresight techniques. The information required to conduct analysis was also collected keeping in mind the relevant objectives.

Sequential application of complex of methods (scanning and literature review, bibliometric and patent analysis, Big Data analysis, surveys, interviews, expert panels) allowed building a system of common S&T development priorities for the BRICS countries, in line with the following scheme (figure 1).

1. Analysis of information resources.
2. Basic working materials.
3. Priority setting.

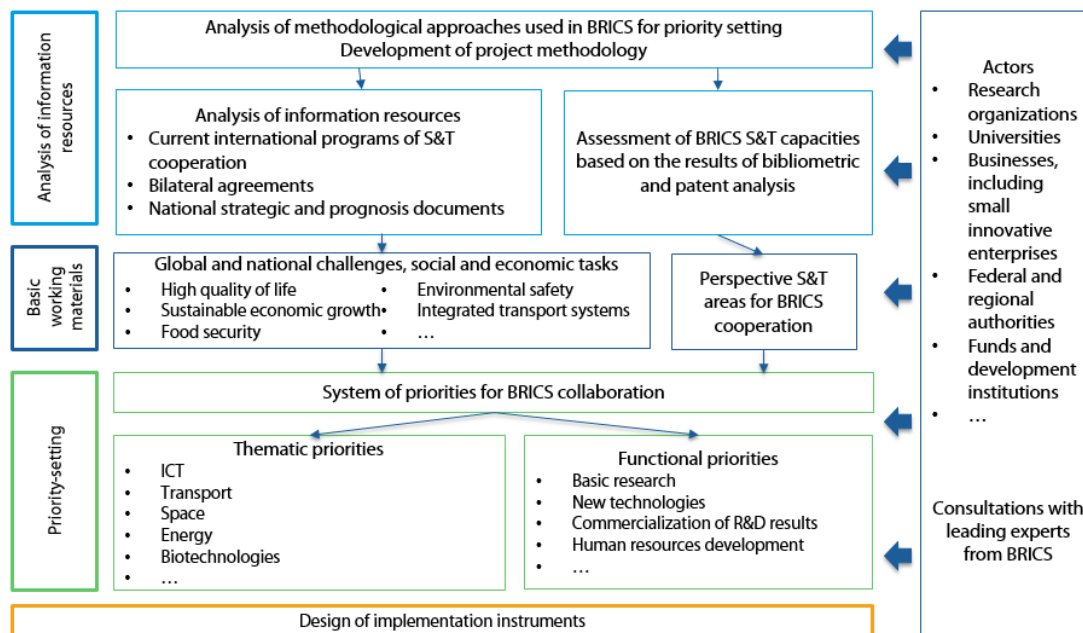


Figure 1. Setting priorities for S&T cooperation of a group of countries: key elements

Brief description of project stages is presented below.

1. Analysis of information resources

At the first stage, the information basis was built, comprising more than 150 strategic documents of the BRICS countries, which set out R&D areas deemed to be particularly important for the group of countries under consideration, and prospective areas for their S&T cooperation, including:

- BRICS countries' official documents on S&T cooperation signed by their governments, or government ministries responsible for shaping and implementing STI policies;
- strategic national documents on BRICS countries' STI development, including STI plans, programmes, strategies, missions, visions, roadmaps, initiatives, priority lists;
- forecasts and Foresight studies reports to assess the BRICS countries' STI development prospects;
- other documents describing socio-economic and S&T trends and challenges relevant for the BRICS countries.

At this stage, experts also were recruited. The specialists to take part in the survey were selected using the Scopus citation database. All joint publications by authors from BRICS countries published between 2005-2017 matching the 14 priority areas were identified in the Scopus database.

2. Basic working materials (drafting a list of major common subject areas and thematic fields for the BRICS countries)

A list of general documents on bilateral and multilateral cooperation between Russia and the BRICS countries was drafted using the above information, reflecting various S&T development priorities. Next, the S&T areas were identified supporting which would contribute to accomplishing common to the BRICS countries socio-economic, S&T, and innovation development objectives. To this end, a summary table was compiled, presenting all the wordings of the relevant priorities in the original documents on bilateral and multilateral cooperation. The BRICS countries' national-level strategic documents were subjected to similar analysis, to identify relevant thematic and functional priorities – which were also presented in the summary table format (similar to the one for international documents).

Synthesis of these two tables produced a list of major common S&T development areas for the BRICS countries, reflecting all the key S&T areas currently being promoted by two or more BRICS countries. The final summary table was based on an analysis of the thematic priorities' wordings presented in the abovementioned initial tables, in line with the criteria adopted for their selection.

The selected areas are considered as priorities by all, or practically all BRICS countries, since they were identified from national strategic documents (strategies, strategic plans, five year plans, initiatives, mission statements, etc.), or from bilateral or multilateral agreements signed by the BRICS countries.

At the next stage, the selected broad S&T development areas were broken down into thematic fields. Typically, each S&T areas was divided into 4-7 thematic fields, to reflect its most important aspects.

The resulting list of thematic fields relevant for the BRICS countries was validated and adjusted in the course of consultations with the BRICS countries' experts, both face-to-face and through expert polling.

Later on, the selected thematic fields' importance for the BRICS countries was assessed, along with available R&D capacities of each country.

3. Priority setting (Selecting S&T areas by analysing their relative importance and the BRICS countries' national R&D capacities).

Prospective thematic fields for BRICS countries' collaboration (or second-level priorities) were identified by calculating and analysing their importance, and the BRICS countries' R&D capacity indices (figure 2).

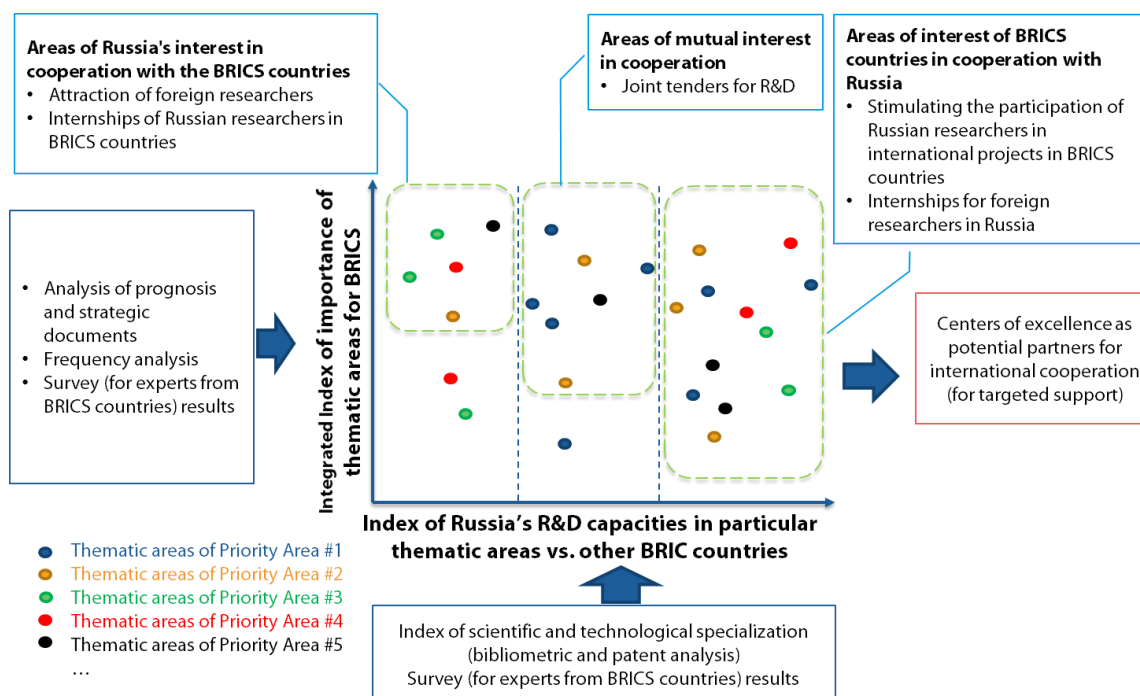


Figure 2. Flow chart of prospective thematic fields' selection

Thematic fields' Importance Index varies between 0 and 1, and is calculated on the basis of the following:

- frequency of references in international documents on BRICS countries' collaboration, and in national strategic documents;
- expert polling in BRICS countries.

Integrated index of importance of a thematic area for BRICS countries is based on:

- data on the importance of thematic areas derived from results of survey of experts from BRICS countries (with the weight of 80%);

- data about mentioning of keywords³ related with the thematic area in news feeds (more than 20 mln. news items were proceeded) (with the weight of 0.15%);
- data about mentioning of keywords related with thematic area j in English-language STI policy documents of BRICS countries (near 100 full text documents) (with the weight of 0.05%).

Integrated index of importance of thematic area j for BRICS countries is calculated as follows.

$$\begin{aligned} \text{Integrated BRICS importance index } j \\ = 0.8 \times \text{Importance index}_{i \text{ average } j} + 0.15 \times \text{Norm ment}_{\text{industr periodic } j} + 0.05 \\ \times \text{Norm ment}_{\text{policy docs } j} \end{aligned}$$

Where *Importance index_{i average}* – average value of individual indices of importance of thematic areas among five BRICS countries; *Norm ment_{industr periodics}* - measure of normalized mentioning of keywords related with thematic area in news feeds; *Norm ment_{policy docs}* - measure of normalized mentioning of keywords related with thematic area in English-language STI policy documents of BRICS countries.

Mentioning of keywords was counted as follows. In a specific news item or English language STI policy document we count all mentions of all keywords related with thematic area j. If in a specific news item/STI policy document one keyword related with thematic area j was mentioned one time we count it as one mention of thematic area j. If in a specific news item/STI policy document 15 keywords related with thematic area j were mentioned in sum e.g. 335 times we count 335 mentions of thematic area j in this news item/STI policy document⁴.

Normalized mentioning of keywords related with thematic area j in news feed and English-language STI policy documents varies from 0 to 1 and is calculated as follows:

- For the thematic area with minimum (among all 74 thematic areas) number of mentions of keywords we set the value of normalized mentioning of keywords as 0;
- For the thematic area with maximum (among all 74 thematic areas) number of mentions of keywords we set the value of normalized mentioning of keywords as 1.

Thematic areas' Importance Index is based on quantification of the experts' responses to question "Estimate the importance of this thematic area for your country", with five options: 1 - Very

³ For each of 74 thematic are we set the list of keywords (from 8 to 47 keywords per thematic area) that in best way describe and characterize it. E.g. for thematic area 1.1. "High-performance computing architectures and systems" we set the following list of 21 keywords: supercomputer; blockchain; parallel computing; metacomputing; alternative architecture; data center; system architecture; NoSQL; exascale; petascale; quantum computer; high performance calculating; high performance computing; cloud computing; cloud service; cloud infrastructure.

⁴ Number of mentions of the studied 74 thematic areas in news feed varies from 220 mentions (thematic area 7.3. Technologies for small and medium power reactors) to 911 583 mentions (thematic area 6.4. Technologies for creating new light sources and intelligent lighting systems). 22 out of 74 thematic areas received more than 100 000 mentions in news feed. Number of mentions of the studied 74 thematic areas in English language STI policy documents of BRICS countries varies from no (i.e. zero) mentions for 10 thematic areas to 480 mentions (thematic area 10.1. Climate change and extreme climatic events forecasting technologies). 37 thematic areas out of 74 received less than 10 mentions in STI Policy documents. Only six thematic areas received more than 100 mentions in STI policy documents.

low; 2 – Low; 3 – Medium; 4 – High; 5 - Very high; Difficult to estimate. For country i and thematic area j the Importance Index is calculated as follows:

$$\begin{aligned} \text{Importance index}_{ij} &= (N \text{ resp}_{\text{very high } ij} \times 1 + N \text{ resp}_{\text{high } ij} \times 0.75 + N \text{ resp}_{\text{medium } i} \times 0.5 \\ &+ N \text{ resp}_{\text{low } ij} \times 0.25 + N \text{ resp}_{\text{very low } ij} \times 0) \div (N \text{ resp}_{\text{total } ij} \\ &- N \text{ resp}_{\text{diff ans } ij}) \end{aligned}$$

Where $N \text{ resp}_{\text{very high } ij}$ is the number of respondents from country i who selected “Very high” option for thematic area j ; $N \text{ resp}_{\text{high } ij}$ is the number of respondents from country i who selected “High” option for thematic area j ; $N \text{ resp}_{\text{medium } i}$ – the number of respondents from country i who selected “Medium” option for thematic area j ; $N \text{ resp}_{\text{low } ij}$ – the number of respondents from country i who selected “Low” option for thematic area j ; $N \text{ resp}_{\text{very low } ij}$ – the number of respondents from country i who selected “Very low” option for thematic area j ; $N \text{ resp}_{\text{total } ij}$ – the total number of respondents from country i who answered the question for thematic area j ; $N \text{ resp}_{\text{diff ans } ij}$ – the number of respondents from country who selected “Difficult to estimate” option for thematic area j .

The R&D Capacity Index in relevant thematic fields varies between 0 and 1, and is calculated on the basis of the following:

- expert polling (taking into account specific countries’ R&D capacities in particular thematic fields, and references to the country as a leader);
- bibliometric analysis (taking into account the R&D Specialisation Index, and citation and publication activity figures);
- patent analysis (taking into account the Technological Specialisation Index).

$$\begin{aligned} \text{R\&D capacity index}_{ij} &= (RCA \text{ Index}_{ij}^{\text{norm}} + RTA \text{ Index}_{ij}^{\text{norm}} + FWCI_{ij}^{\text{norm}} + \text{Leadership index}_{ij} \\ &+ BRICS \text{ collab partners index}_{ij}) \div 5 \end{aligned}$$

Where $RCA \text{ Index}_{ij}^{\text{norm}}$ – is normalized relative comparative advantage index (index of scientific specialization); $RTA \text{ Index}_{ij}^{\text{norm}}$ – is normalized relative technological advantage index (index of technological specialization); $FWCI_{ij}^{\text{norm}}$ – is normalized filed weighted citation impact index; $\text{Leadership index}_{ij}$ – is index of the country’s leadership in a particular thematic area; $BRICS \text{ collab partners index}_{ij}$ – is specific country’s importance index as potential collaboration partner for BRICS countries.

To set the RCA, RTA and FWCI indices’ maximum value to 1.00 for each specific thematic area we normalize the initial value of all these indices. Normalization is done as follows: for each specific thematic area we divide the value of the RCA/RTA/FWCI of specific BRICS country by the maximum value of the RCA/RTA/FWCI among BRICS countries for this specific thematic area.

The country’s Leadership Index in a particular thematic area, and Importance Index as a potential collaboration partner for the BRICS countries are based on quantification of replies by almost 900 experts who have participated in a survey to assess the prospects for S&T cooperation of

the BRICS countries, and tools for such collaboration. Countries Leadership Index in a particular thematic area (*Leadership index_{ij}*) is based on quantification of the experts' replies to the question "Estimate the S&T capacity of your country compared with that of countries – leaders in this thematic area", with four answer options: 1. Cutting edge; 2. Average performer; 3. Lagging behind; 4. Difficult to estimate. For country *i* and thematic area *j* this index is calculated as follows:

$$Leadership\ index_{ij} = \frac{N\ resp_{lead\ edg\ ij} \times 1 + N\ resp_{aver\ perf\ ij} \times 0.5 + N\ resp_{lag\ beh\ ij} \times 0}{N\ resp_{total\ ij} - N\ resp_{diff\ answ\ ij}}$$

Where $N\ resp_{lead\ edg\ ij}$ is the number of respondents from country *i* who selected "Cutting edge" option for thematic area *j*; $N\ resp_{aver\ perf\ ij}$ – the number of respondents from country *i* who selected "Average performer" variant of answer for thematic area *j*; $N\ resp_{lag\ beh\ ij}$ - the number of respondents from country *i* who selected "Lagging behind" option for thematic area *j*; $N\ resp_{total\ ij}$ – the total number of respondents from country *i* who answered the question for thematic area *j*; $N\ resp_{diff\ answ\ ij}$ - the number of respondents from country who selected "Difficult to estimate" option for thematic area *j*.

Countries' Importance Index as a potential collaboration partner for the BRICS countries (*BRICS collab partners index_{ij}*) is based on quantification of the surveyed experts' answers to the question "For this thematic area select no more than two BRICS countries who in your opinion have the best prospects for scientific collaboration with". For country *i* and thematic area *j* this index is calculated as follows

$$BRICS\ collab\ partners\ index_{ij} = \frac{N\ resp_{country\ ij}}{\max_i N\ resp_{country\ ij}}$$

$N\ resp_{country\ ij}$ is the number of respondents who selected country *i* in his/her answer for thematic area *j*; $\max_i N\ resp_{country\ ij}$ – the BRICS country selected by the maximum number of respondents for thematic area *j*.

To set STI priorities for Russia cooperation with other countries there was also calculated index of the national R&D capacities of Russia in comparison with other BRICS countries.

Russian R&D capacity index in relation to that of other BRICS countries' for specific thematic area *j* (*R&D capacity index_{Russia vs. BRICS j}*) is calculated as follows:

$$R\&D\ capacity\ index_{Russia\ vs.\ BRICS\ j} = \frac{R\&D\ cap\ ind_{diff\ Rus-BRICS\ j} - \min_j R\&D\ cap\ ind_{diff\ Rus-BRICS\ j}}{\max_j R\&D\ cap\ ind_{diff\ Rus-BRICS\ j} - \min_j R\&D\ cap\ ind_{diff\ Rus-BRICS\ j}}$$

where $R\&D\ cap\ ind_{diff\ Rus-BRICS\ j}$ is the measure of differences in values of indexes R&D capacities of Russia and four other BRICS countries (Brazil, India, China, South Africa) in thematic area *j*. This indicator is calculated as follows:

$$R\&D\ cap\ ind_{diff\ Rus-BRICS\ j} = R\&D\ capacity\ index_{Rus\ j} - R\&D\ capacity\ index_{aver\ other\ BRICS\ j}$$

where $R\&D\ capacity\ index_{Rus\ j}$ – index of national R&D capacity of Russia in thematic area j ;
 $R\&D\ capacity\ index_{aver\ other\ BRICS\ j}$ – average value of indexes of national R&D capacity of four other BRICS countries (Brazil, India, China, South Africa) in thematic area j .

Primary data for calculating these indices was collected through a specially organised expert polling exercise, and by using techniques such as Big Data analysis, bibliometric and patent analysis. Comprehensive analysis of the various set of indicators of publication and patent activity of BRICS countries in Scopus (including RCA index and FWCI index) can be found in Sokolov et al. (2017).

The experts were polled to obtain their assessment of the drafted priority area and thematic field lists regarding two crucial aspects:

- thematic fields' importance for accomplishing key national STI development objectives; and
- the countries' R&D capacity compared with that of world leaders'.

About 900 experts altogether were involved in the polling exercise.

On the basis of the bibliometric and patent analysis, expert polling, and Big Data analysis the importance and R&D capacity indices were calculated for all thematic fields, and applied to identify common priorities for the BRICS countries.

Thus the common priority system (subject areas and thematic fields) was built using a flexible methodology which allowed, depending on specific objectives, to apply a broad range of quantitative, qualitative and mixed analytical techniques, and involve various experts and stakeholders.

The BRICS countries S&T development priorities

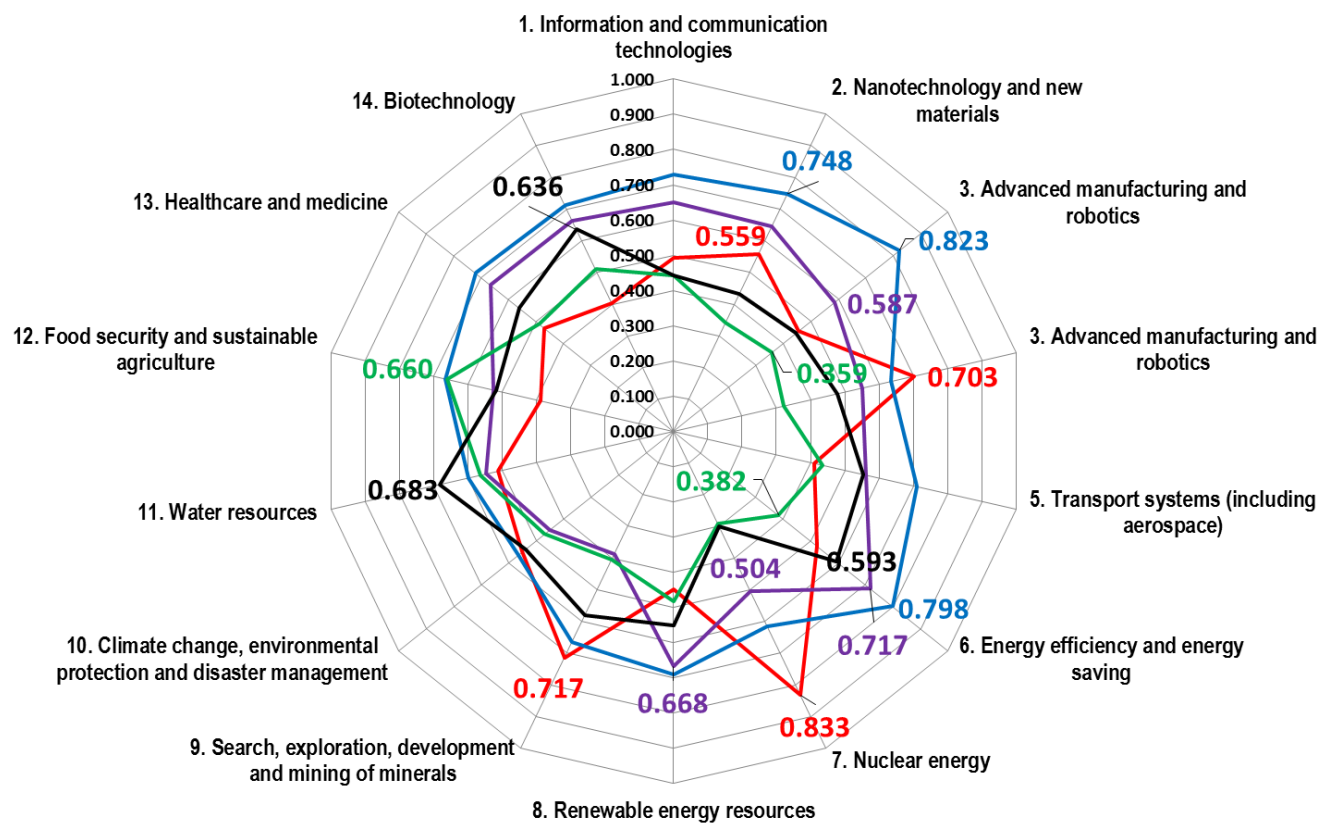
The final list of S&T priorities for the BRICS countries drafted on the basis of analysing forecasts and strategic documents followed by expert consultations, comprised the following areas:

- information and communication technologies;
- nanotechnology, and next-generation materials;
- advanced production technologies, and robotics;
- space systems, and astronomical observations;
- transport systems;
- energy efficiency and energy saving;
- nuclear energy;
- renewable energy sources;
- exploration, prospecting, developing, and mining of natural resources;

- climate change, environment protection,, managing natural disasters;
- water resources, and their usage;
- food security, and sustainable agriculture;
- health and medicine;
- biotechnology.

The selected areas are considered as priorities by all, or practically all BRICS countries, which is confirmed by their strategic national documents (strategies, strategic plans, five-year plans, initiatives, mission statements, etc.). The areas have a wide range of practical applications, and open opportunities for making use of the countries' competitive advantages. This priority system also has a scope for broad complementarity, which would help to deal with the existing S&T problems and limitations through more active exchanges and closer cooperation between member countries, application of their accumulated experience and best practices. Most of these areas are characterized by high importance indices (figure 3).

Index of national R&D capacities



Index of Importance of priority areas

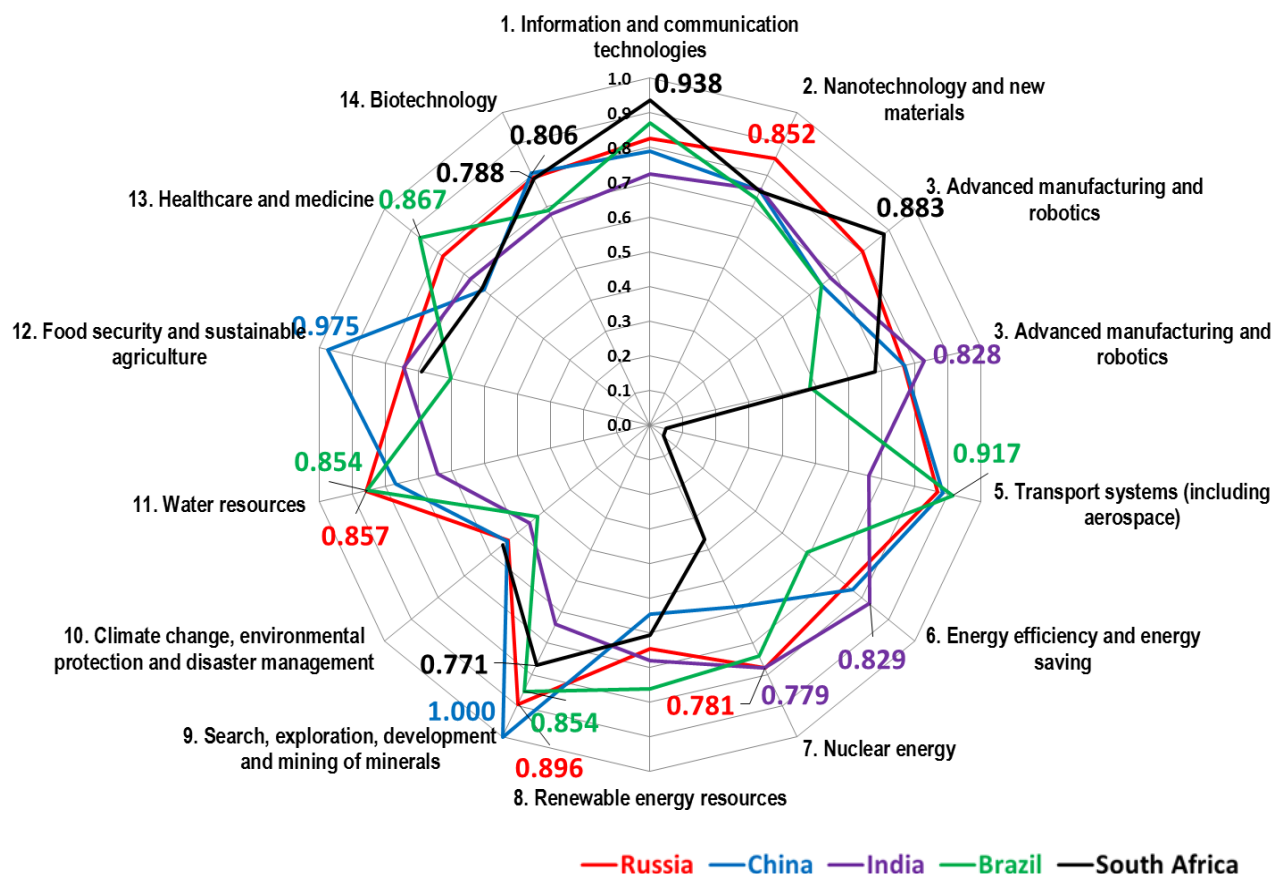


Figure 3. Profiles of BRICS countries by priority areas characteristics

The identified priorities and thematic areas determine the directions for cooperation between any of the BRICS countries and other countries of the group. Further, it is illustrated on Russia's case.

For the thematic fields identified within the priority S&T areas, importance and countries' R&D capacity indices were calculated, and applied to draft a list of thematic fields with the best prospects for Russia's collaboration with the BRICS countries. Over 70 second-level areas were identified altogether, grouped into three blocks depending on Russian R&D capacity in relation to that of other BRICS countries' (figure 4):

- areas where Russia is interested in collaboration with BRICS countries (Block 1);
- areas of mutual interest in cooperation (Block 2);
- areas where BRICS countries are interested in collaboration with Russia (Block 3).

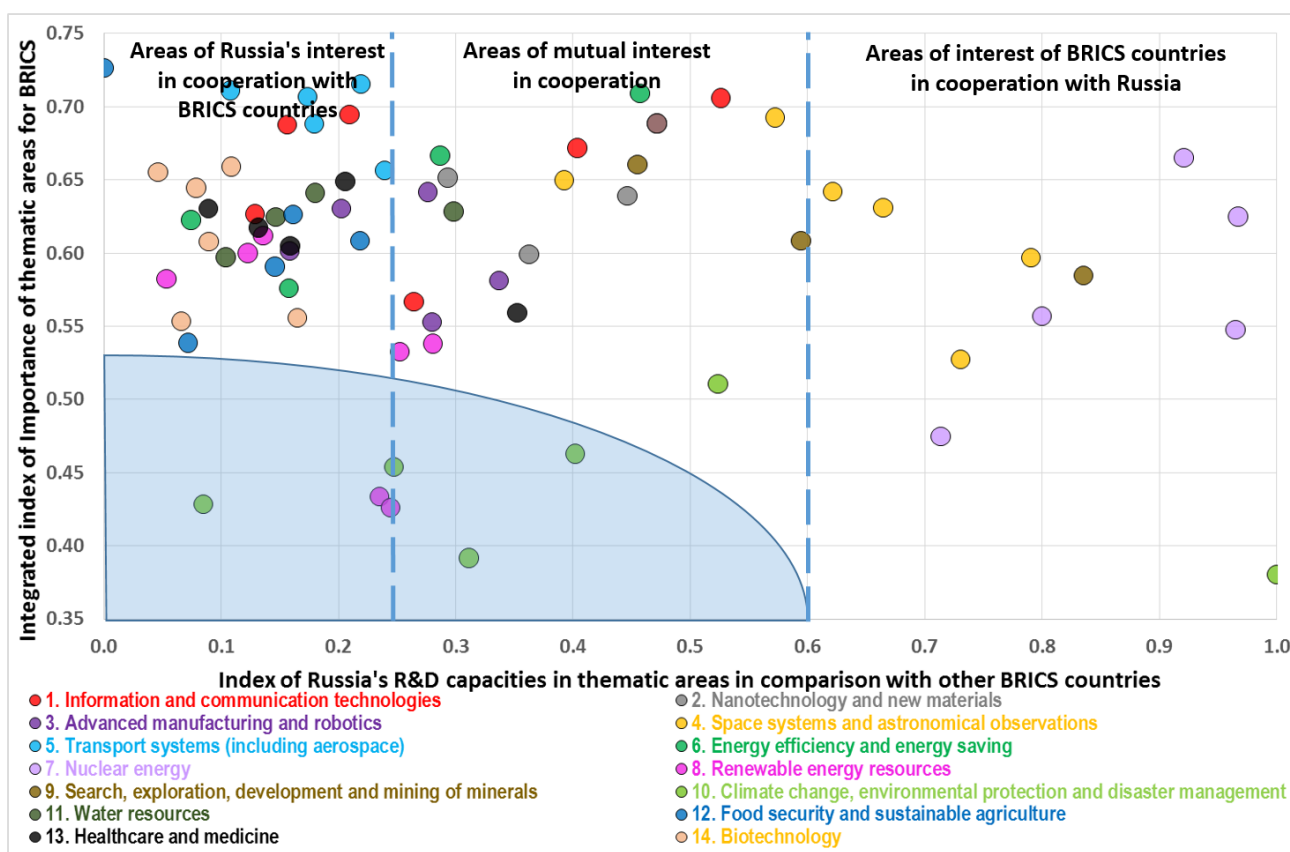


Figure 4. Priority system for BRICS countries' international S&T collaboration

As an example, table 1 presents the ranking of thematic fields in the Information and Communication Technologies priority area.

Table 1. Importance, and R&D Capacity Indices for thematic fields of the Information and Communication Technologies priority area

Thematic field	Importance Index	Russia's R&D Capacity Index	Priority type
1. High-performance computing architectures and systems	0,71	0,53	Block 2
2. Technologies, and communication infrastructures for high-speed data transfer	0,67	0,40	Block 2
3. Data analysis and processing technologies, artificial intelligence	0,69	0,16	Block 1
4. Human-machine interfaces, neural and cognitive technologies	0,57	0,26	Block 2
5. Smart control systems and smart infrastructures technologies, machine-to-machine interaction, internet of things	0,63	0,13	Block 1
6. Information security technologies	0,69	0,21	Block 1

Action, including implementation tools

The abovementioned priority area blocks served as a basis for suggesting relevant implementation mechanisms, including:

- opportunities for mutual cooperation between Russia and the BRICS countries;
- possible thematic areas for joint projects, and potential partners from the BRICS countries (specific companies, R&D centres, universities, etc.).

Best suited (from the experts' point of view) international collaboration tools and mechanisms were suggested for each priority area. The more important ones include the following:

- joint R&D projects;
- incoming and outgoing mobility of R&D personnel;
- information exchanges, maintaining joint data banks, providing access to scientific collections, archives, and libraries;
- setting up international R&D centres (e.g. Joint Nuclear Research Institute);
- joint projects to develop innovative technologies and promote S&T entrepreneurship.

The choice of specific tools to support international cooperation depends on particular subject areas, and the specific BRICS countries.

Finally, mechanisms for priority implementation were proposed, including a draft programme for S&T cooperation between Russia and BRICS countries and a relevant road map.

Conclusions

Given the tougher government budget limitations and the need to use resources more efficiently, setting long-term priorities for S&T cooperation among the BRICS countries becomes an increasingly relevant task. Priority areas for such cooperation should be selected taking into account the current state of domestic R&D activities compared with the world level, and their relevance to the national S&T priorities.

On the basis of our analysis we have identified three types of priorities for scientific and technological cooperation, depending on the interest Russia and the BRICS countries have in collaborating with each other, and suggested specific S&T policy tools for such cooperation.

The list of STI cooperation priorities for BRICS countries can be used to design interstate agreements between BRICS and other countries; R&D plans (roadmaps) and other policy tools, including BRICS STI Framework Programme. The 1st and 2nd Calls of this Programme have been successfully implemented and the 3rd Call is planned to launch.

Selected priorities form the basis for joint research projects and exploratory projects for innovative technologies, STI entrepreneurship development, and commercialisation of R&D results. BRICS cooperation will be more effective if it includes all the stages of the innovation cycle – from obtaining new fundamental knowledge to their use in the creation of new technologies, products and services and their entry into the market.

Subsequently the project results can be applied to build an information basis for use of various participants of the national innovation system, to help them quickly formulate topics for STI cooperation, find partners including research organisations, universities, and enterprises, and identify the most effective instruments for cooperation.

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