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CHALLENGES FACED BY THE BULGARIAN UNIVERSITIES IN THE CONTEXT OF SCIENCE – INDUSTRY RELATIONS

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Abstract. This study aims to present an analysis of the specifics and contemporary challenges faced by research universities in the context of Bulgaria's efforts to create conditions for the development of national science in coordination with and for the benefit of the national industry. The focus on scientific research must be considered in the context of distinguishing the *research universities* from the *non-research universities*, as well as the specialization of their academic staff in either *research professors* or *teaching professors*. The universities play a key role in achieving national goals and priorities. For these purposes, a clear strategic alignment is required between: (1) the areas of scientific research of the universities, (2) the specialization of the students educated by the universities, and (3) the strategically defined needs of the national industry for sustainable economic growth.

The implementation of such *long-term synergy science-industry* builds national competitiveness, achievable through: (1) strategic planning on the national level involving coordinated efforts of five competent ministries in Bulgaria: Ministry of Science and Education, Ministry of Innovation and Growth, Ministry of Economy, Ministry of Labor and social policies, and ministry of finance; (2) involvement in the strategic planning of the rectors of the leading Bulgarian universities, and (3) involvement of the associations of the most advanced industrial enterprises in the country. Such coordinated *strategic planning* aims to establish priority areas for accelerated economic growth, allocate resources, enhance specialization, and ensure national competitiveness in prioritized sectors of the national industry.

From the perspective of the role of research universities in creating national competitiveness, it is essential that university research must be directed towards the needs of the national industry and aligned with the strategic priorities of the Republic of Bulgaria. However, this expectation contradicts a fundamental principle enshrined in the Constitution of the Republic of Bulgaria, according to which universities enjoy "academic autonomy." The Higher Education Act also guarantees "academic self-governance" of the Bulgarian universities. This reality may lead to academic research in scientific areas that are not aligned with the imminent needs of any of the sectors of the national industry, such as energy, healthcare, transport, security, finance, etc. From a market perspective this could serve as an example of inefficient use of resources, time, and highly qualified labor without binding them with the needs of the national industry.

Considering this challenge from the perspective of supply and demand – the forces that make free market economies work – the most efficient areas for university research must be specified and clearly determined in a coordinated manner by the government and the national industry on a five- or ten-year basis *strictly aligned with the national strategic priorities*.

The research methods used in this study include the examination and synthesis of the application of the legal frameworks in the field of higher education in five leading highly developed countries (USA, UK, Germany, Japan and China), a comparative analysis in both theoretical and practical-applied contexts of internationally recognized best practices in the work of leading research universities, content analysis, as well as tabular and graphical data representation on the topic.

The research results provide key findings and conclusions, along with analytically supported recommendations on realistic and feasible measures that could be undertaken to enhance the efficiency and quality of science, education, and university research. These measures aim to enable a synergy between science and industry.

Keywords: priorities; research universities; strategy; science-industry relationship; education; business

Introduction

An old maxim from former US Senator Daniel Patrick Moynihan states, "If you want to build a great city, create a university and wait 200 years." (Times Higher Education, 2024). Numerous examples highlight universities' role in national development through their educational efforts to enhance societal qualifications systematically and, secondly, through their research efforts, which should be tied to national industry and sustainable economic development (Beev 2021). If the educational efforts of universities are to align with the dynamics of the labor market, their research efforts should reflect the needs of industry, both in national and global contexts.

Acknowledging this reality, the first 2 challenges (from the total number of 15 challenges) that the universities of Bulgaria face, as defined by the Strategy for the Development of Higher Education in the Republic of Bulgaria 2021–2030, are: (1) the accelerating dynamics of the labor market and (2) the increasing role of science and innovation in building a competitive national economy and solving societal problems.

Globally, the modern educational ecosystem generally includes two types of universities:

1. Research Universities: These institutions focus on **scientific research and its practical application** as a core part of their mission.
2. Non-Research Universities (Professional Universities): These institutions focus on **teaching** without additional requirements to produce indexed publications in new scientific directions, applied research, or patents.

The **relevance** of this study is associated with the fact that in the last several years, many non-research universities, especially those reliant on state funding, have shown a desire to transition into research universities gradually. Bulgarian universities are no exception to these global trends. Some of the primary reasons for this transformation stem from the visibility of universities participating in global ranking systems, and these ranking systems focus on quantitative and qualitative research criteria adopted on a global scale. These global rankings prioritize (1) **academic research outcomes** that can be compared across universities globally, rather than the results of (2) **student education outcomes** which may hardly be compared.

Professor Ellen Hazelkorn from Technological University Dublin (Ireland), a researcher of global rankings, criticizes this global situation, stating: “Although rankings purport to measure higher education quality, they focus on a limited set of attributes for which (internationally) comparable data is available. They are handicapped especially by the absence of internationally comparable data for teaching and learning, student and societal engagement, third mission, etc. This means that most global rankings focus unduly on research and reputation.” (Hazelkorn 2019).

However, despite the imperfections of the existing systems for ranking and assessing the impact of universities worldwide (Alexandrova 2024), the trend persists. This drives non-research universities to seek development as research universities, strongly focusing on scientific activity and innovation. They aim to attract industry interest and thus more resources for research projects and publish in reputable scientific journals with global impact factors.

Non-research universities, on the other hand, primarily concentrate on teaching and offering educational programs geared toward practical training and preparing students for the dynamics of the labor market (Kirilova 2023).

The criteria for evaluating the quality of universities’ research and educational processes vary across countries. Each nation develops its own assessment system reflecting its specific priorities in education, scientific research, and national industry and business development. Intensive research work must lead to high patent application activity and an ever-growing patent portfolio (Nachev et al. 2024).

The **subject** of the research is the specific challenges that Bulgarian universities face today, and the **aim** of the study is to examine the relevant practice in the leading countries on several continents and based on the findings to summarize recommendations for the universities in the Republic of Bulgaria.

Several Bulgarian researchers **have studied different aspects of the subject topic** in specialized academic publications, including Matilda Alexandrova (societal impact of research related to sustainability), Dimitar Velev and Dimitar Dimitrov (AI-based education for reaching sustainable development), Alla Kirova and Irena Zareva (academic sphere and business in Bulgaria), Mariya Markova and Tzvetana Stoyanova (learning process in higher schools), Andriyana Andreeva and Darina Dimitrova (academic self-governance of the universities), Snejanka Georgieva (quality of education) and others.

1. Specifics of Contemporary Research and Non-Research Universities

The differences between research and non-research universities are based on several key criteria: 1) Differences in their focus and core mission: scientific research versus teaching; 2) Priorities in education and the balance between research activities and teaching; 3) Sources of funding; 4) Differences in evaluation criteria and expectations regarding research outcomes; 5) The mindset and orientation of academic staff in the two types of universities.

Criterion 1: Research universities focus on scientific research and innovation, often aligned with industry needs. Their primary benchmarks include:

– the quantity and quality of scientific output, measured by publications in peer-reviewed journals;

– the number of citations of their research in such journals;

– participation in scientific projects;

– patenting of scientific achievements;

– creation of startup companies.

Through internationally comparable and measurable indicators, research universities gain visibility in global ranking systems, enhancing their global impact. Consequently, they receive significant funding for research activities from governmental and private sources, as well as grants from international organizations.

Non-research universities, on the other hand, primarily focus on educating students and Ph.D. candidates, emphasizing systematic teaching of knowledge rather than research activities. While they engage in scientific research, these activities are secondary to teaching. Faculty at such universities are often more focused on teaching and student preparation.

Criterion 2: Research universities offer undergraduate programs but usually prioritize master's and doctoral programs, which foster scientific research. Students in these programs are actively involved in research and scientific projects.

Non-research universities are primarily oriented toward undergraduate education, with master's and doctoral programs tending to be more applied than research-oriented. The focus here is on teaching and knowledge dissemination rather than creating new scientific achievements.

Criterion 3: Research universities receive funding for scientific activities from national and international agencies, enabling them to maintain state-of-the-art research laboratories and resources for large-scale scientific projects.

Non-research universities receive more limited funding, often directed toward improving the teaching process and education infrastructure. They rarely have extensive resources for scientific research.

Criterion 4: Research universities are commonly evaluated based on their publication activity, number of citations, and the societal impact of their research (e.g., innovations, patents for inventions, and commercialization of new technologies).

Non-research universities are typically assessed based on the quality of teaching, student success in the labor market, and their readiness for professional realization rather than their scientific output.

Criterion 5: Research universities usually have an academic staff of scholars with active research careers. The professional development of their faculty members heavily depends on the quantity and quality of their publications and the scientific projects they participate in.

However, non-research universities employ academic staff primarily focused on teaching, with less emphasis on research participation. The professional achievements of faculty members in non-research universities are primarily measured by the quality of their teaching and interaction with students.

1.1. Key Criteria for Evaluating the Quality of Research Results at Higher Education Institutions in Five Leading Educational and Research Destinations: USA, UK, Germany, Japan, and China

A 2023 study titled “Practices for Improving the Visibility, Citations, and Impact of Research: A Literature Review” (Majhi, Sahu & Behera 2023) summarizes that “greater visibility of scientific research is desired by researchers to increase the academic impact of their publications. This is measured by the number of views and citations.” At the same time, the criteria for evaluating the quality of scientific research at universities vary across countries, aiming to be based on objectively measurable indicators.

In the **United States of America**, peer review, including the so-called double-blind peer review process, is the primary mechanism for assessing the quality of scientific publications. This system requires established academic reviewers to evaluate publications based on their contribution and innovation.

Bibliometric indicators and scientometric data, such as citation counts and the impact factor of publications and journals, are key metrics for assessing the global scientific influence of a specific research study. These indicators measure the dissemination and importance of research within the relevant global scientific community. A high impact factor for the journals in which research is published reflects higher research quality.

Research grants and funding obtained by each university, such as those from the National Science Foundation (NSF) or the National Institutes of Health (NIH), play a significant role in determining the prestige of U.S. higher education institutions. Successfully attracting grants and participating in large-scale research projects demonstrates the capacity of researchers to produce meaningful science.

Innovations and patents for inventions highlight the collaboration and partnerships between universities and industry and are important indicators of the applicability of scientific research. Intellectual efforts must contribute to economic performance (Strijlev 2019). Universities must focus on developing research that is applicable to industry, and the presence of patents clearly demonstrates their ability to commercialize their research outcomes.

The societal impact of scientific research – its social and economic effects, including the implementation of new technologies and economic contributions from research outcomes – enhances not only the prestige of higher education institutions but also aligns with targeted governmental priorities in the sector.

In the **United Kingdom**, the evaluation of university research activities primarily occurs through the Research Excellence Framework (REF), which is the main mechanism for assessing research in the country. The REF places a strong emphasis on the real societal and economic impact of research beyond the academic sphere.

UK universities strive to publish in the most prestigious international journals while actively working to attract leading international researchers and students. The quality of publications is assessed through peer review of research articles and the measurement of their impact, including the number of publications, their journal impact factor, and the number of citations they receive.

The impact of research on society and the economy considers contributions to improving social and economic conditions, including applications beyond the academic community.

The research environment is evaluated based on the available infrastructure, resources, and strategies for developing academic staff and attracting young researchers.

The evaluation of academic research outcomes in **Germany** typically includes the following key criteria:

1. Number of publications and citations: similar to other countries, the number and quality of publications, as well as their citations, play a critical role in Germany. Universities funded by the Deutsche Forschungsgemeinschaft (DFG) emphasize high-impact research.

2. Participation in International Scientific Collaboration: international partnerships are a priority for German universities. Attracting international collaborators, participating in global research projects, and hosting major international scientific forums are central to the development of German science (Tormanov, Goranova, Stefanova & Radev 2020).

3. Industrial funding and university infrastructure: a key factor in evaluating German universities is the availability of modern research infrastructure and their ability to attract large research grants and industrial funding.

4. Quality of research: beyond the combination of quantitative and qualitative indicators, the quality of research is also assessed based on the recruitment of young researchers and the support provided for their training and development.

These criteria underline Germany's focus on fostering high-impact, collaborative, and well-funded research while prioritizing the cultivation of new scientific talent.

The evaluation of research outcomes at the research universities of **Japan** is based on measurable indicators, including:

1. Number of articles, citations, and impact factor: the number of articles published in peer-reviewed scientific journals, their citation counts, and the journals' impact factors are key metrics for assessing the quality and influence of research.

2. Applicability of Research: this includes patents and technological innovations applied in industry. Japan strongly encourages research with potential for commercialization and emphasizes practical contributions to industrial advancements.

3. International Collaboration: Japanese universities' research achievements are evaluated based on their ability to attract international scholars and actively participate in global research projects.

These criteria highlight Japan's focus on high-quality, applicable research and its integration into the global scientific and industrial landscape.

The evaluation of research outcomes at the research universities of **China** is based on the following measurable indicators:

1. Number of scientific articles and citations: Chinese universities emphasize publications in high-impact journals and aim to increase the number of international citations of Chinese authors. Bibliometric indicators are the primary criteria for measuring the research output of universities in China.

2. Scientific innovations and patent activity: The Chinese government promotes research that leads to the registration of patents for inventions and technological innovations with global industrial applications.

3. Volume of funding and industry collaboration: government funding and partnerships with leading industrial companies are expected to increase scientific production at Chinese universities.

These criteria reflect China's focus on producing high-impact research, fostering innovation, and enhancing collaboration between academia and industry to achieve global competitiveness.

1.2. Good International Practices for Funding Research and Non-Research Universities in Leading Global Educational and Research Destinations

Funding for research and non-research universities varies by country depending on (1) national priorities, 2) specific programs aligned with those priorities, and 3) government strategies to stimulate scientific activities and industrial sectors.

In the **United States**, the primary funding source for research universities comes from federal agencies such as the National Science Foundation (NSF) and the National Institutes of Health (NIH). This funding is competitive, with universities vying for grants by submitting research project proposals. In addition to federal support, some universities rely on private donations or industry funding for their research activities.

For non-research universities, funding is primarily determined by the number of enrolled students and their academic performance. These institutions receive funding primarily at the regional (state) level, rather than from federal sources, which are typically reserved for research universities. This funding model supports educational activities and ensures access to higher education at the state level.

In the **United Kingdom**, research funding primarily operates through the dual support system, which includes two streams of funding: (1) quality-related research (QR) funding, which is allocated based on the outcomes of research and its impact, and (2) competitive grants which UK Research Councils award for specific research projects. Research universities also benefit from formula-based funding, determined by their research performance as assessed by the Research Excellence Framework (REF). REF evaluates the quality and impact of research, contributing to the allocation of resources. Non-research universities, on the other hand, rely on government budget funding for educational activities and have limited access to research funding compared to research-intensive institutions. This funding primarily supports teaching and infrastructure improvements.

In **Germany**, research university funding is structured through the Excellence Strategy, which funds universities with high scientific potential. The funding comes from the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) and other state organizations, including the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG). Non-research universities that do not actively participate in scientific projects rely more on higher education budgets rather than scientific programs, as funding for non-research universities is mainly based on student numbers and is primarily used to improve educational infrastructure.

In **Japan**, the state funds research universities through the Ministry of Education and Science, emphasizing large national projects and scientific innovation programs. Non-research universities receive less funding for scientific activities and focus more on teaching programs and education budgets.

In **China**, the Double First-Class University Plan is the main initiative for funding research universities. The government provides significant resources when research universities meet academic and scientific achievement criteria. Non-research universities rely on state funding for educational purposes without encouraging active scientific research.

The top 10 universities in the countries discussed above (USA, United Kingdom, Germany, Japan, and China) are notably research-focused (QS World University Rankings, 2023); see Table 1.

Table 1. Ranking of leading universities in the USA, United Kingdom, Germany, Japan, and China, and information about how many of them are research universities

Country	University	Statute of research university possession		Country	University	Statute of research university possession
USA	Massachusetts Institute of Technology (MIT)	Yes		China	Tsinghua University	Yes
USA	Stanford University	Yes		China	Peking University	Yes
USA	Harvard University	Yes		China	Zhejiang University	Yes
USA	California Institute of Technology (Caltech)	Yes		China	Shanghai Jiao Tong University	Yes
USA	University of Chicago	Yes		China	Fudan University	Yes
USA	University of Pennsylvania	Yes		China	University of Science and Technology of China (USTC)	Yes
USA	Princeton University	Yes		China	Sun Yat-sen University	Yes
USA	Yale University	Yes		China	The University of Hong Kong	Yes
USA	Columbia University	Yes		China	Huazhong University of Science and Technology	Yes
USA	University of California, Berkeley	Да		China	Central South University	Yes
United Kingdom	University of Cambridge	Yes		Germany	Technical University of Munich (TUM)	Yes
United Kingdom	University of Oxford	Yes		Germany	LMU Munich	Yes
United Kingdom	Imperial College London	Yes		Germany	Heidelberg University	Yes
United Kingdom	University College London (UCL)	Yes		Germany	Free University of Berlin	Yes

United Kingdom	University of Edinburgh	Yes		Germany	Humboldt University of Berlin	Yes
United Kingdom	University of Manchester	Yes		Germany	Karlsruhe Institute of Technology	Yes
United Kingdom	King‘s College London	Yes		Germany	RWTH Aachen University	Yes
United Kingdom	London School of Economics (LSE)	Yes		Germany	Technical University of Berlin	Yes
United Kingdom	University of Bristol	Yes		Germany	University of Tubingen	Yes
United Kingdom	University of Warwick	Yes		Germany	University of Freiburg	Yes
Japan	University of Tokyo	Yes				
Japan	Kyoto University	Yes				
Japan	Tokyo Institute of Technology	Yes				
Japan	Osaka University	Yes				
Japan	Tohoku University	Yes				
Japan	Nagoya University	Yes				
Japan	Kyushu University	Yes				
Japan	Hokkaido University	Yes				
Japan	Keio University	Yes				
Japan	Waseda University	Yes				

Sources: For USA – QS World University Rankings 2023, https://www.universityrankings.ch/results?ranking=QS&region=World&year=2023&q=USA
For UK – QS World University Rankings 2023, https://www.universityrankings.ch/results?ranking=QS&region=World&year=2023&q=UK
For Germany – QS World University Rankings 2023, https://www.universityrankings.ch/results?ranking=QS&region=World&year=2023&q=Germany
For Japan – QS World University Rankings 2023, https://www.universityrankings.ch/results?ranking=QS&region=World&year=2023&q=Japan
For China – Shanghai Academic Ranking of World Universities 2023, https://www.shanghairanking.com/rankings/arwu/2023

2. The status of "Research Professor"

Research professors are crucial in shaping academic culture and driving innovation within their academic institutions. They often hold high ranks, such as "Distinguished Professor" or "University Professor," recognizing their significant contributions to academia. They typically focus on research and often lead research initiatives. They secure funding for research and may teach graduate-level courses, with less emphasis on undergraduate teaching. They are expected to publish extensively and engage in strategic departmental planning.

2.1. Criteria for research professors

The criteria for research professors vary across countries, reflecting different academic cultures and expectations. The table below presents a summary of the basic criteria for research professors in the **USA, UK, Germany, Japan, and China** (University College Cork, 2022; Jobs.ac.uk. 2024 (a); Jobs.ac.uk. 2024 (b); Shin & Lee 2022).

Table 2. Basic criteria for research professors in the USA, UK, Germany, Japan, and China

Country	Requirements for Research Professors
USA	– Qualifications: Typically requires a PhD and significant research experience. – Research Impact: Evidence of original contributions to the scientific field, publications in high-impact journals, as well as securing research funding. – Recognition: National or international recognition in their scientific field is necessary. – Teaching: Involvement in teaching and mentoring students is also expected.
UK	– Qualifications: Generally, requires a PhD and a strong undergraduate degree (first or upper second class). – Research Leadership: Leading research projects, securing external funding, and contributing to departmental strategy. – Teaching: Involvement in postgraduate teaching and student support
Germany	– Qualifications: A PhD is mandatory, often accompanied by postdoctoral experience. – Research Impact: Demonstrated excellence in research output and impact, evaluated through publications and citations. – Teaching Commitment: Active participation in teaching at various levels is required
Japan	– Qualifications: A PhD is usually required; international faculties are increasingly needed. – Research Impact: Focus on publishing in international journals and contributing to academic discourse. – Teaching Role: Balancing research with teaching responsibilities, particularly in STEM fields
China	– Qualifications: Requires a PhD with substantial research experience. – Research Impact: Significant contributions to research fields, evaluated through publication metrics. – Collaboration: Increasing emphasis on international collaboration and funding acquisition

Sources: University College Cork., 2022. A National and International Review of the

Classification of Academic Titles [online]. [cited 2024-12-23]. Available from: https://www.ucc.ie/en/media/support/hr/AcademicTitlesReview.pdf

Jobs.ac.uk., 2024. The Global Academic Careers Guide [online]. [cited 2024-12-23]. Available from: https://www.jobs.ac.uk/media/pdf/careers/resources/the-global-academic-careers-guide.pdf

Jobs.ac.uk., 2024. How to Pursue an Academic Career in China (Parts One and Two) [online]. [cited 2024-12-23]. Available from: https://career-advice.jobs.ac.uk/resources/how-to-pursue-an-academic-career-in-china-part-one/

Shin, J.C. & Lee, S.J. 2022. Different measures of international faculty and their impacts on global rankings. Scientometrics 127, 6125 – 6145 (2022). https://doi.org/10.1007/s11192-022-04511-6.

Therefore, while diverse expectations are placed on research professors across different countries, they all emphasize the importance of (1) strong academic **qualifications** and (2) **excellence in research** impact, evaluated through publications and citations. (3) **teaching** involvement, (4) **international recognition** and international collaboration, and (5) attracting and **securing external funding** for research. One more important focus upcoming in the near future would relate to the research professor's (6) **preparedness and skills for total digitalization of the educational process** as "an essential factor for achieving and maintaining competitiveness in the educational market" (Markova and Stoyanova 2024).

2.2. Research professors' performance review and evaluation

In the **United States**, the evaluation of professors incorporates research contributions and teaching effectiveness, with varying weight depending on the university and the specific role of the professor. These two aspects weigh differently in the evaluation process. The research professor performance review in the USA is usually divided into five categories: (1) research productivity, (2) teaching effectiveness, (3) service to the institution, (4) professional development, and (5) mentoring and advising, whose details are worth additional analysis. *The research productivity category* includes evaluation of scholarly output, including the quantity and quality of publications in peer-reviewed journals, conference presentations, and other research contributions; success in securing external funding is also a critical component. *The teaching effectiveness* category involves the assessment of teaching performance, which includes student evaluations, peer reviews, course materials, and contributions to curriculum development; research professors are expected to engage students effectively and mentor them academically. *Service to the institution* category is related to involvement in departmental and university governance, participation in committees, and contribution to community service or outreach activities beyond teaching and research. *The professional development category* includes engagement in continuous professional growth through attending conferences, attending workshops and other educational opportunities, and enhancing teaching and research skills. *The mentoring and advising category involves* contributions to mentoring graduate students and junior faculty and Supervising theses and dissertations.

In the **UK**, based on the practice of the University of Cambridge (University of Cambridge 2024), the performance review of research professors is typically divided into three key categories, reflecting their contributions to research, teaching, and service as follows:

1. Criteria for the *assessment of research*:

– Consistency of rigorous research addressing significant questions, contributing new ideas and advancing the boundaries of the field whilst ensuring the highest standards of research integrity are promoted and maintained as follows: a substantial portfolio of high-quality research outputs that are internationally recognised as world-class in terms of their originality, significance and rigour; the university acknowledges that the intellectual content of a paper is much more important than publication metrics or the identity of the journal in which it was published; makes a significant contribution to the advancement of knowledge in their research discipline; produces and disseminates research outputs that have an impact, for example in the REF or informs national or international policy development; frequently invited to present work at major national and international conferences and institutions; a significant track record of winning competitive research funding; receipt of prizes and honors for research.

– Consistency in providing high-quality research leadership, strategical planning and supporting an inclusive and productive research culture as follows: leads and contributes to collaborative research projects; elected/appointed to research-related leadership roles; creates and manages large research groups; convenes and leads major research conferences and seminar programs; provides intellectual thought leadership which informs and contributes to setting the international research agenda in an individual's area; participation in high-quality public, industrial and/or policy engagement activities linked to research; edits major academic journals; promotes collaboration and develops cross-disciplinary research activities.

2. Criteria for the *assessment of teaching and young researcher development*:

– Consistency in delivering excellent teaching and engaging with the university's research-rich environment and is intellectually challenging as follows: designs and develops new programmes; leads/makes a significant contribution to internal teaching reviews; demonstrates breadth of knowledge and teaches effectively beyond immediate research area; receives prizes for teaching; undertakes examination/acts as a course examiner; provides educational leadership and organisation including curriculum development and learning design; successfully introduces innovative teaching/assessment methods or significant contribution to their enhancement; publishes major textbooks/e-learning materials adopted in courses internal or external to the university; national or global press coverage of the candidate's educational ideas or activities; holding an educational leadership position within a professional body; receives excellent student feedback; demonstrates sophisticated, reflexive approach to teaching and supporting learning which enables students to develop subject knowledge and capabilities.

– Consistently delivers high-quality research supervision that is intellectually challenging and supportive as follows: consistently high research student completion rates; award of prizes and honors for researcher development; consistently receives positive feedback from research students; provides inclusive leadership and delivers excellence through the performance of others; create a positive working environment and acts as a role model in promoting inclusion and mutual respect; contributes significantly towards recruiting and winning support for research students; recognizes and nurtures talent and demonstrates consistent engagement with researcher training and development processes.

– Consistently ensures that early-career researchers receive excellent opportunities to develop their potential and prepare them for future success: consistently receives positive feedback from postdoctoral researchers; enables and encourages early-career researchers to develop independent research lines and/or pursue independent publications or funding applications; mentors or coaches early-career researchers in other groups or departments; provides inclusive leadership and delivers excellence through the performance of others; creates a positive working environment and acts as a role model in promoting inclusion and mutual respect; recognizes and nurtures talent and demonstrates consistent engagement with researcher training and development processes; helps early-career researchers to be creative about their futures and takes active steps to support career pathways both in and beyond academia.

3. Criteria for the *assessment of service to the university and to the academic community:*

– Consistently makes an effective contribution of service to the university and to the academic community beyond the university; promotes collegiality and engenders a culture of mutual respect as follows: departmental/faculty/university academic leadership roles; sits on departmental/faculty university committees and bodies; provides active mentoring and support for colleagues; promotes and demonstrates effective use of the staff review and development scheme; significant and sustained contributions to equality, diversity and inclusion activities; creates a positive working environment and acts as a role model in promoting inclusion and mutual respect; promotes cross-disciplinary collaboration and knowledge sharing; significant and sustained contribution to widening participation activity; contributes to leadership, administration and student support within colleges; engages significantly in peer review activity; advises government and parliamentary bodies; sits on public review bodies; significant and sustained contributions to fostering strategic partnerships (e.g. industry, trusts and foundations, philanthropic donors); supports the work of other HEIs (e.g. significant external examining; participation in research/teaching and learning reviews); significant and sustained public engagement activity.

In Germany, based on the practice of the Technical University of Munich (Technical University of Munich, 2024), the research professor performance review is divided into three categories: *Research and development*; *Academic Teaching*; and *Academic Engagement,* and each category is comprised of several criteria as follows:

1. *Research and development* category, which includes: new methodological and conceptual developments; originality and creativity of the scientific work produced and quality of skills in international comparison; publications with substantial own contribution in peer-reviewed journals and conference contributions (peer-review); international reputation: invitations to speak at international conferences (keynote/plenary lectures), prizes/awards, research professorships, scholarships (e.g. AvH); scientific development potential in international comparison; third-party funding acquired in competitive procedures (EU, DFG, BMBF, AiF, industry, foundations, etc.); interdisciplinary collaborative research: participation in coordinated research projects (for example EU funded collaborative projects); promotion of young scientists (e.g. successful supervision of doctoral and post-doctoral students, quality of follow-up positions and professional careers of graduates); technical innovation capability: registration, granting and exploitation of patents, initiation of technology transfer projects and company spin-offs.

2. *Academic Teaching* category, which includes: Design and implementation of courses of different types (lectures, seminars, internships, etc.) and at different educational levels (BSc, MSc, PhD); Quality of teaching activities (semester evaluation reports by students, statements by deans of studies); Implementation of courses in English and international teaching; Development or introduction of new teaching content, didactic teaching concepts or teaching formats; (Inter)national prizes and awards for good teaching; Supervision of semester, BSc and MSc theses; Participation in didactic training measures and interdisciplinary events; Writing textbooks/monographs (e.g. on new teaching methods and concepts); Organization of or participation in international conferences on teaching methods and educational research.

3. *The academic engagement* category includes three sub-categories for assessment, each of which comprises several criteria explained below and should prove that the research professor works in three sub-areas of engagement:

3.1. In the service of the university: Management of or active participation in internal university commissions or committees; Exercise of the office of Women's Representative or Ombudsperson, special commitment to foreign students, etc.; Professional and scientific contribution to the development strategy of schools (e.g. as a member of the School Council), Integrative Research Centres; Active support of the university internationalization policy (e.g. visiting professorships, application for scholarships, support for the establishment of foreign offices and branches; Active expansion of the university's network of regional business cooperations; Promotion of gender and diversity measures (e.g. participation in the university Gender and Diversity Board).

3.2. In the service of university's young talent: Mentoring as part of the Faculty Tenure Track (promotion of junior professors); Participation in the University's Research Opportunities Week; host for University Foundation Fellows (promotion of postdocs); Participation in training programs of the university's Graduate School (support for doctoral candidates); Support for particularly talented students; Active participation in school partnerships, student research centers, summer schools, Girls Days, promotion of students for STEM subjects, etc.

3.3. In the service of the academic community: Responsible collaboration in foundations for the promotion of science (e.g. DAAD) and in research funding institutions (e.g. the European Union and national ones); Management of or participation in (inter)national commissions or committees; Expert activities; Editorship of peer-reviewed scientific journals (Editor-in-Chief); Membership of the Editorial / Advisory Board of peer-reviewed scientific journals (Associate Editor, Editorial Board Member); Membership of scientific academies and scientific advisory and funding bodies; Responsible participation in important expert committees (e.g. standards committee) or in relevant professional associations and professional representations; Contributions to policy advice or membership of political advisory bodies.

In Japan, the performance review of research professors is usually structured around five key categories: *Research performance*, *Teaching effectiveness*, *Service to the institution*, *Professional development*, *Collaboration, and leadership, as* commented below.

1. *Research performance* involves: (1) Quality and Impact: evaluation focuses on the quality of research output, including publications in peer-reviewed journals and contributions to significant projects. Professors are expected to demonstrate originality and impact in their research; and (2) Funding and Grants: Success in securing research funding is also a critical component of evaluation, reflecting the ability to attract resources for academic inquiry.

2. *Teaching effectiveness:* (1) Engagement and methodology assessment, including the effectiveness of teaching methods and student engagement. Professors are expected to employ innovative teaching strategies that enhance student learning outcomes; and (2) Supervision, which includes the quality of supervision for graduate students and junior researchers, emphasizing mentorship and guidance in academic development.

3. *Service to the institution* includes (1) Institutional Engagement, such as involvement in departmental governance, participation in committees, and contributions to university initiatives, as well as (2) Contribution to the academic community beyond their teaching and research roles.

4. *Professional development* is the category connected with continuous improvement, where professors are encouraged to engage in ongoing professional development through attending conferences, workshops, and other educational opportunities that enhance their teaching and research skills.

5. *Collaboration and leadership* is a category divided into two sub-categories:

– Interdisciplinary collaboration: evaluation may include participation in collaborative research efforts across disciplines, reflecting a commitment to fostering a collaborative academic environment; and

– Leadership roles: professors are assessed on their ability to lead research teams or initiatives, demonstrating leadership within their academic community.

In China, the performance review of research professors at leading universities is also structured around five key categories which reflect the multifaceted roles that research professors play in academia, encompassing research, teaching, and service. The focus of the five respective categories is set on:

1. *Research contributions* focused on the quality and volume of the research work, whereas evaluation focuses on the quantity and quality of research output, including publications in high-impact journals and participation in significant research projects. Professors are expected to demonstrate originality and substantial contributions to their fields; and funding acquisition where success in securing research grants and funding is a critical component of evaluation, reflecting the ability to attract resources for academic inquiry.

2. *Teaching effectiveness*, focused on engagement and methodology where assessment includes the effectiveness of teaching methods, student engagement, and overall contribution to the learning environment. Professors are expected to employ innovative teaching strategies that enhance student learning outcomes supervision where the quality of supervision for graduate students and junior researchers is evaluated, emphasizing mentorship and guidance in academic development.

3. *Service to the institution*, focused on institutional engagement such as involvement in departmental governance, committee participation, and contributions to university initiatives are assessed. Professors are expected to contribute positively to the academic community beyond their teaching and research roles.

4. *International collaboration*, focused on global engagement, where evaluation may include participation in international research collaborations and co-authorships with foreign institutions, reflecting a commitment to fostering a global academic network. This aspect highlights the importance of international perspectives in research.

5. *Industry collaboration*, focused on knowledge transfer, assesses professors' ability to engage with industry partners, translate research into practical applications, and foster relationships that enhance the university's impact on society and the economy.

3. The role of the research universities for industry and sustainable growth of the national economy

Higher education is a game changer both nationally and globally, and its' effect depends upon the successes or failures of universities which are: (1) knowledge-producing, (2) talent-attracting capacity of the nations (countries), and (3) have the potential to contribute for high-end technology-driven, globally competitive, sustainably growing national industry and national economy.

To "wait for 200 years" is unaffordable in the contemporary world, where the rapid global growth of automatization and technologies quickly suppresses the universities to deliver results-oriented teaching focused on the tech skills gap in the labor market to address the threat of "technological unemployment" quickly. On the other hand, the rapid global growth of automation and technology supresses the effectiveness of the private enterprises of the national industry. Quick orientation of the universities to adequately deliver (1) high-end results from the specialized scientific research and (2) high-end teaching to the students shall address the needs of the national industry in the most strategic way.

Strategic national priorities must be set to interconnect academic research and national industry in long-term cooperation, especially for the needs of the prioritized sectors of the national economy and to achieve national competitiveness and sustainable economic growth.

Obviously, uncompetitive economies just sit back and wait to see what happens as people continue losing their jobs, and business entities continuously struggle with their inability to align with the growth of needs for research in the field of AI (Molhova & Biolcheva 2023), nanotechnology, robotics and three-dimensional printing (Pacheva 2024) security and cyber (Dimitrov, Nozharov & Cenkov 2023), intellectual property rights in music (Radev 2020), cloud computing and storage systems, fintech, big data analytics tools, inexpensive energy supply chain procurement, cleantech, and environment etc.

In their 2021 study, drawing attention to the wordplay "From Publications to Public Actions" (Gardner, Thierry, Rowlandson & Steinberger 2021), a team of scientists from the UK and Switzerland, within their interest in environmental changes and the role of universities, indicate that universities, depending on whether they are research or non-research institutions, "can offer solutions in two directions: (1) "research dedicated to overcoming problems; (Schneidewind et al. 2020)", (2) "institutionalization of education ensuring sustainable development (Grund and Brock 2020; Kopnina 2020)".

In a report by the George W. Bush Institute (Clark et al. 2020) focused on the innovative influence of universities in the USA, it is noted that the share of US universities in the overall research and development activity of the world's largest economy is significant, emphasizing its "key role": "American universities play a key role in nurturing innovation, which in turn stimulates economic growth and raises the standard of living in the United States. American universities spend approximately $75 billion annually on research, representing 13% of America's total research and development (R&D) expenditure."

4. Analysis of Bulgaria's Experience: Research Activities, Research Funding, Requirements, Opportunities

To generalize and deliver conclusions about Bulgaria's university research requirements in the context of the science industry and to propose recommendations for optimizing strategic academia-business interaction, a brief analysis of the regulatory framework, research funding practices, and requirements for research universities in the Republic of Bulgaria is needed. It is important to note that Bulgaria has yet to develop a national seven-year framework program for research and innovation and instruments for its implementation. According to European practices, its development will result from joint work between sector ministries and stakeholders. The new legislation will also create conditions for establishing and developing start-up enterprises at universities and scientific organizations in the country. With the strengthening of the National Innovation Fund, incentives are planned to encourage the participation of these enterprises in research and innovation programs and projects with international partners.

4.1. Data on the State of Research Activity in the Republic of Bulgaria: International Databases, Access, Publication Opportunities

Since 2004, Bulgaria has maintained a Current Research Information System (CRIS) called Register of Scientific Activity, which transparently provides the research results of universities, academic staff, and their scientific projects.

Since 2021, Bulgaria has a Portal for Open Access to Scientific Information and Scientific Data (known as the Bulgarian Open Science Portal, bpos.bg), which contains over 60,000 publications and over 7,000 doctoral theses in full volume with free access. All data in the electronic portal is connected to the European Open Science Cloud. It is a common commitment of EU member states to make efforts to transition to an open science regime, which is also the reason for building the cited European Open Science Cloud.

Publishing in open access is supported by all organizations in Europe and Bulgaria that fund scientific research. The leader in this regard is the European Union Framework Programme for Research and Innovation, which, during the current programming period, publishes all publications resulting from research projects funded by this program in open-access mode.

It is important to note that leading Bulgarian universities are already creating specific policies in their strategic documents, specifically in their research development strategies, precisely to stimulate the publication of research results in open access.

The Bulgarian Ministry of Education and Science (MES) maintains a National Contract to Support Open Access with Elsevier, which owns hundreds of journals and the Scopus reference database. It is worth noting that relatively short timeframes have been achieved from research submission to publication in Elsevier, ranging between 30 and 150 days (and, in sporadic cases, a longer period).

At first glance, many countries' ministries of education and science (including the Ministry of Education and Science of the Republic of Bulgaria, MES) enter into contracts with monopolists in the field, such as Elsevier Publishing House. However, to reach such a contract, each major scientific publisher and each ministry have negotiated numerous details that form the basis for building long-term partnerships. The Bulgarian MES, for example, began its relationship with Elsevier in the year following Bulgaria's accession to the European Union. In 2008, on the initiative of leading scientific organizations and higher education institutions in Bulgaria, actions were taken to provide national subscriptions for access to electronic databases containing indexed full-text publications in journals, periodicals, books, and reference and scientometric databases. After conducting public procurement procedures, the first three-year contracts were signed, providing the country's scientific and academic community with access to electronic databases for the period 2009 – 2011 through the companies:

– Elsevier, which owns the reference and scientometric database SCOPUS and the platforms ScienceDirect (SD), Engineering Village, Embase, Compendex;

– Thomson Reuters, which at that time owned the Web of Knowledge platform, later renamed to Web of Science (currently owned by Clarivate).

After analyzing the benefits of these subscription plans in 2011, a new three-year contract was signed for 2011 – 2014, providing access to ScienceDirect publications and the reference and scientometric databases SCOPUS and Web of Science. In subsequent years, consecutive three-year contracts were signed, covering continuous access to indexed publications and scientific information resources, with the penultimate contract ending at the end of February 2022.

In June 2022, the Ministry of Education and Science signed a new three-year agreement with Elsevier. The agreement implements the National Strategy for Development of Scientific Research in the Republic of Bulgaria and provides subscription access for both research and non-research universities and scientific organizations to the publisher's databases. The current agreement for 2022 – 2025 offers expanded subscription coverage, which includes electronic books for the entire period and organizing a seminar on scientific activity development in the higher education system.

Perhaps the biggest success of the agreement between MES and the publisher is the "Open Access" pilot project, through which articles are published with open access in major hybrid journals owned by Elsevier. Authors from Bulgaria can publish a certain number of open access articles within the agreement period without paying a publication fee. A fundamental principle adopted in Bulgaria and regulated in Article 5 of the Law on Promotion of Scientific Research and Innovation is that "research activity funded by public funds is based on the principle of open science", without contradicting intellectual property protection rules, having in mind that "intellectual property system in the modern economy is constantly growing"

(Papagalska 2022). Open science is defined as "knowledge transfer through providing access to research data and wide dissemination of scientific research results for which public funding has been provided" (Law on the Promotion of Scientific Research and Innovation, 2024, Art. 5, paragraph 2).

In case the maximum number of articles for each subscription year is reached (100 open access articles for the subscription year 01.03.2022 – 28.02.2023; 180 open access articles for the subscription year 01.03.2023 – 29.02.2024; and 260 open access articles for 01.03.2024 – 28.02.2025), the agreement provides preferential prices for Bulgarian users. The full text of the contract and provided services is available on the Ministry of Education and Science website in the "Buyer's Profile" section (https://app.eop.bg/today/197457).

With the introduction of digital library subscriptions, Bulgarian scientists and all students and doctoral students have the opportunity through university libraries to access available articles in full-text format from 2,000 high-quality journals (their issues from 1995 to present) covering all scientific fields. For example, subscriptions to the full-text database ScienceDirect FC are provided for 64 scientific organizations and universities.

For two years, Bulgaria has been implementing a national program to stimulate the publication activity of higher education institutions and scientific organizations. The program provides incentives for high-quality research and the achievement of research excellence. During its operation, the Program has encouraged over 43% of Bulgarian researchers to publish their publications in open access.

4.2. Research Activity, Scientific Fields, Research Personnel, and Research Expenditure in the Republic of Bulgaria

The National Roadmap for Scientific Infrastructure of Bulgaria is a key instrument for building modern scientific infrastructure to conduct competitive research at a high international level. It supports 52 facilities, and invested funds have exceeded 90 million euros since 2018. The National Roadmap for Scientific Infrastructure combines instruments, conditions, expertise, methods, materials, activities, and related services for creating, transferring, exchanging, and preserving new knowledge obtained through scientific research and technological developments.

The new Law on Promotion of Scientific Research and Innovation, which came into force in May 2024, introduces a legal framework for state policy to promote scientific research and innovation. It establishes principles, mechanisms, and instruments for sustainable planning of national measures to support scientific excellence and applied research benefiting the country's economy and building the European Research Area. The law distinguishes between two types of scientific activity: fundamental research and applied research. Its main goal is to regulate the principles, mechanisms, and instruments for forming, implementing, and coordinating state policy to promote scientific research and innovation in Bulgaria, as well as public relations related to these activities. This will better coordinate sectoral policies and instruments for promoting research and innovation based on regulated functional relationships between all process participants (government, research organizations, universities, researchers, innovators, businesses, and society).

Research and Development (R&D) expenditure in Bulgaria in 2023 was 1,467.5 million BGN, 15.9% more compared to the previous year, according to NSI data (Table 3). The trend of annual growth during 2019-2023 continues.

R&D intensity in Bulgaria in 2023 (measured as a percentage of R&D expenditure from GDP) amounts to 0.79% and is 0.04 points higher compared to 2022.

By scientific fields and sectors in Bulgaria in 2023, as in the previous year, the largest share of R&D expenditure was in technical sciences – 47.2%, or 693.5 million BGN, followed by medical and health sciences - with a share of 22.3%, or 326.9 million BGN, and natural sciences – 18.7%, or 273.9 million BGN.

Personnel engaged in research and development in Bulgaria in 2023 was 25,411 people (full-time equivalent), 6.2% less compared to the previous year. The share of women in total R&D personnel is 48.6%. The number of researchers in full-time equivalent is 16,357 people, which is 6.5% less compared to 2022.

Table 3. R&D Expenditure by Fields of Science and Sectors in the Republic of Bulgaria, in thousand BGN

Sectors/ Fields of Science	**2019**	**2020**	**2021**	**2022**	**2023***	
Total	1002132	1023790	1074004	1265635	1467491	100%
Natural Sciences	157903	163937	187013	217146	273868	
Technical Sciences	541108	554468	553186	638598	693483	47,25%
Medical and Health Sciences	182869	187025	206704	259329	326898	
Agricultural and Veterinary Sciences	52039	52253	57553	76511	81563	
Social Sciences	25302	24642	25591	28326	34520	2,35%
Humanities and Arts	42911	41465	43957	45725	57159	
Enterprise Sector	673122	691077	707194	858334	943747	
Natural Sciences	23961	22048	25498	35724	38305	
Technical Sciences	489162	500602	491877	577585	605444	
Medical and Health Sciences	150769	157932	179750	230457	285719	
Agricultural and Veterinary Sciences	1746	2029	2840	5578	5339	
Social Sciences	5497	6617	5203	7308	7639	
Humanities and Arts	1987	1849	2026	1682	1301	
Government Sector	249420	263625	291274	321922	421817	

Natural Sciences	109445	121782	137842	148709	205260	
Technical Sciences	36764	37828	41301	42231	58919	
Medical and Health Sciences	..	..	6804	9038	16463	
Agricultural and Veterinary Sciences	49047	49065	53519	69590	74756	
Social Sciences	12435	12148	14025	12877	15917	
Humanities and Arts	..	..	37783	39477	50502	
Higher Education Sector	73294	62215	69282	79123	95310	
Natural Sciences	21800	17109	20691	29926	27988	
Technical Sciences	14494	15201	..	18380	28672	
Medical and Health Sciences	26357	20477	20150	..	..	
Agricultural and Veterinary Sciences	1063	1052	..	..	..	
Social Sciences	4798	4105	4727	5900	7569	
Humanities and Arts	4782	4271	3118	3786	4942	
Non-profit Organizations Sector	6296	6873	6254	6256	6617	
Natural Sciences	2697	2998	2982	2787	2315	
Technical Sciences	688	837	..	402	448	
Medical and Health Sciences	..	..	-	..	..	
Agricultural and Veterinary Sciences	183	107	..	..	..	
Social Sciences	2572	1772	1636	2241	3395	
Humanities and Arts	..	..	1030	780	414	
Preliminary data; „..“ – confidential data; „-“ – no case.						

Source: National Statistical Institute, 2024, Research and Development Activity in 2023 (preliminary data), https://www.nsi.bg/en/content/21855/%D0%BF%D1%80%D0%B5%D1%81%D1%81%D1%8A%D0%BE%D0%B1%D1%89%D0%B5%D0%BD%D0%B8%D0%B5/research-and-development-activity-2023-preliminary-data

Another important characteristic of the Bulgarian research ecosystem is state funding on a project basis for expanding partnerships between scientific organizations, administration and academic circles with the Bulgarian scientific diaspora worldwide, which, in addition to expanding international scientific cooperation, also leads to improving research quality and achieving excellence.

4.3. Data on the Effects of Republic of Bulgaria's Policies for Research Development, Universities, and Created Opportunities for Economic Growth

The publication activity of Bulgarian scientists has been positively influenced, including as a result of the above-mentioned conditions and opportunities created in the Republic of Bulgaria over the years. According to Web of Science data from 2013 to 2023, there has been a 50% increase in publications in the most prestigious Q1 journals as a result of international scientific projects. Traditionally, social science scientists, including economics, report weaker results in terms of publication activity. At the same time, social sciences have a relatively larger number of employees in both research and non-research universities in Bulgaria. However, only 2.35% of R&D expenditure is directed towards social sciences, while 47.25% is directed towards technical sciences. Here (see Fig. 1) is one of the paradoxes from the perspective of research expenditure because there is a significant imbalance between different fields of science and sectors in the Republic of Bulgaria. This needs to be addressed with specific policies in the public sector.

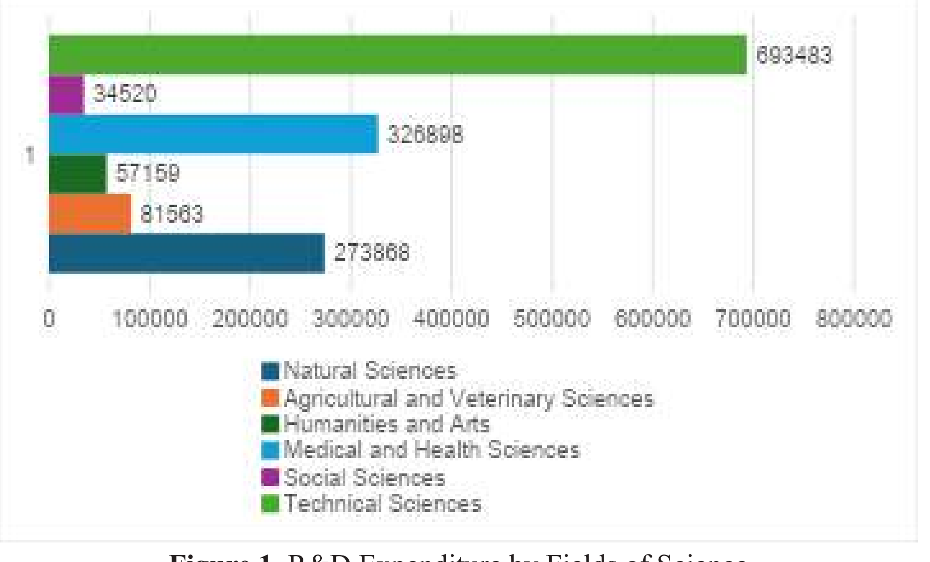

Figure 1. R&D Expenditure by Fields of Science in the Republic of Bulgaria for 2023

Note: The chart shows the total R&D expenditure across different scientific fields in Bulgaria for 2023 which are distributed as follows: Technical Sciences: 47.25% (693.5 million BGN); Medical & Health Sciences:

22.3% (326.9 million BGN); Natural Sciences: 18.7% (273.9 million BGN); Social Sciences: 2.35% (34.5 million BGN)

Source: National Statistical Institute, 2024, Research and Development Activity in 2023 (preliminary data), https://www.nsi.bg/en/content/21855/%D0%BF%D1%80%D0%B5%D1%81%D1%81%D1%8A%D0%BE%D0%B1%D1%89%D0%B5%D0%BD%D0%B8%D0%B5/research-and-development-activity-2023-preliminary-data

Obviously there are significant disparities in R&D expenditure across different scientific fields in Bulgaria in 2023. The chart shows the dominance of technical sciences, which receives 47.25% of total R&D funding, while social sciences receive only 2.35%. This stark contrast highlights the imbalance in research funding distribution that needs to be addressed through specific public sector policies. This data helps emphasize the paradox in the text regarding the disparity between the number of employees in social sciences and the amount of funding allocated to this field.

From the overview in the first part of this study, dedicated to the practice in the USA, UK, Germany, Japan, and China, the strongest national economies have leading research universities, but the reverse is not always true. This is because the connection between university research and the commercialization of their scientific achievements for industry needs is neither automatic nor immediate and most likely not mandatory. Individual well-managed universities within a consistent state economic policy and two-way interaction with industry can achieve mutually beneficial engagement, which enables sustainable long-term economic development based on three interrelated dependencies: (1) scientific research – industry and (2) regional youth generation – knowledge and expertise, (3) national competitiveness – global market for products and services.

Some regions worldwide have industries and communities that are more ready to transform knowledge produced by universities into accelerated economic development. In other regions, to which the Republic of Bulgaria should rightfully be included (Petkov 2023), these connections are broken, with universities and industries functioning independently, unable to achieve synergy that would lead to a common strategy and shared priorities between leading industry sectors and leading universities, which in turn would lead to achieving national competitiveness and sustainability of economic development (Velev, Dimitrov & Zlateva 2023). As emphasized above, the sustainability of economic development requires it to be supported through (1) targeted applied research by universities for the benefit of national industry needs and (2) the existence of a young generation of experts, highly trained in their professional fields with the most up-to-date knowledge and skills from leading universities in full accordance with national industry needs.

In the absence of such reality and weak “science-industry synergy,” at least two distortions occur that result in inevitable economic contraction in the foreseeable future: (1) universities create knowledge and experts who cannot find practical application in the national industry and either remain unemployed or become economic migrants and (2) the national industry contracts due to experiencing a deficit of knowledge, technology, and professional expertise.

Table 4. R&D Expenditure in Bulgaria for 2023 by Statistical Regions and Sectors, in thousand BGN

Sectors/ Statistical Regions	2019	2020	2021	2022	2023*
Total	1002132	1023790	1074004	1265635	1467491
Northern and Southeastern Bulgaria	174218	154210	160636	205361	213313
Northwestern Region	32106	31830	34996	39369	32702
North Central Region	30462	31642	32565	39502	45672
Northeastern Region	63852	45651	48188	66373	71790
Southeastern Region	47798	45087	44887	60117	63149
Southwestern and South Central Bulgaria	827914	869580	913368	1060274	1254178
Southwestern Region	736037	778431	827264	959849	1153818
South Central Region	91877	91149	86104	100425	100360
Enterprise Sector	673122	691077	707194	858334	943747
Northern and Southeastern Bulgaria	121474	106716	106658	136964	132286
Northwestern Region	23867	21930	24116	27537	17329
North Central Region	27949	29174	29883	36467	39804
Northeastern Region	32899	21706	20747	32277	31620
Southeastern Region	36759	33906	31912	40683	43533
Southwestern and South Central Bulgaria	551648	584361	600536	721370	811461
Southwestern Region	493731	525967	550244	656846	753741
South Central Region	57917	58394	50292	64524	57720
Government Sector	249420	263625	291274	321922	421817
Northern and Southeastern Bulgaria	30854	33600	36358	41171	47822
Northwestern Region	7958	9655	..	..	12934
North Central Region	556	865	..	..	1382
Northeastern Region	16096	16166	17338	17972	21750
Southeastern Region	6244	6914	7569	11083	11756
Southwestern and South Central Bulgaria	218566	230025	254916	280751	373995
Southwestern Region	207407	216840	239989	263130	354568

South Central Region	11159	13185	14927	17621	19427
Higher Education Sector	73294	62215	69282	79123	95310
Northern and Southeastern Bulgaria	21763	13469	17284	27010	32910
Northwestern Region	..	..	..	..	..
North Central Region	1957	1603	1513	2060	4486
Northeastern Region	..	..	..	15948	18185
Southeastern Region	..	4244	..	..	..
Southwestern and South Central Bulgaria	51531	48746	51998	52113	62400
Southwestern Region	31272	31850	33769	36320	..
South Central Region	20259	16896	18229	15793	..
Non-profit Organizations Sector	6296	6873	6254	6256	6617
Northern and Southeastern Bulgaria	127	425	336	216	295
Northwestern Region	..	..	-	-	..
North Central Region	-	-	..	..	-
Northeastern Region	..	..	..	176	235
Southeastern Region	..	23	..	..	..
Southwestern and South Central Bulgaria	6169	6448	5918	6040	6322
Southwestern Region	3627	3774	3262	3553	..
South Central Region	2542	2674	2656	2487	..
Preliminary data; „..“ – confidential data; „-“ – no case.					

Source: National Statistical Institute, 2024,
Total intramural R&D expenditure (GERD) by regions and sectors,
https://www.nsi.bg/bg/content/2684/%D1%80%D0%B0%D0%B7%D1%85%D0%BE%D0%B4%D0%B8-%D0%B7%D0%B0-%D0%BD%D0%B8%D1%80%D0%B4-%D0%BF%D0%BE-%D1%81%D1%82%D0%B0%D1%82%D0%B8%D1%81%D1%82%D0%B8%D1%87%D0%B5%D1%81%D0%BA%D0%B8-%D1%80%D0%B0%D0%B9%D0%BE%D0%BD%D0%B8-%D0%B8-%D1%81%D0%B5%D0%BA%D1%82%D0%BE%D1%80%D0%B8

It is interesting to examine which sectors of the national industry in the Republic of Bulgaria and with what scope of activity the organizations finance research and development in Bulgaria, as this would provide more information about the “science-industry” relationship. Similarly, interesting conclusions about the “science-industry” relationship could be reached by collecting, summarizing, and analyzing statistical data about which universities, which of their faculties, and which departments have conducted applied research that has attracted funding. At this stage, the National Statistical Institute does not collect and, therefore, could not provide such information in a structured way for analysis.

Table 5. R&D Expenditure in Bulgaria by Sources of Funding and Sectors for 2023, in thousand BGN

Sectors/ Sources of Funding	**2019**	**2020**	**2021**	**2022**	**2023***
Total	1002132	1023790	1074004	1265635	1467491
By Sources of Funding					
Enterprises	377191	362722	353671	439685	455807
Government Sector	236663	259444	279970	311059	387834
Higher Education	1037	2208	7070	6305	5664
Non-profit Organizations	2535	2559	2322	2816	3121
Foreign Sources	384706	396857	430971	505770	615065
Sector Enterprises	673122	691077	707194	858334	943747
By Sources of Funding					
Enterprises	342899	327118	316868	404862	415931
Government Sector	9017	7233	5696	..	..
Higher Education	193	232	274	..	..
Non-profit Organizations	2047	2467	2155	2326	2318
Foreign Sources	318966	354027	382201	445881	520825
Government Sector	249420	263625	291274	321922	421817
By Sources of Funding					
Enterprises	24917	22277	27288	25241	27198
Government Sector	199321	220396	241612	269822	342994
Higher Education	..	140	..	..	..
Non-profit Organizations	..	-	..	..	..
Foreign Sources	24817	20812	22083	26693	51262
Sector Higher Education	73294	62215	69282	79123	95310
By Sources of Funding					
Enterprises	9187	12894	9256	9407	12519
Government Sector	27934	31114	32268	36138	39985
Higher Education	626	..	..	6017	..
Non-profit Organizations	218	..	..	381	..
Foreign Sources	35329	16338	21127	27180	36827
Sector Non-profit Organizations	6296	6873	6254	6256	6617
By Sources of Funding					
Enterprises	188	433	259	175	159

Government Sector	391	701	394	..	..
Higher Education	..	..	-	-	..
Non-profit Organizations	..	..	41	..	26
Foreign Sources	5594	5680	5560	6016	6151
Preliminary data; „..“ – confidential data; „-“ – no case.					

Source: National statistical institute, 2024, Total intramural R&D expenditure (GERD) by the source of funds and sectors, https://www.nsi.bg/bg/content/2678/%D1%80%D0%B0%D0%B7%D1%85%D0%BE%D0%B4%D0%B8-%D0%B7%D0%B0-%D0%BD%D0%B8%D1%80%D0%B4-%D0%BF%D0%BE-%D0%B8%D0%B7%D1%82%D0%BE%D1%87%D0%BD%D0%B8%D1%86%D0%B8-%D0%BD%D0%B0-%D1%84%D0%B8%D0%BD%D0%B0%D0%BD%D1%81%D0%B8%D1%80%D0%B0%D0%BD%D0%B5-%D0%B8-%D1%81%D0%B5%D0%BA%D1%82%D0%BE%D1%80%D0%B8

Table 5. Budget Expenditure on Research and Development (R&D) by Socio-economic Objectives for 2023 in Bulgaria, thousand BGN

Socio-economic Objectives	**2019**	**2020**	**2021**	**2022**	**2023**
Total	267 311	283 804	325 833	365 778	417 451
Exploration and Exploitation of the Earth's Surface, Waters, and Atmosphere	14 009	12 190	13 092	34 057	44 889
Environmental Protection	592	1 315	1 010	1 268	2 587
Civil Space Research	2 841	2 979	3 122	4 046	4 422
Development of Transport, Telecommunications and Other Infrastructure	9 443	12 323	14 555	15 968	25 871
Production, Storage, Distribution, and Use of Energy	904	2 435	2 233	1 105	3 487
Improvement of Industrial Production and Technologies	23 948	19 561	22 674	21 625	27 801
Healthcare Development	5 771	5 978	7 866	11 448	10 931
Development of Agriculture, Forestry, and Fishing	48 506	49 721	56 785	70 797	78 685
Development of Education	10 784	3 200	3 475	3 639	4 384

Cultural, Entertainment, and Religious Activities	1 988	3 119	3 420	3 222	3 913
Research of Political and Social Systems, Structures and Processes	4 595	4 905	6 352	5 616	6 284
General Knowledge Development: R&D Funded by Public University Funds	22 538	34 710	37 616	46 296	58 694
General Knowledge Development: R&D Funded by Other Sources	119 515	129 014	152 454	145 177	143 808
Defense	1 877	2 354	1 179	1 514	1 695

Source: National statistical institute, 2024, Government budget allocations for R&D (GBARD) by socio-economic objectives, https://www.nsi.bg/bg/content/2708/%D0%B1%D1%8E%D0%B4%D0%B6%D0%B5%D1%82%D0%BD%D0%B8-%D1%80%D0%B0%D0%B7%D1%85%D0%BE%D0%B4%D0%B8-%D0%B7%D0%B0-%D0%BD%D0%B0%D1%83%D1%87%D0-%BD%D0%BE%D0%B8%D0%B7%D1%81%D0%BB%D0%B5%D0%B4%D0%BE%D0%B2%D0%B0%D1%82%D0%B5%D0%BB%D1%81%D0%BA%D0%B0-%D0%B8-%D1%80%D0%B0%D0%B7%D0%B2%D0%BE%D0%B9%D0%BD%D0%B0-%D0%B4%D0%B5%D0%B9%D0%BD%D0%BE%D1%81%D1%82-%D0%BD%D0%B8%D1%80%D0%B4-%D0%BF%D0%BE-%D1%81%D0%BE%D1%86%D0%B8%D0%B0%D0%BB%D0%BD%D0%BE-%D0%B8%D0%BA%D0%BE%D0%BD%D0%BE%D0%BC%D0%B8%D1%87%D0%B5%D1%81%D0%BA%D0%B8-%D1%86%D0%B5%D0%BB%D0%B8

4.4. Imperfections and Challenges in the Practice of the Republic of Bulgaria for Sustainable Economic Development Based on Synergy of Science and Industry

In a strategic context, it should be noted that in the Republic of Bulgaria, there are no clearly defined long-term priorities in the industry ("priority directions for the country's development" within the meaning of the Law on Promotion of Scientific Research and Innovation), and this is crucial for achieving strategic synergy between priority industries and the long-term focus of science and education in the relevant fields of science. Strategic instability of priorities could not allow sustainable development of the national economy (Van Mensel, Dentchev, Yordanova, Diaz & Izquierdo 2024).

From a systematic perspective, it should be noted that in the Republic of Bulgaria, "there has been an absence of a consistent national policy for promoting the development of scientific research in recent decades" (National Strategy for Development of Scientific Research in the Republic of Bulgaria 2017 – 2030 "Better Science for Better Bulgaria," 2017, p.21).

In a coordination context, another challenge is presented by the circumstance that in the Republic of Bulgaria, where separate from the Ministry of Education and Science, there is also a Ministry of Innovation and Growth, which, according to current legislation, together with the Council of Ministers are called upon to "implement state policy for promoting scientific research and innovation" (Law on Promotion of Scientific Research and Innovation, 2024, Art. 8, Para. 1). In the same context, it should also be noted that the Ministry of Economy is separate from them, which further complicates the coordination of synergy in research activities and innovation on one side, innovations on another side, and industry on the third.

From the perspective of the need for specialization in both science and industry to achieve competitiveness in sectors of specialization, it should be noted that the Republic of Bulgaria "cannot afford significant presence in all scientific fields" (National Strategy for Development of Scientific Research in the Republic of Bulgaria, p. 27). It is more than evident that specialization in some specific fields of science seems obligatory, which in some sense contradicts "the academic autonomy" and "academic self-governance" of the universities in Bulgaria (guaranteed by the Constitution and the Higher Education Act) but seems inevitable for the achievement of national competitiveness.

From the perspective of the state of the industry in the Republic of Bulgaria, it should be noted that the dynamics in the EU and the absence of sustainable growth in Europe for a decade and more are among the reasons for numerous restructurings and closures of traditional cross-border links including with Russia, Belarus, partially with Ukraine (due to Russia's war on European territory), and also with Northern Africa because of the economic uncertainty in those African countries, which in their entirety cause delayed industrial development in Bulgaria, resulting in reduced business planning (Blagoev 2023) and lack of interest in science and scientific research in a strategic horizon. Moreover, this situation has persisted for several years and contradicts the marketing principle that "the companies target sustainability as the key ingredient for their survival" (Todorova 2024). Sustainable management constitutes a strategic choice for the 21st century (Stoyanova 2024), but unfortunately, it has become increasingly impossible because of global factors.

There is an absence of systematic discussion, evaluation, planning, and monitoring of results in the fields of science, education, and industry with the simultaneous participation of ministry heads, rectors of leading universities, and business leaders, who, within periodic sessions, would form standard policies for sustainable economic development based on the synergy of science and industry (Sterev 2023).

There are no substantial incentives for conducting high-quality scientific research because the existing general criteria in the Republic of Bulgaria examine indicators that correspond to the quality of scientific research only indirectly and insofar as the research is linked to its publication in scientific journals with an impact factor. However, there is no direct assessment from industry representatives or specific practical fields that, even within specific forums, would recognize or acknowledge the quality contributions of relevant scientific research by Bulgarian universities.

The connections between universities and scientific organizations in Bulgaria, as well as national industry and Bulgarian business, are weak. Unfortunately, to a considerable extent, businesses are passive in their attitudes toward scientific research and opportunities for interaction with universities in various areas of strategic importance. Most likely because there are no incentives for private investments in joint or purely university research, there is no adequate regulatory framework, and there is no practice for implementing joint scientific or practical-applied research.

Findings, Conclusions, and Recommendations

The review of existing deficits unambiguously imposes **the main conclusion that long-term priorities for the economic development of the Republic of Bulgaria are persistently absent**. This reality is a real challenge for Bulgarian universities to set strategic research directions and to focus on the education and training of the needed specialists for the national industry for three reasons: (1) the strategic management of the country does not establish strategic priorities, (2) Bulgarian universities, under their autonomy, conduct research and educational process without discussions with the country's industry, and (3) national industry experiences a shortage of knowledge, research and trained experts to maintain its competitiveness. In connection with this conclusion, the following recommendations can be proposed:

Recommendation 1: Competent national institutions should forecast which sectors of the national economy will develop most intensively over the next decade and, similarly, forecast the directions of scientific research and educational focus of the leading Bulgarian universities, which are called upon to provide industry with respective knowledge and personnel.

Recommendation 2: Competent national institutions should assess the current potential of universities and assign leading universities to develop research and teaching capacity specifically in the priority areas while ensuring long-term funding programs and resources for the needs of Bulgaria's leading universities.

Recommendation 3: A scientific analytical unit under the Council of Ministers of the Republic of Bulgaria should monitor the dynamics of science priorities of globally most developed countries and also at the EU level and Balkan Peninsula level, with a view to systematic comparison and systematic assessment of the state of science results in the Republic of Bulgaria for achieving long-term national specialization and competitiveness in science and industry by the strategic priorities.

Secondly, it should be concluded that there are numerous opportunities for Bulgarian universities to improve the quality of their research output by applying the good practices of leading research institutes worldwide. The following recommendations are possible:

Recommendation 4: Obviously, the role of research universities will continue to grow. For a Bulgarian research university to rank in prestigious positions in world ranking systems, it must adopt an appropriate and realistic strategy for changing the evaluation of scientific research activities of its academic staff and set deadlines for making this change.

Recommendation 5 – to consider the possibility of specializing academic staff into two distinct groups: (1) Research Academic Staff – capable of research activity and engaging them more with it and less with teaching, but therefore at master's and doctoral levels, and (2) Teaching Academic Staff – capable of teaching activity and engaging them more with it, primarily at bachelor's level and less with scientific research.

Recommendation 6 – to promote higher responsibility in student education in Bulgaria by adopting measurable requirements for mandatory student attendance in class, both in lectures and exercises, which benefits simultaneously (1) students' academic knowledge and skills, (2) the national industry's need for a greater level of qualification of the university graduates, and (3) the development of modern society.

Recommendation 7 – Research universities in Bulgaria should commit to building a university system for technology transfer to connect academic research with industry through patents and commercialization of academic research. The emphasis in research activity in the most developed countries is on innovation and applicability of scientific research, including several patents – "as an economic pillar for steady development" (Aleksandrov 2022).

Thirdly, it should be noted that despite a sound regulatory framework for scientific research, this study concludes that the research system of the Republic of Bulgaria needs modernization. There are various positive trends, but also a lack of normatively established diverse opportunities for research funding, stimulating high-quality achievements, introducing modern criteria for evaluating researchers, and others. Given this conclusion, the following recommendations should be made:

Recommendation 8 - the creation of a national system for annual qualitative research evaluation and identification of highest-quality research professors with academic impact in three areas: (1) researcher contribution; (2) teacher contribution; (3) contribution to the university, the academic community, and society.

Recommendation 9 – public promotion of highest-quality research professors as (1) members of strategic councils in government bodies; (2) leaders of national working groups for updating strategic documents; (3) external experts in advisory bodies on regional or municipal level; (4) public lecturers and media commentators on behalf of the university for forming public opinion aligned with modern scientific achievements.

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