

Innovations in Bulgaria: problems and challenges for sustainable development

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Abstract. The main goal of the research is to study the limitations, deficits, advantages, and potential for innovation in Bulgaria with focus on sustainable development and green models. The study goes through different dimensions of factors such as: availability of favourable infrastructure, the development of innovation activities at the company level, and the achieved results of the innovation activity. By carrying out a comparative analysis, we aim to identify directions for improving the innovation ecosystem. The main result is establishing the key problem areas in the research of innovations in Bulgaria after the country's acceptance into the European Union especially green and bio innovations and their key role for development. We found that the major implication was the need for targeted and systematic interventions at a high level, including strategic documents that support the creation and implementation of innovations. The research pointed permanent deficits and outlined some positive processes.

1 Introduction

Innovations are driver of growth and has the potential to transform the economy so that growing needs are met in a way that does not negatively affect the environment.

They are directly related to the topics of green and digital transition, circular economy and sustainable development. Innovations related to the circular economy and green transformation are particularly relevant in the context of ever-decreasing access to key raw materials. This is a serious challenge that requires the application of innovative approaches and solutions for the optimization of resources and the introduction of more sustainable business models, including green ones.

Innovations are the source for economic development, they increase labour productivity, create new products; improve existing processes at the organizational and technological level [1]. Companies operating in a dynamic environment strive to reduce costs, to increase production efficiency and to continuously pursuit of innovations. The interaction between science and business is key to innovation in the modern knowledge economy, which finds expression in 'triple helix' and 'quadruple helix' models where innovations occur at the intersections between different spheres and actors [2]. While the Bulgarian economy's innovation performance is improving, according to the European Innovation Scoreboard, it

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remains unsatisfactory. Key challenges are related to the low levels of knowledge and technology transfer caused by the limited interaction between science and business, as well as the deepening regional disparities in economic development. The effective management of innovation activity at different levels requires knowledge and adaptation to the constantly changing conditions of the globalizing economy. The identified limitations, established advantages and hidden opportunities are key prerequisites for the development and implementation of adequate measures for the improvement of the innovation environment in Bulgaria.

Bulgaria has potential for the development of organic agriculture, for the creation of innovative products and services, in the application of green models. This implies the binding of the traditional sectors of the national economy with the implementation of innovations contributing to the achievement of sustainable development. Achieving high innovation growth in support of sustainability has a number of positive effects - protection and restoration of the environment and resources, increased competitiveness of economic entities, improved socio-economic environment in the regions. Achieving a high degree of innovation, however, requires investment, functioning of an adequate innovation system, reduced administrative burden, involving and engaging stakeholders and, last but not least, creating an innovation culture.

Research interest in innovation has been increasingly wide-ranging and multifaceted in recent years. Questions were related to the opportunities and challenges facing innovation activity in Bulgaria at various levels. The role of the government in the processes of building a favourable environment for innovation activity is emphasized [3] [4]. The need for a targeted policy to increase R&D spending [5], the institutional support for the investment initiatives of business organizations [6][7], and the promotion of the effective interaction between science and business were part of the identified guidelines for interventions that were essential for the development of the innovation potential. At the same time, the low initiative of the organizations to search for opportunities for innovations was considered [8]. Specialization and interest in product innovations and service innovations at the expense of process innovations was established, and the latter is major contributor for economic growth and competitiveness.

At the sectoral level, innovations are studied in the agricultural, industrial, tourism, and service sectors. Alexieva-Nikolova & Valeva [6] identify three groups of problems facing innovation activity in the bio-sector: financial-economic (lack of own resources and difficult access to subsidies, uncertainty regarding market demand and investment returns); corporate (lack of qualified personnel and expertise); and others covering low demand for eco-products, stifling regulations, weak links between science and business. Bachev & Mihailova [9] identify, through expert assessments, the main problems facing innovation in the agricultural sector:

- Low funding of agricultural research at scientific institutes and stations;
- Insufficient investments for digitization in the agricultural sector and low real access of producers to digital services;
- Limited access to product innovations and production methods, most pronounced in innovations in marketing and forms of organization.

Due to these problems, 95% of agricultural companies do not invest in R&D but use innovations from outside - through innovative products (planting material and fertilizers) and digital and smart services of mobile operators [5].

Boycheva [4] considers several problems facing innovations in the tourism sector, related to the seasonal nature of employment in the sector, the low motivation of staff to introduce innovations and good practices (low innovation culture); the inadequate state policy in managing destinations, and supporting start-up companies; the deteriorating

business environment. Sotirova [8] indicates the following main problems facing innovations in industrial enterprises:

- Human, related to low qualification and inefficient management of human resources;
- Financial, related to limited funding opportunities (lack of internal and external sources); Large size and high risk of investments and Low profitability;
- Institutional, related to the lack of adequate institutional support from the state, market, expressed in a lack of sufficient market information and trust among customers and supply chains.

Digitization and the introduction of artificial intelligence are taking place slowly in industry and services [10].

The other research axis is related to innovation at the national level and in terms of cross-border cooperation. A cross-border case study [12] showed that the majority of enterprises were not innovating, and when there were innovations, they were with low novelty levels, and streaming primarily from in-house sources. The enormous innovation potential of digitalization was hampered by the lack of online presence and connectivity to digital platforms, insufficient capabilities to process big data, and deficient collaboration across the value chain. Ociepa-Kubicka & Pachura [7] point out that, for Bulgaria, the capacity for eco-innovations has a negative impact on the unsatisfactory access to existing subsidies and the regulatory framework. Yosifov & Taneva [3] note strong disparities in R&D funding by region, that suppresses innovation potential outside the Southwest region. An increase in innovation activity in Bulgaria is directly related to the implementation of a purposeful state policy to improve the business environment and stimulate innovation in the long term. Dimitrova [12] found that the highest drive for product innovation was observed in large companies, associated with the use of well-established practices and higher resource availability. The problems facing innovation are due to the lack of focus on external and internal development activities, weak participation in networks and cooperation, limited resources, low motivation of human capital for knowledge exchange and creativity, and low innovation culture. Chobanova [13] it examines the innovation activities in Bulgaria based on EIC data and identifies a number of problems related to both business policy and state strategy. The business is not engaged in innovation cooperation, emphasizing the import of innovations rather than national knowledge. Registered patents and utility models are declining, with individuals' applications predominating, in contrast to the prevailing R&D spending by businesses. The state administration withdraws from the implementation of a national innovation policy.

The identified problems from the literature review can be grouped into three main areas: **financial and economic difficulties** related to access to resources: lack of financial resources and access to subsidies for innovation and digitalization; low funding and poor management of scientific activities; shortage of qualified staff and expertise; insufficient market information and uncertainty about demand and returns. Difficulties due to ineffective management of **knowledge transfer**: lack of innovation culture; lack of trust and cooperation in the supply chain, weak links between science and business, weak participation in networks; and limited access to product and organizational innovation and digital services. **Institutional difficulties** are expressed in the presence of oppressive regulations and inadequate state support.

Table 1. Problems facing innovation activities

Problems facing innovation activities	Alexieva-Nikolova & Valeva (2021)	Aliyeva and Garabedyan(2022)	Bachev & Mihajlova (2019)	Biolcheva et al. (2023)	Boycheva (2017)	Sotirova (2016)	Chobanova & Kocarev (2019)	Dimitrova (2019)	Chobanova (2023)	Ociepa-Kubiacka & Pachura (2017)	Yosifov & Taneva (2017)
Lack of financial resources and access to subsidies for innovation and digitization	X	X	X			X	X	X		X	X
Oppressive regulations/lack of adequate government support	X				X	X			X	X	X
Lack of innovation culture		X		X	X	X	X	X			
Lack of supply chain trust and collaboration/Weak links between science and business/Weak networking	X					X	X	X	X		
Lack of qualified staff and expertise	X				X	X		X			
Low funding/Poor management of scientific activities			X					X	X		X
Limited access to product and organizational innovation/digital services			X				X				
Insufficient market information/Uncertainty about demand and returns	X					X					

Source: Authors research

2 Materials and Methods

The study is based on a standard scientific approach to the study of scientific literature and secondary sources of information. It conditionally goes through 5 stages:

1. Based on the research objective, 10 keywords related to the innovation system of Bulgaria, its development compared to others, and the challenges facing it are defined. They are: innovations, challenges, problems, perspectives, innovation environment, research activity, investments, innovation ecosystem, formal connections, and informal networks. A period of 2014-2023 has also been defined, with 2014 being the beginning of the country's second program period.

2. A selection of scientific publications was made based on the specified criteria and period in the world scientific databases Scopus and Web of Science, as well as in secondary databases, and the portal of the European Commission and the Bulgarian Council of Ministers to bring documents containing strategic innovation policies. A sample of 80 sources was formed.

3. A content analysis of the content of the sample and a secondary selection was made in the context of current problems and challenges to innovation. The final sample in the study covered 30 sources.

4. Scientific publications, strategic policies, and evaluation reports on the state of the innovation system in Bulgaria were subjected to a thematic and comparative analysis. The

results were systematized, analysed critically, and presented through descriptive methods, incl. and visualized by table and figure.

5. Through induction, translation, and deduction, conclusions were made and priority directions for the development of the national innovation system were defined through intervention through public policies.

3 Results and Discussion

Bulgaria's innovation system is facing significant challenges related to the emerging geopolitical and geo-economics crises, which require a reorientation of policies and public resources in order to control the consequences. The transition between the two program periods, the changes in European policies, and their reflection in the national, deepening political crisis, significantly limit the possibilities for proactive innovative behaviour and slow down the dynamics of innovative development.

In addition, in 2023, the limitations to innovations in Bulgaria are considerable, regardless of the registered general improvement of the country's innovation performance on an annual basis within the EU-27 - nearly 14%. The increase in the innovation index is not high enough and does not help to overcome the lag compared to the EU average. The country remains firmly in the group of emerging innovators at 46.7%, lagging even below the group's average performance of 54% [14].

The lack of sufficient national financial resources for science and innovation is the main problem of the national innovation system. It is deepened by the reduction and aging of the population, as well as by structural problems of the education system, which are reflected in the reduced quality of the available human resources. According to PISA, fewer and fewer students are interested in and succeed in natural sciences, and critical and creative thinking skills are increasingly rare among young people [15]. In their complexity, these are strategic challenges that must be analysed in many aspects and overcome with adequate sectoral policies and on time. These two factors are decisive for achieving innovation growth and moving to intensive innovation development. Historically and geopolitically speaking, however, achieving such innovative growth is increasingly unlikely, raising expectations for the country's continued backwardness in the future.

All this affects the intensity of technological and scientific product creation in Bulgaria. In 2023, only 45 patent applications were registered with the European Patent Office, which places the country in twenty-fourth place among the 27 EU members. Bulgarian companies and organizations received only 22 patents from the European Patent Office. In the same year, 197 applications for patents were submitted to the Patent Office of the Republic of Bulgaria. Higher applicant activity is due to academic institutions. 35% of all applications for 2023 are from the Bulgarian Academy of Sciences (BAS) and higher schools, which exceeds the European average of 8% according to the official Patent Index. [16].

Financing is the main problem of the innovation system. Although in 2022 [17] research and development (R&D) spending grew by 18% year-on-year, still catching up to the pre-Covid 19 growth of 21% in 2019. The growth in 2020 compared to the previous year is only 2% and in 2021 - 5%. In practice, the national innovation system is still overcoming the effects of the pandemic. Regardless of the absolute increase in R&D spending in 2022, in relative terms, it is only 0.75% of GDP, which is in practice a decrease of 2 p.p. on an annual basis.

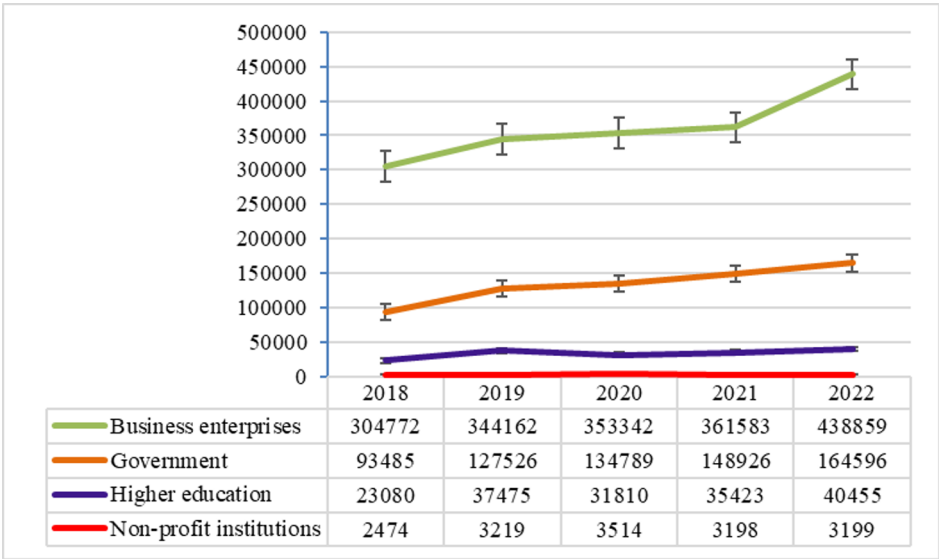


Fig. 1. R&D expenditure in Bulgaria by sector in 2022 (thousand euros) Source: Author's calculations based on NSI data

The main investor in innovation is business. In 2022, it forms 68% of all R&D expenditures in the country, with the growth compared to the previous year being 21%. A worrisome fact is the lack of growth in funds for R&D in higher education, as they are a relatively constant amount - only 0.05% of GDP. In practice, scientific organizations do not have sufficient financial resources for the development of qualitative research and subsequent implementation of the results. The public sector registered a decline in invested funds for R&D, forming only 0.19% of GDP. More than 60% of the investments in research and development are from abroad [18].

In 2022, there are 37,056 people employed in R&D, with equivalent employment of 27,090 people [19]. The increase is 7% compared to the previous year, after the decrease of 1.4% registered in 2021. Half of the research personnel are employed in the enterprises, and the growth is 15% on an annual basis. Almost unchanged is the number of employees in the State sector and in the Higher Education sector. The largest share - 42% of those employed are in technical sciences, followed by those in medical and health sciences - 22%, 16% are engaged in natural, 8% in social, in agricultural and veterinary sciences - 7% and at least – 6% in humanities and arts [20].

A high turnover of the labour force is registered, and significant differences in the payment of labour are both based on education and planning regions. In addition, based on the political and economic reforms that took place after 1990 in Bulgaria and the accelerated labor emigration of young people, a significant aging of the population is currently being registered, which leads to a limited supply of labor, in general, and of qualified labor, in particular. The advent of digital technologies and artificial intelligence imposes new requirements on the qualification of human resources to support the implementation of innovations. Several strategic documents emphasize that achieving growth is possible through investment in personnel, retaining talent, building digital skills and competent information management, and supporting the establishment of an innovation culture [21].

In terms of talent, it is perceived as the main driver of innovation progress. In terms of the Global Talent Competitiveness Index in 2023, Bulgaria is in 49th place, ahead of only

Romania among the member countries, and behind countries such as Georgia, Costa Rica, and Saudi Arabia [22]. Regarding the World Talent Index, Bulgaria is in 58th place, being the last of the EU member states and sharing positions with countries such as India, Colombia, and Mexico [23]. All this gives reason to direct attention in the development and implementation of public policies to special interventions aimed at the development and retention of talents, which is important for achieving a sustainable economy based on innovation and knowledge.

The strategic documents that aim at the development of innovations consider precisely the defined weaknesses, but effective solutions are not planned for all of them. For example, according to data, direct and indirect government support for R&D in the business sector in Bulgaria is only 5.6% compared to the average levels for Europe [14]. According to data from the ranking of the Global Innovation Index for 2023, Bulgaria dropped by 0.5 points, reaching the lowest value for the last 10 years [24]. The decline of the index is associated with the unsustainable behavior of the Bulgarian innovation policy and the ineffective innovation system. In this context, it is important to note that scientific organizations in Bulgaria face systemic difficulties in the process of implementing the created scientific results in practice. The systematic underfunding of science in the country, the lack of support and incentives for increasing patent activity, the lack of clear regulation in the creation and subsequent functioning of spin-off and spin-out companies, the understated interest of young people in a scientific career, due to non-competitive remuneration and the long career path, the outflow of talent beyond national borders. These problems are addressed in some documents related to scientific research and innovation, as the main source for their solution are planned measures in the "Education" programs [25] and "Research, Innovation and Digitization for Smart Transformation" 2021-2027 [26], financed by the European Structural and Investment Funds, National Reform Program [27].

Regarding entrepreneurship, which is an important indicator for the development of the innovation system, Bulgaria occupies the 63rd position in the Global Innovation Index for 2023 [24]. At the same time, a Eurobarometer survey [28] shows positive attitudes and high activity in the field of youth and social entrepreneurship. The state is a leader in the field of youth entrepreneurship. The highest share of committed young people with their own business is registered in our country - 14%, compared to the average for Europe - 9%. Bulgarian youth are also the most active in terms of starting their own business - 23%, with an average share for Europe - 14%. This entrepreneurial picture is extremely encouraging for the development of innovation and should be a powerful stimulus for the development of the innovation ecosystem.

Public policies related to building entrepreneurial attitudes are important and at this stage, they are effective. In Bulgaria, over 150 programs and trainings are implemented annually to support young people who want to start a business. The main need that young entrepreneurs have is the support of mentors to help realize a viable business idea. From this perspective, innovation networks are key. As a positive point in the development of the innovation environment is their increased intensity and interconnectedness, which are multinational. In the Global Innovation Index 2023, the "innovation links" indicator places the country in 38th place [24]. Research communities are active in networking and connections with the outside world (10th place). At the same time, however, the interaction between academia and business is underdeveloped (53rd place), which makes it difficult for highly innovative scientific knowledge to be put into practice. It should be noted that networks have an essential role in the ecosystem of innovation relationships and governments should normatively and strategically support them.

4 Conclusions

Undoubtedly, Bulgaria must invest in the creation and implementation of sustainable solutions; lead an adequate innovation policy in support of the goals of sustainable development. This requires a comprehensive review of the existing planning documents and implemented initiatives and, on this basis, the development of decisions at the national level on what structures, instruments and policies should be implemented in support of sustainable development goals[29]. Further emphasis in this review and future interventions should be placed on the innovation-sustainable development relationship.

The identified deficiencies in the analysed publications and the suggested guidelines for improvements require targeted and systematic interventions at a high level. The overview of the main indicators in the field of innovation in Bulgaria proved permanent deficits and outlined some positive processes. To respond adequately to the environment, the state must modernize administrative processes and build the capacity of national institutions in the following areas [30], [31]: developing evidence-based policies and increasing their transparency; high-quality administration of policy implementation, better accountability, and control over results; overall improvement of management, coordination, and subordination. Investment in people and talent development is an important priority to achieve innovative growth; this requires a focused effort to maintain high levels of competence by providing diverse forms of learning and self-learning. Support is needed for building sustainable partnerships between science and business with the mediation of state institutions, to be implemented at the program level. Creating an innovation culture is a major challenge for the Bulgarian innovation system. Targeted efforts to build an innovation-supportive environment are an important prerequisite that can accelerate the development of an innovation culture. Important aspects of the environment that need to be reformed and developed are: improvement of the regulatory framework, reduction of bureaucracy, diversification of funding sources, promotion of the principles of the sharing economy, of clusters and hubs, development of start-ups and spin-off companies. Overcoming the identified deficits requires support for the knowledge economy. In this context, it is necessary for Bulgaria to increase national public funding for science and innovation in absolute terms and as a share of GDP, and to define a medium-term budget framework for innovation. This will reduce the risk of conjectural influence on the innovation environment in the country and will ensure relative sustainability of policies for the development of innovation and business infrastructure. In practice, the main task of strategic documents is focused on the support for the creation and implementation of innovations, but also on the creation of a supportive environment that will intensify the innovation process in public and private enterprises, including support for scientific organizations and public bodies that are important actors in innovation systems at different hierarchical levels. Prerequisites must be created for effective interaction between the participants in the innovation system and for increasing the impact of the created scientific research and commercialized scientific products.

This study does not interpret issues related to the regionalization of innovations in Bulgaria, ethical issues related to artificial intelligence and its application in innovation activity, as well as specific sectoral perspectives and limitations. It presents a general picture of the innovation environment in Bulgaria, which is developing positively, albeit at a slower pace.

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