ISSN 2786-491X, e-ISSN 3083-7472

Philosophy, Economics and Law Review

Vol. 5. No. 2. 2025
Received: 25.05.2025
Revised: 03.11.2025
Accepted: 27.11.2025
Published: 26.12.2025

Journal homepage: https://phelr.com.ua/en

UDC 347.72:338.24 (438)

DOI: 10.63341/2786-491X-2025-2-17

Poland's experience in organising the monitoring of legal support for scientific and technological, and innovative activities

Kateryna Sokolova*

Postgraduate Student
State Institution "Dobrov Institute for Scientific and Technological Potential and Science History Studies of the NAS of Ukraine"
01032, 60 Taras Shevchenko Blvd., Kyiv, Ukraine
https://orcid.org/0009-0004-4401-3505

Abstract. The purpose of the study was to determine how the control of legal support for scientific, technical, and innovation activities was implemented in Poland. Legislative acts of the Republic of Poland, Germany, and France were examined. The study employed the following methods: system analysis, comparative-legal method, formal-legal method, content analysis, and synthesis. The instruments for stimulating innovation – tax reliefs for research and development activities (ulga B+R), the Innovation Box mechanism, and public-private partnership mechanisms in the innovation sphere – were also explored. The article analysed how Poland implemented the monitoring of legal norms' effectiveness through digital tools (including Open System of Funds and Government Legislation Centre, ex-ante and ex-post evaluations, as well as through public consultations and legislative transparency. An institutional model was presented, providing coordination between state authorities, scientific institutions, and independent auditors, particularly the Supreme Audit Office. A comparative analysis of legal support approaches for scientific, technical, and innovation activities in Poland, Ukraine, France, and Germany was carried out. The study also examined countries' rankings in the Global Innovation Index 2024, according to which Germany ranked 9th, France 12th, and Poland 40th. Based on the conducted analysis, a set of practical recommendations was formulated regarding the implementation of elements of the Polish experience in the Ukrainian legal framework, including the introduction of digital monitoring mechanisms, business tax incentives, and the creation of institutional infrastructure for innovation support. It was determined that implementing a comprehensive legal model similar to Poland's could enhance the effectiveness of Ukraine's state innovation policy and harmonise it with European standards. The practical significance of the study lies in developing a clear algorithm for introducing European experience in organising the monitoring of legal support for scientific, technical, and innovation activities in Ukraine to increase the effectiveness of national innovation policy

Keywords: intellectual property; tax incentives; state strategy; digital tools; innovation management

Introduction

In the 21st century, scientific, technical, and innovation activities (STIA) have been the strategic foundation of sustainable development and economic competitiveness. The effectiveness largely depended on efficient legal regulation and the continuous monitoring of legal support. The relevance of legal monitoring increased under the conditions of the digital economy, integration into international scientific and innovation networks, and the necessity to adapt to European Union (EU) standards. The legal framework for STIA covered both general provisions on science and innovation and specific instruments such as research funding, intellectual property (IP) protection, public-private partnership (PPP) incentives, and tax reliefs. At the same time, the monitoring mechanism – the evaluation of efficiency, relevance to contemporary needs, and harmonisation with international practice – was no less important than the adoption of legislation itself. It enabled the timely

Suggested Citation:
Sokolova, K. (2025). Poland's experience in organising the monitoring of legal support for scientific and technological, and innovative activities. *Philosophy, Economics and Law Review*, 5(2), 17-35. doi: 10.63341/2786-491X-2025-2-17.

*Corresponding author

identification of gaps, removal of barriers, and improvement of knowledge management. A country that succeeded in creating an effective model of legal monitoring in the field of STIA was Poland. After joining the EU in 2004, Poland underwent a transformation from a post-socialist model to full integration into the European scientific and innovation area. Through the digitalisation of legal processes, active involvement of civil society, expert engagement, and systemic evaluation of the legal framework, the country formed an effective model of innovation management aligned with EU standards.

In the field of legal support for innovation activity, one persisting issue was the low level of effective integration between science and business, which hindered the commercialisation of research results and slowed the development of national innovation systems. This problem was examined by I. Jonek-Kowalska (2021), who analysed the activities of Polish research institutes between 2014 and 2019 under legislative reforms aimed at stimulating the commercialisation of research outcomes. The author identified a positive trend of increased financial autonomy of institutes, openness to cooperation with business, and partial reduction of dependence on budgetary funding. Similar aspects – though with an international emphasis – were discussed by S.I. Kubiv *et al*. (2020), who focused on the innovation potential of Eastern European countries, highlighting inefficiencies in intellectual property rights use and the limited role of state funding in developing innovation exports.

Another problem was the insufficient adaptation of modern innovation management theories to the specific characteristics of individual states, which complicated strategic planning. D. Zieliński *et al*. (2024) studied this issue using "horizon scanning" and "trend radar" methods to identify seven promising technological directions for Poland by 2030. The conclusions indicated potential for strategic management of national innovation policy through expert assessment of technological trends. Similarly, Y. Kharazishvili *et al*. (2021) employed foresight techniques to model long-term scenarios for Ukraine's integration into the European research area, drawing on Polish experience. The researchers emphasised the need to transform foresight into a tool with clear quantitative benchmarks that would enable adaptive strategic management of the innovation system. At the macro level, one of the challenges in innovation policy implementation was the unexpected effects of integrating European innovation strategies into national contexts, especially in post-socialist countries. This issue was studied by A. Karpińska (2020), who analysed the "science and innovation paradox" in Poland – a phenomenon where formal compliance with EU requirements did not lead to a significant increase in innovation capacity. The author identified four types of paradoxes – of entrepreneurship, resources, financing, and absorptive capacity – which together signalled a gap between the normative framework of innovation policy and the actual capabilities of the academic sector. Another challenge was the uneven innovation development of EU countries, which complicated policy unification.

A further problem concerned the unclear role of local governments in supporting and implementing innovation, as well as the lack of systemic analysis of innovation activity dependence on municipality type. N. Derlukiewicz *et al*. (2021) established that the type of municipality significantly influenced the nature of innovations, most of which were related to information and communication technologies, e-governance, and cross-sectoral cooperation. The study emphasised the importance of institutional capacity and local resources for innovation. Unequal access to open innovation platforms among professional groups also remained an issue. J. Ober (2022) discovered that barriers to implementing open innovation varied by respondents' positions, requiring differentiated management solutions. Despite existing research on the legal support of innovation policy, the issue of monitoring legal regulation of STIA in Central and Eastern European countries remained insufficiently covered, particularly regarding institutional mechanisms, digital tools for legal assessment, and the participation of academic and business sectors in the legal dialogue. The purpose of this study was to examine Poland's experience in organising the monitoring of legal support for scientific, technical, and innovation activities. The research objectives were to study Poland's legal approaches to managing STIA, compare the Polish experience with that of other EU countries (France, Germany), and assess the potential for adapting the Polish experience to the Ukrainian context.

Materials and Methods

The methodological basis of the study consisted of a combination of several methods applied to the corresponding sources. The formal-legal and comparative-legal methods were used to analyse the legislative acts of the Republic of Poland. These include the Law of Poland No. 2201 (2017), Law of Poland No. 21 (1992), and Law of Poland No. 80 (1991). The analysis also covered the Industrial Property Law (2000), Law of Poland No. 96 (2010), and Law of Poland No. 1668 (2018). In addition, Law of Poland No. 534 (2019), Law of Poland No. 19 (2008), and Law of Poland No. 9 (1991) were examined. Using content analysis, documents of Poland's strategic planning were examined, such as Resolution No. 16 (2013) and the National Regional Development Strategy (2025). The purpose of examining these materials was to identify legislative mechanisms for supporting innovation, principles of research funding, and features of state policy implementation in the field of STIA. Based on system analysis, the entire body of sources was studied as an integrated structure, and the synthesis method allowed the generalisation of the obtained results and formulation of conclusions.

Within the study, several strategic and institutional programmes aimed at supporting scientific, technical, and innovation activities were analysed. The Smart Specialization Poland (n.d.) programme was examined to explore mechanisms for forming regional smart specialisation strategies. The Innovation Box programme was also analysed to investigate the application of a preferential income tax rate on profits derived from qualified intellectual property rights (Innovation Box tax…, n.d.). The Smart Growth Operational Programme 2014-2020 (2015) was analysed to study practices of supporting science-business consortia and commercialising research results. The Bridge Alfa programme was explored to assess the role of venture financing in innovative projects (Research in Poland, n.d.). The STRATEGMED programme was studied to evaluate support for biomedical research and the implementation of innovative health technologies ([NCBR] Strategmed…, 2023). Within the Regional Operational Programme (ROP) Podlaskie Voivodeship, the funding of the company "Dary Natury" for creating research and development (R&D) infrastructure was analysed (Polish natural products…, 2019). The Biznesmax programme providing credit guarantees for innovative and environmental projects was examined (Biznesmax – ERDF guarantee…, 2023). The First Business – Start up Support programme was also studied, which offered grant and preferential support for business creation (Start-up funding for…, 2024), as well as the e-Pionier programme implemented on the basis of pre-commercial procurement for developing prototype solutions (MVPs) (PIONIER-LAB…, 2020). In addition, Poland's participation in international PPP formats was analysed, particularly within the European Research Area Network (ERA-NET) and Horizon 2020 programmes, where the National Centre for Research and Development (NCBR) (n.d.) acted as the national coordinator of competitions (Poland: NCBR, n.d.; NEURON, n.d.). In the broader European context, the activities of the European Innovation Council (EIC) were examined, including its instruments – EIC Pathfinder, EIC Transition, and EIC Accelerator – aimed at supporting start-ups and small and medium-sized enterprises (SMEs) (European Innovation Council, n.d.a; n.d.b; n.d.c). For quantitative analysis of funding, the European Structural and Investment Funds (2015) Report was used.

To broaden the analytical perspective, materials from France and Germany were also used. In particular, The Future Investment Programme (2018), Search Code (n.d.), and Smart Specialisation Strategy (About S3…, n.d.) were analysed. The study also examined the Regional Development Strategy (SRDEII Île-de-France…, 2022) and the Noé Bretagne Strategy (The Noé Brittany…, n.d.). In addition, Germany's High-Tech Strategy (Federal Ministry of Education and Research, n.d.) and the Basic Law for the Federal Republic of Germany (1949) were considered. For comparison with the Ukrainian context, the Law of Ukraine No. 2404-VI (2010), Law of Ukraine No. 40-IV (2002), and Law of Ukraine No. 848-VIII (2015) were analysed. The study also examined Global Innovation Index (GII) data for 2020-2024 for Germany, France, and Poland, to determine the dynamics of innovation development (Germany ranking in…, 2024; France ranking in…, 2024; Poland ranking in…, 2024).

Results

The legal regulation of STIA in Poland is one of the instruments for shaping an effective innovation policy, ensuring technology transfer, stimulating applied science, and integrating academic knowledge into the sphere of entrepreneurship. The Polish model is based on a complex of interrelated strategic documents, legislative acts, and institutions that ensure the implementation of state policy in this field. Its key feature lies in the integration of science, business, and the state on the principles of partnership and the combination of regulatory mechanisms with economic incentives for innovative activity. One of the main documents is the Resolution No. 16 (2013), which outlines the long-term directions of Poland's socio-economic development under the conditions of globalisation. The document defines innovation as the main driver of modernising the economy and society, envisages an increase in expenditure on R&D to 2% of gross domestic product (GDP), the development of regional Smart Specialisation strategies (About S3…, n.d.), the digital transformation of education, and the strengthening of human capital. The strategy emphasises the need for close integration between science and business, which corresponds to European approaches to the development of innovative ecosystems. An additional reference point is the National Regional Development Strategy (2025), which focused on improving Poland's competitiveness through investments in knowledge, new technologies, and the development of cooperation between science, industry, and the state. The strategy defined four priority areas: the modernisation of education, the digitalisation of the economy and administration, market-oriented research, and the stimulation of innovative activity among enterprises. These strategic directions are actively implemented and deepened through the system of existing legislative and regulatory acts that create legal mechanisms for implementing the objectives in the field of STIA. The main role in the legal framework for STIA in Poland is played by sectoral laws, each of which contributes in its own way to organising the monitoring and evaluation of the effectiveness of state policy.

Accordingly, the Law of Poland No. 2201 (2017) became a key element in creating a favourable legal environment for the development of innovative entrepreneurship and stimulating research activity in the private sector in Poland. This legislative act does not create new legislation from scratch but introduces significant

amendments to already existing laws regulating financial, tax, and administrative activities of innovation entities. Such an approach demonstrated the flexibility and responsiveness of the Polish legislator to the needs of the innovation ecosystem through targeted yet systemic adjustments. One of the innovations introduced by this Law is the implementation of tax incentives for R&D. This was achieved by amending the Law of Poland No. 2201 (2017) and the Law of Poland No. 80 (1991). The key provision here is Article 18d of the Law of Poland No. 21 (1992), which defined the "R&D relief" (ulga B + R). According to this provision, taxpayers who incur qualified R&D expenses have the right to deduct up to 100% of these costs (or even more, depending on the type of enterprise and the nature of the expenditure, as refined by later amendments) from the taxable base (Law of Poland No. 80, 1991). This means that enterprises may double-count certain expenses: once as operating costs and once as tax deductions. Qualified expenses include, in particular, the costs of salaries of employees engaged in R&D, the purchase of materials and raw materials, the use of laboratory equipment, and the depreciation of research instruments. This mechanism was designed to directly stimulate private sector investment in innovation by reducing the tax burden and increasing the attractiveness of innovative activities.

Monitoring the effectiveness of this provision involves analysing data on the number of enterprises that used the relief, the volume of declared qualified expenses, and the impact on the overall level of R&D investment in the private sector. The Law also aims to simplify IP commercialisation mechanisms. This is achieved through amendments to the Industrial Property Law (2000) and other related acts. The purpose of these amendments is to accelerate and simplify the procedures for registering patents, utility models, industrial designs, and trademarks, as well as to create clearer rules for the licensing and transfer. Overall, the Law of Poland No. 2201 (2017) represents a significant step towards improving Poland's innovation climate. Its main contribution lies in creating systemic tax incentives and optimising legal procedures that directly influence the attraction of private capital into R&D and the acceleration of innovation commercialisation. Monitoring its effectiveness requires a comprehensive approach that includes both quantitative indicators (investment volumes, tax deductions) and qualitative ones (number of innovative enterprises, level of commercialisation, evaluation of administrative burden). This Law, together with other legislative and strategic documents, forms an integrated system of support and monitoring of STIA in Poland.

Next is the Law of Poland No. 1668 (2018), which comprehensively regulates the higher education and science system in Poland, replacing previous acts. Its most important aspect for monitoring is the introduction of a new system for evaluating the quality of scientific activity. Part II, Chapters 5 and 6 (Articles 263-356), detail the processes of periodic assessment of the quality of scientific activity and scientific disciplines conducted by the Science Evaluation Commission (KEN). This directly forms the basis for monitoring scientific achievements and the compliance with established standards, as well as influencing the distribution of basic funding for universities and research institutions. The Law establishes parameters for classifying and ranking scientific institutions and universities based on the scientific achievements (Article 388). This makes it possible to track the dynamics of development in higher education institutions and research institutes, as well as the effectiveness of implemented reforms. Part II, Chapter 1 (Articles 111-209) regulates the process of obtaining academic degrees (Doctor and Doctor habilitatus) and academic titles. Monitoring allows for tracking changes in the scientific human resources and the effectiveness of training new research personnel. The Law also encourages international cooperation and the internationalisation of scientific activity (Articles 16, 21, 23). This requires tracking the international activity of Polish science, including the number of joint projects and publications with foreign partners. Overall, this Law defines the organisational and qualitative aspects of monitoring, creating a framework for assessing the performance and efficiency of scientific research and its international competitiveness.

The final specialised legislative act is the Law of Poland No. 96 (2010). This Law is central to monitoring the implementation of state policy in the field of applied research and innovation. It establishes the tasks and functions of the NCBR as the key institution supporting R&D, particularly applied research, and the implementation of its results into the economy. Article 2 of this Law details the tasks of the NCBR, which include managing research and development funding programmes, supporting the commercialisation of research results, and promoting cooperation between science and business. Monitoring involves analysing the implementation of these tasks. The Law defines the procedures for competitions, grants, and programmes implemented by the NCBR. Articles 14-16 regulate the mechanisms for providing financial support. This requires monitoring the procedures for project selection, implementation, and achieved results, including the number of implemented innovations and attracted investments. The NCBR often acts as an expert and consultant for the government, which is also part of its mandate. Monitoring the activities of the NCBR, based on this Law, allows for tracking progress in research commercialisation, supporting technological development, and contributing to economic growth. It also makes it possible to assess to what extent the legal framework of the NCBR's activities contributes to achieving Poland's strategic goals in STIA.

Additionally, it is worth noting the Law of Poland No. 534 (2019). This legislative act established a

national network of over 30 research institutes. The purpose of the Law is the institutional integration of applied research with market needs, providing comprehensive solutions "from idea to technology", attracting private investors, and optimising costs through a network structure (Article 3). The Łukasiewicz Network has become an important platform for effective coordination of applied research and its implementation in production, which, in turn, requires separate monitoring of its effectiveness and contribution to innovation development (Franaszek *et al*., 2021). A complement to these institutional and organisational mechanisms is the legislation on public-private partnerships, which creates legal and financial conditions for cooperation between the state and business in implementing innovative projects. The Law of Poland No. 19 (2008) defines the legal framework for cooperation between the state and business in joint projects, including in the field of innovation. The Law provides for: joint financing of science parks, technology transfer centres, and innovation platforms; the involvement of European structural funds (Horizon Europe, Smart Growth); simplified procedures for the participation of small and medium-sized enterprises in PPP projects (innovations of 2020); increased transparency of contract conclusion through digitalisation and public procedures; guarantees of tax stability for private partners.

PPPs are actively used in Poland to implement regional innovation projects, create science parks, incubators, and technology transfer centres, which increase the efficiency of using public resources and stimulate investment (Solak, 2024). Thus, Poland has created a multi-level legal system that integrates national development strategies, innovation legislation, and public-private partnership mechanisms. This system ensures effective interaction between the state, science, and business, combining regulatory governance with financial and organisational incentives. The Polish experience demonstrates that the complexity, transparency, and adaptability of legal regulation contribute to building an innovation-oriented economy, which can serve as an example for countries with transition economies, including Ukraine, in the process of modernising the legal framework in accordance with European standards.

In the context of ensuring the effectiveness and compliance of legislation in the field of STIA, Poland demonstrates a comprehensive approach to monitoring legal norms. This process is multifaceted and includes the use of modern digital tools, regular evaluation of effectiveness, ensuring transparency, and active engagement of civil society, as confirmed by numerous sources and practices. One of the key directions is the implementation of digital tools that enhance the efficiency of monitoring legal norms. The central element of this process is the Unified Electronic Registers of Legislation. An example of such a platform is the Internetowy System Aktów Prawnych, which serves as the official source of Polish legislation, where all current laws, decrees, and other legal acts, including those related to STIA, are published. This system provides easy, quick, and free access to information for all interested parties – researchers, innovators, entrepreneurs, lawyers, and the public. This not only promotes transparency but also facilitates tracking legislative changes and ensuring compliance with legal norms.

The next direction of monitoring is the use of platforms for electronic consultations. These are online tools that allow collecting feedback from the public, businesses, and the scientific community regarding draft legal acts or existing norms. An example of such a platform is the governmental portal where draft laws are published for public discussion (for instance, the Rządowe Centrum Legislacji portal, which primarily serves for publication but also includes mechanisms for submitting comments). These platforms increase the inclusiveness of the law-making process by allowing stakeholders to express the opinions and suggestions, which is valuable for forming high-quality and effective legislation in the field of STIA. This approach is consistent with the recommendations of the Organisation for Economic Co-operation and Development (2012) concerning regulatory quality improvement, which emphasise the importance of transparency and public consultation. Thus, digital tools in Poland play a central role in ensuring transparency, accessibility, and efficiency in monitoring legal norms, which forms the foundation for developing a stable and supportive environment for scientific, technical, and innovation activity.

It is worth noting that in Poland, the effectiveness of legislation is not limited merely to its existence but also includes regular assessment of its real impact on the field of STIA. This approach is systematic and consists of several key stages that ensure continuous improvement of the legal framework. Poland actively practises *ex-ante* and *ex-post* evaluations. *Ex-ante* evaluation is conducted before adopting a new law or introducing significant changes. It involves a detailed analysis of potential consequences, risks, and benefits of the new regulation for the field of STIA. At this stage, economic, social, and environmental assessments may be conducted, allowing forecasts of the regulation's impact on various aspects of society and the economy. These assessments serve as a tool for informed decision-making and minimising potential negative effects. For example, within the framework of the regulatory impact assessment procedure in Poland, ministries and agencies are required to conduct a detailed analysis of the impact of draft laws before submitting the draft laws to the Council of Ministers (Colombo *et al*., 2022). *Ex-post* evaluation, in turn, is carried out after a certain period of the legislation's implementation. Its goal is to assess the actual effectiveness of adopted norms and the extent to which the established objectives have been achieved. This process may include statistical data analysis, such as the

number of patents, the volume of R&D investments, and the number of newly created start-ups, which provide a quantitative assessment of the legislation's impact. In addition, qualitative methods are used, including stakeholder surveys, focus groups, and case studies, which allow for gathering feedback from direct participants in the process and identifying practical problems in the application of legal norms (Sukiennik, 2023). Examples of such assessments can be found in reports by NIK or NCBR, which periodically publish analyses of the effectiveness of state programmes and support instruments for STIA (Legal basis for the…, n.d.).

The next component is monitoring implementation. This involves regularly tracking how effectively the adopted legal norms are being implemented in practice. Monitoring helps identify obstacles to the application, such as bureaucratic procedures, insufficient funding, or lack of awareness. This allows for prompt responses to challenges and adjustments in policy to ensure that the legislation aligns with the needs of the STIA sector. Transparency is the main principle of monitoring and public trust in the Polish legal system. It is ensured at several levels, guaranteeing the accessibility of information and openness of processes. A key element is the publication of draft legal acts. All draft laws and by-laws, including those related to STIA, are published on official government portals. This enables the public, experts, and stakeholders to become familiarised with forthcoming legislative changes and provide comments and proposals before the final adoption. In addition, access to monitoring and evaluation results is ensured. Reports on the effectiveness of legislation, analytical studies, and the results of public consultations are publicly available. This promotes greater accountability of public authorities and allows society to oversee how efficiently resources are used and goals are achieved in the STIA field (Wang *et al*., 2022). Transparency is also supported through open meetings and hearings. Parliamentary committees, particularly the Committee on Innovation and New Technologies of the Sejm, as well as other bodies involved in law-making in the field of STIA, conduct open sessions. This allows the public and the media to observe the process of discussion and decision-making, thereby enhancing the accountability of state institutions.

It should also be noted that the participation of civil society is an integral part of shaping an adequate and effective legal framework in the field of STIA in Poland. The involvement of scientific and innovation associations, the business community, and non-governmental organisations ensures that legislation remains relevant to the actual needs of the sector. One of the main mechanisms is public consultation. The organisation of official consultations with experts, business representatives, scholars, and civic activists on draft legislative acts makes it possible to collect a broad range of opinions and proposals. These consultations are often conducted in the form of public hearings, online surveys, and the collection of written comments. For deeper expert interaction, expert councils and working groups are created. These are advisory bodies at ministries and agencies, composed of representatives of the academic and business communities. The role is to provide expert assessments and develop specific proposals for improving legislation in the field of STIA. For instance, the Ministry of Science and Higher Education has such councils to discuss strategic directions for the development of science (Warwas *et al*., 2021). Furthermore, lobbying and advocacy opportunities are of great importance. Stakeholder groups have legal means to actively communicate the positions to legislative and executive authorities, which is a natural process in democratic countries. This ensures that the interests of various actors in the innovation ecosystem are taken into account when shaping legal policy.

The monitoring of legal norms in Poland is carried out with the participation of numerous institutions, each performing its specific role and ensuring a multidimensional approach. The Parliament (Sejm and Senate) is the key legislative body. It not only adopts laws but also exercises parliamentary oversight of the implementation. Parliamentary committees, particularly the Committee on Innovation and New Technologies, play a key role in reviewing and assessing legislative initiatives, as well as in conducting hearings and inquiries concerning issues of STIA. The government and individual ministries, such as the Ministry of Science and Higher Education and the Ministry of Development and Technology, are the main bodies responsible for developing and implementing policy in the field of STIA. These bodies also conduct primary monitoring of the effectiveness of the secondary legislation adopted by these authorities, ensuring its alignment with the country's strategic development goals. The NCBR is the key institution responsible for financing research and development. At the same time, it plays an important role in evaluating the effectiveness of STIA support instruments, as it possesses a substantial amount of data on the performance of funded projects. Its experience and data are an important source for the overall monitoring of legal support (National Centre for…, n.d.). The NIK is the supreme body of state audit. It oversees the use of public funds and the efficiency of government programmes, including in the field of STIA. NIK reports contain critical analyses and independent recommendations for improving legal regulation and the efficiency of budget spending (Legal basis for the…, n.d.). Scientific institutes and universities also contribute to monitoring by conducting independent studies on the effectiveness of public policy and legislation in the field of STIA. These institutions provide objective data and expert conclusions, which are a valuable source of information for government and legislative bodies. Finally, business associations and chambers of commerce

represent the interests of businesses and provide direct feedback on the impact of legislation on innovative activity. The participation in consultative processes is critically important for ensuring the practical effectiveness and relevance of legal norms. Such a multi-actor approach to monitoring legal norms ensures comprehensive analysis, independent oversight, and the continuous improvement of the legislative framework, which is key to the development of scientific, technical, and innovation activity in Poland.

Poland systematically employs a variety of legal instruments to stimulate STIA, creating a favourable environment for the development of the country's innovation potential. This comprehensive approach includes tax incentives, public grants, and public-private partnerships, allowing for investment attraction and sustaining the innovation cycle at all its stages. Tax incentives are among the most common and effective instruments for supporting STIA, due to directly affecting the financial benefits of companies investing in innovation. The key instrument is R&D relief. This measure allows companies to deduct additional expenses related to research and development activities from the taxable income. It covers a significant share of qualified costs such as researchers' salaries, equipment, materials, and services purchased for R&D purposes. The amount of the relief may reach 100-200% of qualified costs, which significantly reduces the tax burden on innovative companies and encourages these companies to increase investment in research and development (Białek-Jaworska *et al*., 2024). Another instrument is the Innovation Box. This mechanism allows for the application of a reduced corporate income tax rate of 5% to income derived from qualified IP rights. Such rights include, in particular, patents, industrial designs, copyrights on computer programs, and topographies of integrated circuits developed or improved within the framework of R&D. The purpose of the IP Box is to encourage companies to commercialise the innovations by motivating the companies to obtain and protect IP rights. Detailed provisions regarding the IP Box are also contained in the aforementioned income tax laws (Innovation Box tax…, n.d.).

In addition, there are incentives for promoting innovative products. These are measures granted to companies that implement innovative solutions, helping the companies cover the costs of marketing and promoting new products and services. Although less well-known compared to R&D relief, such incentives contribute to innovation commercialisation by reducing the financial burden of market entry. At the local level, property tax exemptions may be applied. In some cases, local authorities may grant full or partial exemption from property tax for facilities used for R&D or innovation activities. This applies, for instance, to science parks, technology incubators, and other innovation centres, creating favourable conditions for the development. This decision is made at the level of local self-government bodies in accordance with the Law of Poland No. 9 (1991). Grant support is another important pillar of stimulating STIA, especially for projects with a high level of risk or a long payback period, where private investment may be insufficient. The key institution responsible for allocating substantial amounts of R&D funding is the NCBR. The NCBR offers a wide range of grant programmes aimed at different stages of the innovation cycle – from fundamental research to product development and commercialisation. Examples of popular programmes include STRATEGMED (for projects in the field of medical technologies) or those funded by European funds ([NCBR] Strategmed…, 2023). These programmes serve as instruments for implementing national innovation policy and promoting the commercialisation of research results.

In addition to national programmes, Poland is one of the beneficiaries of EU structural and investment policy funds. A significant share of these funds is directed towards supporting innovation and R&D through regional operational programmes co-financed by the European Union. This includes grants for infrastructure development, support for SMEs in the field of innovation, and the development of human capital for STIA. Within the framework of the European Union's structural and investment policy implementation, Poland receives funding through a number of key funds aimed at supporting innovation activities and research and development work. One of the central programmes is the Smart Growth Operational Programme 2014-2020 (2015), which is the largest EU grant programme in the field of innovation. It is aimed at supporting consortia that combine science and business, as well as at commercialising research results and implementing regional smart specialisation strategies. Another important financial instrument is the Bridge Alfa programme, implemented under the auspices of the NCBR and financed by the European Regional Development Fund (ERDF) through the Program Operacyjny Inteligentny Rozwój (POIR) during 2014-2020 (Research in Poland, n.d.). The main objective of the programme is to enhance cooperation between scientific institutions and entrepreneurs, particularly through investments in early-stage start-ups.

ROPs, implemented across all 16 Polish voivodeships, also play a significant role. A considerable share of ROP funds is directed towards innovation, energy infrastructure development, and transport. For example, the Małopolskie Voivodeship received up to EUR 2.92 billion in 2014-2020, much of which was directed towards supporting innovation projects. Under the Podlaskie Voivodeship ROP, the company "Dary Natury" received EUR 538,092 from the ERDF to establish its own innovative R&D infrastructure (Polish natural product…, 2019). Another element of the investment infrastructure is the Polish Development Fund (Polski Fundusz Rozwoju – PFR) Investment Fund Company (n.d.), which implements loan, guarantee, and venture capital

programmes for small and medium-sized businesses as well as for innovative enterprises. The activities of PFR are financed, among other sources, by EU structural funds, primarily within the POIR framework (Holecki *et al*., 2020). Overall, during 2014-2020, Poland received approximately EUR 86 billion from ESI funds, and with national co-financing, the total resources exceeded EUR 105 billion (European Structural and..., 2015). All the above-mentioned funds are aimed at developing infrastructure, supporting SMEs, implementing innovative technologies, and strengthening human capital in the regions. Given Poland's positive experience, such a system may be adapted in other countries, including Ukraine, to effectively launch regional innovation programmes within the framework of European funding.

In Poland, there are separate grant programmes aimed at supporting start-ups and SMEs. These programmes are specialised and provide funding to innovation-oriented companies at different stages of the development – from research projects and prototype creation to patenting, technology validation, and market entry. The administration of such grants is usually carried out through regional development agencies, state funds, or sectoral ministries whose aim is to stimulate entrepreneurship, digitalisation, and innovative activity in the SME sector. Among the financial instruments of a guarantee nature, the Biznesmax programme deserves a mention (Biznesmax – ERDF guarantee..., 2023). It is a credit guarantee mechanism aimed at innovative and environmental projects by SMEs. The programme is implemented with the support of the ERDF and was adapted to EU crisis-response initiatives during the COVID-19 pandemic (CRII/CRII Plus). Its goal is to reduce financial barriers for businesses implementing new technologies.

In the pan-European context, the activities of the EIC (n.d.a; n.d.b; n.d.c) are of great importance. The EIC implements several grant instruments for start-ups and SMEs: EIC Pathfinder (up to EUR 3-4 million for early-stage research), EIC Transition (up to EUR 2.5 million for validation), and EIC Accelerator (blended financing – up to EUR 17.5 million). These programmes are open to Polish innovative companies that meet the eligibility criteria for participation in EU framework programmes. In addition, an important mechanism for supporting start-ups in Poland is venture capital funds operating under the PFR Ventures (n.d.) – a subsidiary of the PFR. A substantial portion of these funds' resources is derived from European sources within the POIR programme framework. A separate category includes programmes for young entrepreneurs. For example, the "First Business – Start-up Support" is a government programme initiated by the Polish Ministry of Family and Social Policy and implemented through Bank Gospodarstwa Krajowego (Start-up funding for..., 2024). The programme provides grant and preferential support for individuals starting the own businesses and is financed from the state Labour Fund. All the mentioned programmes demonstrate a multi-level approach to financing innovative entrepreneurship that combines European resources, national strategy, and regional initiatives. Such a system ensures support for start-ups at every stage of the development – from research to market commercialisation – and can serve as a useful model for developing similar mechanisms in other countries, including Ukraine. The visualisation of changes in Poland's innovation development in 2020-2024 is presented in Table 1, which reflects its positions in the GII and indicators in the areas of "innovation investments" and "innovation output".

Table 1. Poland's ranking in the Global Innovation Index 2024

Year	GII Position	Innovative inputs	Innovative outputs
2020	28	38	40
2021	40	37	42
2022	38	41	36
2023	41	50	36
2024	40	45	38

Source: compiled by the author based on Poland ranking in the Global Innovation Index 2024 (2024)

Analysing Table 1, it can be concluded that Poland occupies a mid-level position (40th in 2024) in the global innovation ranking, demonstrating a moderate but unstable level of innovation development. The main challenge lies in the weakness of the investment component, which prevents higher results from being achieved. Despite some improvement in innovation efficiency during 2022-2023, the lack of stable financing and long-term strategies slows progress. PPP is a recognised and effective tool in Poland for combining the resources and competencies of the public and private sectors to implement large-scale and complex innovation projects. This approach enables risk-sharing, mobilisation of the necessary financial resources, and the utilisation of both sectors' strengths, which significantly accelerates the development of scientific, technical, and innovation activity. One of the key areas of implementing PPP policy in Poland is the joint execution of research projects. The Polish government, in particular through the NCBR, actively supports cooperation models in which research is conducted by private companies or consortia involving scientific institutions. This approach allows financial and technological risks typical for innovation activity to be distributed while

ensuring private-sector access to public infrastructure, scientific equipment, and the expertise of universities and research institutes.

Relevant mechanisms are implemented through specialised programmes and competitions administered by the NCBR, which acts as an institutional partner that partially assumes risks and simultaneously encourages private sector participation in high-tech projects. One example of this cooperation model is the e-Pionier programme, based on the pre-commercial procurement (PCP) model. This programme is implemented by the NCBR in partnership with accelerators and is aimed at engaging small teams – start-ups and independent developers – to address clearly defined public challenges. Under the PCP mechanism, the public side (represented by the NCBR or an authorised operator – Programme Component Operator) announces a call, manages contract conclusion processes, and oversees performance. Participants – Programme Component Partners (IT companies and start-ups) – develop MVPs. Based on the results of the first two calls conducted in 2017-2020, 81 MVP solutions were developed and funded, confirming the effectiveness of this model in the field of digital innovation (PIONIER-LAB…, 2020).

In addition to national initiatives, Poland actively participates in implementing international PPP formats within the ERA-NET and Horizon 2020 programmes. Specifically, the NCBR acts as the national coordinator for ERA-NET calls, co-financing the participation of Polish organisations in international research consortia (Poland: NCBR, n.d.). For instance, under the NEURON ERA-NET programme, which funds neuroscience research, Polish companies and universities can receive up to 100% funding for both fundamental and applied projects under international partnerships (NEURON, n.d.). Thus, the use of PPPs in Poland, particularly through NCBR instruments, provides several advantages: it enables effective risk-sharing between public and private sectors; grants business access to institutional and scientific infrastructure; engages private IT teams in solving public challenges; and supports high-tech development through national and international programmes. This PPP model combines the flexibility of private entrepreneurship with the possibilities of targeted state financing, thereby forming an effective innovation environment.

PPP is also actively used to establish innovation centres and clusters. This cooperation promotes the development of innovation parks, technology incubators, and specialised clusters where companies, universities, and research centres collaborate on joint projects. Such infrastructure facilities create a favourable environment for generating and commercialising innovations, fostering synergy among the various participants of the innovation ecosystem (Schulders, 2023). Another aspect of stimulating innovation through PPP is public procurement of innovations. Polish legislation actively encourages public bodies to purchase innovative solutions developed by the private sector. This creates a stable market for new technologies and products that can be used in the public sector (for example, in healthcare, energy, and digital services) (Kania, 2023). This practice not only supports innovative companies but also improves the efficiency and modernisation of public services.

Hence, the Polish government actively involves private capital in joint investment funds, including venture capital and development funds. These funds, established under PPP principles, finance start-ups and innovative companies with high growth potential that require substantial investment at early stages. Integration into the European area requires candidate countries not only to undergo political and economic transformation, but also to carry out deep legal reforms to adapt national legislation to EU standards. In this context, the experience of the Republic of Poland – which transitioned from a post-socialist state to a full EU member – is of significant scientific and practical interest. Poland's experience in legal regulation of scientific, technical, and innovation activities can serve as a reference point for Ukraine's European integration process. After gaining independence from the Soviet management model, Poland embarked on a deliberate path of European integration, officially applying for EU membership on 8 April 1994. Accession negotiations opened on 31 March 1998 and concluded on 13 December 2002 at the European Council meeting in Copenhagen.

The Accession Treaty was signed on 16 April 2003 in Athens, and on 1 May 2004, Poland became a full EU member. Thus, the institutional and regulatory preparation for membership lasted a clearly defined 10-year period (1994-2004), during which the country undertook large-scale adaptation of its domestic legal system to the *acquis communautaire* (Petrova & Pospieszna, 2021). One of the fundamental factors behind the successful implementation of this process was the presence of political will from the Polish government. Governmental structures demonstrated consistent commitment to implementing European standards, even under challenging socio-economic conditions (Kolodziejczyk, 2016). Another systemic factor was the series of economic transformations carried out during the 1990s and early 2000s, including privatisation of the state sector, price and trade liberalisation, macroeconomic stabilisation, and active attraction of foreign direct investment. These measures created a competitive economy capable of operating within the EU's internal market (De Búrca, 2022). A key milestone was the process of adapting national legislation to the *acquis communautaire* – the body of rights, obligations, and principles binding upon EU member states. This process involved not only the technical transposition of norms but also the establishment of an effective institutional infrastructure for the implementation.

Particular attention was paid to strategic sectors – including research, innovation, competition law, and intellectual property protection (Florea & Gales, 2021). As a result of these transformations, Poland not only fulfilled the EU accession criteria but also became a leading country among Central and Eastern European states in terms of economic growth, investment volume, and innovation performance. Given the structural similarities with Ukraine, Poland's model of legal system reform and innovation policy can serve as a practical roadmap for implementing European standards in science, technology, and innovation within the Ukrainian context. Poland's experience in legal support for R&D, as examined in previous sections, contains several key elements that can be implemented in Ukrainian practice. Ukraine, aspiring to European integration, must likewise adapt its legislation and institutional framework to European standards in the field of science and innovation.

In France, the system of legal regulation of scientific, technical, and innovation activities is one of the most structured and strategically oriented within the European Union. The central instrument for implementing innovation policy is the The Future Investment Programme (2018) (Programme d'Investissements d'Avenir – PIA), launched in 2010 and adapted through several successive cycles (PIA 1, 2, 3, 4). It provides long-term financing for innovation-oriented projects in health care, digital transformation, environmental transition, education, science, transport, and energy, among others. The distinctive feature of the PIA lies in the use of public-private partnership mechanisms, allowing the combination of public funds with private investments and the reduction of risks in high-technology sectors. At the same time, the Search Code (n.d.) serves as the fundamental regulatory document governing the functioning of the scientific sphere. It regulates the status of researchers, the autonomy of higher education institutions, the principles of funding scientific organisations, and provides for state support for mobility, technology transfer, and research cooperation. The Code promotes the integration of universities into the innovation ecosystem through institutional autonomy and decentralised budget management. Special attention in French legislation is paid to the commercialisation of research results. Legislative provisions establish flexible forms of IP management, including the transfer of technology rights from universities to private companies, joint patenting, and the creation of spin-offs and start-ups based on scientific institutions. In this context, innovation clusters (pôles de compétitivité) play an important role by ensuring the territorial concentration of research institutions, enterprises, and state agencies for the joint implementation of innovation projects (Fernández-González *et al.*, 2023). Moreover, France was one of the first EU countries to fully implement the concept of Smart Specialisation Strategy (S3) in regional policy during the formation of the Europe 2020 strategy (About S3…, n.d.). This enabled the concentration of state investment in the most promising sectors, taking into account the competitive advantages of each region. Unlike Poland, which began implementing S3 principles later and faced significant difficulties in regional coordination, France demonstrates a high level of institutional integration between regional and national levels in strategic innovation planning. This high-level manifests itself through a well-developed multilevel governance system: the key instrument being contracts between the state and regions (State-Region plan contracts, 2022), concluded on a multi-year basis and covering joint funding of projects in science, technology, infrastructure, and innovation. Additionally, strategic planning coordination is carried out through the National Agency for Territorial Cohesion (n.d.), which acts as a mediator between the government and regions, ensuring alignment between national programmes and regional development strategies (SRDEII Île-de-France…, 2022). Regional participation in forming national innovation policy is institutionally guaranteed: regions have a legally defined right to develop and implement the own specialisation strategies in accordance with S3 principles that align with national priorities.

An example of such an integrated approach is the Noé Brittany strategy, within which over 30 institutions – universities, research centres, clusters, and businesses – jointly implement projects in close coordination with regional authorities and national policy frameworks (The Noé Brittany…, n.d.). In view of the above, France's legal model represents a balanced approach to regulating innovation activity. It ensures not only formal interaction but also real functional alignment of strategies and funding across different governance levels – an indicator of a high degree of institutional integration. In the context of scientific adaptation for Central and Eastern European countries, including Ukraine, the French experience deserves attention regarding public-private partnership, IP management, cluster policy, and the regionalisation of innovation strategies. However, its implementation requires consideration of the specific features of Ukraine's regulatory base, institutional development, and regional ecosystem maturity. A visual representation of the dynamics of France's innovation activity during 2020-2024 is presented in Table 2, illustrating its position changes in the GII and rankings for "innovation inputs" and "innovation outputs".

Table 2. France's ranking in the Global Innovation Index 2024

Year	GII Position	Innovative inputs	Innovative outputs
2020	12	16	12
2021	11	17	10

Table 2. Continued

Year	GII Position	Innovative inputs	Innovative outputs
2022	12	13	11
2023	11	17	11
2024	12	17	10

Source: compiled by the author based on France ranking in the Global Innovation Index 2024 (2024)

Analysing Table 2, it can be concluded that France maintains a stable position within the second ten of the GII. The improvement in innovation output indicates the effective performance of institutions focused on tangible results. The legal regulation of scientific, technical, and innovation activities in Germany is characterised by a high degree of decentralisation, stemming from the country's federal structure. The main strategic document in this field is the High-Tech Strategy (HTS), first adopted in 2006 and subsequently updated several times, including in 2010, 2014, and 2020. The latest version, High-Tech Strategy 2025 (HTS-2025), was published by the Federal Ministry of Education and Research (BMBF) (n.d.) in 2020. Although not legally binding, the document functions as a framework for coordinating actions among the federal government, federal states, research institutions, businesses, and other stakeholders. HTS-2025 identifies key development directions – artificial intelligence, sustainable development, energy transition, digital transformation, medicine, biotechnology, mobility, and climate protection – which are strategically significant for the knowledge economy. The document also specifies the role of public-private partnership, interdisciplinary cooperation, and technology transfer from science to industry. The key legal foundation for implementing innovation policy is the Basic Law for the Federal Republic of Germany (1949), which, under Article 91b, stipulates that the federation and the federal states may cooperate in the field of science, research, and education when matters are of national significance (Art. 91b GG). Meanwhile, under the principle of subsidiarity, the main competences in education and science remain with the federal states. This allows each state to develop its own innovation programmes, fund universities and research centres, and design specialisation strategies at the regional level. Thus, Germany's legal system enshrines a multilevel governance model in which the states are full participants in the implementation of R&D policy.

In this context, an important instrument is the funding of research through joint programmes between the federation, the states, and research institutions. This approach is implemented via the German Research Foundation (n.d.) and the Federal Ministry of Education and Research (n.d.), which, in cooperation with financial institutions such as KfW Development Bank (n.d.), support industrial research, start-ups, and technology transfer. Moreover, HTS-2025 places particular emphasis on creating a favourable legal environment for knowledge transfer, IP management, and innovation entrepreneurship. It explicitly highlights the need to strengthen partnerships between universities and SMEs, focusing on joint patenting programmes, creation of scientific-technical platforms, and competence centres. An additional component of Germany's institutional innovation infrastructure is its research networks: Fraunhofer-Gesellschaft (n.d.), Leibniz-Gemeinschaft (n.d.), Helmholtz-Gemeinschaft (n.d.), and Max-Planck-Gesellschaft (n.d.), funded at both the federal and state levels. These organisations play a crucial role in transforming scientific results into applied technologies used in industry, energy, and IT sectors. A visual representation of Germany's innovation dynamics during 2020-2024 is presented in Table 3, illustrating its GII position changes and rankings in "innovation inputs" and "innovation outputs".

Table 3. Germany's ranking in the Global Innovation Index 2024

Year	GII Position	Innovative inputs	Innovative outputs
2020	9	14	7
2021	10	14	8
2022	8	12	7
2023	8	13	6
2024	9	13	6

Source: compiled by the author based on Germany ranking in the Global Innovation Index 2024 (2024)

Analysing Table 3, it can be concluded that Germany remains one of the leaders in innovation development, although the latest years show relative stability without breakthrough growth. The positive trend of increasing innovation outputs, even with minor fluctuations in investment levels, indicates high institutional efficiency and well-designed state innovation policy. Unlike Poland, where innovation policy is more centralised and implemented through a clearly defined vertical of state governance (for example, via the Ministry of Development and Technology and NCBR), the German model provides flexible multilevel governance in which the federal states possess broad powers. This approach not only allows innovation policy to be adapted to

local needs but also creates a competitive environment among regions for attracting resources, researchers, and investors, stimulating the overall development of the national innovation ecosystem. Thus, the German model represents an effective combination of centralised strategy and decentralised implementation, allowing rapid responses to challenges in scientific and technological development. For Ukraine, currently in the process of revising and updating its innovation policy, the German experience may serve as a reference for building a multilevel legal regulation system that accommodates both national priorities and the needs of regional innovation ecosystems. In addition, it is appropriate to present a comparative analysis of Ukraine's legal framework in scientific, technical, and innovation activities with that of Poland and other EU countries to identify key discrepancies and improvement areas.

In Ukraine, the legal regulation of scientific and technical development relies on several fundamental laws but remains fragmented, insufficiently systematic, and ineffective in stimulating innovation. Specifically, the Law of Ukraine No. 848-VIII (2015) establishes the autonomy of research institutions and provides for the creation of the National Council on Science and Technology Development; however, in practice, this autonomy is limited by low budget funding and an underdeveloped applied science market. Unlike Poland, which has introduced specific financial and institutional instruments for implementing autonomy, in Ukraine it largely remains declarative. The Law of Ukraine No. 40-IV (2002) is largely outdated and inconsistent with modern European approaches, particularly the concept of Smart Specialisation (About S3…, n.d.). It lacks effective mechanisms for science-business interaction and does not provide research incentives through tax benefits or grant programmes – which differs significantly from the Law of Poland No. 2201 (2017), where fiscal incentives and start-up support procedures are detailed. Another important element, the Law of Ukraine No. 2404-VI (2010), is rarely applied in science and innovation due to the absence of specialised by-laws, standards, and procedures (Pashchenko, 2025). In contrast, the Law of Poland No. 19 (2008) has become an effective tool for implementing innovation projects – including those supported by European structural funds – and is successfully used at the regional level.

Moreover, Ukraine lacks a developed system for monitoring innovation policy effectiveness, which makes adaptive regulation impossible. There are no legislative mechanisms for regular collection, evaluation, and publication of data on R&D results. This sharply contrasts with Polish practice, where an integrated digital reporting system (for example, Open Society Foundation, n.d.) ensures transparency, control, and policy adjustment based on outcomes. Thus, compared with Poland and other EU countries, Ukraine's legal framework for R&D is less integrated, lacks modern incentive mechanisms, shows weak coordination among government, science, and business, and is deficient in effective legal monitoring tools. This analysis highlighted the need for comprehensive modernisation of Ukrainian legislation, incorporating successful European practices – particularly strengthening financial incentives, creating digital evaluation mechanisms, and increasing transparency and accountability in innovation policy. Hence, it can be concluded that Poland, compared with France and Germany, implements an intermediate model of legal regulation of R&D that combines European strategic planning approaches with adaptation to national conditions. The main advantage of the Polish system lies in the existence of specialised laws that unite science, innovation, and business within a single legal framework, as well as functioning monitoring institutions. Ukraine, in turn, requires deeper legislative transformation, strategic framework development, tax incentives, and the creation of effective mechanisms of public-private partnership in the innovation sphere.

The conducted analysis of R&D legal regulation in Poland, France, and Germany makes it possible to formulate comprehensive recommendations for Ukraine aimed at modernising its national innovation system, increasing its efficiency, and accelerating integration into the European Research Area. These recommendations should be considered across key reform directions. The first direction concerns strategic planning and multilevel governance. Ukraine should develop a flexible national strategy for science and innovation development, similar to Germany's HTS. Such a framework document should define 5-7 key national priorities – including defence, agrotechnology, artificial intelligence, and green energy – and serve as the basis for coordinating the actions of government, regions, science, and business. It is also important to create long-term financing mechanisms similar to France's PIA, ensuring stable multiyear funding for strategic innovation projects and avoiding dependency on annual budget cycles. Additionally, it would be appropriate to implement a model of "state-regional innovation contracts", based on France's Contrats de plan État-Région, involving multi-year agreements between central and regional authorities to co-finance priority projects within national and regional smart-specialisation strategies. The next direction covers financial and tax incentives. Ukraine should introduce effective tax benefits similar to Poland's Ulga B + R (R&D tax deduction) and Innovation Box (reduced corporate tax rate for income from IP commercialisation). It is crucial to establish clear application criteria for businesses to prevent misuse. Furthermore, it is advisable to create a unified grant agency modelled on Poland's NCBR, which would become the main operator of state and donor funds and ensure transparent competitive procedures for financing research and development at all stages – from fundamental to commercial.

The final direction concerns the modernisation of institutional infrastructure. Ukraine needs to reform its public research sector, guided by the German Fraunhofer and Max Planck models. This entails the creation of specialised research networks focused on applied industrial developments and solutions to societal challenges, with joint financing from the state, regions, and private sector. It is also essential to develop innovation clusters and PPPs, following the example of France's pôles de compétitivité and Polish programmes. To achieve this, legislation must be improved, procedures simplified, risks distributed between public and private participants, and conditions created for venture fund development. Equally important is establishing a unified digital platform for monitoring regulatory acts in the R&D field – following Poland's digital platform for monitoring regulatory acts and official government portals for draft legislation – to ensure open access to legislative documents and transparent oversight of changes. The implementation of these recommendations – combining Poland's systematic approach, France's strategic vision, and Germany's decentralised efficiency – will enable Ukraine to build a balanced, sustainable, and competitive innovation ecosystem capable of responding to global challenges and fostering integration into the European Research and Innovation Area.

Discussion

The discussion of the research results allows for a deeper understanding of the identified problems in the field of monitoring the legal framework of scientific, technical, and innovation activities. The analysis of the Polish model showed that the system of legal monitoring in this country remains fragmented, declarative, and insufficiently institutionalised. Despite the existence of certain digital tools and open databases, there are no stable and integrated mechanisms for analytical generalisation of legal changes, particularly at the regional level. This complicates the formation of a timely and effective regulatory response to innovation challenges and limits the adaptability of Poland's innovation ecosystem.

Comparison with the experience of France made it possible to better understand the potential of open digital platforms in ensuring transparency and strategic integration of legal monitoring. In particular, the study by L. Bracco *et al*. (2022) demonstrated the effectiveness of the National Open Science Monitor (BSO), which functions as a publicly accessible digital tool for the collection, analysis, and visualisation of data in the field of open science. It enables the prompt identification of changes in the regulatory landscape, records the response of the academic community, and facilitates the adaptation of regulatory strategies in real time. Based on the current study, it was established that Poland, as of 2025, lacks a functional tool similar to the BSO that could provide systematic and open analytics of regulatory processes in the sphere of science and innovation. Monitoring in Poland is mostly limited to reporting within programmes such as POIR or ROP and does not include centralised analysis of legal indicators at the level of national policy. The French legal model was also identified in this study as an example of a balanced approach to regulating innovation activity. It ensures not only the presence of an effective regulatory framework but also real functional coordination of strategies and implementation tools at all levels – national, regional, and institutional. This high level of institutional integration is maintained through interaction between state bodies, scientific institutions, and local executive structures, ensuring the stability and effectiveness of innovation management.

Similarly, the experience of Germany – particularly the "coarse-fine radar" model proposed by N. Weinberger *et al*. (2013) – confirms the importance of multilevel strategic monitoring for the timely identification of future technological priorities. This approach, implemented through the BMBF, allows for the assessment not only of existing policies but also the creation of a regulatory environment capable of responding to emerging challenges – in biotechnology, digital infrastructure, and hydrogen energy. In Poland, however, similar dual-level systems are absent, and the existing mechanisms are primarily focused on administrative maintenance of current programmes rather than strategic forecasting and legal analysis. This supports the conclusion made in the present study regarding the absence of structured legal analytics and the need to implement unified analytical tools similar to the German "radar" for monitoring the effectiveness of legal acts and updating the regulatory framework in a timely manner.

The results of the study by R. Frietsch *et al*. (2024) provide a deeper understanding of the conceptual evolution of innovation monitoring systems in Germany and highlight the importance of legal stability combined with indicator analysis for effective regulatory governance. The authors argued that innovation indicators are not a static tool but evolve constantly in line with technological developments, analytical methods, and increasing political demands. This approach is consistent with the conclusions of the present study regarding the need for adaptive legal monitoring that responds to the dynamics of the innovation system. However, in Polish practice, a number of key differences have been identified that significantly limit the effectiveness of this process. The conclusion of the German researchers – that indicator monitoring must be flexible yet institutionally grounded – can be fully supported. In the present study, it was established that Poland has not achieved this balance: the system of digitalised monitoring of R&D frameworks is developing mainly within individual initiatives and is not integrated into a unified legal or strategic architecture. The lack of a stable electronic platform for the aggregation and analysis of regulatory data, along with the unclear distribution of

competences between central and local authorities, indicates a lack of institutional maturity required for the effective functioning of an indicator-based system. At the same time, the findings of the current study do not fully agree with the authors' claim that the development of indicators automatically leads to improved regulatory efficiency. As demonstrated by this research, a set of metrics alone – without full integration into the regulatory cycle – does not guarantee a transformative impact. In Poland, despite the existence of indicator reports, there is no mechanism by which these data are incorporated into law-making or governmental practice. This means that indicator analytics exist in isolation from the legal process, which contradicts the fundamental principle formulated by the German authors – that indicators must serve as a tool, not an ultimate goal. Overall, the research largely confirms the importance of developing legal analytics based on indicators, but the results of this study emphasise that the decisive factor for success lies in the integration of such analytics into management and regulatory systems.

The influence of legal formulations on innovation processes in Germany's patent legislation was examined by E. Opie (2023). The author demonstrated that clearly defined legal norms can serve as a catalyst for technological breakthroughs by providing research institutions and start-ups with simpler conditions for IP protection. Against this background, the findings of the present study revealed that Polish patent legislation does not provide sufficient predictability and clarity for innovative actors. In a study devoted to the development of business models in the renewable energy sector in developing countries, particularly in the case of Lebanon, H. Elmustapha & T. Hoppe (2020) focused on the challenges and prospects of transforming institutional and financial models in the context of the sustainable energy transition. The main attention was given to analysing barriers that arise in the process of implementing solar technologies – such as dependence on donor support, lack of financial instruments, insufficient institutional maturity, and the need to strengthen community participation. The authors emphasised the importance of knowledge transfer and consumer engagement as key factors for the successful formation of new business models in decentralised energy. The results of this study partially correspond with the findings of the present research, particularly regarding the critical role of institutional and regulatory frameworks for the successful implementation of innovations. As in the Lebanese context, the Polish system also exhibits dependence on external financial sources, especially European funds, as well as limited institutional capacity to integrate innovative initiatives into a broader strategic and legal framework. A shared feature is the emphasis on knowledge transfer and interaction with local actors – including businesses and civic organisations – to ensure the sustainability of innovative solutions. However, this study adopted a more critical perspective on the legal mechanisms that ensure the durability and scalability of innovations. Unlike the Lebanese case, where the legal context is treated as a background condition, this research argues that without structured legal monitoring, unified digital analytics, and clear distribution of competences, even promising models – such as start-ups or microfinancing – remain vulnerable to institutional instability. Thus, despite similar approaches to increasing community participation and the need for institutional change, this study stressed that the legal environment must play an active rather than passive role in creating favourable conditions for scaling innovations, particularly in transition economies.

Institutional interaction between science and business was examined by E. Wojnicka-Sycz & P. Sycz (2016), who identified such cooperation as one of the key factors of innovation efficiency in Poland. The authors emphasised the importance of promoting collaboration, knowledge exchange, and state support – particularly through grants and enterprise participation in European programmes. Meanwhile, the current study analysed the role of PPPs in the field of innovation, positioned as a promising model for mobilising resources and infrastructure to enhance the country's innovation potential. Within the framework of this study, these conclusions were partially confirmed – horizontal interactions between sectors are indeed important. However, it also demonstrated that the existence of institutional cooperation or PPP mechanisms alone does not guarantee sustainable results if these processes are not accompanied by structured legal monitoring and regulatory adaptation. Specifically, the study identified the absence of clear legal mechanisms for supporting innovation projects in areas such as technology transfer, IP protection, patent expertise, digital ethics, and compliance with international standards. This gap reduces the effectiveness of both institutional linkages and state subsidies, creating uncertainty for participants in the innovation system and limiting the capacity to realise the potential of cooperation in practice. Thus, the comparative analysis indicates that institutional interaction is necessary but insufficient unless complemented by systemic legal support – particularly through effective mechanisms of legal monitoring and forecasting of regulatory needs in the field of R&D.

A similar issue was explored by R. Rauter *et al*. (2019), who analysed how open innovation and collaboration with different partners affect corporate innovation activity – particularly regarding the combination of economic efficiency and sustainability-oriented innovation. The issue the authors addressed lies in the underexplored potential of cooperation with non-traditional partners (non-governmental organisations (NGOs), intermediaries) within open innovation and the insufficient understanding of whether economic and sustainable development goals contradict or reinforce

each other. The authors concluded that cooperation not only with universities and clients but also with NGOs and innovation intermediaries positively influences overall innovation performance, and that economic and environmental innovation goals can be achieved simultaneously rather than being mutually exclusive.

The results of the present research align in many respects with these findings, also pointing to the need for broader integration of innovative actors into the process of shaping legal policy in R&D. Like the authors, this study emphasised the role of interaction between scientific institutions, business, and civil society organisations in enhancing the efficiency of innovation processes. Furthermore, the results confirmed that sustainable development is not the opposite of economic innovation but rather an organic component of it – provided there is appropriate regulatory support and coordination. However, not all aspects of that study's conclusions can be fully agreed upon. Specifically, the authors underestimated the role of the legal environment as a prerequisite for effective implementation of open innovations, whereas the key finding of this research is that the absence of structured legal monitoring and regulatory adaptability can nullify even the most effective cross-sectoral cooperation. Cooperation with NGOs or intermediaries without support in the form of clear procedures, digital mechanisms for legal analysis, and coordination platforms will not ensure a sustainable outcome. Therefore, the role of the state and its capacity to create a legal framework for innovation interaction should be conceptualised more strongly than in the cited work. The conducted discussion of the research results made it possible to summarise the key shortcomings of Poland's system of legal monitoring in scientific, technical, and innovation activities, as well as to compare it with best practices in France and Germany. All the reviewed international studies confirm the importance of an integrated, analytical, and adaptive approach to legal monitoring, which should be based on digital platforms, indicator analysis, and inter-institutional cooperation. In this context, it is appropriate to proceed to the conclusions, which summarise the key results and outline directions for improving legal monitoring.

Conclusions

The study established that the legal regulation of scientific, technical, and innovation activities in Poland is systematic, multi-level, and integrated into the national innovation policy. The Polish model combines strategic planning, legal regulation, economic incentives, public-private partnership, and digital monitoring, creating a favourable environment for interaction between the state, business, and the scientific community, thereby stimulating innovation development. The qualitative results of the study indicated that Poland has laid the foundation for long-term innovation growth through key normative acts such as the Sustainable Development Strategy "Poland 2030", the Law on Innovation, the Law on Higher Education and Science, the Law on NCBR, and the Public-Private Partnership Law. These documents have ensured an increase in R&D expenditure to 2% of GDP (target indicator), expanded access to business support tools (ulga B + R, IP Box), transparency of funding through competitive selection, and active involvement of the private sector and European funds in innovation projects. Poland has also implemented monitoring mechanisms that include digital platforms, ex-ante/ex-post legislative evaluations, public consultations, and civil society participation.

The experience of France and Germany demonstrates the effectiveness of a comprehensive approach to regulating innovation activity that combines regulatory analytics with strategic forecasting. In Germany, the model implemented through the BMBF provides policy analysis and creates a legal environment capable of responding to challenges in biotechnology, digital infrastructure, and hydrogen energy. An important component is the dual-level evaluation system: monitoring policy implementation and verifying its effectiveness in the light of long-term trends. The Polish system, in this regard, is limited: it lacks unified tools for strategic analysis, and the existing mechanisms are focused on the administrative maintenance of programmes. This confirmed the need for tools similar to the German "legal radar", which allows for the identification of gaps and timely adaptation of legal acts. France, in turn, offers a balanced approach integrating strategies and instruments at national, regional, and institutional levels. Such coordination between government, research institutions, and local authorities ensures institutional stability and the effectiveness of innovation policy.

Ukraine is currently at the stage of forming its own model of legal support for scientific and technical development. National legislation remains fragmented, with limited autonomy of scientific institutions, insufficient business incentives, and weak integration of applied science. The absence of policy monitoring and evaluation systems complicates adaptive regulation. This highlights the need to introduce unified analytical and digital tools for developing a modern and effective innovation policy. The conducted research confirmed the feasibility of adapting the Polish model of regulatory governance in scientific and technical development to the Ukrainian context. To improve the effectiveness of innovation policy in Ukraine, it was recommended to: create a coherent legislative framework aligned with modern European approaches; implement digital tools for monitoring legal acts (similar to Polish official government portal for draft legislation); introduce tax incentives for R&D and mechanisms of public-private partnership in science; ensure sustainable financing through competitive research funds. Future research should focus on a more in-depth analysis of regulatory integration mechanisms within digital

transformations, incorporating case studies of other Central and Eastern European countries.

Acknowledgements
None.

Funding
None.

Conflict of Interest
None.

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Досвід Польщі стосовно організації моніторингу правового забезпечення науково-технічної та інноваційної діяльності

Катерина Соколова

Аспірант
Державна установа «Інститут дослідження науково-технічного потенціалу та історії науки імені Г.М. Доброва НАН України»
01032, бульв. Тараса Шевченка, 60, м. Київ, Україна
https://orcid.org/0009-0004-4401-3505

Анотація. Метою дослідження було з'ясувати, як у Польщі реалізується контроль правового гарантування науково-технічної та інноваційної діяльності. Були розглянуті законодавчі акти Республіки Польща, Німеччини та Франції. В дослідженні були використані такі методи: системний аналіз, порівняльно-правовий метод, формально-юридичний метод, контент-аналіз, метод синтезу. Також, були досліджені інструменти стимулювання інновацій – податкові пільги на науково-дослідні та дослідно-конструкторські роботи (ulga B + R), механізму Innovation Box, а також механізмам державно-приватного партнерства в інноваційній сфері. У статті проаналізовано, як у Польщі реалізується моніторинг ефективності правових норм через цифрові інструменти (зокрема, Відкрита система фінансування, Урядовий центр законодавчої діяльності), ex-ante та ex-post оцінки, а також за допомогою публічних консультацій і прозорості законодавчого процесу. Представлено інституційну модель, що передбачає координацію між органами державної влади, науковими установами та незалежними аудиторами, зокрема Верховною контрольною палатою. Здійснено порівняльний аналіз підходів до правового забезпечення науково технічної та інноваційної діяльності у Польщі, Україні, Франції та Німеччині. Проаналізовано рейтинги країн у Глобальному індексі інновацій за 2024 рік, відповідно до якого Німеччина посідає 9 місце, Франція – 12, а Польща – 40. На основі проведеного аналізу сформульовано низку практичних рекомендацій щодо імплементації елементів польського досвіду в українське правове поле, зокрема запровадження цифрових механізмів моніторингу, податкових стимулів для бізнесу та створення інституційної інфраструктури підтримки інновацій. Визначено, що впровадження комплексної моделі правового забезпечення, подібної до польської, може сприяти посиленню ефективності державної інноваційної політики України та її гармонізації з європейськими стандартами. Практичне значення дослідження полягає у розробці чіткого алгоритму впровадження в Україні європейського досвіду організації моніторингу правового забезпечення науково технічної та інноваційної сфери з метою підвищення ефективності національної інноваційної політики

Ключові слова: інтелектуальна власність; податкові пільги; державна стратегія; цифрові інструменти; управління інноваціями