GUIDELINES

“EUROPEAN EXPERIENCE IN TECHNOLOGY TRANSFER”

in the context of

Jean Monnet UniTECH - 101047891 - JEAN-MONNET CHAIRS «European technology transfer for Ukrainian universities» / UniTECH

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CONTENT

1. Introduction

The inclusion of courses such as "Basics of EU Experience in Technology Transfer" (for Bachelors), "EU Experience in Technology Transfer: Theory and Practice" (for Masters), "Technology Transfer at Universities: EU Experience" (for PhD), and "EU Experience in Technology Transfer: Practical Guidelines" (for Lifelong Learning) in Ukrainian higher education is crucial for encouraging innovation-driven growth. These courses give students and professionals at different levels a solid understanding of the EU's best practices in technology transfer, intellectual property protection, and commercialization. By following European standards, they prepare Ukrainian specialists to work in international partnerships, adopt advanced methods, and improve Ukraine's innovation system. Together, these programs help build a knowledge-based economy and support Ukraine's goal of becoming more integrated with the European Union.

The "Basics of EU Experience in Technology Transfer" course for Bachelor's students introduces the key principles, processes, and structures of technology transfer in the EU. It provides students with basic knowledge of the EU's approach to innovation and intellectual property, helping them understand the importance of turning research into commercial products and working with industry. This foundation encourages students to think critically about how innovation drives economic growth and prepares them for more specialized studies.

The Master's-level course, "EU Experience in Technology Transfer: Theory and Practice," expands on this foundation by offering both theoretical knowledge and practical skills. Students learn through case studies, simulations, and projects how to organize technology transfer, secure funding, and evaluate innovative projects. This course prepares future leaders and managers to use EU methods in Ukraine, helping to improve the local innovation system and align it with European standards.

At the PhD level, "Technology Transfer at Universities: EU Experience" goes deeper into the strategic and institutional aspects of technology transfer. It focuses on EU policies, university-industry partnerships, and the challenges of applying

technology transfer in higher education. By training PhD students to tackle systemic issues and lead efforts to commercialize research, this course strengthens the role of universities as innovation centers and promotes sustainable technological development in Ukraine.

The "EU Experience in Technology Transfer: Practical Guidelines" course for Lifelong Learning (LLL) is aimed at professionals and policymakers. It provides practical advice on navigating complex regulations, negotiating partnerships, and applying technology transfer strategies. This program ensures that Ukrainian professionals stay up to date with the latest EU practices, enabling them to foster innovation in their organizations and contribute to Ukraine's integration into the European innovation community.

Together, these courses at various academic and professional levels help Ukrainian higher education institutions train specialists who can drive technology transfer and innovation according to EU standards. They play a key role in positioning Ukraine as a competitive and collaborative partner within the European Union.

2. Technology transfer in Sweden

2.1. The legal framework for technology transfer in Sweden

The legislation of the Kingdom of Sweden supports a number of regulatory acts that directly and indirectly affect the processes of technology transfer between research centers and enterprises, and between Sweden and other countries of the world. Its structure can generally be divided into three levels:

1) Laws and other regulatory documents of Sweden;
2) Legislative acts of the European Union;
3) International treaties;

There are no separate laws regulating technology transfer in Sweden, however, the issue of competitiveness is quite relevant, which is expressed in the Swedish Act "On Block Exemptions for Anti-Competitive Technology Transfer Agreements" No. 2008:586, issued on 18.06.2008, as amended by No. 2014:935, which belongs to a number of supporting documents to the comprehensive Competition Act No. 2008:579. According to its content, its effect does not extend to license agreements, which are subject to Acts No. 2008:582 (specialization exemptions) and No. 2008:583 (regarding research and development). It applies to agreements that partially or completely restrict competition; the exemption itself can also be imposed on group agreements. So, in short, this document simply allows the Swedish Competition Authority (Konkurrensverket) to grant exemptions to individual technology transfer agreements [1].

The Kingdom of Sweden has also adopted laws that indirectly affect technology transfer, namely regulating aspects of technology creation and intellectual property protection:

1. The Swedish Patent Act No. 2024:945 of 24.10.2024, which will replace the outdated No. 1969:837 of 01.12.1967 starting from January 1. Its purpose is to characterize patents at the state level and determine their protection;

2. The Swedish Trademark Act No. 2010:1877 of 09.12.2010, as amended by No. 2024:866, which protects the use of trademarks;

3. Swedish Act "On the Ethical Review of Research Involving Human Subjects" No. 2003:460 of 05.06.2023, as amended by No. 2024:232;

4. Swedish Act on the Protection of Interference-Sensitive Research No. 2006:499 of 24.05.2006, as amended by No. 2022:493, which provides for the possibility of registering for special protection technologies that are important to the public;

5. Regulation "On Support for Research, Development and Innovation" No. 2015:208 of 03.26.2015 as amended by No. 2024:376. This act gives the government the right to provide support for various technological developments in various forms (grants, fee reductions, consultations, etc.). It is mainly based on the use of the provisions of the EU Commission Regulations No. 651/2014 of 17.06.2014 (categories of aid compatible with the internal market) and No. 2023/2831 of 13.12.2023 (aid de minimis);

6. Resolution "On State Support for Research, Development and Innovation in the Energy Sector" No. 2008:761 of September 11, 2008, as amended by No. 2024:373. This document specifically addresses support for research in the strategically important energy sector.

Laws No. 2008:579 and No. 2008:586 are harmonized with the EU Commission Regulation "On the application of Article 101(3) of the Treaty on the Functioning of the European Union to technology transfer agreements" No. 316/2014 of 21 March 2014. It provides an expanded explanation of the exceptions to Article 101, which prohibits agreements between undertakings, decisions by associations and concerted practices that restrict or distort competition in the EU internal market, in particular in Section b , which concerns the restriction of technological development and production.

According to the regulation, a technology transfer agreement is a license agreement concluded between two enterprises for the purpose of manufacturing contract products by the licensee and/or its subcontractors. The action applies to

“technology rights”, which include know-how and applications for their registration: patents, utility models, design rights, topographic maps of semiconductor products, supplementary protection certificates for medicinal products or other products, where they can be obtained, plant breeder’s certificates and software copyrights [9] . Structurally, the regulation is divided into the following relevant articles:

1. No. 2 "Exemption", which defines an exception that Article 101(1) of the Treaty does not apply to technology transfer agreements, which applies until the technology licensing rights have expired, become invalid, are declared invalid, etc.;
2. No. 3 "Market share thresholds", which defines the conditions for limiting the application of the regulation, namely, the market share between business entities should not exceed 20% (competitors) and 30% (non-competitors);
3. No. 4 "Hard restrictions", which includes:
    a. The exception of Article 2 does not apply to agreements between competing enterprises if their purpose is to restrict the parties' ability to determine the prices at which they sell their products to third parties; to limit output; to allocate markets or customers; and to restrict the use of proprietary technology rights or the conduct of research;
    b. For non-competing enterprises, restrictions relate to the determination of the selling price to third parties, territory, active or passive sales;
4. No. 5 “Excluded Restrictions”, which relate to the licensee's obligations to grant an exclusive license or assign rights to the licensor or a third party regarding its own improvements;
5. No. 6 "Non-application of the regulation" - if the parallel boundaries of such agreements cover more than 50% of the market, the EU Commission may declare this regulation invalid for the relevant technology transfer agreement;
6. No. 7 “Application of market share thresholds”, which deals with the rules for calculating shares.

Regulation No. 316/2014 is described in more detail in the Commission Communication “Recommendations on the application of Article 101 of the Treaty on the Functioning of the European Union to technology transfer agreements” No.

2014/C 89/09, which considers the procedure for withdrawing funds, settlement agreements, technology pools, restrictions (sales, production, areas of use), types of licenses, etc..

For example, the new regulation differs from the old one (EC No. 772/2004) in that technology pools may restrict competition, despite the fact that they are useful for maintaining an industry standard and partly promoting competition by reducing transaction costs and limiting cumulative royalties. The reason is considered to be the content of the pool, namely substitutable technologies, which as a result create a price-fixing cartel (prohibited by Articles 101, 102 of the Treaty) and reduce the pace of innovation [3].

2.2. Government policy and regulatory bodies for technology transfer in Sweden

Sweden's technology policy, which includes the issue of transfer, is shaped by many directions. The main contributors should be considered the Ministry of Climate and Entrepreneurship, the Ministry of Digital Development, the Ministry of Education and Science, the Office of the Minister for International Development Cooperation (within the Ministry of Foreign Affairs), and others.

According to the Computer article Weekly , in January 2024, Sweden launched a new national technology strategy, the main focus of which is the development of artificial intelligence (AI) and its integration with Blockchain , Internet of Things (IoT) and other Industry 4.0/5.0 technologies. Its goal is to increase the competitiveness of large and small companies in the international arena.

As a key element of the strategy, the Artificial Intelligence Commission (AIC) was established, headed by Carl-Henrik Svanberg , former CEO of Ericsson. The AIC’s main task – create specific proposals for shaping government policy in the field of AI in the private and public sectors based on a broad analysis of conditions (market, legislative, educational, etc.). The main areas of AI creation are healthcare, defense, public administration, engineering and financial services. In addition,

Sweden is strengthening the project " National Advanced Digitalization ” (NAD) with additional funding from the Ministry of Finance [4].

The main government body that acts as an intermediary in technology transfer between research centers, academia, organizations, and enterprises is Big Science Sweden , Office of Industrial Relations . Its network includes 13 international research institutions funded by the Swedish government . The total number of suppliers and partners is more than 262. The main offices are located in Lund (Ideon Science Park), Gothenburg (Chalmesrs Industriteknik), Uppsala (Uppsala University/ Science Park), Borås (RISE Research Institutes of Sweden), and Luleå (LTU Business) [5].

Mission Big Science Sweden consists of three elements:

1) Support Swedish industry, universities and research institutes in creating great ground-based Big Science;
2) Focus on high technologies that stimulate research, innovation and international cooperation and create good business for Sweden;
3) Create value for Swedish industry and society by transferring new knowledge, technology and competence to other areas of application [5].

Fig. 2.1. Logo Big Science Sweden as of 06.11.2024 [6]

Big Science Sweden leads the consortium, which also includes: The Swedish Engineering Industry Association (Teknikföretagen), the industrial development

center Industrikluster IUC Syd, Chalmers University of Technology, Lund University of Technology, Luleå University of Technology , Uppsala University, RISE and Region Skåne. The committee chair for November 2024 is Björn Ekelund (Ericsson Group).

In general, the organization can be divided into two offices: Industrial Liaison Office (ILO) and Knowledge Transfer Office (KTO). The former is focused on providing first-hand information on business and collaboration opportunities, while the latter is more focused on the potential application of technological advances and managing the flow of knowledge from research institutions to industry and vice versa. In addition, Big Science Sweden produces its own publications as “2024 The Swedish Guide”, “Knowledge , innovation , internal collaboration”, “Gora affarer” and others, and also provides a wide range of student programs and employment opportunities in research organizations for groups of students, postgraduates and professionals.

The main funding comes from two large organizations: the Swedish Research Council (Vetenskapsrådet) and the Swedish innovation agency Vinnova [5].

As part of the technology transfer policy, international relations with developing countries play an important role. In general, technology transfer goes hand in hand with the financing of promising projects. One of the most relevant goals is to promote the far-sighted conservation of natural resources and environmental protection.

According to the defined programs, technology transfer occurs in several ways. First, providing international courses, for example, on sustainable transport development, improving energy efficiency, green energy, waste management of industrial facilities, innovative construction technologies without the use of air conditioners. Second, the Start programs Syd and Start Ö st provide assistance for joint projects between Swedish and foreign companies in the form of transfer of skills, knowledge, and know-how [7].

Fig. 2.2. SIDA logo as of November 6, 2024 [8]

Funding and the main operations for technology transfer abroad are provided by the Swedish International Development Cooperation Agency (SIDA). However, other organizations are also involved: the Church of Sweden (CoS), the Swedish Trade Council (STC), the Swedish Export Credit Guarantee Board (SECGB), etc. [7].

SIDA's scope of activity is broader than technology transfer, namely international development and poverty reduction in the world. Its structure consists of 9 departments headed by the Director General, Jakob Granit. Important areas for cooperation are Eastern Europe , the Middle East, Latin America, Africa and Asia.

SIDA activities is characterized by the creation of relevant strategies. In the 2020s, 26 interstate strategies were launched, including Ukraine (2023-2027), 7 regional ones, including Moldova-Georgia-Belarus-Armenia, and 16 thematic strategies, for example, the Strategy for Innovation, Partnership and Capacity Development [8].

2.3. Ecosystem and technology transfer process in Sweden

Technology transfer should be considered as part of the broader technological ecosystem in Sweden. It includes the entire chain: from the birth of an idea to the sale of finished products. It is advisable to divide the ecosystem into groups of elements:

1. Sources of ideas, knowledge and ready-made technologies:

   a. Higher education institutions: universities "universitet" (Uppsala University, Lund University, Luleå University of Technology), university

colleges "högskola" (KTH Royal Institute of Technology, Karolinska Institute);

b. Research laboratories;

c. Innovative science clusters and parks;

d. Swedish Research Council;

2. Destinations for the use of technologies:

a. Swedish companies;

b. Foreign enterprises;

c. Others: government agencies, international organizations, governments of other countries around the world.

3. Intermediaries and platforms:

a. Big Science Sweden (EU internal market);

b. Swedish International Development Cooperation Agency (other regions of the world);

c. Sweden Tech Ecosystem and others ;

4. Other bodies:

a. Government bodies that determine legislation, national policy, licensing, etc.;

b. Other elements of technological infrastructure.

Fig. 2.3. The process of technology transfer from CDC [9]

The technology transfer process, in general, can be divided into several stages:

1. Creation – the new technology is in its raw form and requires additional development before it can be commercialized;
2. Big Transfer Office Science Sweden to describe the innovation;
3. Evaluation – determines the marketability and patentability of the new technology;
4. Protection – all processes of protecting a new technology take place, including patent registration;
5. Marketing – market research for the need for a new technology. In addition, companies can independently create applications for the creation of technology on the Big platform Science Sweden ;
6. Licensing – the inventor and the company enter into a technology transfer agreement;
7. Results – a summary of the financial results from concluding an agreement for its further support or the creation of a new one [8].

According to Oleg Duma (2021) [10], the process of technology transfer in Sweden follows the Scandinavian model. In general, the country's innovation sphere is built on the principle of the "triple helix", that is, close interaction between the state, science and business at the sectoral, national and integral levels.

From the point of view of science, most of the developments that are implemented in business originate from higher education institutions, research laboratories, clusters and science parks in Sweden. In addition, participation in the European Union has made it possible not only to harmonize the transfer process, but also to simplify access to European scientific institutions. The most priority areas for Sweden are biology, medicine, digital technologies with a focus on artificial intelligence, climate, etc.

The Swedish Research Council is responsible for supporting basic research in the country, namely in the humanities and social sciences, natural sciences and engineering, and medicine. In addition, other research councils operate. Ministerial agencies fund innovation (Vinnova), technology transfer (Teknikbrostiftelser), energy (STEM) and others (the ALMI - group network) [10].

Basically, technology transfer centers in Sweden focus on:

1) Market research to identify demand for innovative products;
2) Training in the development of innovative technologies, cost and feasibility assessment;
3) Creation of a database of university technologies;
4) Event monitoring;
5) Finding and using online channels to promote technologies;
6) Licensing [10].

Entrepreneurship in Sweden is characterized by a relatively low use of new technologies [10], which is why Sweden collaboration platform has been launched. Tech Ecosystem, where you can access various elements of the technological ecosystem in a simplified mode to obtain technologies, statistical data, etc. In general, its members can be divided into several groups:

1. Initiators and partners:

a. Dealroom.co is a global data platform that provides analytical information on startups , companies, investment strategies, innovation ecosystems, etc. The main goal:

b. The Swedish Institute – a state agency that creates interest and trust in Sweden around the world;

c. Business Sweden – a company that helps Swedish companies increase global sales and foreign investors develop in Sweden;

d. Vinnova – Agency for Innovation Systems, strengthens Sweden's ability to innovate and promote sustainable development;

e. Tillväxtverket is a national agency whose task is to promote entrepreneurship and regional development;

2. Data Partners:

a. Swedish Incubators & Science Parks (SISP) – the national association of business incubators and science parks in Sweden;

b. Region Skåne – Skåne Regional Council, the local government body of Skåne County, responsible for the development of trade, industry, etc.;

3. Industry data partners:

a. PropTech Sweden – a membership organization to stimulate the digital transformation of the real estate industry;

b. Sweden Foodtech is an organization that develops a food system based on the digital transformation of entrepreneurship;

c. Sthml Fintech Week is a fintech event focused on establishing new connections and improving cooperation [11].

2.4. Analysis of Swedish technology transfer sector

Among the main indicators that need to be analyzed is the allocation to research and development (Table 2.1), as it shows the areas that Sweden focuses on the most. The data selected for the analysis are from Statistics Sweden in euros (the average exchange rates of the Swedish krona (SEK) to the euro (EUR) for each year are used for the determination).

Table 2.1

Results of the analysis of the dynamics of allocations for research and development in Sweden for the period 2010-2022, million euros [12-14]

Indicators, units of measurement	Periods												
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
01 Agriculture, forestry, hunting, construction and services	24.3	51.6	58.1	52.9	53.7	46.6	51.9	48.3	42.8	45.6	49.1	79.6	78.7
02 Industrial production and technology	104.5	72.6	70.5	95.0	98.0	129.2	135.7	125.7	120.3	154.5	158.3	98.1	122.3
- relative deviations chain deviations, %	-	*-30.5*	*-2.9*	*34.7*	*3.2*	*31.8*	*5.0*	*-7.4*	*-4.3*	*28.4*	*2.4*	*-38.0*	*24.7*
- relative deviations basic deviations, %	-	*-30.5*	*-32.5*	*-9.1*	*-6.2*	*23.7*	*29.9*	*20.3*	*15.2*	*47.9*	*51.5*	*-6.1*	*17.1*
03 Energy production and distribution	146.9	168.7	176.6	144.7	152.7	143.4	164.8	164.2	159.6	148.3	163.4	157.6	166.7
- relative deviations chain deviations, %	-	*14.9*	*4.7*	*-18.0*	*5.5*	*-6.1*	*15.0*	*-0.3*	*-2.8*	*-7.1*	*10.2*	*-3.6*	*5.7*
- deviations basic deviations, %	-	*14.9*	*20.3*	*-1.4*	*3.9*	*-2.4*	*12.2*	*11.8*	*8.7*	*1.0*	*11.3*	*7.3*	*13.5*
04 Transport and telecommunications	154.8	125.6	138.0	152.5	148.5	138.3	148.8	146.0	135.4	124.5	133.6	224.9	231.0
- deviation chain deviation, %	-	*-18.9*	*9.8*	*10.5*	*-2.6*	*-6.8*	*7.6*	*-1.9*	*-7.3*	*-8.1*	*7.3*	*68.4*	*2.7*
- deviations basic deviations, %	-	*-18.9*	*-10.9*	*-1.5*	*-4.1*	*-10.7*	*-3.9*	*-5.7*	*-12.5*	*-19.6*	*-13.7*	*45.2*	*49.2*
05 Living conditions and physical planning	14.7	22.6	24.2	27.9	28.6	37.5	41.5	34.4	31.1	31.2	33.8	-	-

06 Pollution control and spatial planning	39.9	62.3	69.4	75.8	69.5	52.4	56.5	52.0	47.0	61.2	65.0	97.0	101.3
07 Disease prevention and control	52.8	43.7	44.7	63.2	60.4	73.1	79.8	82.7	80.9	83.9	82.7	103.7	108.6
08 Social conditions	35.7	40.8	53.0	52.6	60.8	35.5	35.1	133.4	34.0	29.0	30.3	104.7	96.7
09 Culture, media and leisure	6.2	7.6	8.3	4.9	5.1	7.8	8.5	4.5	6.6	6.5	6.6	5.0	7.6
10 Improving learning	19.8	5.6	6.1	5.8	6.0	6.9	9.6	20.1	19.8	19.3	19.2	26.7	34.3
11 Working conditions	13.2	15.4	16.5	17.6	18.0	18.0	18.7	24.6	24.2	25.7	25.9	-	-
12 Economic planning and public administration	19.1	28.2	30.0	17.2	15.2	27.4	29.2	41.2	40.5	41.8	37.0	-	-
13 R & D , Earth exploration	20.9	22.4	20.0	13.6	12.6	33.6	34.4	43.6	41.3	39.0	44.9	77.6	75.4
- deviation chain deviation, %	-	*7.1*	*-10.6*	*-31.8*	*-7.3*	*165.6*	*2.3*	*26.9*	*-5.2*	*-5.6*	*15.1*	*72.7*	*-2.9*
- deviations basic deviations, %	-	*7.1*	*-4.2*	*-34.7*	*-39.5*	*60.8*	*64.6*	*108.8*	*98.0*	*87.0*	*115.2*	*271.8*	*261.1*
14 General advancement of knowledge	1977.8	2230.3	2355.1	2619.3	2603.6	2565.9	2592.7	2597.7	2552.1	2488.0	2610.7	3104.6	2939.9
15 Space exploration	24.4	10.7	73.8	68.2	62.8	29.1	29.6	34.2	33.1	34.0	39.7	33.3	32.7
- deviation chain deviation, %	-	*-56.1*	*587.0*	*-7.5*	*-8.0*	*-53.7*	*1.8*	*15.4*	*-3.2*	*2.9*	*16.7*	*-16.1*	*-1.9*
- deviations basic deviations, %	-	*-56.1*	*201.8*	*179.0*	*156.7*	*19.0*	*21.1*	*39.7*	*35.2*	*39.2*	*62.4*	*36.2*	*33.6*
16 Protection	233.2	250.2	288.4	145.8	135.6	118.4	124.2	81.5	83.9	98.8	92.4	92.4	99.5
- deviation chain deviation, %	-	*7.3*	*15.3*	*-49.5*	*-7.0*	*-12.7*	*4.9*	*-34.4*	*3.0*	*17.6*	*-6.4*	*-0.1*	*7.7*
- deviations basic deviations, %	-	*7.3*	*23.7*	*-37.5*	*-41.8*	*-49.2*	*-46.7*	*-65.1*	*-64.0*	*-57.7*	*-60.4*	*-60.4*	*-57.3*
17 Unallocated goals	0	0	0	0	81.5	78.6	74.0	72.9	78.0	66.9	77.1	-	-
Total	**2888.1**	**3158.5**	**3432.8**	**3557.0**	**3612.6**	**3541.7**	**3635.0**	**3706.9**	**3530.7**	**3498.2**	**3669.8**	**4205.3**	**4094.5**
- deviation chain deviation, %	-	***9.4***	***8.7***	***3.6***	***1.6***	***-2.0***	***2.6***	***2.0***	***-4.8***	***-0.9***	***4.9***	***14.6***	***-2.6***
- deviations basic deviations, %	-	***9.4***	***18.9***	***23.2***	***25.1***	***22.6***	***25.9***	***28.4***	***22.2***	***21.1***	***27.1***	***45.6***	***41.8***

R & D allocations allows us to determine which areas of the economy are considered more priority for the Swedish government. In general, the trend in total spending is increasing, which is confirmed by the state strategic goal of transforming Sweden into one of the largest technological centers in Europe (in terms of R & D it is second only to Switzerland). The trend in the priority area of defense is decreasing during 2013-2022 due to, firstly, the general decline in concerns in Europe about future wars (even a neutral country that needs to maintain its domestic defense complex), and, secondly, due to the influence of NATO countries on maintaining the security of most neighboring countries. Interestingly, the trends in space exploration, Earth and atmosphere exploration, and the fight against environmental pollution are all growing during the period 2016-2022, as evidenced by support for the EU 2030 strategy for sustainable development and green energy.

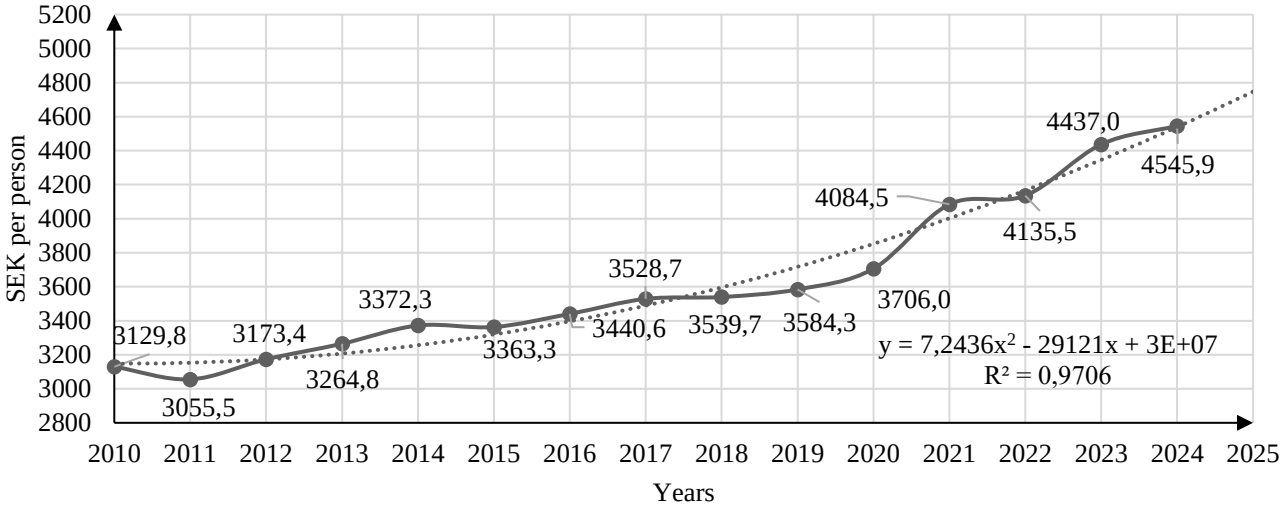

Fig. 2.4. Results of analysis and forecasting of R & D allocations per capita in Sweden for the period 2010-2022, SEK / person [15-16]

It is also necessary to analyze how the increase in R & D allocations will affect the average citizen (Fig. 2.4). It is analyzed that in the period 2012-2024 there is an increasing trend. It can be considered a successful result of Sweden's scientific and technological policy, because the budget allocations for R & D per capita increased by 1.45 times. In addition, it is predicted that in 2025 it will be equal to 4589.3 SEK /person

In addition to government spending, it is necessary to analyze and forecast the total costs of R & D (Table 2.2). Data from Statistics Sweden in euros were selected for analysis (average exchange rates of the Swedish krona (SEK) to the euro (EUR) for each year are used for determination).

Table 2.2

Results of analysis and forecasting of domestic R&D expenditures by sector in Sweden for the period 2019-2023, million euros [14, 17]

No.	Indicators, units of measurement	Periods						Sir . Nature .	Ser. acc . temp ., %
		2019	2020	2021	2022	2023	2024 *		
1	**All sectors**	**16165.2**	**16773.7**	**18386.2**	**19164.7**	**19477.8**	**21929.7**	**13141.5**	**5.5**
2	***- relative chain deviations, %***	**-**	**2.8**	**6.2**	**9.1**	**9.8**	**11.9**	**-**	**-**
3	***- relative deviations of the baseline, %***	**-**	**2.8**	**9.1**	**19.1**	**30.7**	**46.3**	**-**	**-**
4	Business sector	**11590.5**	**12135.5**	**13320.2**	**14108.4**	**14469.1**	**16477.6**	**10867.5**	**6.3**
5	*- relative chain deviations, %*	*-*	*3.7*	*6.3*	*10.9*	*10.8*	*13.2*	-	-
6	*- relative deviations of the baseline, %*	*-*	*3.7*	*10.3*	*22.2*	*35.4*	*53.4*	-	-
7	Public sector	729.4	737.3	811.4	806.2	800.3	870.9	367.3	3.5

8	*- relative chain deviations, %*	-	*0.1*	*6.6*	*4.0*	*7.2*	*8.2*	-	-
9	*- relative deviations of the baseline, %*	-	*0.1*	*6.7*	*11.0*	*19.0*	*28.8*	-	-
10	Higher education sector	3826.4	3881.3	4233.6	4215.9	4171.0	4528.8	1849.3	3.4
11	*- relative chain deviations, %*	-	*0.5*	*5.6*	*4.2*	*6.9*	*8.0*	-	-
12	*- relative deviations of the baseline, %*	-	*0.5*	*6.1*	*10.6*	*18.3*	*27.7*	-	-
13	Private non-profit sector	18.8	19.6	21.0	34.3	37.4	52.4	57.5	16.6
14	*- relative chain deviations, %*	-	3.0	3.9	70.9	17.9	39.4	-	-
15	*- relative deviations of the baseline, %*	-	3.0	7.0	82.9	115.6	200.6	-	-

* Data for 2024 was forecasted .

According to the results, it was determined that the largest cumulative increase for the period 2019-2023 is in the private non-profit sector, although in monetary terms these costs are relatively insignificant. In general, there is an increasing trend of the aggregate sectors for the entire period. Thus, it is known that the positive trend in the volume of R & D expenditures , similarly, is a consequence of the successful government campaign to support a scientifically developed society and the transition to Industry 4.0/5.0.

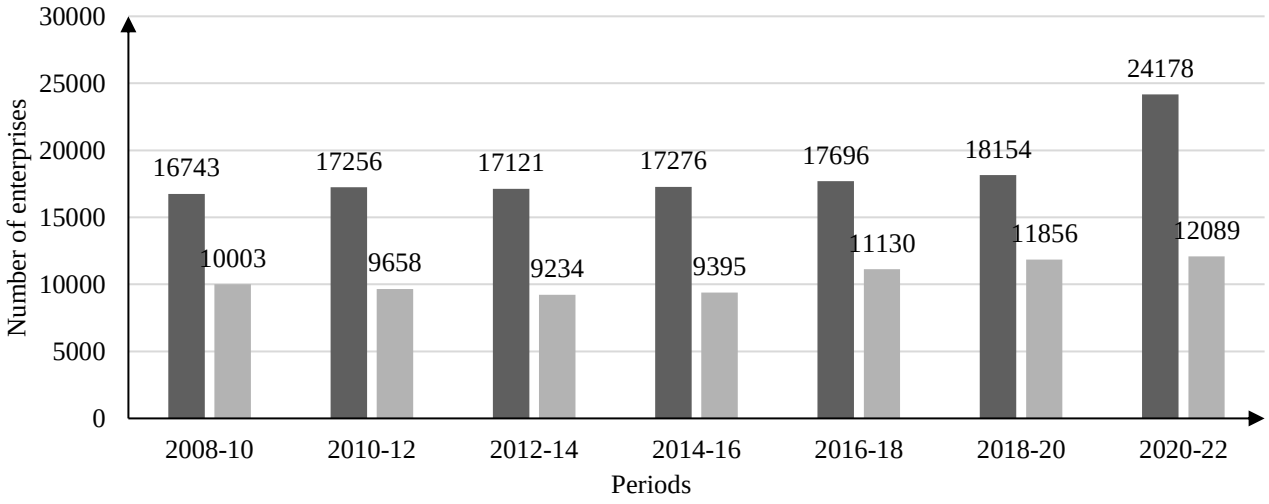

Fig. 2.5. Results of the analysis of the number of innovative enterprises in Sweden according to SA 10 in the period 2008-2020, units [18-20]

In addition, it is important to determine whether there is an increase in the use of innovative products among Swedish enterprises (Fig. 2.5). According to the results, for the period 2016-2022, there is an increasing trend of enterprises with innovative activities. However, the share of innovative enterprises fell by 16.3% (to 50%) over the entire period, which confirms the phenomenon of a relatively low level of use of high, innovative technologies at enterprises that are not large and/or TNCs. Thus, although the Swedish scientific and technical policy has been successful, there

are problems with attracting new technologies among a significant proportion of enterprises, especially traditional industries (forestry, agriculture) and small businesses, where constant updating is not required.

To obtain a complete picture of technology transfer in Sweden, the channels for obtaining relevant know-how, skills and knowledge were analyzed. In general, the most used source in the period 2016-2018 was identified as conferences, fairs and exhibitions, followed by scientific and technical journals and professional publications [21]. A trend of increasing importance of crowdsourcing and social web networks was also identified. Including repetitions, a total of 84,064 innovation transfers (including technologies) were carried out in the period 2016-2018. Thus, in general, there is a preference of enterprises to use more traditional professional areas of innovative technology transfer, although due to the digitalization process , which is considered a state priority in Sweden, there has been an increase in non-traditional sources of information.

In addition to financial and innovation statistics, the level of new technology creation (Table 2.3) is analyzed using intellectual property data. It also allows us to determine the level of scientific and academic success of Swedish inventors.

Table 2.3

Results of analysis of intellectual property data of Sweden for the period 2010-2021, units/million people [23-25]

No.	Indicators, units of measurement	Periods											
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	**Patent applications, total**	**2549**	**2341**	**2436**	**2495**	**2425**	**2428**	**2384**	**2297**	**2280**	**2190**	**2196**	**2196**
2	***relative chain deviations, %***	*-*	***-8.2***	***4.1***	***2.4***	***-2.8***	***0.1***	***-1.8***	***-3.6***	***-0.7***	***-3.9***	***0.3***	***0.0***
3	***relative deviations of the baseline, %***	*-*	***-8.2***	***-4.4***	***-2.1***	***-4.9***	***-4.7***	***-6.5***	***-9.9***	***-10.6***	***-14.1***	***-13.8***	***-13.8***
4	Patent applications, residents	2196	2004	2288	2332	1984	2038	2032	1992	1838	1802	1764	1771
5	Patent applications, non-residents	353	337	148	163	441	390	352	305	442	388	432	425
6	**Industrial samples, total**	**808**	**606**	**814**	**724**	**570**	**848**	**750**	**615**	**579**	**658**	**297**	**419**
7	***relative chain deviations, %***	*-*	***-25.0***	***34.3***	***-11.1***	***-21.3***	***48.8***	***-11.6***	***-18.0***	***-5.9***	***13.6***	***-54.9***	***41.1***
8	***relative deviations of the baseline, %***	*-*	***-25.0***	***0.7***	***-10.4***	***-29.5***	***5.0***	***-7.2***	***-23.9***	***-28.3***	***-18.6***	***-63.2***	***-48.1***
9	Industrial designs, resident applications	734	583	735	694	549	821	689	551	457	529	287	390
10	Industrial designs, applications of non-residents	74	23	79	30	21	27	61	64	122	129	10	29

According to the results, there is a downward trend in the total number of patent applications in Sweden for the period 2010-2021, and in industrial designs for the period 2016-2021. The data confirm that only large enterprises or TNCs are engaged in the development of the latest technologies in Sweden, and there is also a general decline in the scientific potential of residents, as the trend in the number of patents of non-residents is increasing during 2018-2021.

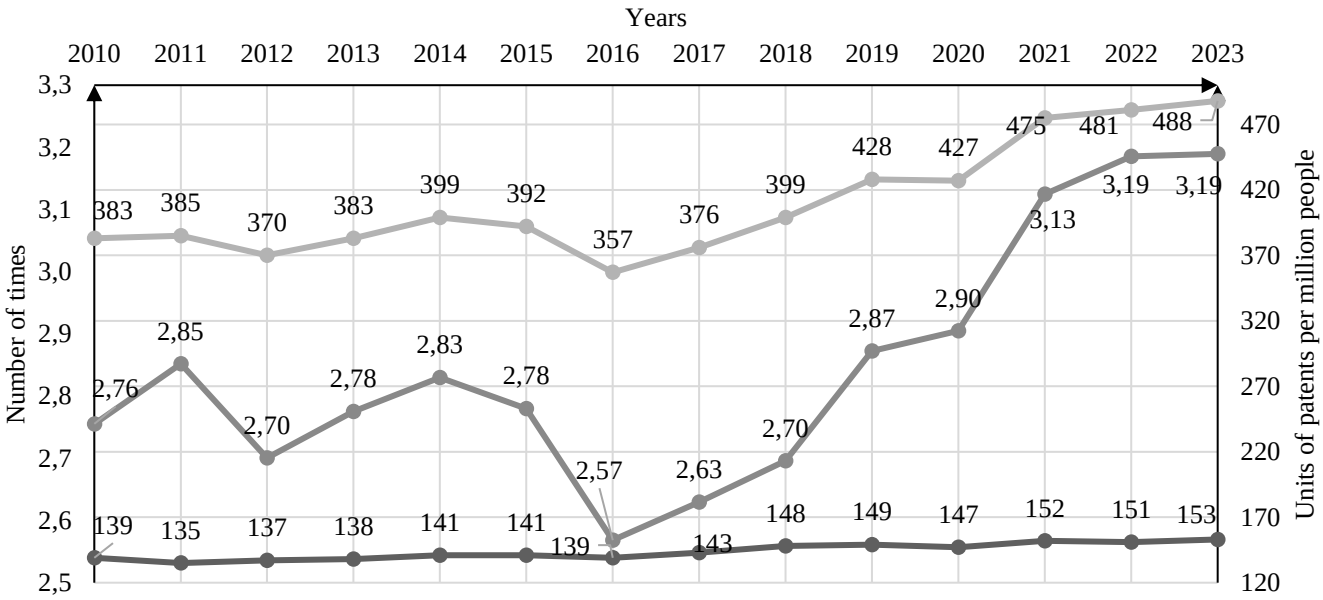

Fig. 2.6. Results of the analysis of the number of patent applications to the European Patent Office (EPO) of Sweden and the EU for the period 2010-2023, units/million people [26]

At the same time, the situation with the EU is relatively different (Fig. 2.6), because for the period 2018-2023 the trend of the number of patent applications per million people to the EPO is increasing, and the ratio to the European average increased to 3.19 times. These statistics indicate, on the contrary, the successful implementation of R & D policy in Sweden .

Technology transfer in the Netherlands

3.1. State policy on technology transfer – regulatory legal acts

In the Netherlands, technology transfer is regulated by the updated Block Exemption Regulation for 'technology transfer agreements' adopted by the European Commission on 21 March 2014 [27]. The Regulation concerns the technology sector and covers the transfer and licensing of copyright in software as well as rights to topographies of semiconductor products. It defines technology transfer agreements as arrangements between two economic operators which provide for the licensing or transfer of technological rights, such as patents, industrial designs and know-how, in connection with the production of certain contract products [28].

The Regulation exempts certain forms of technology transfer that comply with its requirements from the "European" prohibition of cartels enshrined in the Treaty on the Functioning of the European Union ("TFEU") [29]. It is also relevant to the application of the Dutch prohibition of cartels, which is set out in Section 6 of the Competition Act.

3.2. Technology transfer in the Netherlands

The Netherlands is one of the best countries for IT and technology companies and has the following advantages (Fig. 3.1). Figure 3.1 shows the dynamics of the value of the Dutch IT industry.

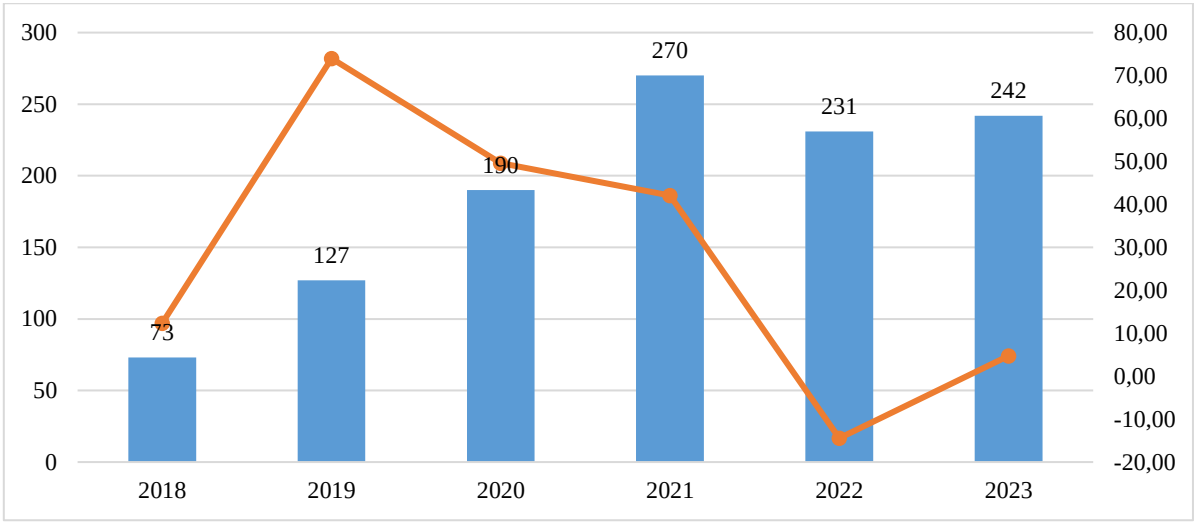

Fig. 3.1. Dynamics of the Dutch IT industry for the period 2018-2023, billion euros [30, 31]

In 2023, a record number of deals were concluded in the Netherlands, with a total value of $429 billion, up 54.87% from 2022. Among the largest deals were the acquisitions of PayU for over €550 million, SynAffix for €100 million and Youda Games for 81 million euros.

The Netherlands' technological landscape is based on a cutting-edge digital infrastructure. The country ranks second in the world in terms of online connectivity, with 98% of households having broadband internet access. The Netherlands is also home to the Amsterdam Internet Exchange (AMS-IX), one of the world's leading digital data hubs. This infrastructure ensures robust digital connectivity, facilitates remote working, fosters innovation in technology, and supports a healthy work-life balance.

The peak of the IT industry in the Netherlands was observed in 2021, but in 2022, due to crisis phenomena, its value decreased by 14.44%. At the same time, in 2023, the industry began to recover, showing growth of 4.76%.

The Dutch government's IT and technology policy is outlined in the Digital Strategy for the Netherlands. It aims to accelerate digitalization in key sectors such as healthcare, mobility, energy and agri-food . It also focuses on strengthening the digital foundation, including cybersecurity , privacy, digital skills development and

fair competition. Providing every citizen with the necessary digital skills is one of the main principles of this strategy.

3.3. Academic technology transfer in the Netherlands

Almost all Dutch academic institutions have technology transfer offices (TTOs), which connect researchers with market participants. In this way, scientific knowledge is optimally used and transformed into value for society. The offices help researchers find new funds, partners, networks and conclude agreements.

Table 3.1 lists the most well-known technology transfer offices in the Netherlands.

Table 3.1

Dutch technology transfer offices [32]

Name	**Institute**	Expertise	**Website**
TTO-NKI	NKI	Oncology	https://www.nki.nl/research/technology-transfer/
Oncocode Evaluation Team	Oncode	Oncology	https://www.oncode.nl/valorization/our-strategy-and-team
Amsterdam Innovation Exchange	Amsterdam UMC, University of Applied Sciences Amsterdam	Wide	https://www.ixa.nl
Technology Transfer Office	Erasmus MC	Biotechnology, medical technology , ICT	https://www.erasmusmc.nl/en/pages/technology-transfer-office-tto
Brightlands	Maastricht University	Focus on sustainability, health and the digital age	https://www.brightlands.com/
Department of Technology Assessment and Transfer	Radboudumc	Grant support, licensing, spin- offs	https://www.radboudumc.nl/patientenzorg
Research Support Network	TU/e	Grant support	https://www.tue.nl/en/research/research-support-network
Luris	LUMC	Wide	https://luris.nl/
Valuation Center	Delft University of Technology	Technological knowledge	https://www.tudelft.nl/en/innovation-impact
Novel -T Knowledge Transfer Office	University Twente	Technological solutions, medtech	https://novelt.com/nl/support/spin-off/
Knowledge Transfer Office	KNAW	KNAW Institutes	https://www.knaw.nl/instituten

Knowledge transfer program	TNO	Broad, focus on the pre-sowing preparation stage	https://www.tno.nl/nl/technologie-wetenschap/tech-transfer/
Utrecht Holdings	UMC Utrecht	New drugs and techniques	https://utrechtholdings.nl/

Dutch universities have been conducting research commissioned by businesses for years. The income from this (the so-called third cash flow) is growing. Some universities not only carry out occasional research projects for industry, but also enter into more long-term strategic alliances. Large firms in particular see long-term joint ventures of this kind as valuable, but various contacts also exist with other public organizations, quasi-state institutions, and the care and service sectors [33] . In addition, by establishing special industry-specific professorships and offering postgraduate students part-time work at both the university and the company, knowledge is exchanged with the business world at various levels.

3.4. Technology transfer statistics – data on the volume of patents, inventions, investments, statistics of technology transfer companies

Therefore, it is proposed to start by analyzing the dynamics of the number of patents filed by the Netherlands (Fig. 3.2).

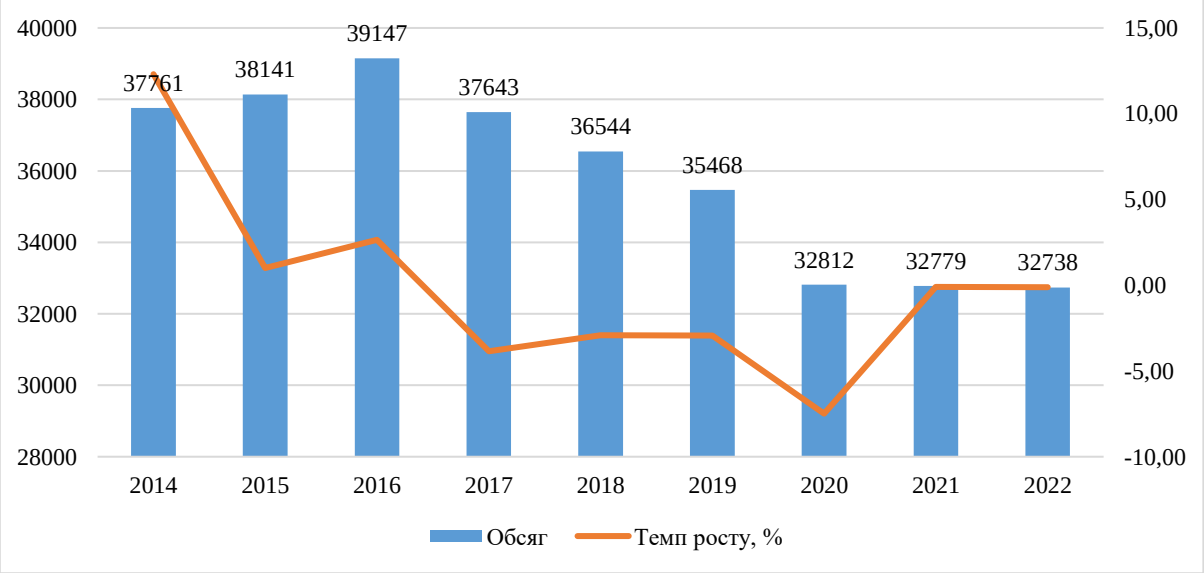

Figure 3.2. International patent applications filed by the Netherlands for the period from 2014 to 2022. [34]

After analyzing the data, we can say that the number of patent applications filed under the PCT procedure is consistently high every year, which indicates the country's development in the IT direction.

The following is a structure of companies by the number of patents filed (Fig. 3.3).

So, analyzing the data in Fig. 3.3, it can be seen that the largest number of patent applications falls on Koninklijke Philips Electronics NV, which operates in the electronics, medical equipment, and lighting industries.

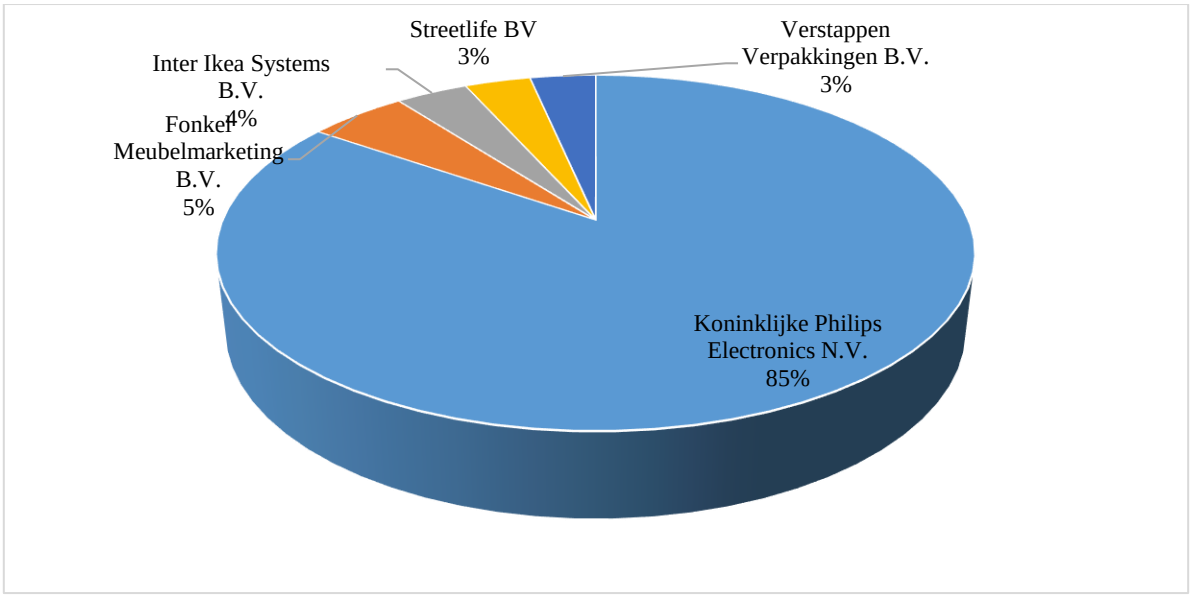

Fig. 3.3. - Structure of companies by number of patents filed in the Netherlands for the period 2020 and 2022 % [34]

Next, we will examine the volume of venture capital investment in the Netherlands and its dynamics over the past few years (Fig. 3.4).

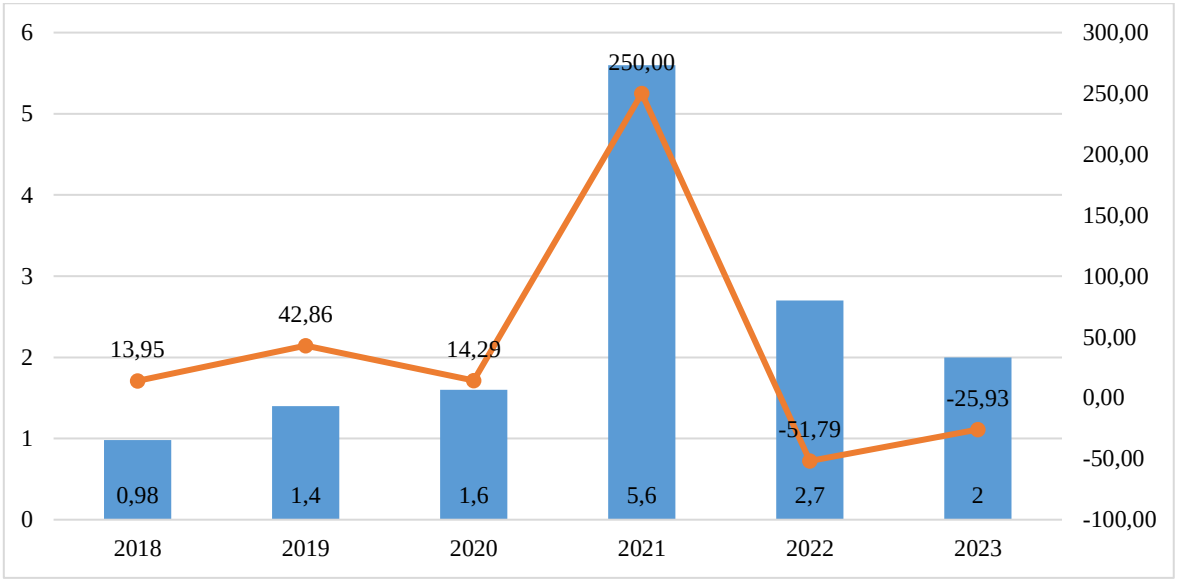

Fig. 3.4. Dynamics of venture capital investment in the Netherlands for the period 2018-2023, billion euros [30; 31]

So, we see a decrease in venture capital investments in 2022, which was caused by the war in Ukraine and general instability in the market, this trend also had an impact on investments in 2023 - the volume of venture capital investments was 2 billion euros compared to 5.6 billion euros in 2021. Next, we will determine the share of IT exports in the country's total exports (Fig. 3.5).

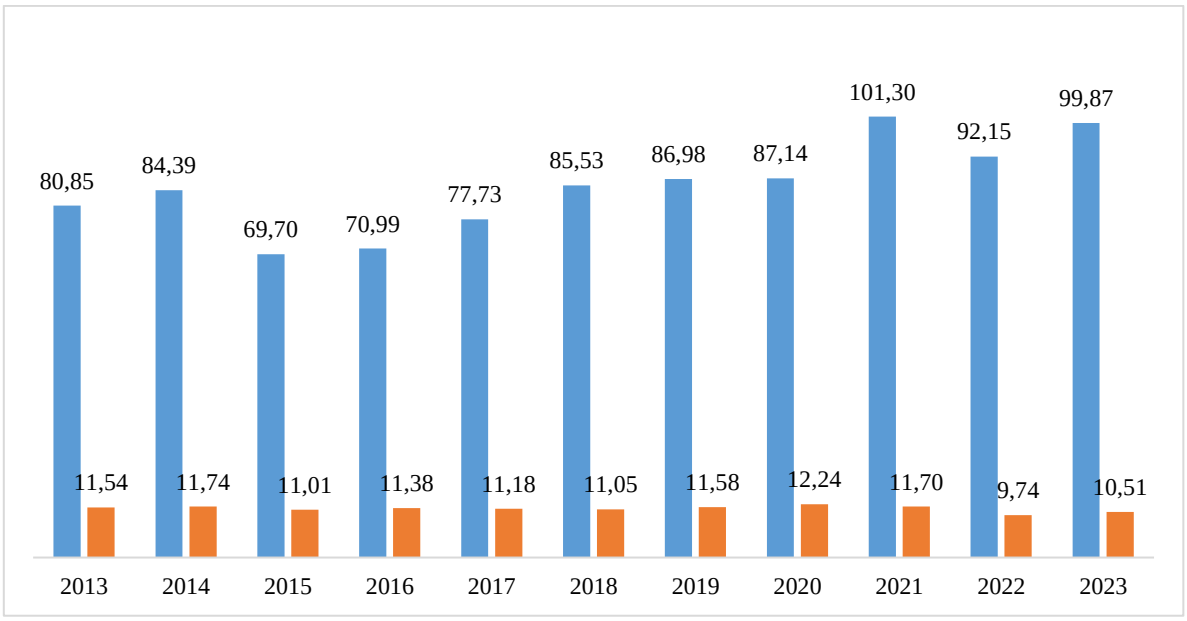

Fig. 3.5. Dynamics of the share of exports of technological products in exports of the Netherlands for the period 2018-2023, % [35; 36]

Analyzing the share of IT exports, we see that on average it accounts for 10-11% of the country's total exports, which makes the IT industry important for the

Dutch economy. Despite the decline in export volumes in 2022, in 2023 the wine grew and the share of IT exports amounted to 10.51%.

Next, we will analyze the share of workers employed in the IT industry in the Netherlands. We see that the share of employees working in IT in the Netherlands in 2022 is 19%, which is a fairly high share of employment in the country.

It should be noted that technology companies from all over the world are achieving success in various areas of activity and locations of the Dutch IT industry.

Major players such as IBM, Microsoft, Google , NTT and Oracle have chosen the Netherlands for their European headquarters, customer service centers, research centers, etc. (Fig. 3.6).

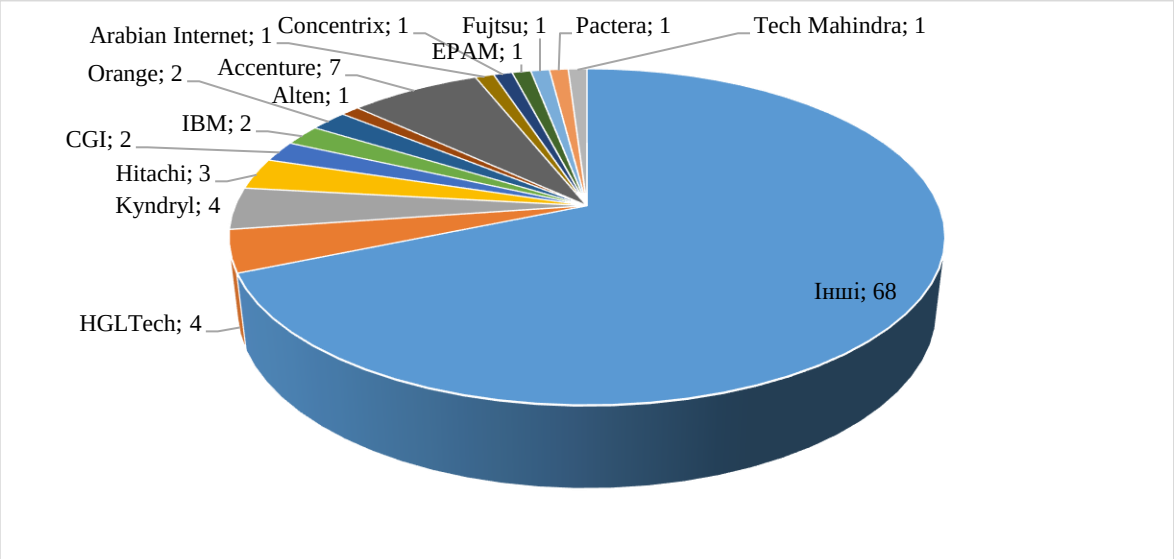

Fig. 3.6. Structure of the share of IT companies in the Dutch market for the period 2023, % Source: [37]

So, it can be noted that the Netherlands has become a global center for international IT companies, which indicates a favorable economic climate and favorable working conditions that the government creates for foreign partners.

3.5. Volumes of EU support for technology transfer

Therefore, we propose to investigate the dynamics of internal spending by Dutch companies on technology development as a share of total spending (Fig. 3.7).

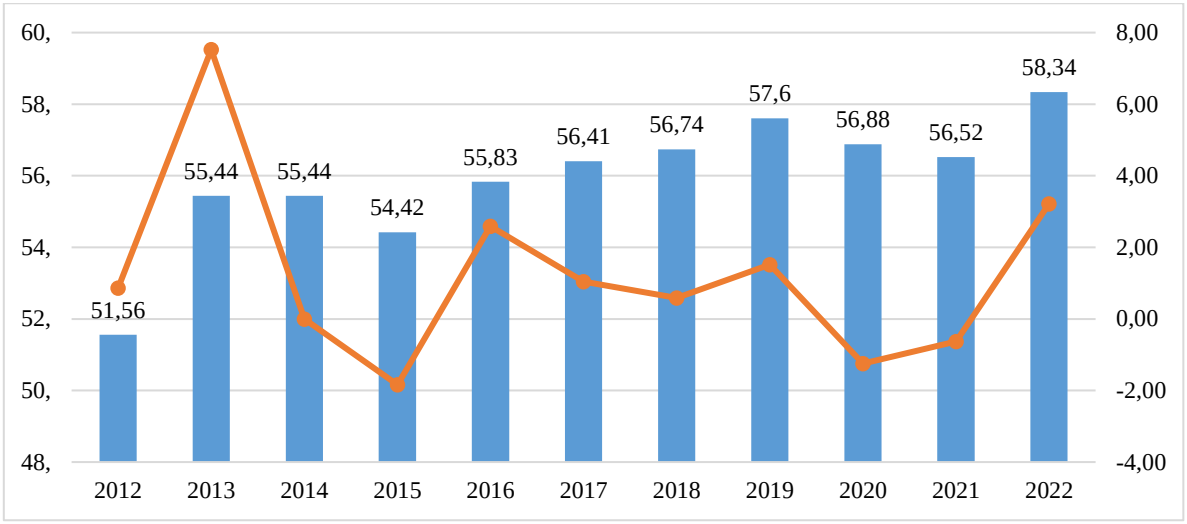

Fig. 3.7. Dynamics of internal spending of Dutch companies on technology development for the period 2012-2022, % Source: [38]

So, analyzing the data in Fig. 5.1, it is clear that the share of domestic spending on technology development is growing and in 2022 it amounted to 58.34%, compared to 51.56 in 2012.

Next, it is proposed to examine the dynamics of the share of government spending on financing the development of technology and the IT sector in the Netherlands (Fig. 3.8).

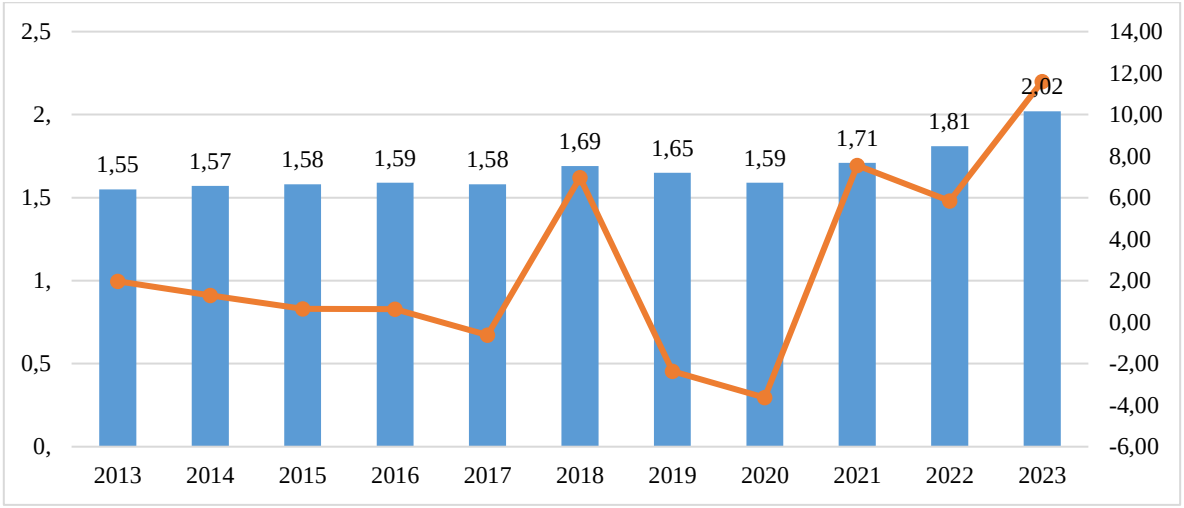

Fig. 3.8. Dynamics of government spending on technology development for the period 2013-2023, % [38]

As can be seen from Fig. 3.8, the share of government support is relatively small compared to companies' own financing, but it is growing every year, which indicates the government's interest in technology development.

The Netherlands is an example of a country where the government combines economic development with trade and investment. The main focus is on increasing climate resilience and connecting people to digital infrastructure. To this end, the government cooperates with Dutch businesses, civil society organizations and local partners. Therefore, it is fashionable to determine that the government of the country is interested in the development of the IT industry and the digitalization of society, which actually has a positive impact on the development of the country in general.

The Dutch government's policy on IT and technology development is outlined in the Dutch Digital Strategy , which envisages accelerating digitalization in sectors such as healthcare, mobility, energy and agri-food , as well as strengthening the foundation for digitalization in areas such as cybersecurity , privacy, digital skills and fair competition.

The Netherlands has become a global hub for international IT companies, which is a testament to the favorable economic climate and favorable working conditions that the government creates for foreign partners.

The Netherlands is one of the most competitive countries in the IT sector, because all the conditions are created for this in the country, there are well-known IT companies, there is a highly qualified workforce, and there is state support, which ultimately creates a strong competitive advantage among EU member states.

So, based on our research, the Netherlands has great potential in the development of information technologies and is making the most of it. The government of the country finances and supports the development of IT, the country has created favorable conditions for the work of foreign companies, and the demand for information services is growing every year, which makes the industry highly competitive and in demand.

Technology transfer in Romania

4.1. State Policy on Technology Transfer

The technological gap between Romania and more developed countries continues to widen each year. Closing this gap requires systemic reforms in state regulation of economic development, education, and the establishment of an innovative model focused on high-tech growth. Import substitution, viewed as a transitional phase for rapid production modernization, can help create the foundational conditions for developing an export-oriented, high-tech economy. The production, creation, and export of high-tech goods are crucial for Romania as it seeks to advance in import substitution, economic growth, and international competitiveness. To accurately assess Romania's high-tech export and import flows, it is important to calculate the share of high-tech exports and imports in the total foreign trade volume [39].

Romania’s state policy on technology transfer is designed to stimulate innovation, enhance economic competitiveness, and integrate scientific advancements into the production sector. The key state organizations involved in this process and their roles are as follows:

1. National Authority for Research and Innovation (ANCSI) – Responsible for developing and implementing policies in science, technology, and innovation, as well as managing the funding of scientific projects.
2. Institute of National Research and Development (INCD) – Oversees research programs, promotes the commercialization of scientific research results, and fosters cooperation between scientific institutions and businesses.
3. Project and Program Implementation Agency (UEFISCDI) – Manages and finances projects in higher education, scientific research, development, and innovation, including technology transfer projects.

The regulatory and legal framework governing technology transfer in Romania includes the following key pieces of legislation:

1. Law on Innovation and Research No. 324/2003 – Lays the foundation for innovation policy and establishes mechanisms for supporting technology transfer.
2. Law on Education and Science No. 1/2011 – Regulates the activities of scientific institutions and their collaboration with businesses in the field of technology transfer.
3. The National Strategy for Innovation and Research 2021-2027 – Outlines the state's priorities for scientific and technological development and technology transfer [39, 40].

4.2. Technology transfer in Romania

The Department of Technology Transfer (ICICTT) is an organizational unit responsible for facilitating the transfer of technology and leveraging the outcomes of collaborative research in IT and information technologies at both national and international levels. This approach helps attract funding, boost innovation, and enhance economic competitiveness in Romania.

The primary mission of the ICICTT is to explore emerging trends in IT&C (Industry 4.0 - 6.0) and identify strategies for their implementation and optimization at the national level, allocating resources for individual studies and research [42].

By promoting and stimulating the development of new collaborations, ICICTT aims to engage private sector stakeholders (such as SMEs), national and international research and development institutions, government bodies, academic scientific communities, and startup accelerators, to encourage innovation and technology transfer [43].

The department supports research and innovation activities in Bucharest and works on increasing the visibility of ICI Bucharest’s research and development results, utilizing effective means for technology transfer. Furthermore, ICICTT aims to foster new partnerships between ICI Bucharest and other IT actors to stimulate technology transfer [44].

To strengthen its capabilities, the department emphasizes the continuous training of its team on technology transfer priorities. Additionally, one of its objectives is to increase the number of patented products and technologies developed by ICI Bucharest. General objectives of technology transfer of the department [42-45]:

- Promote research and innovation activities in Bucharest.
- Enhance the visibility of ICI Bucharest's R&D results through effective technology transfer.
- Build new partnerships between ICI Bucharest and other IT entities to facilitate technology transfer.
- Provide ongoing training for the team on technology transfer priorities.
- Increase the number of patented products and technologies from ICI Bucharest.

5.Technology transfer in Germany

5.1. Germany's State Policy in Technology Transfer

Germany is the largest economy in the European Union and competes with Japan for third place in the ranking of the world's largest industries. Germany's success is based on science and technology. In Germany, state regulation of technology transfer is carried out through a comprehensive system of legal acts, institutions, and programs aimed at stimulating innovation activities and ensuring the effective exchange of technological knowledge between research institutions and industry.

A key role in this process is played by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF), which develops and implements policies in the field of innovation and technological development. The ministry supports programs that promote cooperation between research institutions and enterprises, particularly through funding research projects and creating innovation clusters. For example, within the framework of High-Tech Strategy 2025, BMBF defines priority directions for technological development and supports their implementation in the economy.

An essential element of the institutional infrastructure is the Federal Network Agency (Bundesnetzagentur), which regulates the markets for electricity, gas, telecommunications, postal services, and railways. The agency ensures non-discriminatory access to infrastructure and promotes competition, which is crucial for the development of innovation and the adoption of new technologies. In particular, Bundesnetzagentur implements efficiency incentive mechanisms, such as incentive-based regulation tools, which contribute to increased efficiency and innovation in the energy sector [46,47].

The roles of German governmental organizations in the technology transfer ecosystem are described in Table 5.1.

Table 5.1 – Key Components of Germany's Technology Transfer Ecosystem [48; 49]

Organization	Functions
Federal Ministry of Education and Research (BMBF)	Development and implementation of state policy in the field of education, science and research; financing of scientific programs and projects that promote technology transfer.
Federal Ministry of Economic Affairs and Energy (BMWi)	Supporting innovation and entrepreneurship; developing policies to stimulate economic development through technological innovation; promoting cooperation between science and business.
German Research Society (DFG)	Funding of fundamental scientific research in higher education institutions and research institutions; supporting projects with potential for technological application.
Fraunhofer Society	Conducting applied research; collaborating with industry to develop and implement new technologies; mediating technology transfer between science and business.
Max Planck Society	Fundamental scientific research at the highest level; promoting scientific discoveries that can become the basis for new technologies.
Helmholtz Association	Uniting large research centers; conducting interdisciplinary research in the fields of energy, medicine, ecology and others; supporting technological development and innovation.
Leibniz Association	Association of independent research institutions; research in areas important to society and the economy; promotion of knowledge and technology transfer.
German Patent and Trademark Office (DPMA)	Protection of intellectual property rights; registration of patents, trademarks and designs; support for innovation through protection of inventors' rights.
High-Tech Gründerfonds (HTGF)	Venture fund investing in early-stage high-tech startups; providing financial and expert support for technology commercialization.
KfW Bankengruppe	State Development Bank; providing financial instruments and programs to support innovative enterprises and technological projects.
ZIM (Central Innovation Program for Small and Medium-sized Enterprises)	Financial support for innovative projects of small and medium-sized enterprises; promotion of cooperation between business and scientific institutions.
Technology transfer offices at universities and research institutions	Commercialization of scientific developments; conclusion of licensing agreements; support for startups based on university research.
Technology parks and incubators	Creating infrastructure for the development of innovative enterprises; providing premises, services and advisory support for startups and technology companies.

At the legislative level, the regulation of technology transfer is carried out through a series of legal acts that define the conditions for technology transfer, intellectual property protection, and support for innovation activities. In particular, the legislation provides mechanisms to encourage enterprises to invest in research

and development, as well as to facilitate the commercialization of scientific achievements. The key legislative acts include [50]:

1. Patent Law (Patentgesetz) – This law establishes procedures for obtaining and protecting patents for inventions. It grants inventors exclusive rights to use their inventions for a period of 20 years. The law regulates the conditions for patenting, the rights and obligations of patent holders, as well as procedures for patent transfer or licensing. This provides a legal framework for the commercialization of technological innovations and their transfer to industry.

2. Employee Inventions Act (Arbeitnehmererfindungsgesetz) – This law defines the rights and obligations of employees and employers regarding inventions created within the scope of employment relationships. It stipulates that rights to service inventions belong to the employer, while the employee is entitled to fair compensation. The law regulates the process of invention disclosure, rights transfer, and remuneration calculation, thereby promoting effective management of intellectual property in companies and research institutions.

3. Trade Secrets Protection Act (Geschäftsgeheimnisgesetz) – This law provides legal protection for trade secrets and confidential information against unlawful acquisition, use, and disclosure. It defines the criteria by which information qualifies as a trade secret and establishes legal remedies for owners of such information. This is particularly important for the transfer of know-how and other non-patented technologies.

4. Civil Code – The Civil Code regulates general legal relations between entities, including contractual relationships, which serve as the foundation for technology transfer agreements, licensing contracts, and joint research projects. The code establishes general principles for contract formation, execution, and termination, ensuring legal certainty and the protection of parties' interests.

5. Copyright Law – This law protects the rights of authors over their creative works, including software, scientific articles, technical drawings, and other intellectual property that may be part of technological developments.

6. Trademark Law – This law regulates the registration and protection of trademarks and trade names. Brand and trademark protection is crucial for the commercialization of technologies, as they help distinguish products and services in the market and create additional value for companies.

7. European Regulation on Technology Transfer Block Exemption (Technologietransfer-Gruppenfreistellungsverordnung, TTBER) – As part of European Union law, this regulation is directly applicable in Germany. It defines the conditions under which licensing agreements for technology transfer are exempt from EU antitrust restrictions. TTBER provides legal certainty for companies when entering into licensing agreements and promotes the effective transfer of technologies.

Furthermore, Germany actively participates in European programs and initiatives aimed at fostering innovation and technology transfer. This integration allows the national innovation system to be embedded within the broader European context and provides additional resources to support scientific and technological development.

For instance, the TRIPS Agreement (Agreement on Trade-Related Aspects of Intellectual Property Rights) establishes minimum standards for intellectual property protection among World Trade Organization (WTO) member states, including Germany. Similarly, the Paris Convention for the Protection of Industrial Property regulates patenting and industrial property protection at the international level. These and other regulatory acts form a comprehensive legal framework for governing technology transfer in Germany. By ensuring intellectual property protection, setting contractual relationship rules, and stimulating innovation, they contribute to the effective commercialization of scientific developments.

This framework enables Germany to maintain a high level of technological development and global competitiveness.

Thus, the state regulation of technology transfer in Germany is based on a combination of legal, institutional, and financial mechanisms aimed at promoting

innovation activities and ensuring the efficient exchange of technological knowledge across different sectors of the economy.

5.2. Germany's State Programs for Supporting Technology Transfer

Germany actively supports technology transfer through a range of state programs aimed at strengthening innovation potential and fostering collaboration between research institutions and industry.

High-Tech Strategy 2025 is a key initiative of the German Federal Government designed to promote innovation and technological leadership. The strategy focuses on six missions, including competitive industry, climate protection, health, digital sovereignty, space exploration, and social resilience. It facilitates technology transfer by supporting research and innovation in these areas (Fig. 5.1).

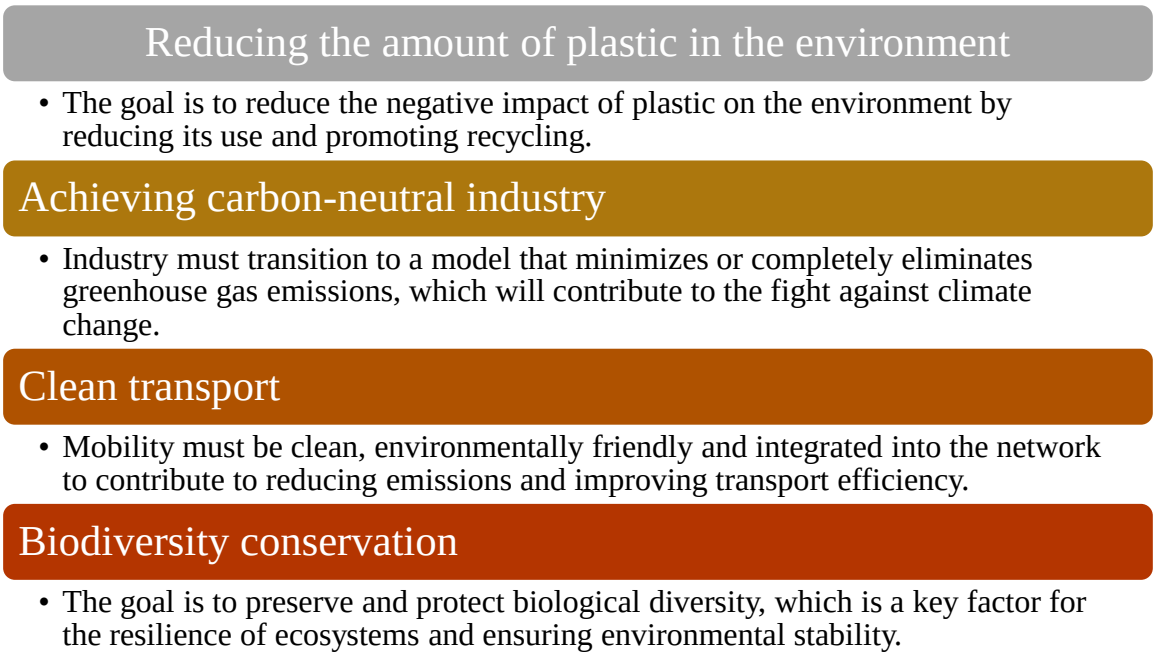

Figure 5.1 – High-Tech Strategy 2025 [46]

The German Agency for Transfer and Innovation (DATI) is an initiative of the Federal Ministry of Education and Research of Germany, aimed at accelerating the implementation of scientific developments into practice and unlocking the country's innovation potential. The primary goal of DATI is the effective transfer of ideas,

knowledge, and technologies into economic and social spheres, thereby enhancing Germany's competitiveness.

The agency supports small and medium-sized enterprises (SMEs), startups, and research institutions in the commercialization of their developments by providing financial and advisory assistance. DATI offers a variety of programs and initiatives, including:

1.An experimental program designed to simplify and accelerate funding processes for social and technological innovations. It includes two modules: "Innovation Sprints", which facilitate the rapid implementation of ideas; "Innovation Communities", which foster strategic collaboration within regional innovation ecosystems (Fig. 5.2).

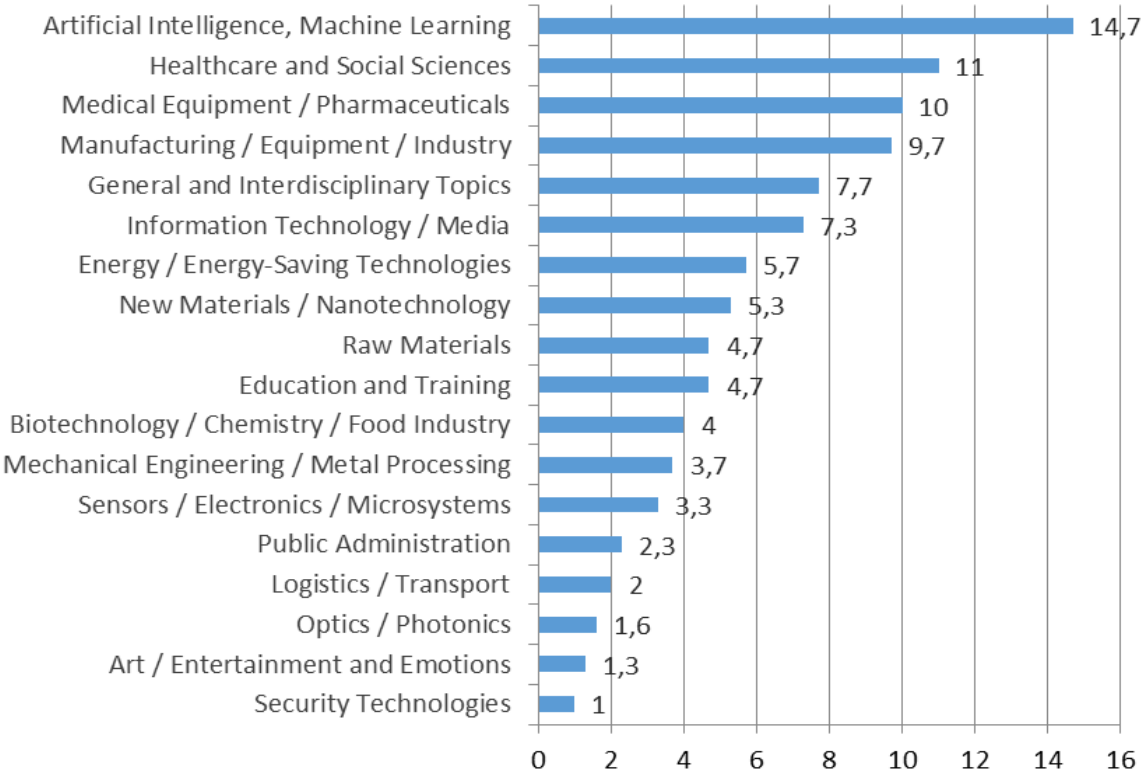

Figure 5.2 – Distribution of Innovation "Sprints" (Short-Term Projects) in Germany by Thematic Areas within DATApilot [51]

The largest percentage of innovation sprints is focused on artificial intelligence and machine learning (14.7%), highlighting the importance of digital technologies for the country. The next most popular areas are healthcare and social services (11%) and

medical technology and pharmaceuticals (10%). Smaller shares are allocated to fields such as manufacturing technologies, environmental sciences, information technology, energy, new materials, and nanotechnology.

The lowest level of interest is observed in areas such as security technologies, optics/photonics, transportation and logistics, as well as public administration, indicating that these sectors hold a relatively lower priority within the innovation sprint program.

2.The initiative promotes experience exchange and strategic collaboration among various regional innovation ecosystems by engaging universities, research institutes, enterprises, and civil society organizations.

DATI also aims to establish strong transfer networks, integrating various initiatives and partnerships to facilitate the effective implementation of innovations. The agency operates as a flexible and independent structure, adapting to the needs of different stakeholders and providing a "one-stop transfer" approach.

IKT 2020 – Forschung für Innovationen (ICT 2020 – Research for Innovations). IKT 2020 was a strategic program launched by the Federal Ministry of Education and Research of Germany (BMBF) to strengthen the country's position in the information and communication technology (ICT) sector. Implemented between 2007 and 2017, the program aimed to support research and development in key technological areas such as electronics, microsystems, software, knowledge processing, communication technologies, and networks.

The program’s main instruments included: Leitinnovationen (Leading Innovations), Technologieverbünde (Technology Consortia), Diensteplattformen (Service Platforms), Specialized support for small and medium-sized enterprises (SMEs) in the ICT sector.

The IKT 2020 program fostered close collaboration between research institutions and industry, stimulating innovation and ensuring Germany’s global competitiveness. Further details about the program are available on the official BMBF website [52].

5.3. Germany's Technology Transfer Ecosystem

The technology transfer ecosystem in Germany is a complex and well-structured system that integrates government institutions, research institutes, universities, and the private sector. It is designed to facilitate the efficient transfer of scientific developments into industry, thereby fostering the country's innovation-driven growth (Fig. 5.3).

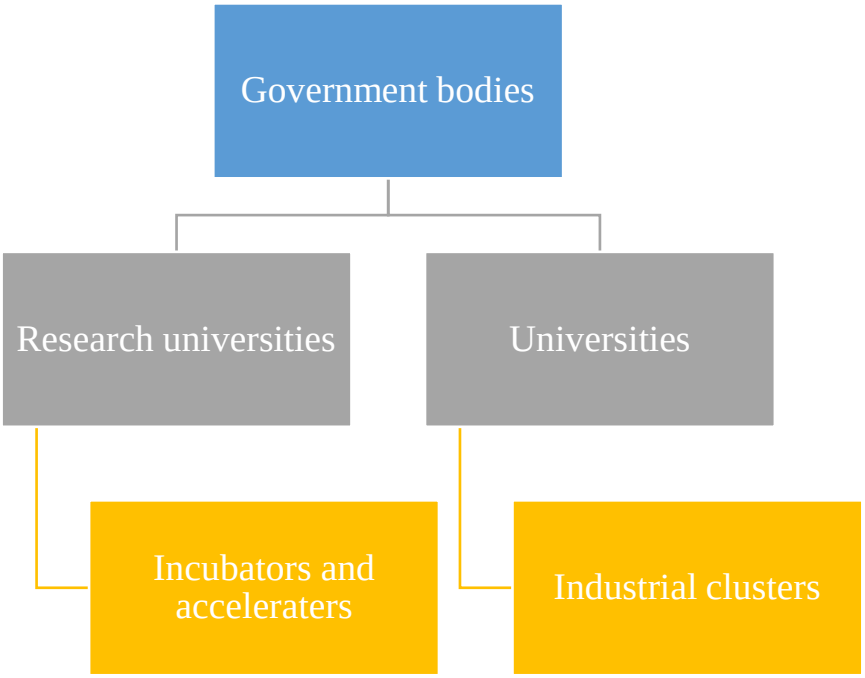

Figure 5.3 – Germany's Technology Transfer Ecosystem [53,54]

However, despite the well-developed institutional framework, a significant portion of scientific advancements in Germany remains underutilized. The main challenges include insufficient funding for commercialization, the reluctance of research institutions to rapidly transfer their developments, and a stronger focus on academic achievements rather than applied innovations.

One of the key components of this ecosystem is research institutes, particularly the Max Planck Society and the Fraunhofer Society, which specialize in fundamental and applied research, respectively.

The Max Planck Society primarily focuses on fundamental research and rarely engages in commercialization, leading to an underutilization of its commercial potential.

The Fraunhofer Society, on the other hand, is more oriented towards applied research and works directly with companies to develop commercially viable products. However, even Fraunhofer faces scaling challenges due to limited public funding and a lack of venture capital.

Universities also play a crucial role in technology transfer, but they encounter significant limitations. Technical universities, such as the Technical University of Munich (TUM), have Technology Transfer Offices (TTOs) dedicated to patenting and licensing innovations. These offices facilitate commercialization but often struggle to effectively engage with businesses due to differences in innovation management approaches.

As highlighted in the Interreg Europe analysis, universities tend to retain an academic perspective when evaluating innovations, which slows down their implementation in the real sector.

Government bodies support innovation development through programs such as "High-Tech Strategy 2025" and the "Industrie 4.0" initiative. These programs aim to stimulate research in high-tech industries, finance startups, and encourage investments in cutting-edge technologies. However, this funding is often insufficient to cover all technology transfer needs, particularly in sectors requiring high capital investments for scaling. Additionally, the limited integration of small and medium-sized enterprises (SMEs) reduces the overall potential for innovation adoption at the national economic level.

Incubators and accelerators, such as Berlin Startup Hub, play a crucial role in the ecosystem by providing resources, mentorship, and networking opportunities for young companies. These centers serve as platforms for the growth of innovative businesses but often face limited capacity to support startups in later development stages, where large-scale investments are required.

Industrial clusters, such as Silicon Saxony in Dresden, bring together companies, universities, and research institutes, fostering specialization in specific fields, such as microelectronics. However, as experts highlight, these clusters require additional state support to scale internationally and compete on a global level.

Intellectual property protection is a key driver of innovation in Germany. The European Patent Office (EPO), headquartered in Munich, ensures high standards of intellectual property protection, allowing inventors to safeguard their rights and generate revenue through licensing. However, the complexity of patent procedures and high patenting costs often deter young companies from registering patents, impacting their competitiveness in the long run.

Funding innovation is a critical component of the ecosystem. State-backed funds, such as High-Tech Gründerfonds, provide early-stage investment for startups, helping them secure initial capital. Despite the important role of this fund, young companies often struggle with funding shortages for further development, especially in industries with high entry barriers.

Thus, the technology transfer ecosystem in Germany is multi-layered and complex, yet it faces several challenges that limit its overall effectiveness. Insufficient funding, the inertia of the academic sector, and difficulties in patenting are among the key barriers that hinder the country's full potential in technological innovation.

Academic technology transfer is a complex and dynamic process that goes beyond simply creating and commercializing new products. It also involves developing human capital through education and internships at research institutes, providing students and scientists with direct involvement in innovation projects.

Universities actively build infrastructure for scientific startups, offering acceleration programs and specialized hubs, such as the Munich Innovation Hub in Munich. These hubs provide mentorship support and access to investors, facilitating the growth and commercialization of new ventures.

For guide users, it will be valuable to review statistical data on the German technology transfer ecosystem, illustrating its scale and trends in recent years. The first key indicator is the volume of patents.

Table 5.2 – Key Indicators of Patent Activity in Germany for 2022-2023 [60]

Indicator	2022	2023	Changes in %
Applications (DPMA patent applications and PCT applications after national phase)	57,212	58,656	+ 2.5
Open examination procedures	43,466	44,489	+ 2.4
Completed examination procedures	45,513	42,634	- 6.3
Published patent grant decisions	23,591	22,363	- 5.2
Valid patents	142,671	148,359	+ 4.0

A slight increase in the number of patent applications filed and ongoing examination procedures reflects a stable interest in the commercialization of innovations, confirming the willingness of enterprises and research institutions to continue investing in new developments even amid global economic uncertainty. At the same time, the growing requirements for the quality of new technologies and their compliance with current technological standards, particularly environmental and "green" criteria, may explain the decline in the number of completed examination procedures and published patent grants. This is likely the result of stricter quality assessments of innovative solutions, which have become a priority for enhancing the competitiveness of technologies in the international market.

The 4% increase in the number of active patents indicates stable retention of patents in portfolios, suggesting the presence of a substantial pool of potentially promising technologies for further economic development. The patent activity indicators for 2023 generally demonstrate Germany's ability to maintain a high level of innovation activity and reaffirm its significant role in the global patent ecosystem. The dynamics of patent applications for the period 2019–2023 are presented in Fig. 5.4.

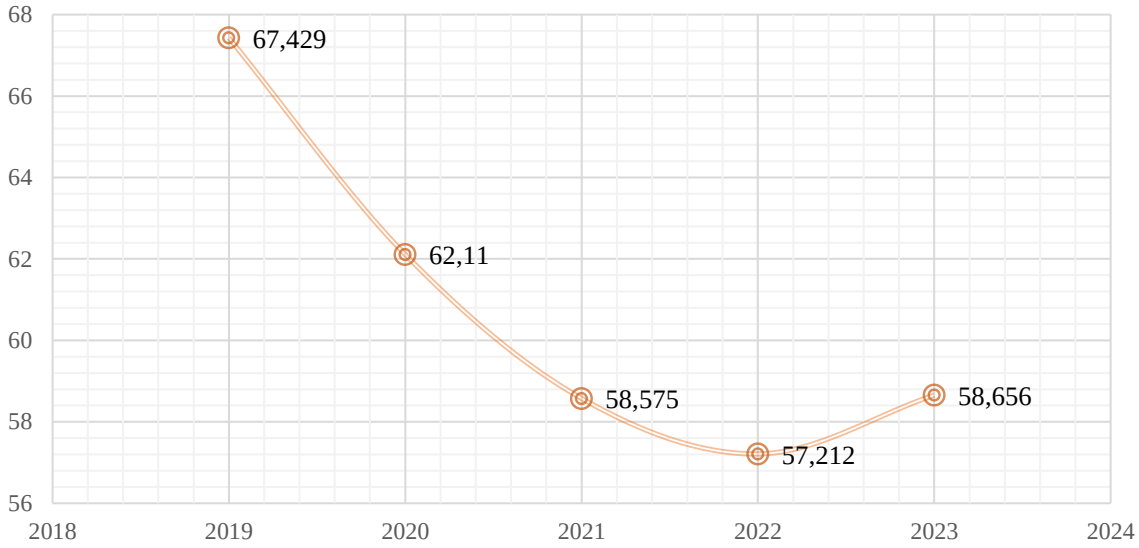

Figure 5.4 – Patent Application Dynamics in Germany from 2019 to 2023

The analysis of patent application dynamics in Germany from 2019 to 2023 reveals a gradual decline, from 67,429 applications in 2019 to 57,212 in 2022, with a slight recovery to 58,656 in 2023. This trend may indicate the impact of the COVID-19 pandemic and the accompanying economic challenges on the decline in innovation activity. However, the recovery in 2023 could signal a return to a stable level of innovation. These changes directly affect the technology transfer process: a decrease in the number of new applications limits the potential volume of new technologies available for commercialization, which may slow down the pace of technology transfer. Nonetheless, the stabilization of indicators in 2023 fosters optimism regarding future growth and the intensification of technology transfer in the near term.

According to data from the German Patent and Trade Mark Office (DPMA), a total of 58,656 patent applications were filed in 2023, marking a 2.5% increase compared to the previous year. German companies increased the number of filed inventions by 3.4%, reaching 38,469 applications. This growth represents a positive signal for the economy. The sectors of "Electricity" (+6.1%) and "Semiconductors" (+16.6%) demonstrated significant growth, particularly in battery technologies, supported by advancements in digital technologies, including artificial intelligence

[61]. The structure and volume of investments in Germany's technology transfer ecosystem are presented in Fig. 5.5.

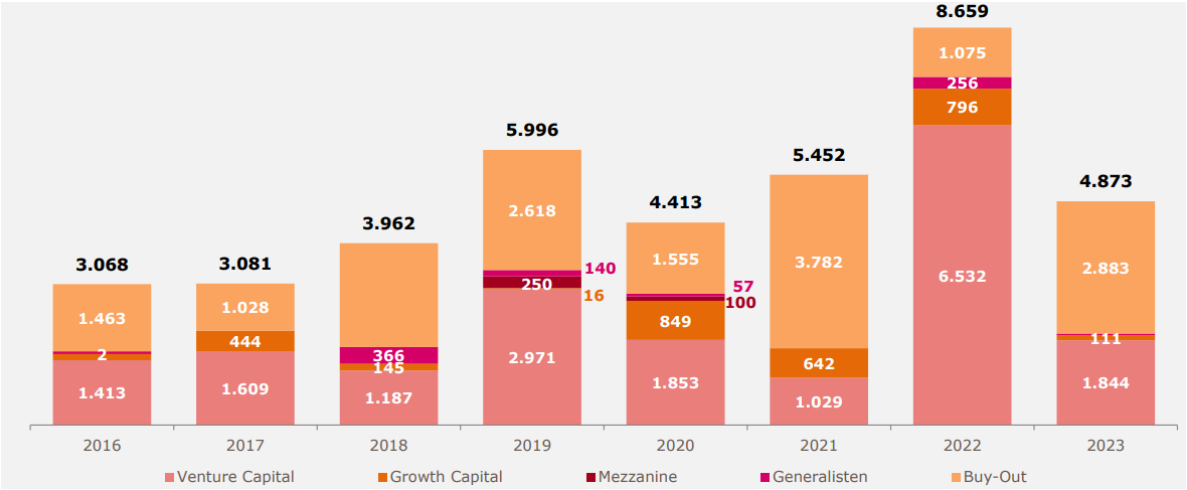

Figure 5.5 – Fundraising Volumes in Germany Across Different Investment Fund Categories from 2016 to 2023 [60]

Between 2016 and 2023, Germany experienced fluctuations in the financing of various investment directions, including venture capital, growth capital, mezzanine financing, general funds, and buyouts. The most notable trend is the increase in venture capital investments, which peaked in 2022 at €6,532 million. This reflects a strong interest in supporting startups and technological innovations, particularly in high-tech sectors where companies require substantial early-stage investments. This trend aligns with the global movement toward enhanced support for technology-driven enterprises.

The year 2019 also saw a significant influx of capital (€5,996 million), particularly due to the rise in growth capital, which reached €2,618 million. This suggests that investors during this period were focused on expanding existing companies that were ready for scaling. Additionally, the high level of investment in 2022 was driven by substantial contributions to buyouts and mezzanine financing, indicating investors' preference for more stable assets amid economic uncertainty.

In the context of technology transfer, investment trends highlight increased support for innovative companies in Germany. The growth of venture capital facilitates the emergence of new technological solutions that can be transferred from

research and scientific institutions to the commercial sector. Furthermore, the high level of growth capital creates favorable conditions for scaling innovative businesses, enabling them to integrate cutting-edge technologies into production more rapidly and expand into international markets.

According to the Federal Ministry of Education and Research of Germany, in 2022, the share of expenditures on research and development (R&D) amounted to 3.13% of the country's GDP, making it one of the highest in Europe. Germany holds a leading position in Europe in terms of government investments in R&D. According to Eurostat data for 2023, government budget allocations for R&D in Germany amounted to €529.3 per capita, ranking among the highest in the EU.

This high level of funding contributes to the active development of the innovation ecosystem and the effective transfer of technology. Germany invests substantial resources in scientific research, ensuring the rapid implementation of cutting-edge technologies in industry. Additionally, the country actively promotes collaboration between research institutions and businesses, facilitating the commercialization of scientific advancements. This is reflected in Germany's high level of innovation activity and the significant number of patents registered by German companies [61].

5.4. Academic Technology Transfer in Germany

Academic technology transfer is carried out through specialized technology transfer offices at universities and research institutes, such as the Fraunhofer Society and the Max Planck Society. These institutions facilitate the commercialization of scientific developments through patent licensing, the creation of spin-off companies, joint research projects, and participation in innovation clusters.

The Fraunhofer Society, in particular, is renowned for its focus on applied research, with results frequently translated into commercial products and technologies. For example, in collaboration with the Max Planck Society, the GT-4-ET project was implemented, aimed at developing key components for the future

European gravitational wave detector—the Einstein Telescope. This project integrates cutting-edge technologies in glass manufacturing and nanofabrication with expertise in gravitational wave detection and laser interferometry [56].

The Max Planck Society also actively promotes technology transfer through its subsidiary, Max Planck Innovation, which specializes in identifying, protecting, and commercializing intellectual property created within the society's institutes. This includes patent licensing and support for spin-off company formation. For instance, in 2024, Nanoscope Therapeutics obtained a license for an optogenetic technology developed at Max Planck Society institutes for the treatment of degenerative retinal diseases [57].

Joint research projects between the Fraunhofer Society and the Max Planck Society serve as a key mechanism for technology transfer. Since 2005, more than 20 joint projects have been implemented under the Pact for Research and Innovation, aimed at combining fundamental and applied research to develop new technologies.

Another unique approach is the participation of German research institutes in European and international collaboration programs. For instance, under the Horizon Europe program, projects are funded that bring together researchers and companies from various countries to address global challenges such as digitalization and climate change. This approach allows Germany not only to integrate foreign technologies but also to expand its own potential through cooperation with leading international innovation centers.

The role of clusters and innovation ecosystems is also noteworthy. Clusters such as Silicon Saxony, a hub for companies and research institutions specializing in microelectronics, provide a foundation for knowledge and technology exchange across different sectors, fostering the emergence of innovations at the intersection of various scientific disciplines. At the same time, major corporations like Siemens actively engage in academic technology transfer through partnerships with universities, supporting research programs and technology developments tailored to their industry needs.

During the war, Ukraine and Germany intensified academic technology transfer efforts aimed at supporting scientific and technological development as well as Ukraine's reconstruction. In October 2024, Ukraine and Germany signed the first intergovernmental agreement since Ukraine's independence on cooperation in science, technology, innovation, and higher education. This agreement provides for expert exchanges, joint scientific and technological programs, the organization of conferences and seminars, the establishment of innovation structures, and the development of partnerships between universities in both countries [58].

In 2024, four Ukrainian-German centers for advanced research were established, receiving financial support from Germany amounting to approximately €10 million. These centers, located in Lviv, Kharkiv, and Kyiv, focus on the following areas [59]:

1. The development of new antibacterial compounds to combat infectious diseases and address the problem of antibiotic resistance.
2. The analysis of historical traumas of the 20th century, studying key historical events to understand societal transformations and the consequences of conflicts.
3. The application of plasma technologies in spintronics, opening new possibilities for the advancement of cutting-edge electronic devices.
4. Research on quantum materials and the development of high-tech solutions in information technology and physics.

The Academ.City science and technology park, founded in Kyiv, actively facilitates technology transfer and innovation. The park provides support for grant applications, establishes partnerships, and fosters the development of digital projects. Notably, it has implemented the AgriFootprint project, aimed at assessing the carbon footprint in agri-food value chains.

5.5. EU Support for Technology Transfer in Germany

The European Union actively supports technology transfer in Germany through various programs and initiatives aimed at fostering innovation and enhancing competitiveness. One of the key programs is Horizon Europe, which runs from 2021 to 2027 with a total budget of approximately €95.5 billion. This program funds research and innovation projects, including those related to technology transfer, across all EU member states, including Germany.

Germany also benefits from a network of innovation centers and clusters that receive EU funding to support technology transfer. For example, the European Innovation Ecosystems program is designed to strengthen collaboration between research institutions, businesses, and government agencies to facilitate innovation and technology dissemination [62].

Additionally, the European Investment Bank (EIB) allocated €8.6 billion for financing projects in Germany in 2023 [63], in accordance with the structure outlined in Table 5.3.

Table 5.3 – Investment Volumes of the European Investment Bank in Innovation Development in Germany [64]

Volume, billion euros	Characteristic
3,475	aimed at developing sustainable cities and regions.
2,632	on innovation, digital technologies and human capital development.
1,507	on sustainable energy and natural resources.
0,998	on supporting small and medium-sized businesses (SMEs) and medium-sized enterprises.

The most relevant funding category for consideration is Innovation, Digital Technologies, and Human Capital, as it is directly related to technology transfer. This category received an allocation of €2.632 billion, supporting innovations and digital initiatives that can facilitate technology dissemination. These funds may have been directed toward projects related to digitalization, technological innovation, and educational initiatives that contribute to human capital development in the context of modern technologies.

Although this is not a direct indicator of funding specifically for technology transfer, investments in the innovation sector and digitalization play a crucial role in the diffusion of technological knowledge and advancements in Germany. Other funding categories, such as Sustainable Urban and Regional Development (€3.475 billion), Sustainable Energy and Natural Resource Development (€1.507 billion), and Support for Small and Medium-sized Enterprises (SMEs) (€998 million), may also have an impact on technological development but are only indirectly related to technology transfer.

6. Technology transfer in France

6.1. State policy on technology transfer, regulatory legal acts

The state policy of France in the field of technology transfer is implemented through the support of technology transfer centers, which are usually more focused on joint research agreements rather than licensing intellectual property rights and technologies. In fact, the licensing of intellectual technologies and commercialization are relatively new activities for most universities, having been incorporated into their functions following the adoption of the Law on Innovative Developments on July 12, 1999, as well as after the French Ministry of Scientific Research issued the Recommendations on Intellectual Technology Policy in 2001.

Most universities in France are public. Thus, technology transfer centers receive funding in the form of an allocated share of the funds provided to universities by the French government. The allocated amount is symbolic (ranging from €15,000 to €40,000). However, the autonomy of each university grants it the authority to distribute its budgetary funds at the sole discretion of its governing board. As a result, the practice of state support for technology transfer centers has evolved into two main models. If a technology transfer center is part of a university, its funding is determined by the university's council and may be partially supported through (1) percentage deductions from amounts received from the SII, as well as (2) percentage deductions from revenues generated through the licensing of intellectual technologies, if applicable.

If a technology transfer center operates as a branch of a university, its funding is provided exclusively through percentage deductions from all received revenues, either from joint research projects or from licensing intellectual technology rights.

Over the past five years, France has introduced significant innovations at the administrative, coordination, and advisory levels, as well as within financial and evaluation bodies. Specifically, the following institutions have been established: the High Council for Science and Technology (HCST) in 2006, the General Council for Industry, Energy, and Technology (CGIET) in 2009, the National Industry

Conference (CNI) in 2010, and the Strategic Committees for Production Chains (CSF) in 2010, which are responsible for shaping and implementing technological and innovation policies.

To enhance the funding of fundamental and applied research and innovation, the National Research Agency (ANR) was established in 2005, along with the State Corporation for Innovation Development and Support of Small and Medium Enterprises (OSEO) in the same year. In order to evaluate the effectiveness of public spending on research and education, an assessment body was created—the Agency for the Evaluation of Research and Higher Education (AERES) in 2007.

In France, the transfer and commercialization of R&D results funded by public resources are managed by the National Agency for Enhancing the Innovation Appeal of Scientific Research. This agency was established in 1979 as a government institution aimed at promoting industrial innovation, primarily in the small and medium-sized business sector. On the one hand, the National Agency holds the status of an independent consortium; on the other hand, its activities are defined by the government, which provides the primary funding for this program.

The transfer and commercialization of technologies developed with public funds are carried out on a licensing basis. The National Agency provides financial support to innovative enterprises and research laboratories. One form of support is an interest-free loan for up to six years, covering 50% of the project's cost, which must be repaid only if the funded innovation project proves successful. Additionally, subsidies, grants, and allowances are available for implementing innovation programs. Any form of funding is designed to stimulate the participation of small and medium-sized enterprises in regional or international programs.

French innovation policy is a highly dynamic process. The French government perceives the regulation of research and higher education as crucial for the future role of French industry in the global market. Accordingly, the measures taken reflect the pursuit of an optimal principle of public interest, which is understood in terms of the productivity of French industry. This concept of public interest is defined by economic success.

French state policy strongly supports regional interests. The development of a network of competitiveness clusters across the country takes into account the historical characteristics of France's industrial landscape and research institutions, which have evolved in different regions. It appears that centralized governance, compared to a system that delegates relevant powers to regional authorities, could have been better positioned to balance regional interests. The effectiveness of measures taken by centralized governance may have been an advantage over the inevitable negotiation processes among various regional authorities, especially if the latter hold greater regulatory power over innovation policy.

6.2. French government programs to support technology transfer

The competitiveness cluster policy was launched in 2004 to mobilize key factors of competitiveness, the most important of which is the ability to innovate, as well as to promote growth and employment in emerging markets.

A competitiveness cluster brings together small and large companies, research laboratories, and educational institutions within a clearly defined territory and around a specific thematic focus. National and regional government authorities are closely involved in this dynamic. The forces present within a competitiveness cluster are diverse, and all are essential for fostering dynamic ecosystems that generate wealth.

The competitiveness cluster is primarily aimed at supporting innovation. It facilitates the development of particularly innovative joint research and development (R&D) projects. Additionally, it supports the growth and expansion of its member companies, particularly through the development and commercialization of new products, services, or processes resulting from research projects. By enabling participating companies to secure leading positions in their respective markets in France, Europe, and internationally, competitiveness clusters serve as drivers of growth and employment.

A competitiveness cluster is strongly tied to a specific territory, relying on existing structures such as industrial bases, campuses, and shared infrastructure.

Competitiveness clusters (Pôles de compétitivité) are initiatives of the French government aimed at enhancing economic competitiveness through collaboration between businesses, research institutes, and public institutions. These clusters focus on fostering innovation and developing new technologies across various industries, including aerospace, biotechnology, and automotive sectors. They bring together small and medium-sized enterprises (SMEs), large corporations, universities, and research centers into integrated networks to accelerate research and development.

Competitiveness clusters receive government support, which includes financial incentives as well as assistance in finding international collaboration partners. Their funding comes from various sources, such as state grants and European Union programs.

Aerospace Valley Cluster: Located in southwestern France, this cluster specializes in aerospace technologies, bringing together hundreds of companies and research organizations to develop new solutions in aviation and space technologies.

The "France 2030" program was announced by President Emmanuel Macron in 2021 and entails a large-scale investment plan of over €30 billion to support strategic innovations in key industries. This long-term initiative is designed to strengthen France's industrial and technological independence. Key Focus Areas:

- Green Energy and Clean Technologies – Investments in the development of new clean energy sources such as hydrogen, the expansion of renewable energy, and the decarbonization of industry.
- Digital Transformation – Advancement of cutting-edge digital technologies, including artificial intelligence, quantum computing, and cybersecurity, to enhance competitiveness in the digital sector.
- Medicine of the Future – Development of biomedical technologies, including innovations in genetics and personalized medicine, to improve treatment and diagnostics.
- Space and Aerospace Industry – Support for innovations in space exploration and the aerospace sector.

The Research and Development Tax Credit (Crédit d'Impôt Recherche, CIR) is one of the most powerful incentives for the private sector in France. This program allows companies to receive tax benefits for expenses related to research activities. CIR enables businesses to reduce their tax burden by offsetting a portion of their research and development (R&D) costs.

The tax credit can cover up to 30% of R&D expenses up to a certain threshold, making it highly attractive for both large corporations and small and medium-sized enterprises (SMEs) investing in innovation. The program includes expenses related to the development of new products, patents, salaries of research staff, and other R&D-related costs.

The National Startup Financing Fund (Fonds National d'Amorçage, FNA) was established to support innovative startups and projects in the early stages of development. It was created as part of the Investment for the Future Plan (Plan d'Investissement d'Avenir). The FNA provides funding for startups, particularly through venture capital funds specializing in the support of young technology companies. The fund co-finances innovative projects alongside private investors, enabling startups to secure capital for product development and market entry.

Government Support Measures for Innovation in France:

- The right of public research institutes to participate as shareholders or founders of commercial innovation companies.
- Encouraging the creation of joint ventures between research institutes and business sectors.
- Promoting the application of innovative technologies at the level of small and medium-sized enterprises (SMEs).
- Direct financing of innovative enterprises (grants, preferential loans, and other funding programs).
- Encouraging patenting.
- Supporting inventors through additional payments to employees when their inventions are commercially utilized.

— Tax incentives for innovative enterprises.

— Assigning innovation policy to specially designated government bodies.

6.3. Technology transfer in France, technology transfer ecosystem

Key Elements of the Technology Transfer Ecosystem in France:

1.Universities and Research Centers. In France, most universities are public and play a crucial role in research and the development of new technologies. Universities have their own Technology Transfer Acceleration Companies (SATT - Sociétés d'Accélération du Transfert de Technologies), which specialize in the commercialization of scientific research results. University research projects are often funded by the state or through partnerships with private companies. France has established a network of SATTs that focus on accelerating technology transfer from scientific research to the market. SATTs receive funding both from public sources and through collaboration with industry, enabling them to actively promote the commercialization of scientific discoveries.

SATTs act as economic players in the region, aiming to enhance the efficiency of the French system for supporting public research, particularly by accelerating its transfer and application in the industrial sector. They operate as service providers in research promotion on behalf of their shareholders (universities, schools, research organizations) and other potential clients. SATTs have financial resources to invest in projects at the maturation stage before industrial proof of concept, originating from laboratories within their respective geographical regions. As regionally focused structures, their objective is to improve the professionalization of research valorization and strengthen the expertise of university sites. [64]

2.National Research Agency (ANR - Agence Nationale de la Recherche). ANR is a key body that supports research and innovation. The agency funds both fundamental and applied research and facilitates cooperation between the public and private sectors for technology transfer [69].

ANR was established in 2005 to support project-based French research and stimulate innovation by fostering the emergence of multidisciplinary joint projects and encouraging public-private collaboration. It also aims to strengthen the positioning of French research at the European and global levels.

The agency's objectives, defined by the decree of August 1, 2006, and amended on March 24, 2014, include:

— Funding and promoting the development of fundamental and applied research, technological innovations, and technology transfer, as well as fostering partnerships between the public and private sectors.

— Implementing research programming approved by the minister responsible for research, who consults with ministers overseeing research organizations or public higher education institutions.

— Managing major public investment programs in higher education and scientific research, ensuring their proper execution.

— Strengthening scientific cooperation at the European and international levels by aligning its programming with European and international initiatives.

— Analyzing the evolution of research output and assessing the impact of the agency's funding on national scientific production [69].

3.OSEO and Bpifrance. OSEO (now part of Bpifrance) is a public organization that supports innovative enterprises and helps small and medium-sized enterprises (SMEs) access financing for the development of new technologies. Bpifrance provides loans, grants, and investments in startups, assisting them in implementing innovative projects and commercializing technologies.

4.Tax Incentive Programs. France offers substantial tax incentives for research and development (Crédit d'Impôt Recherche, CIR), which encourage companies to invest in R&D, fostering technology development and transfer. Established by the Finance Act of 1983, the research tax credit (CIR) was initially a temporary incentive system designed to boost investments in R&D by French companies. It was intended to replace the exceptional depreciation system, which allowed companies to amortize their research materials and equipment. The government at the time considered the

latter insufficient to encourage companies to invest both human and material resources in research and development.

In its earliest version, only industrial and commercial enterprises subject to real corporate income tax were eligible, provided they had already incurred research expenses in the previous year as declared in the CIR report. However, newly established companies that met the SME criteria at the time could benefit from the CIR starting from their year of inception. France is home to 61 science parks, involving more than 5,700 companies, 65 universities, and over 2,000 various research institutes and their subdivisions. One of the most successful technology parks is Metz-2000, established in 1983. A key feature of France's technology parks is their specialization. For example, the Gerland Biopôle science park near Lyon focuses exclusively on biotechnology, which strengthens its competitive positioning and market presence in the technology sector [66].

6.4. Technology transfer statistics in France

The French National Institute of Industrial Property (Institut National de la Propriété Industrielle, INPI) is the primary organization responsible for registering patents and other intellectual property assets in France. According to INPI, France is one of the leading European countries in terms of the number of patent applications, particularly in fields such as aerospace technology, pharmaceuticals, and information technology (Fig. 6.1).

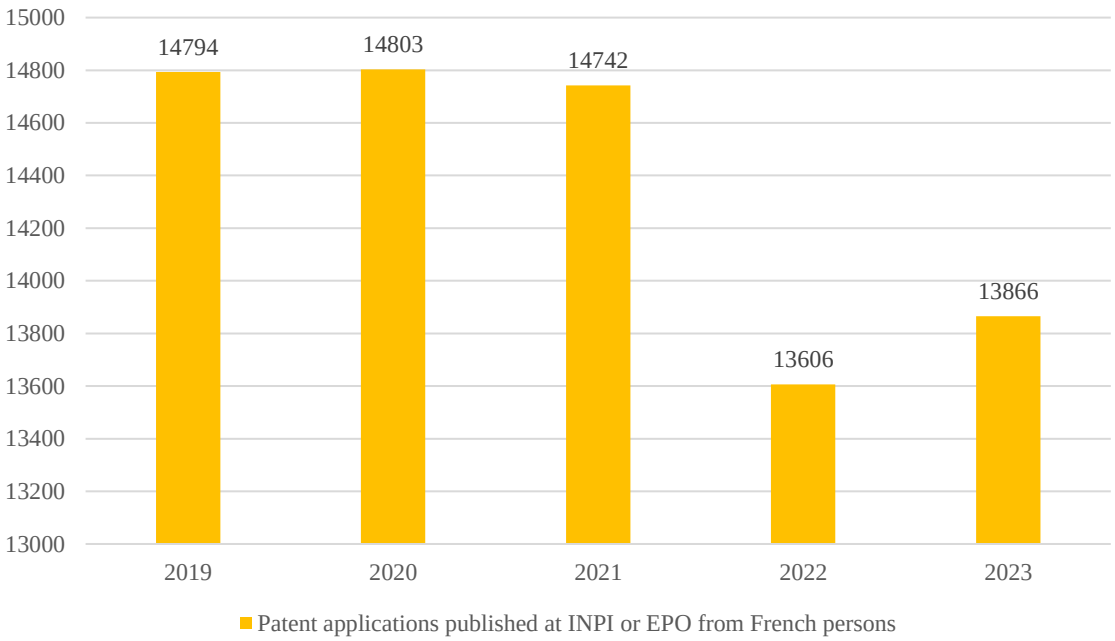

Figure 6.1. Number of patent applications of French legal entities published at INPI or EPO from 2019 to 2023 [67]

France actively invests in technology transfer through a range of public and private programs. Bpifrance, the French public development bank, invests in innovative startups and companies. In 2022, more than €3.5 billion was invested through its programs in research, development, and innovation. [68]

Over recent years, SATTs have invested more than €100 million to support technologies developed in French universities and have signed over 700 licensing agreements with companies. [68] The Innov'Up Fund and La French Tech also support startups in France. In 2022, venture capital investments in startups and innovative companies exceeded €11 billion, marking a record for the French technology ecosystem.

France has a well-developed network of companies engaged in technology transfer, operating through research institutes, universities, and technology parks. More than 13 SATT companies have signed hundreds of commercialization agreements and have helped create over 500 startups based on university research and development.

France Brevets specializes in intellectual property and technology transfer, assisting organizations with patenting and licensing developments while also participating in large-scale investment programs.

France also leverages tax incentives to stimulate investment in research and technology transfer. Crédit d'Impôt Recherche (CIR) is a tax incentive that allows companies investing in research and innovation to receive up to 30% reimbursement on their investments. The annual amount reimbursed under this program exceeds €6 billion. According to reports from the OECD and Eurostat:

— France's investment in research and development (R&D) accounts for approximately 2.2% of the country's GDP.
— As of 2022, France ranks second in Europe in terms of the number of registered patents, following Germany.
— As of 2022, France has one of the highest shares of private investment in R&D in Europe, accounting for approximately 50% of total investments in this sector [73].

6.5. Volume of EU support for technology transfer in France

The European Union's support for technology transfer in France is part of large-scale funding programs for research and innovation, aimed at stimulating economic growth, competitiveness, and scientific research across all EU member states. The primary sources of funding for technology transfer support in France include the Horizon 2020 and Horizon Europe programs, as well as the European Regional Development Fund (ERDF).

The Horizon 2020 program (2014–2020) was the EU's flagship initiative for funding research and innovation, allocating over €80 billion to support research, innovation, and technology transfer across the EU. France was one of the largest beneficiaries of this program. Over the course of Horizon 2020, French institutions received more than €6.5 billion. A significant portion of this funding was directed

toward technology transfer support, including financing for research institutions, startups, and companies specializing in innovation commercialization. [71]

The Horizon Europe program (2021–2027) is the successor to Horizon 2020, with a budget of approximately €95.5 billion dedicated to supporting research, development, and innovation across all EU member states. As one of the leading participating countries, France is already receiving significant funding through this program. It is expected that France's share of the total budget will amount to approximately €7–8 billion over the entire program period.

Horizon Europe also supports technology transfer through specialized programs, such as the EIC Accelerator, which focuses on the development of startups and small innovative enterprises [76].

The European Regional Development Fund (ERDF) provides financial support to reduce regional economic disparities, including investments in innovation and technology transfer. France received over €3 billion from this fund during the 2014–2020 program period, with a significant portion allocated to supporting innovative projects and developing technological infrastructure [75].

Other sources of funding include the European Innovation Council (EIC), which is also a key instrument for supporting innovation and technology transfer. Through the EIC, millions of euros have been invested in France via grants and other forms of support for startups and small enterprises working in innovation. [76]

Additionally, COSME is another EU program that provides funding for small and medium-sized enterprises (SMEs) engaged in technology transfer. France actively participates in this funding program as well.

7. Technology transfer in Finland

7.1. Characteristics of Finland's Technology Transfer Ecosystem

Finland has emerged as a global leader in high technology without possessing significant natural resources. As early as the 1990s, the country made a breakthrough in the development and utilization of high-tech, knowledge-intensive products, successfully entering the global market. The foundation for Finland's economic transition from traditional industries to a dominance of knowledge-intensive production was laid over several decades. A decisive factor in this transformation was the increase in investments in research and development, as well as a strong emphasis on education. Within a relatively short period, Finland evolved from a country with one of the lowest levels of research intensity into a recognized global leader, ranking second in the world. Even during the economic downturn in the early 1990s, investment in research and development remained substantial, and public support for such activities grew, despite budget cuts in other areas.

Today, the primary objective of Finland's national innovation policy is the balanced development of the innovation ecosystem and collaboration among its participants. Additionally, connections with other public sectors—such as economic, industrial, environmental, and healthcare—are becoming increasingly significant. The key directions for the development of Finland's innovation ecosystem include [10]:

- Research, technology, and expertise;
- Demand and user-oriented innovations;
- Service innovations;
- Entrepreneurship development;
- Internationalization of innovation activities;
- Innovation environment.

Universities are one of the most important elements of Finland's technology transfer ecosystem. In particular, Aalto University is a pioneer in the development of

commercial activities related to innovations. The university operates Aalto University Innovation Services, which supports researchers in patenting technologies and assists in the commercialization of new developments. Aalto actively collaborates with local companies and international corporations, engaging them in funding research projects.

A similar role is played by the University of Helsinki, which has its own innovation development center—Helsinki Innovation Services. This center focuses on supporting research in biomedicine, information technology, artificial intelligence, and other fields with high demand for innovation. The university facilitates the technology transfer process by helping researchers find commercial partners to bring technologies to the market (Helsinki Innovation Services).

Technology Transfer Offices (TTOs) play a key role in the commercialization of academic research and the implementation of innovations in the industrial sector. They operate within many universities and research institutes, acting as intermediaries between science and business. For example, VTT Technical Research Centre of Finland—one of the largest independent research institutes in Europe—focuses on technology transfer in the fields of industrial innovation and applied research.

VTT collaborates with numerous companies and has developed technology transfer support programs, enabling Finnish enterprises to access cutting-edge developments in IT, electronics, biotechnology, and other fields (VTT Technical Research Centre of Finland) [10].

Espoo Innovation Garden and other technology parks, such as Turku Science Park and Oulu Innovation Alliance, serve as hubs for innovative companies, startups, as well as university branches and research centers. These technology parks provide infrastructure and resources for the development of new technologies and offer spaces for knowledge exchange between researchers and entrepreneurs.

One example of an effective ecosystem is Oulu Innovation Alliance, a platform for collaboration between universities, businesses, and local authorities, focused on the development of digital and medical technologies. Here, startups receive the

necessary resources for rapid market entry, which is particularly crucial for technology transfer.

In conclusion, the key parameters of Finland's technology transfer model have been identified (Table 7.1).

Table 7.1 – Features of the Technology Transfer Model Functioning in Finland

Target	Task
Purpose of support and funding	Creating a business based on innovation
Project support criteria	- - Job creation - - Tax payment - - Export organization - - Support for the development of critical industries - - Project team experience and competencies
Support form	Co-financing, subsidizing, granting, loan
Main industries	SMART – technologies Mobile applications Software Biotechnology Internet of Things (IoT) Engineering devices and components (inventions)
Project focus	Focus on the needs of the potential consumer
Focus of advisory support	Testing the finished product, preparing for market entry
Organizing collaboration within the ecosystem	Horizontal connections, supporting the community of innovators and founders within the ecosystem

Finland became the first country to adopt the concept of a national innovation system as a fundamental element of its science and technology policy.

At the state level, several institutions have been established to stimulate innovation activities, support, and develop funding programs for relevant projects. These include the National Technology Agency (TEKES), the Finnish Research and Development Fund (SITRA), the Industrial Investment Company (Industry Investment LTD), the Finnish Invention Fund (InnoFin), the consulting organization FINPRO, and the specialized company financing business stimulation services (FINNVERA).

Two key organizations play a crucial role in Finland's technology transfer ecosystem: the National Technology Agency (TEKES) and the Finnish Research and Development Fund (SITRA).

7.2. Characteristics of the Business Finland Program

Two key structures—The Academy of Finland and the "Business Finland" community—play a crucial role in the development of the technology transfer system and the innovation ecosystem as a whole. The Academy of Finland provides research funding for Finnish universities. Its flagship R&D&I program supports Finland's development vision up to 2030 and aims to establish a billion-euro innovation ecosystem. Substantial long-term funding is allocated to six major ecosystems, known as "flagships," each operating in a specific field [77].

Organizations managing these ecosystems include six universities, two research institutes, and Helsinki University Hospital. Between 2019 and 2022, these organizations will invest a total of €320 million in the development of these ecosystems, while the Academy of Finland's financial contribution amounts to only €54.5 million.

The predecessor of Business Finland, established in 2018, was the Finnish Funding Agency for Innovation (Finnish: TEKES).

The functions of the National Technology Agency of Finland (TEKES) include:

• Implementing the country's technology policy;

• Actively providing financial support to private companies engaged in high-risk technological projects;

• Funding various projects of public research institutes and universities in the field of applied technologies;

• Coordinating the initiation, execution, and investment support of technological programs implemented through joint efforts of private companies, universities, and research institutes;

• Actively participating in and coordinating a wide range of joint international scientific and technological projects;

• Serving as a powerful instrument for stimulating innovation.

As part of supporting the country's science and technology policy, three key functions have been identified for stimulating scientific, technological, and

innovation-driven growth through TEKES resources. These include supporting modern high-tech industries, fostering the development of promising sectors (including lending), and ensuring competitiveness by creating and maintaining cross-sectoral R&D networks (Research and Development). Business Finland provides funding services to support the functioning of Finland's innovation ecosystem. The funding services offered by Business Finland include [77]:

1. Business Finland Programs: Services for internationalization and innovation financing.
2. International Growth: Advisory and online services for international expansion.

Collaboration between Companies and Research Organizations:

• Funding for joint engineering and creative projects;

• Co-financing of innovations;

• Creating new businesses based on funding for research-driven ideas (TUTLI).

4. Growth Engines:

• The purpose of the so-called "growth engines," supported by the R&D&I program of the Academy of Finland, is to develop promising growth ecosystems based on the strategic priorities outlined in Finland's vision for 2030.

• The Finnish government allocated €60 million in capital funding for growth engines in 2018 (€30 million) and 2019 (€30 million). Additionally, Business Finland directs its funding and services toward projects that meet the growth engine criteria:

• Management funding in organizations that fit the growth engine criteria;

• Competitive bidding for ecosystems;

• Capital loan financing for Growth Engine platform companies;

• Provision of capital loans;

• Capital loan financing for the preparation of growth engine company projects.

5. Testbed Finland: Funding and support for companies developing activities within the testbed and seeking international leadership.

6. Sustainable Production in Finland: Strengthening innovation and establishing manufacturing companies, supporting business development, and fostering SME growth.

7. Support from Major Regional Firms (Veturiyrityksistä vipuvoimaa): Funding and support for ecosystems led by international companies.

In its strategy, Business Finland has set specific goals to be achieved by 2025:

• Double investments in research and development as well as SME exports;

• Create new world-class ecosystems with a total value of €20 billion;

• Become the most attractive destination for foreign direct investment in Northern Europe;

• Become the most desirable tourist destination in the Scandinavian countries.

The priority areas in technology transfer, supported by both the Academy of Finland and Business Finland, include:

• SMART health and well-being ("SMART life," personalized medicine);

• SMART energy and clean energy (technologies for energy generation and storage);

• SMART industry (sustainable industrial development);

• Resilience in communities (mobility and efficiency, support for talented citizens);

• Circular economy and responsible consumption.

Business Finland also actively supports technology transfer in universities through:

• Strategic public-private partnerships in science, technology, and innovation;

• Funding universities to enhance technology transfer processes and build expertise;

• Financing research projects where scientists continue developing their research, preparing for the commercialization of ideas into new businesses.

7.3. Finland's Research and Development Fund (SITRA)

The SITRA Fund was established in 1967 as a financial organization of the Finnish state with the aim of supporting innovation and technological development in Finland. The creation of the fund was intended to facilitate the advancement of new ideas and technologies. SITRA is focused on stimulating economic growth and social progress, serving as a financial instrument of the state that benefits citizens and helps ensure Finland's competitiveness in the global market [78].

In the 1990s, SITRA underwent changes in its strategy and direction. It began focusing on the challenges posed to Finland by globalization and climate change. Specifically, SITRA prioritized the use of digital technologies and sustainable energy sources to foster innovation and enhance economic productivity.

The primary mission of SITRA is to develop an innovation-friendly environment and boost Finland's economic productivity. The fund strives to achieve these goals while adhering to the principles of sustainable development and environmental protection.

One of the key tasks of the SITRA Fund is to ensure the effective use of digital technologies across various sectors of life—from business to social services. The fund develops projects aimed at creating innovative online services that can be applied in education, healthcare, public administration, and other fields.

In addition, SITRA focuses on promoting and implementing solutions designed to reduce the environmental impact of human activities. Specifically, the fund supports projects that encourage the use of sustainable technologies and energy sources, reduce carbon emissions, and promote the utilization of renewable resources. SITRA also fosters the development of a collaborative economy, which is based on the interaction between different industries and the creation of joint innovative projects.

SITRA follows several key priorities when making decisions on project funding. The first priority is the innovativeness of the project. The fund seeks projects that introduce new solutions and approaches to addressing significant challenges.

The second priority is the impact of the project on society and the environment. SITRA actively supports projects that can positively influence people's lives and the natural environment.

The third priority is the scalability of the project. SITRA seeks projects that not only function successfully at the regional level but also have the potential to expand and succeed internationally.

Additionally, SITRA supports projects that promote balanced economic growth, enhanced economic productivity, and reduced environmental impact.

Other key priorities of SITRA include innovative development, which fosters new technologies and approaches to solving societal challenges. The fund also actively supports projects that encourage civic engagement, improve access to and quality of services, and strengthen social justice and equality.

SITRA is committed to fostering a sustainable society, ensuring the efficient use of resources, and reducing greenhouse gas emissions. The fund collaborates with various sectors, including business, government, and research institutions, to finance projects that drive innovation, balanced resource utilization, and climate impact mitigation.

SITRA focuses on priorities such as ensuring clean water and air, reducing reliance on fossil fuels, and promoting a circular economy. The fund also works on projects that advance the digital economy and enhance cybersecurity.

The SITRA Fund offers several programs to support small technology firms. One of them is the SITRA Innovation Fund, which provides funding for startups and innovative projects in energy, transportation, and other industries. Another program, SITRA Investment Services, helps technology firms find investors. In addition, the fund offers consulting services, training, and networking opportunities, enabling businesses to develop their skills and connect with industry experts. More information about these programs can be found on SITRA’s official website.

The SITRA Startup Fund is an initiative aimed at supporting the development of innovative startups in Finland. The fund provides financial support and expert services to startups with the potential to become industry leaders. Beyond financing,

the program also offers access to a network of partners and a platform for knowledge exchange among participants. To receive funding, startups must go through a selection process, which includes an evaluation of their business plan and growth potential. The SITRA Startup Fund serves as a crucial source of funding and support for emerging companies in Finland.

The SITRA Pre-Seed Fund is a financing tool for early-stage startups, helping them secure initial capital during the early development stages. This program is designed to support innovative projects that have the potential to transform industries or even create global impact [78].

The SITRA Pre-Seed Fund provides startups with funding of up to €100,000 at the early stages of project development. In addition to financial support, startups participating in the program receive guidance and consulting services from professional experts in business and technology. Participants also have the opportunity to attend international conferences and events, which can help them connect with new clients and investors. The SITRA Pre-Seed Fund is an excellent opportunity for startups to gain initial traction and develop their potential.

The SITRA Growth Fund is a financial support initiative for startups and small businesses in Finland. Its goal is to stimulate the development of innovative technologies and enhance the competitiveness of local companies in the international market. The program offers funding of up to €10 million per project, along with expert support in business strategy, product development, and investment attraction.

The SITRA Social Impact Fund is an initiative aimed at providing financial support to social enterprises and projects with significant social impact. Established in Finland in 2014, the fund seeks to foster the growth of social entrepreneurship and support innovative ideas that drive progress in this sector.

The SITRA Social Impact Fund is one of the most successful programs of its kind. The fund collaborates with various social projects and organizations, helping them secure the necessary financial resources while providing consulting and expert support.

One of the key principles of the SITRA Social Impact Fund is the combination of social mission and financial profitability. This means that the fund supports projects that are capable of generating revenue while also making a significant social impact. The fund helps social enterprises and projects obtain financing under competitive conditions, enabling them to focus more on their mission and social objectives.

The SITRA Social Impact Fund also offers support in the form of consultations, training programs, and the development of a social enterprise network, creating a favorable environment for the growth of social entrepreneurship.

SITRA's partnerships with private investors and venture capital funds play a crucial role in fostering innovation and creating new markets. These collaborations allow the fund to attract additional resources to support promising initiatives and projects, while also expanding their impact in the market.

Such partnerships are not only important for SITRA, but also for investors and venture capital funds, as they gain access to cutting-edge technologies and innovative projects, allowing them to maintain a leading market position. Moreover, this collaboration helps attract new investments, which enhances the efficiency of technological and business development. Partnering with SITRA also enables investors and venture funds to engage in socially responsible projects, fostering corporate social responsibility and a positive societal impact [78].

The SITRA Fund (The Fund for Innovation and Technology in Finland) has a significant impact on the development of innovation and technology in the country.

One of its key focus areas is shifting mindsets and approaches to addressing global challenges, including climate change, waste management, and resource utilization. The fund dedicates both time and financial resources to research and initiatives that promote a transition toward a more sustainable and green economic model.

Additionally, SITRA supports innovation in digital technologies and artificial intelligence, facilitating their development and implementation across various industries.

SITRA plays a crucial role in Finland's economic development. Its mission is to ensure sustainable investments in progressive technologies and innovations, fostering the transformation of Finland's economy into a more resilient and sustainable system. SITRA also provides financial support to high-tech enterprises, helping them thrive in competitive industries.

Moreover, SITRA is an active participant in a range of projects aimed at solving societal issues such as poverty, unemployment, and environmental challenges. Due to its proactive role and transparency, SITRA has become a driving force of innovation and a source of new ideas for Finland's economic and social development.

It is also worth noting that SITRA has a significant influence on shaping and implementing Finland's development strategy, contributing to the country's long-term stability and sustainable growth.

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