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LEVEL AND DYNAMICS OF SELECTED MEASURES OF RESEARCH AND DEVELOPMENT ACTIVITY IN POLAND

POZIOM I DYNAMIKA WYBRANYCH MIERNIKÓW DZIAŁALNOŚCI BADAWCZO-ROZWOJOWEJ W POLSCE

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ABSTRACT

Research and development (R&D) activity is an important source of knowledge for innovative processes in business entities. In practice, this activity is accompanied by numerous dysfunctions that reduce the efficiency and universality of the functioning of the R&D sphere. One of them is random, intuitive management. The aim of the publication is to attempt to analyse the level and dynamics of selected measures of R&D activity, to assess the prevalence of this activity in Polish business entities and to propose directions for improvements in the management of the R&D sphere. The article was prepared using the following research methods: cognitive-critical analysis of selected literature on the subject to identify the research problem; descriptive-comparative method for the presentation of a research problem; statistical method to determine the percentage shares of selected measures; and the projection method to propose the concept of rational management of R&D&I activities.
The time range of the study covers the years 2018–2021. The subject scope concerns the level and dynamics of selected measures of R&D activity in Poland. The source of empirical data for the analysis of the phenomenon are publications of the Central Statistical Office. The analysis of the source material indicates a relatively low level of adopted measures of R&D activity and their dynamics on a national scale, and in the adopted cross-sections of analysis, as well as the random, intuitive nature of R&D management.

Key words: research and development activity, innovation, organisation, knowledge, management

ABSTRAKT

Działalność B+R stanowi ważne źródło wiedzy dla procesów innowacyjnych w podmiotach gospodarczych. W praktyce działalności tej towarzyszą liczne dysfunkcje obniżające sprawność i powszechność funkcjonowania sfery B+R. Jedną z nich jest przypadkowe, intuicyjne zarządzanie. Celem publikacji jest próba analizy poziomu i dynamiki wybranych mierników działalności B+R, ocena powszechności tej działalności w polskich podmiotach gospodarczych oraz zaproponowanie kierunków usprawnień w zakresie zarządzania sferą B+R. Artykuł opracowano przy wykorzystaniu następujących metod badawczych: analizy poznawczo-krytycznej wybranej literatury przedmiotu – do identyfikacji problemu badawczego; metody opisowo-porównawczej – do prezentacji problemu badawczego; metody statystycznej – do określenia udziałów procentowych wybranych mierników i metody projekcyjnej do zaproponowania koncepcji racjonalnego zarządzania działalnością B+R+I. Zakres czasowy badania obejmuje lata 2018–2021, zakres przedmiotowy dotyczy poziomu i dynamiki wybranych mierników działalności B+R w Polsce. Źródłem danych empirycznych do analizy zjawiska są publikacje Głównego urzędu Statystycznego. Analiza materiału źródłowego wskazuje na względnie niski poziom przyjętych mierników działalności B+R i ich dynamiki w skali kraju oraz w przyjętych przekrojach analizy, a także na przypadkowy, intuicyjny charakter zarządzania sferą B+R.

Słowa kluczowe: działalność badawczo-rozwojowa, innowacja, organizacja, wiedza, zarządzanie

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Introduction

A rationally managed enterprise, systemically focussed on dynamic development at the stage of progress, competitiveness, conquering new markets, or increasing its position on existing markets, must be able to combine three spheres of activity into one systemic whole. Such spheres include: the pre-production sphere, the production sphere, and the post-production sphere. A special role should be assigned to the pre-production sphere, because it involves the processes of generating/acquiring knowledge necessary to effectively solve all managerial, organisational, technical, and technological problems arising in the company and its environment. The ability to quickly and effectively conduct the processes of

generating/acquiring knowledge requires a rational link between research and development (R&D) and innovation activities into one common whole research-development-innovation (R&D&I). The concept of treating the above phases together makes up the cycle of the research system, which can be considered the most important stimulus for the generation of knowledge in the structures of the modern economic entity (Mate & Molero, 2021, p. 1–14). The presented concept requires changes in the approach to managing individual spheres of the company's activity, it requires innovation in management.

Particular emphasis should be placed on developing the ability to identify problems and acquire the knowledge necessary to solve them efficiently, materialised in the form of streamlining and radical innovations. Such knowledge is acquired as a result of organised R&D activities carried out within the enterprise or organised acquisition of external knowledge. Research and development is considered the cornerstone of the competitive advantage, the long-term success of the organisation (Heij et al., 2020, p. 277–294). In the absence of sufficient resources of up-to-date knowledge, effective solutions to even the smallest problems are not possible. Therefore, the management faces an important task consisting of organising R&D activities in such a way as to ensure a systematic supply of knowledge necessary to identify and solve problems and create innovations, especially product and process innovations.

Rational organisation of R&D and innovation activities, efficient management of these functions, should be based on the ability to identify the actual state, the knowledge of which would be the basis for designing and implementing structural and process changes covering both R&D and innovation activities (Heij et al., 2020, p. 277–294). Rational organisation of R&D activities and linking them with innovative activities is an important challenge for the management of modern business entities. However, in the context of daily practice, it may be doubtful whether managers feel the need to take such actions or improve them. Do they see a connection between the results of R&D and innovation activities and the technical and economic results of the company and its market position?

In general, there are significant differences in the perception of the essence of R&D&I activities presented in the literature and the daily activities of many business entities in this field. The European

Commission's report concludes that sound research and innovation policies can help build an inclusive, sustainable, competitive, and resilient Europe. R&D and innovation are a source of prosperity and a catalyst for social, economic, and environmental sustainability. Research and innovation are the basis for productivity growth and the competitiveness of the economy. They support the creation of new and better jobs and the development of knowledge-based sectors (Report, 2022a, p. 5).

According to statistical data presented by EUROSTAT (2020), the percentage of enterprises conducting internal R&D was at the level of 17.1% in the European Union (EU). In Poland, on the other hand, the percentage of such companies was only 8.8% (https://ec.europa.eu/databrowser/). According to the European Innovation Scoreboard, Poland is in the group of so-called emerging innovators (the fourth group-the lowest classified). In 2022, it reached 60.5% of the EU average (Report, 2022b, p. 20). Recent surveys conducted among 846 respondents from 17 countries (including Poland) indicate a 10% decrease in internal resources in the R&D sphere compared to the previous year (Ayming Report, 2023, p. 7).

Examples of data indicate the need to undertake systemic improvement activities leading to the popularisation of R&D&I activities in business entities. An important instrument for such changes should be innovations in management with particular emphasis on social aspects (shaping innovative behaviour among employees), organisational and financial aspects, which are the basis for ensuring the smooth course of R&D&I activities.

Literature Review

The literature on R&D activities can be divided into two groups focussed on: (1) analysis of theoretical aspects of the essence of R&D activities and its role in the development of the organisation, and (2) identification of the actual involvement and achievements of the organisation in the field of R&D. In the publications of the first group, many issues related to this activity, its level, and its management are raised (Kisielnicki, 2018, p. 25–43). In practice, managers of organisations are not always aware of the role of R&D in the development of business

entities and entire societies, therefore they do not show interest in this sphere of activity, or this interest is weak and not supported by scientific research (Jasiński, 2021, p. 22; Mate & Molero, 2021, p. 1–14). One of the reasons for this may be the uncertainty about the unambiguously positive impact of R&D activities on innovation and the results of the entire organisation (Heij et al., 2020, p. 277–294; Salisu & Abu Bakar, 2019, p. 56–61). In the literature on the subject of R&D activity, an important function is attributed to generating knowledge (Świadek, 2017, p. 75–84). According to Nonaka and Takeuchi, an organisation's ability to effectively solve problems and create innovations depends on the ability to efficiently create knowledge (Nonaka & Takeuchi, 2000, p. 66), which is created within the framework of rationally managed R&D activities (Baruk, 2006, p. 55–90; Ferreira et al., 2023, p. 322–338; Suomala & Jokioinen, 2003, p. 213–227). The lack of organised R+D activities in business entities is one of the main barriers to the efficient creation and implementation of innovations (Das et al., 2018, p. 96–112; Kozioł-Nadolna, 2022, p. 3192–3201; Okoń-Horodyńska, 2004, p. 141–163). However, the knowledge generated within the organisation is not always enough to efficiently create innovations. It is therefore necessary to acquire external knowledge (Klessova et al., 2023, p. 1–23; Serrano-Bedia et al., 2010, p. 439–465; Śliwa & Patalas-Maliszewska, 2015, p. 267–280; Smiljic et al., 2023, p. 260–278). It is believed that economic entities conducting their own R&D activity are more likely to reach for external knowledge (Yamaguchi et al., 2021, p. 114–126). Organisations that decide to implement technological changes based on R&D should also introduce changes in the social system. Such changes include innovations in management (Heij et al., 2020, p. 277–294). It seems that these issues are a weakness of the managers of Polish enterprises.

The second group of publications on R&D activities are empirical research reports. An example of such a study is the report on R&D activities in Poland. Surveys show that 65% of companies from the industrial sector and 49% from the trade and service sector were involved in R&D projects (own work or outsourced) (KPMG w Polsce, 2013, p. 1–48). The relatively low level of R&D activity in Poland is evidenced by the results of research conducted by the Polish Agency for Enterprise Development, published in a report in 2013 (PARP, 2013, p. 1–173).

Although subsequent studies indicate an increase in some measures of R&D activity in Poland, their level does not match, for example, the average values in the EU (Deloitte Polska, 2016, p. 1–40; European Commission – Joint Research Centre, 2021, p. 1–32; IDEA Instytut, 2021, p. 1–174; Polski Instytut Ekonomiczny, 2019, p. 1–38; Raport Ayming, 2019, p. 1–44). This thesis is also confirmed by the publications of the author of this text (Baruk, 2016, p. 57–78; Baruk, 2019, p. 1–26; Baruk, 2020, p. 21–48; Baruk, 2022, p. 25–52). As a consequence, Poland ranks among the 'emerging innovators'. A systemic improvement in the level and universality of R&D work should therefore be sought, among others, in the change in the concept of management of the R&D&I sphere.

Research problem: the article attempts to solve the research problem contained in the question: what is the level and dynamics of R&D activity in Polish business entities, treated as an important source of knowledge in the processes of generating innovations? Answering the question formulated in this way required the adoption of the following measures of R&D activity: (1) the number of entities conducting R&D activities; (2) percentage share of entities conducting R&D in the total number of business entities in the industry; (3) employment in R&D activities and its structure; 4) expenditure on R&D and its structure.

Aim: The aim of the publication is to analyse the level and dynamics of the adopted measures of R&D activity, to assess the prevalence of R&D activity in Polish business entities, and to propose directions of improvement in this area.

Research methods: The following research methods were used to develop the publication: (1) cognitive-critical analysis of selected literature on the subject, (2) descriptive and comparative method, (3) statistical method, and (4) projection method.

The first three methods were used to interpret R&D activities, treated as an important source of creating knowledge necessary to effectively solve problems occurring in innovative processes, with particular emphasis on assessing the level and dynamics of adopted measures of R&D activity. The projection method was used to propose improvement changes in R&D&I business management processes and to develop a rational management model for R&D functions and creating innovations.

Results: R&D activity is one of the basic functions generating knowledge necessary for the efficient creation and implementation of innovations in all functional areas of business entities. A prerequisite for the rational development of this activity is efficient management and combining it with innovative activities into one common system. In practice, R&D activity is rather sporadic, intuitive, and deviating from theoretical assumptions. The high rank of R&D activities as a source of knowledge materialised in innovative processes largely depends on the ability of the management to innovatively manage this functional area. However, the level and dynamics of the analysed measures of R&D activity indicate the accidental, rather than innovative nature of this management.

Research limitations/implications: It seems that, for many business managers, the current technical and economic performance of the organisation is a priority in the decision-making process. On the other hand, new management concepts focussed on the future of the organisation, on the knowledge generated in R&D processes, systemically related to innovative activities, are not the strengths of the managerial staff. Systemic changes in the mentality and substantive preparation of managers are necessary so that R&D&I activities fulfil the role assigned to them in the development of business entities.

Practical implications: Awareness of the high importance of R&D&I activities in the improvement of social, organisational, technological, and economic development of the company, its understanding and striving for practical use, determining the improvement of the efficiency of management of R&D&I processes, increasing their impact on the economics of the organisation, and improving customer relations.

Social implications: Efficient management of R&D&I activities can inspire to generate/acquire knowledge, learn, share knowledge, and systematically materialise it in innovations that provide new values to both employees and customers who are more willing to engage in shaping the internal R&D&I environment.

Originality: The content of the publication contributes to the theory of R&D management and its systemic connection with innovative activities. The concept of basing the information and decision-making process on the results of the assessment of the existing state in the field of R&D activities using specific measures and linking this activity with innovative activity

was proposed. The concept of a model approach to the management of R&D spheres and an innovative one, constituting a model for practical management activities, was also proposed.

Type of publication: Theoretical-Research

Research Results and Discussion: Entities involved in R&D activities

According to the statistics of the Central Statistical Office (GUS), entities involved in R&D activities include those organisations in which R&D activity is the main type of economic activity, which implement R&D projects in addition to other basic activities or finance R&D works performed by other entities (GUS, 2022c, p. 20). As can be seen from Table 1, in the analysed period of time, the number of entities involved in R&D activities showed a slight upward trend from 5,779 in 2018 to 7,370 in 2021. Year-on-year, these increases amounted to: 1.5% in 2019, 8.8% in 2020, and 15.5% in 2021, which is a positive phenomenon.

Table 1. Number of entities conducting R&D activities in 2018–2021 in Poland

Specification	Years			
	2018	2019	2020	2021
Total number of economic operators in the industry:	227,914	237,658	239,301	240,648
Total number of entities conducting R&D activities:	5,779	5,863	6,381	7,370
• up to 9 employed	1,325	1,380	1,614	1,875
• from 10 to 49 employed	1,619	1,588	1,760	2,065
• from 50 to 249 employed	1,708	1,719	1,804	2,078
• 250 and more employed	1,127	1,176	1,203	1,352
Percentage share of entities conducting R&D in the total number of business entities in the industry (in %)	2.54	2.47	2.67	3.06
Structure of entities involved in R+D by size classes (in %):				
• up to 9 employees	22.93	23.54	25.29	25.44
• from 10 to 49 people	28.01	27.08	27.58	28.02
• from 50 to 249 people	29.55	29.32	28.27	28.19
• 250 or more people	19.50	20.06	18.85	18.34

Based on data from: GUS (2019, tab. 1, p. 20, tab. 3, p. 22; 2020, tab. 1, p. 20, tab. 3, p. 22; 2021, tab. 3, p. 22; 2022a, tab. 6(421), p. 516; 2022b, tab. 1, p. 33; 2022c, tab. 1., p. 20; tab. 3, p. 22).

A positive phenomenon is the systematic, albeit small, increase in the number of organisations involved in R&D. Compared to 2018, this increase was 1.45 % in 2019, 10.42% in 2020, and 27.53% in 2021. The analysis of the percentage share of entities carrying out R&D works in the total number of business entities in the industry indicates a small percentage of such organisations that dealt with this form of activity. This share remained at around 2.5%. Only in 2021, it slightly exceeded 3%.

Taking into account the size of business entities conducting R&D activities, measured by the number of employees, it should be stated that medium-sized entities employing from 50 to 249 employees were the most common in this area. Next came small entities. Large entities did it the least. On average, in the period under review, the prevalence of such work was at the level of 28.85% in medium-sized entities with a slight downward trend over time. In large organisations, this percentage was 19.2% also with a downward trend. Slightly higher prevalence of R&D activities was characteristic of the smallest entities employing up to 9 employees. On average, in the analysed period, it was at the level of 24.3% with a slightly upward trend. Greater universality of R&D activities was demonstrated by small entities employing from 10 to 49 employees. On average, 27.7% of such organisations carried out some work in this area. This prevalence was rather stable over the time interval considered.

R&D staff

The efficiency of R&D activities depends on the employment of properly prepared personnel. This group includes persons: (1) directly involved in the implementation of R&D work (persons working in an organisation conducting R&D activities and external collaborators), (2) persons providing direct services for R&D activities (e.g. managers of R&D works, administrative service employees, office workers, and technicians).

In general, these staff can be divided into two groups (GUS, 2022c, p. 34–35): (a) internal staff-including people working in an organisation carrying out R&D work and directly contributing to the implementation of R&D activities (persons employed on the basis of an employment

relationship or service relationship; employers and self-employed persons; agents working on the basis of agency contracts; homeworkers; persons who are members of agricultural cooperatives) and (b) external staff, that is, independent (self-employed) or dependent workers (salaried) participating in the R&D activities of a given organisation, but not being formally employed by the organisation carrying out R&D work.

As can be seen from Table 2, 266,283 people worked in the R&D sphere in 2018. Most of them (76.5%) were internal staff. In 2019, the number of such employees increased to 271,025 people. Compared to the previous year, an increase of 4,742 people was recorded, that is, by 1.8%. Here, too, internal staff dominated. It accounted for 79.3% of the total staff. In 2020, there was a further increase in the number of people employed in the R&D sphere by 4.6% compared to the previous year. These were mainly internal staff (79.8% of the total staff). The next year of analysis (2021) was characterised by a further increase in the total number of employees in the R&D sphere, which is a positive phenomenon. Compared to the previous year, this number increased by 22,132 people, that is, by 7.8%. In that year, internal staff accounted for 81.5% of the total number of employees in the R&D sphere.

In general, in the analysed period, the total number of R&D staff increased in subsequent years from 266,283 people in 2018 to 305,563 people in 2021. The number of internal staff also increased steadily from 203,588 people in 2018 to 249,014 people in 2021. The second group of R&D employees were external staff, whose number varied from year to year. Compared to the previous year, the number of external staff decreased by 10.4% in 2019. In 2020, it increased by 1.95% compared to the previous year. In 2021, there was a further decrease in the number of external staff by 1.3% compared to 2020. Compared to 2018, the number of external staff decreased by 9.8% in 2021.

Referring to the number of R&D staff to the size of business entities, it should be stated that this number was the lowest in micro-enterprises employing up to 9 employees. During the period under review, this number increased from 5,979 in 2018 to 9,101 in 2021 – an increase of 52.1%. The largest number of R&D staff was characterised by large organisations employing 250 or more employees. In 2018, 197,433 people involved in research and development worked in them. In 2021, this number increased to 222,998 people. Thus, there was an increase in employment by 12.9%.

Table 2. R&D staff in 2018–2021 in Poland

Specification	Years			
	2018	2019	2020	2021
B&R internal staff per 1,000 employees	8.1	8.4	8.8	9.3
Number of researchers in internal R&D staff per 1,000 employees	6.1	6.1	6.4	6.8
B&R staff by main groups and size classes in total (persons):	266,283	271,025	283,431	305,563
including:				
• internal	203,588	214,823	226,131	249,014
• external	62,695	56,202	57,300	56,549
• up to 9 working in total:	5,979	6,778	9,302	9,101
including:				
• internal	3,043	3,806	4,473	5,113
• external	2,936	2,972	4,829	3,988
• from 10 to 49 working in total:	17,086	16,859	20,445	23,647
including:				
• internal	13,381	13,627	16,547	19,288
• external	3,705	32,32	3,898	4,359
• from 50 to 249 working in total:	45,785	45,698	44,092	49,817
including:				
• internal	35,129	37,516	36,968	41,604
• external	10,656	8,182	7,124	8,213
• 250 and more working in total:	197,433	201,690	209,592	222,998
including:				
• internal	152,035	159,874	168,143	183,009
• external	45,398	41,816	41,449	39,989

Based on data from: GUS (2019, tab. 1, p. 20, tab. 4, p. 24, tab. 7(11), p. 37; 2020, tab. 1, p. 20, p. 22, tab. 4, p. 24; 2021, tab. 4, p. 24; 2022a, tab. 6(421), p. 516; 2022b, tab. 1, p. 33; 2022c, tab. 1., p. 20; tab. 4, p. 24).

Overall, in 2018, the share of R&D staff of micro-enterprises in the total number of R&D staff was 2.2%. In small enterprises, this ratio was at the level of 6.4%; 17.2% in medium-sized enterprises and 74.1% in large enterprises. In 2019, these shares amounted to: 2.5% in micro-enterprises, 6.2% in small enterprises, 16.9% in medium-sized enterprises, and 74.4% in large enterprises. In 2020, R&D staff of micro-enterprises accounted for 3.3% of all R&D personnel; 7.2% in small enterprises, 15.5% in medium-sized enterprises, and 73.9% in large enterprises. Similar relations took place in 2021. In the case of micro-enterprises, this share was 3.0%; 7.7% in small enterprises, 16.3% in medium-sized enterprises, and 73.0% in large enterprises.

It should be noted that, in all groups of analysed business entities conducting R&D activities, the majority were the internal staff. The smallest difference between the number of internal and external staff appeared in micro-enterprises. It amounted to 107 employees in 2018, 834 in 2019, and 1,125 in 2021. In 2020 alone, external staff outnumbered internal staff by 356. The small differences in the number of internal and external staff involved in R&D in micro-enterprises are understandable. They result from the limited financial capacity of these economic operators and the small number of employees in total. In other groups of companies, the predominance of internal staff increased as their size increased. Between 2018 and 2021, there was an average of 8.65 internal staff per 1,000 employees. On the other hand, the number of researchers in internal R&D staff per 1,000 employees was on average 6.35 people in the same period.

The development of the number of R&D staff can also be analysed across groups and executive sectors. As Table 3 shows, the largest number of R&D staff was employed in the higher education sector. In 2018, 141,877 employees worked there. However, in the next 2 years, this number decreased by 1,071 people in 2019 and by 3,881 people in 2020. In 2021, this sector employed 2,197 employees less than in the base year. However, compared to the previous year, there was a slight increase (by 1,684 people) in R&D staff.

The second largest R&D staff was occupied by the corporate sector. In 2018, 113,395 R&D staff were employed there, that is, 28,482 people less than in the higher education sector. In contrast to the higher education sector, the number of R&D staff in the enterprise sector increased in the following years of the analysis. For 2018, this number increased by: 7,815 people in 2019 (6.9%), 21,332 people in 2020 (18.8%), and 42,289 people in 2021 (37.3%). Compared to the higher education sector, the employment of R&D staff in the enterprise sector was lower in subsequent years of the analysis by: 28,482 people in 2018, 19,596 people in 2019, and 3,269 people in 2020. The exception was 2021, when the number of employees in the R&D sphere of the enterprise sector was higher by 16,004 people compared to the higher education sector.

In terms of the number of employed R&D personnel, the government ministry was in third place. In 2018, 8,080 people worked there. In the

following year, this number decreased by 1,356 people, that is, by 16.8%. The year 2020 was characterised by an increase in the number of B&R staff to 8,813 people. Compared to the base year, this increase amounted to 9.1%, and 31.1%, compared to the previous year. However, in 2021, employment decreased by 280 people, that is, by 3.2%, compared to the previous year. The variable level of R&D staff in the government sector indicates the lack of a prospective research and development policy in this sector.

Table 3. R&D staff by groups and executive sectors in 2018–2021

Executive sectors	Peronel R&D in the years			
	2018	2019	2020	2021
	[in persons]			
Overall:	266,283	271,025	283,431	305,563
internal staff	203,588	214,823	226,131	249,014
external staff	62,695	56,202	57,300	56,549
Enterprise sector in general:	113,395	121,210	134,727	155,684
internal staff	98,400	107,785	117,728	137,823
external staff	14,995	13,425	16,999	17,861
Total government:	8,080	6,724	8,813	8,533
internal staff	6,086	5,551	6,329	6,761
external staff	1,994	1,173	2,484	1,772
Total higher education sector:	141,877	140,806	137,996	139,680
internal staff	98,073	100,631	101,449	103,771
external staff	43,804	40,175	36,547	35,909
Total private non-profit sector:	2,931	2,285	1,895	1,666
internal staff	1,029	856	625	659
external staff	1,902	1,429	1,270	1,007

Based on data from: GUS (2019, tab. 7(11), p. 37; 2020, tab. 7(11), p. 35; 2021, tab. 7(11) p. 35; 2022c, tab. 7(11), p. 35).

By far, the least R&D staff was employed in the sector of private non-profit institutions. In this sector, the total number of R&D employees decreased in subsequent years of the analysis. In 2018, it amounted to 2,931 people. In 2019, it decreased by 646 people (22.0%), in 2020, by 1,036 people (35.3%), and in 2021, by 1,265 people (43.2%). A characteristic feature of this sector is the higher number of external staff compared to internal staff

during the period considered. At the same time, the number of employees in the R&D sphere, both internal and external, decreased in subsequent years of the analysis. It can therefore be assumed that R&D activity in this sector was of marginal importance. In other sectors, the number of internal staff far exceeded the number of external staff.

Expenditures on R&D activities

R&D activity, like any other form of activity, requires adequate financial resources. The basic statistical indicator in this area is gross domestic expenditure on R&D activities (GERD). They constitute the amount of total internal expenditures on R&D activities carried out on the territory of a given country in the indicated reporting period. Internal expenditures on R&D activities include all current expenditures and gross capital expenditures on fixed assets related to R&D activities conducted in a statistical unit in a given reporting period, regardless of the source of financing (GUS, 2022c, p. 19). As shown in Table 4, in 2018, GERD amounted to PLN 25,647.8 million. Compared to 2018, in subsequent years of the analysis, these expenditures gradually increased: by 18.1% in 2019, by 26.3% in 2020, and by 46.9% in 2021. Year-on-year, these increases were 18.1% in 2019, 7.0% in 2020, and 16.3% in 2021, respectively. The share of these inputs in the gross domestic product (GDP) in the period considered was on average at the level of 1.34%. A positive phenomenon is a slight increase in this indicator in subsequent years of analysis from 1.21% in 2018 to 1.44% in 2021. In 2018, PLN 668 of these expenditures accounted for per capita. In subsequent years of analysis, this amount gradually increased and in 2021, reached the level of PLN 992.

The source of financing for R&D activities was also the rest of the world. In 2018, PLN 1,804.5 million came from this source. In subsequent years, this amount increased by 18.3% in 2019, by 28.9% in 2020, and by 70.6% in 2021, reaching PLN 3,079.1 million. The share of foreign funds in GERD was on average at the level of 7.35% in the analysed period. It reached its highest value in 2021–8.2%.

Table 4. The amount of expenditure on R&D in 2018–2021

Specification	Years			
	2018	2019	2020	2021
Gross domestic expenditures on R+D activities (GERD) in PLN million (current prices)	25,647.8	30,284.8	32,402.1	37,675.8
Ratio of gross domestic capital formation for R&D activities (GERD) to GDP (in %) (intensity index)	1.21	1.32	1.39	1.44
Internal expenditures on R&D activities per one inhabitant in PLN	668	789	849	992
Internal expenditures on R&D activities financed from the rest of the world sector in PLN million	1,804.5	2,134.2	2,325.4	3,079.1
Share of foreign funds in total gross domestic expenditure on R&D activities (in %)	7.0	7.0	7.2	8.2
European Commission funds in PLN million	1,035.7	1,424.5	1,712.3	2,391.8
Share of European Commission funds in gross domestic expenditure on R&D activities (in %)	4.0	4.7	5.3	6.3
Number of entities in R&D activities benefiting from European Commission funds	891	1,031	1,124	1,369
Percentage of entities benefiting from European Commission funds in entities in R&D activities	15.4	17.6	17.6	18.6

Based on data from: (GUS, 2022c, tab. 1, p. 20., tab. 2, p. 21).

The funds of the EC were also used to finance R&D works. In 2018, it was PLN 1,035.7 million. In subsequent years, these amounts increased by 37.5% in 2019, by 65.3% in 2020, and by 130.9% in 2021. However, the share of these measures in gross domestic inputs averaged 5.1%. On a positive note, it has gradually increased from 4.0% in 2018 to 6.3% in 2021. The European Commission's funds for R&D activities were used by a relatively small number of entities. In 2018, it was 891 organisations, which accounted for only 15.4% of entities conducting R&D work. In subsequent years of analysis, the number of entities using EU funds for R&D activities increased slightly (year-on-year) by 15.7% in 2019, by 9.0% in 2020, and by 21.8% in 2021. In the last year, 1,369 entities benefited from EU funds, which accounted for 18.6% of all organisations conducting R&D work.

The level of internal expenditures on R&D activities considered in the cross-section of individual executive sectors and size classes of enterprises is interesting. As can be seen from Table 5, in total, in the country, the amount of expenditure on R&D increased along with the increase in the size of enterprises. For example, in 2021, the share of expenditures

incurred by micro-enterprises accounted for 2.5% of the total expenditure incurred on R&D. In the case of small entities, this share increased to 7.7%. An even higher value–15.7%–was achieved in medium-sized entities and the highest in large entities–74.1%. In each enterprise size class, the volume of expenditures incurred increased, with the exception of medium-sized enterprises, where in 2020, PLN 172.4 million less was allocated to R&D than in the previous year.

Table 5. Internal expenditures on R&D activities by executive sectors and size classes in 2018–2021

Executive sectors and enterprise-size classes	Volume of internal expenditures in years:			
	2018	2019	2020	2021
	In PLN million			
Total:	**25,647.8**	**30,284.8**	**32,402.1**	**37,675.8**
Micro-enterprises	472.5	630.7	746.2	946.1
small	1,796.9	1,937.7	2,259.1	2,901.7
medium-sized	4,636.5	5,232.9	5,060.5	5,907.3
large	18,741.8	22,483.4	24,336.3	27,920.8
Executive sectors:				
Enterprise sector in general:	**16,950.8**	**19,030.9**	**20,359.1**	**23,769.1**
Micro-enterprises-up to 9 employed	443	583.2	707.1	.
Small from 10 to 49 employed	1,680.5	1,824.2	2,144.9	.
Medium from 50 to 249 working	3,508.3	3,989.8	3,909.2	.
Large 250 and more employed	11,319.0	12,633.6	13,597.8	.
Total government:	**498.6**	**384.2**	**639.1**	**770.3**
Micro	220.7	.	0.4	.
Small	223.6	.	54.5	.
Medium		102.0	256.8	.
Large		242.8	327.4	.
Total higher education sector:	**8,121.7**	**10,779.4**	**11,324.4**	**13,059.0**
Micro-enterprises		.	1.2	.
Small		.	23.5	.
Medium	892.0	1,127.1	888.6	.
Large	7,199.2	9,607.0	10,411.1	.
Total private non-profit institutions:	**76.7**	**90.3**	**79.5**	**77.5**
Micro-enterprises	28.2	46.0	37.5	.
Small	33.0	30.2	36.2	.
Medium	15.5	14.0	5.8	.
Large	–	–	–	.

Based on data from: GUS (2019, tab. 3, p. 22; 2020, tab. 3, p. 22; 2021, tab. 3, p. 22; 2022c, tab. 3, p. 22).
Designations: (–) the phenomenon did not occur; (.) lack of information.

Turning to the sector analysis, it should be stated that the largest expenditure on R&D took place in the corporate sector. In 2018, they amounted to PLN 16,950.8 million, which accounted for 66.1% of total expenditures on R&D. In subsequent years of analysis, these shares amounted to: 62.8% in 2019, 62.8% in 2020, and 63.1% in 2021, respectively. Total expenditures in the enterprise sector increased in subsequent years of analysis. In 2019, they increased (year-on-year) by PLN 2,080.1 million, by PLN 1,328.2 million in 2020, and by PLN 3,410 million in 2021.

In the enterprise sector, micro-enterprises spent the least funds on R&D. In 2018, they accounted for only 2.6% of the total expenditures incurred in the entire enterprise sector. In 2019, this share was 3.1%, and 3.5% in 2020. Much larger amounts on R&D were spent by small entities. In 2018, the share of expenditures for this purpose accounted for 9.9% of all expenditures incurred in the enterprise sector. In 2019, it was 9.6% and, in 2020, it was 10.5%. In terms of absolute value, medium-sized companies allocated even higher funds to R&D. In 2018, they accounted for 20.7% of total expenditures. In the following year, this share was 21% and in 2020, it was 19.2%. The highest expenditure on R&D was incurred by large entities in the enterprise sector. In 2018, it was PLN 11,319.0 million, which accounted for 66.8% of the total expenditures of this sector. In the following year, this share was at a similar level of 66.4%, to increase to 66.8% in 2020. The development of the considered measure in 2021 was omitted due to the lack of numerical data presented by the GUS.

The higher education sector ranked second in terms of internal expenditure on R&D activities, analysed in the cross-section of executive sectors and size classes of enterprises. Its expenditure for this purpose accounted for 31.7% of total expenditures in 2018. In subsequent years, these shares amounted to 35.6% in 2019 and 34.9% in 2020. In this sector, it is impossible to fully analyse the development of expenditures on R&D in the cross-section of size classes of entities due to the lack of data. Data for 2018–2020 indicate that large enterprises allocated the largest amounts to R&D. In 2018, PLN 7199.2 million was spent for this purpose. This amount accounted for 88.6% of total expenditure in the higher education sector. In 2019, PLN 2407.8 million more was allocated to R&D than in the previous year. They accounted for 89.1% of total expenditure in this sector.

Even higher expenditures were incurred by large enterprises in the higher education sector in 2020. Compared to the previous year, they increased by PLN 804.1 million, which amounted to 91.9% of the total expenditures of the sector considered. Much less internal expenditure on R+D was borne by the government sector. In 2018, PLN 498.6 million was spent there. The share of this amount in total expenditures is only 1.9%. In the following year of analysis, PLN 114.4 million less was spent for this purpose than in the previous year. These funds accounted for only 1.3% of total expenditures. In 2020, PLN 639.1 million was allocated to R&D in the government sector, that is, PLN 254.9 million more than in the previous year. The share of these expenditures in total expenditures is less than 2% (1.97%). Compared to the previous year, R&D expenses in 2021 increased by PLN 131.2 million. They accounted for only 2% of total domestic expenditure. The available figures indicate that large companies have invested the most in R&D in this sector. In 2018, they accounted for 44.8% of total government sector expenditures. In 2019, this ratio was 63.2%, and in 2020, 51.2%.

The least active entities in the field of financing R&D activities were recorded by entities from the sector of private non-commercial institutions. In subsequent years of analysis, a total of PLN 76.7 million was spent in 2018, that is, 0.3% of total expenditure. In 2019, these expenses increased to PLN 90.3 million. They accounted for 0.3% of total expenditures. In the following year, these expenditures decreased by PLN 10.8 million and their share in total expenditures amounted to 0.2%. In 2021, R&D expenditures fell further to PLN 77.5 million. This amount represented 0.2% of the total expenditure for this purpose. In the cross-section of size classes of entities in this sector, micro-enterprises and small enterprises incurred greater expenditures, but without regular increases in the amounts spent.

The results of the analysis of internal expenditures on R&D activities considered according to types of costs and implementation sectors are interesting. The structure of internal expenditures on R&D consists of current (including personnel) and investment expenditures. Current expenditures include personnel expenditure on R&D personnel as well as other current expenditures related to R&D activities: services and items consumed within one year, annual fees, and rents. Personnel expenses include the remuneration of R&D staff and related costs or additional

benefits. On the other hand, investment outlays are the annual gross amount paid for acquired fixed assets, repeatedly used in R&D activities for a period longer than one year (GUS, 2022c, p. 27).

As can be seen from Table 6, the total country was dominated by current expenditures over capital expenditures in individual years of the analysis. Current expenditures were characterised by their systematic growth (year-on-year): in 2019 by 22.4%, in 2020 by 9.3%, and in 2021 by 16.6%. The share of current expenditures in total expenditures was: 79.5% in 2018, 82.4% in 2019, 84.2% in 2020, and 84.4% in 2021. On the other hand, the share of capital expenditures in internal expenditures was much smaller, irregular, and amounted to: 20.5% in 2018, 17.6% in 2019, 15.8% in 2020, and 15.6% in 2021.

Current expenditures in R&D activities also dominated in individual executive sectors. In the enterprise sector, they increased in subsequent years of analysis, and their share in the total expenditures of this sector amounted to: 74.2% in 2018, 78.4% in 2019, 82.4% in 2020, and 84.3% in 2021. The higher education sector ranked second in terms of R&D expenditures. Most of them are current expenditures. In 2018, they accounted for 89.7% of total expenditures in this sector. In 2019, this share was 89.3%. In the next two years, current expenditures accounted for 87.4% and 84.9% of total expenditures, respectively.

Significantly, lower R&D expenditures were incurred in the government sector and in the sector of private non-profit institutions. In the first sector, the share of total expenditures in total domestic expenditures amounted to: 1.9% in 2018, 1.3% in 2019, and 2% each in 2020 and 2021. The private non-profit institutions sector had even lower values of these shares: 0.3% in 2018, 0.3% in 2019, 0.2% in 2020, and 0.2% in 2021. Significantly less money was spent on investments in all sectors. They accounted for a small percentage of total expenditures.

The results of the structure of internal expenditures on R&D activities considered by types of activities and implementation sectors are interesting. As can be seen from Table 7, in total, development work absorbed the most funds in the country. The share of expenditures on these works in total expenditures was: 54.2% in 2018, 46.5% in 2019, 51.0% in 2020, and 53.4% in 2021. Year-on-year, these expenditures increased by: 1.21% in 2019, 17.5% in 2020, and 21.8% in 2021. In the second place in

terms of the amount of expenditure on R&D was basic research. The share of these expenditures in total expenditures was: 32.5% in 2018, 40.1% in 2019, 33.2% in 2020, and 32.1% in 2021. In contrast to expenditure on development works, expenditure on basic research did not increase in subsequent years of analysis. In 2019, they increased by 45.5% compared to the previous year. In 2020, PLN 1,377.5 million less was spent on basic research than in the previous year. Therefore, there was a decrease in expenditures for this purpose by 11.3% compared to the previous year. In 2021, PLN 1,315.0 million more was spent on basic research than in 2020. Thus, there was an increase in expenditures by 12.2%.

Table 6. Internal expenditures on R&D activities by types of costs and executive sectors in 2018–2021

Executive sectors:	Internal expenditures in years:			
	2018	2019	2020	2021
	In PLN million			
Total:	**25,647.8**	**30,284.8**	**32,402.1**	**37,675.8**
Current	20,390.7	24,962.9	27,286.7	31,815.1
Investment	5,257.0	5,321.9	5,115.4	5,860.7
Enterprise sector:				
Total	**16,950.8**	**19,030.9**	**20,359.1**	**23,769.1**
Current	12,577.1	14,914.5	16,775.1	20,036.2
Investment	4,373.8	4,116.4	3,584.0	3,732.9
Government sector:				
Total	**498.6**	**384.2**	**639.1**	**770.3**
Current	455.0	337.1	533.4	619.3
Investment	43.6	47.1	105.7	151.0
Higher education sector:				
Total	**8,121.7**	**10,779.4**	**11,324.4**	**13,059.0**
Current	7,289.1	9,628.6	9,901.2	11,085.0
Investment	832.6	1,150.9	1,423.2	1,974.0
Private non-profit institutions:				
Total	**76.7**	**90.3**	**79.5**	**77.5**
Current	69.6	82.7	77.0	74.6
Investment	7.1	7.5	2.5	2.9

Based on data from: GUS (2019, tab. 1(5), p. 28; 2020, tab. 1(5), p. 28; 2021, tab. 1(5), p. 28; 2022c, tab. 1(5), p. 28).

Table 7. Internal expenditures on R&D activities by type of R&D activity and executive sectors

Executive sectors:	Volume of expenditures in years:			
	2018	2019	2020	2021
	In PLN million			
Overall:	**25,647.8**	**30,284.8**	**32,402.1**	**37,675.8**
Basic research	8,346.5	12,146.5	10,769.0	12,084.0
Applied research	3,395.7	4,064.8	5,102.3	5,457.0
Development work	13,905.6	14,073.5	16,530.8	20,134.8
Enterprise sector in general:	**16,950.8**	**19,030.9**	**20,359.1**	**23,769.1**
Basic research	1,866.6	3,331.9	1,815.7	2,211.9
Applied research	2,189.0	2,669.0	3,264.6	3,513.1
Development work	12,895.3	13,030.0	15,278.7	18,044.0
Government in general:	**498.6**	**384.2**	**639.1**	**770.3**
Basic research	244.4	198.7	300.2	300.8
Applied research	74.6	73.5	171.8	127.5
Development work	179.6	111.9	167.1	342.0
Higher education sector in general:	**8,121.7**	**10,779.4**	**11,324.4**	**13,059.0**
Basic research	6,207.2	8,583.1	8,637.2	9,558.9
Applied research	1,102.5	1,297.9	1,632.3	1,789.9
Development work	812.0	898.4	1,055.0	1,710.2
Total private non-profit sector:	**76.7**	**90.3**	**79.5**	**77.5**
Basic research	28.3	32.8	15.9	12.4
Applied research	29.6	24.4	33.6	26.5
Development work	18.7	33.1	30.0	38.6

Based on data from: GUS (2019, tab. 5(9), p. 33; 2020, tab. 5(9), p. 32; 2021, tab. 5(9), p. 32; 2022c, tab. 5(9), p. 32).

The least popular was the funding of applied research. This is evidenced by the lowest amounts allocated for this purpose in individual years of the analysis. A positive feature of these expenditures was their systematic, albeit slight increase in subsequent years. They increased by 19.7% in 2019, 25.5% in 2020, and 6.9% in 2021.

Across the implementation sectors, the priorities in terms of the amount of expenditure on R&D were variable. The enterprise sector was dominated by expenditures on development works. The amount of these expenditures increased in subsequent years of the analysis (year-on-year): by PLN 134.7 million in 2019, by 17.3% in 2020, and by 18.1% in 2021. The share of expenditures

on development works in the enterprise sector in total development expenditures in the country amounted to: 92.7% in 2018, 92.6% in 2019, 92.4% in 2020, and 89.6% in 2021.

In the enterprise sector, applied research was the second largest in terms of expenditure, with the exception of 2019, when more resources were spent on basic research. The difference amounted to PLN 662.9 million. A positive feature of expenditures on applied research was their successive but slight increase in subsequent years of analysis. Year-on-year, these amounts increased by: 21.9% in 2019, 22.3% in 2020, and 7.6% in 2021. In 2018, expenditures on applied research in the enterprise sector accounted for 64.5% of such expenditures incurred in total in the country. In subsequent years, these relations amounted to: 65.7% in 2019, 64.0% in 2020, and 64.4% in 2021.

In the enterprise sector, relatively, the smallest expenditure was spent on basic research. Most funds were spent in 2019, the least in 2020. The share of these expenditures in the total expenditures of the enterprise sector was at the level of: 11.0% in 2018, 17.5% in 2019, 8.9% in 2020, and 9.3% in 2021. Compared to the total expenditure on basic research in the country, expenditures for this purpose in the enterprise sector amounted to: 22.4% in 2018, 27.4% in 2019, 16.9% in 2020, and 18.3% in 2021.

In contrast to the business sector, basic research was the most financial resource in the higher education sector, followed by applied research. In third place were development works. A characteristic feature of all types of R&D activities in the higher education sector was a gradual increase in expenditures incurred in subsequent years of analysis. In relation to overall expenditure in the higher education sector, expenditure on basic research was 76.4% in 2018, 79.6% in 2019, 76.3% in 2020, and 73.2% in 2021. The amount of these expenditures in subsequent years of the analysis increased by: 38.3% in 2019, 0.6% in 2020, and 10.7% in 2021. Much lower investment in the higher education sector was spent on applied research.

Their share in the total expenditures of this sector was: 13.6% in 2018, 12.0% in 2019, 14.4% in 2020, and 13.7% in 2021. The least popular in the higher education sector was the development work, on which the least financial resources were spent during the period under review.

The share of R&D expenditures of the private non-profit sector in the total domestic expenditure was 0.3% in 2018, 0.3% in 2019, 0.2% in 2020, and 0.2% in 2021, respectively, with no clear emphasis on any type of R&D activity.

Conclusion

The analysis of empirical material indicates that, in the analysed period of time, a small percentage of business entities (less than 4%) conducted R&D activities. Medium-sized organisations were most often involved in R&D activities. However, their share in this work did not exceed 30% and had decreasing trends in subsequent years of analysis. There were between 8.1 internal staff per 1,000 employees in 2018 and 9.3 in 2021. By contrast, the share of researchers in internal R&D staff stood at 6.1 in 2018 and 2019, rising to 6.8 in 2021. A positive phenomenon was the increasing number of total R&D staff in subsequent years. These were mainly internal staff, constituting on average 79.3% of all R&D employees in the analysed period. While the number of internal staff increased in subsequent years, the number of external staff did not show an upward trend. In 2021, it accounted for 90.2% of the 2018 figure.

The number of R&D staff changed along with the change in the size of business entities measured by the number of employees. Micro-organisations had an increasing overall workforce until 2020 and a decline in 2021. The second feature was the slightly higher number of internal staff compared to the number of external staff. Along with the increase in the size of business entities, the number of B&R staff in total increased, which is a normal phenomenon. There was also a growing gap between the number of internal and external staff in favour of the former. On the other hand, there were no regular increases in the number of R&D employees in subsequent years of the analysis, especially with regard to external staff. In large organisations, the number of external R&D employees has been gradually decreasing, which suggests greater independence of such organisations in conducting R&D activities.

Across the overall implementation sectors, the higher education sector employed the largest number of R&D staff, with the exception of 2021, when the corporate sector took the lead. The sector of private non-profit institutions came last. In this sector, as the only one, the number of external staff exceeded the number of internal staff and decreased in subsequent years of the analysis, as did the total number of staff. Downward trends in the number of external R&D employees were also recorded in the higher education sector. In other sectors, there were irregularities in the development of this measure.

In general, the number of R&D employees increased with the size of business entities. This is a specific regularity resulting from the fact that

the smallest organisations do not have the staff, organisational and financial conditions to separate R&D cells in their structures. Such entities are more likely to be assisted by external staff.

Another positive phenomenon is the increase in expenditure on R&D in the analysed period of time and their increasing amount per capita. There was also a slight increase in the share of gross domestic capital formation for R&D activities in GDP. However, this share was significantly lower than the EU average. In addition to national funds, the source of financing R&D activities were also funds from the European Commission (EC) and funds from the rest of the world. The share of foreign funds in domestic outlays was only 8.2% in 2021. The European Commission's funds accounted for an even smaller share in national expenditures. In the most favourable 2021, this share was 6.3%. A small but increasing percentage of entities benefiting from EC funds was also beneficial. In 2021, it was 18.6%.

A characteristic feature of total internal expenditures on R&D was their increase in subsequent years of analysis. Similar trends occurred in operators considered by size classes, with the exception of medium-sized organisations. These outlays increased as the size of enterprises increased. In the cross-section of executive sectors, the largest internal expenditure on R&D was incurred in the corporate sector, and the lowest in the sector of private non-profit institutions.

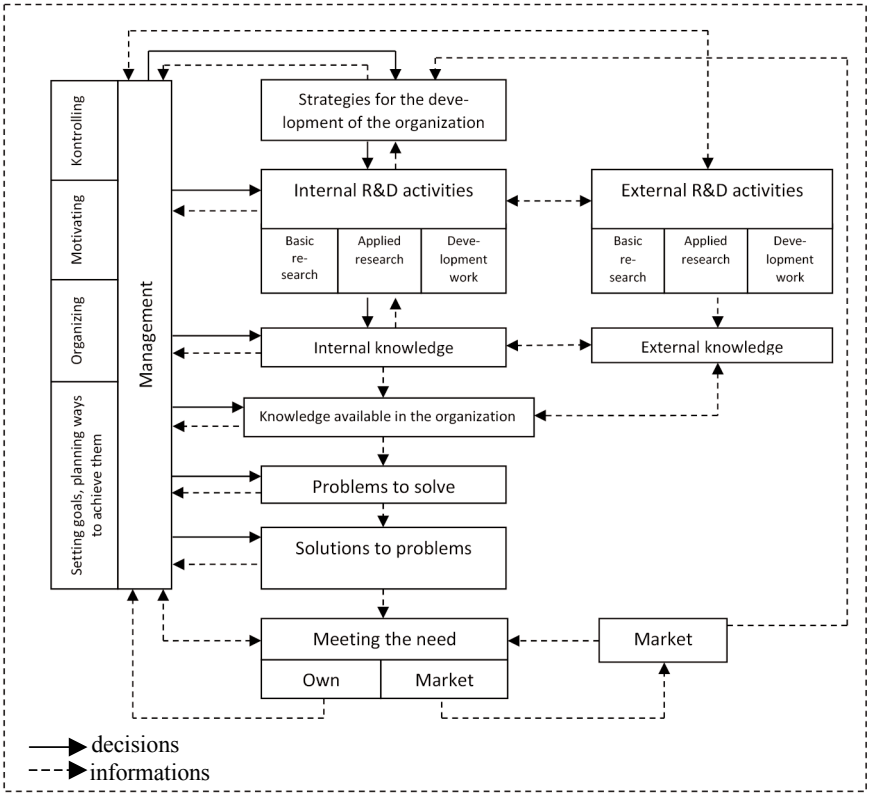
In the structure of total internal expenditures on R&D, current expenditures dominated over capital expenditures. Similar relations occurred in all executive sectors without clear upward trends. The priority in this expenditure was the financing of development work, followed by basic research. In last place was applied research. The accents in R&D expenditures in individual sectors were slightly different. In the enterprise sector, the largest amount of funds was allocated to development work, followed by applied research (with the exception of 2019). At the end of the priorities were basic research. The exception was 2019, when expenditure on basic research exceeded expenditure on applied research. In the government sector, basic research has been the most resourced, as has the higher education sector. In the sector of private non-profit institutions, preferences in financing R&D activities were not as diverse as in other sectors.

In general, the level and dynamics of selected measures of R&D activity indicate that this activity was not a priority in the information and decision-making processes of managers. The actions taken were more focussed on overcoming current problems than on solving strategic issues. In many

entities, the problem of systemic R&D work did not exist at all, as indicated by a small percentage of companies conducting R&D activities. The insufficient interest of management in systemic business development is also evidenced by the relatively low position of Poland compared to the average results in the EU.

The level, dynamics, and universality of R&D activity depend on many internal and external factors. One of the internal factors is the ability of the management to rationally, systemic, future-oriented management of the R&D&I sphere (Tidd & Bessant, 2013, p. 114–120). There are significant reserves in this area for improving management efficiency. It is necessary to give up accidental management, focussed on solving current problems and move to rational, systemic, future-oriented management of the enterprise, based on the knowledge and widespread use of modern management methods, especially management through innovation, innovation management, and knowledge management. The concept of such management is illustrated in Figure 1.

Figure 1. The concept of systemic management of R&D and innovation activities



Source: own elaboration.

This concept emphasises the rational combination of the general strategy of development of the business entity with functional strategies. These strategies set the directions of internal R&D&I activities and cooperation with external organisations conducting external R&D. The consequence of such activity and cooperation should be the resources of knowledge necessary to efficiently identify and solve internal and market problems of an operational and strategic nature. The solution to problems results in streamlining radical innovations that efficiently meet current and future of own and market needs. The areas of activity of the business entity listed in the model should be subject to rational management. In process terms, it includes four basic management functions: setting goals and planning ways to achieve them; organising work in a structural and process sense; conduction; controlling (Griffin, 2007, p. 8). An indispensable condition for rational management according to the proposed concept is to change the mentality of the management staff and to realise the need to master and use modern management methods in information and decision-making processes (Bieniok, 2011; Błaszczyk, 2022; Zimniewicz, 2009).

Suggestions for further research

In the context of the issues discussed in this publication, it seems reasonable to undertake further empirical research aimed at verifying the correctness of the theoretical model of systemic management of R&D and innovative activities in the context of efficient implementation of the overall strategy of organisational development and the resulting functional strategies. The concept of such research should be guided by the following questions: 1. Do managers understand the importance of R&D activities and related innovation activities in the development of each business entity? 2. Do managers systematically follow the literature on the subject and get acquainted with new concepts of managing integrated R&D and innovation activities? 3. Do managers have the will to have these concepts empirically verified and why? 4. What advantages and disadvantages can result from the use of modern concepts of R&D and innovation

management? It is also reasonable to answer the question: does the management of the organisation want, can, and can efficiently manage R&D&I activities?

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