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Key Competences for Effective Commercialisation

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Abstract:

Purpose: *Commercialisation is treated as the design, development, manufacture, and marketing of products based on new technologies to launch them in the market. Effective commercialisation depends heavily on the competence of staff involved in commercialisation activities. The paper aims to identify key commercialisation competences needed in a research network organisation.*
Design/methodology/approach: *The authors analyse the state of the art by studying publications in the Web of Science database and present a single case study. As a result of the state-of-the-art review, commercialisation competences are identified. The empirical part of the paper is a single case study. The methodology of the study is based on two modules: an online survey (CAWI) followed by face-to-face (CAPI) and telephone interviews (CATI).*
Findings: *The result of the analysis is a list of key commercialisation competences presented in terms of their importance in the commercialisation process, accompanied by data on the competence gaps of employees involved in commercialisation activities.*
Practical implications: *The findings can be used as a base for creating a human resource strategy. The conclusions include recommendations for managers of research organisations involved in commercialisation, focusing on the aspects of strategic competence development that are key to the effectiveness of commercialisation processes.*
Originality: *The paper takes a complex approach to the competences required for commercialisation of research results. Furthermore, it fills the gap of overlooking how capable an individual is of performing a given skill, thanks to both providing key competence lists and considering the extent of competence possession by commercialisation specialists.*

Keywords: *Human resources, R&D organisation, technological innovations, commercialization, commercialisation competences.*

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1. Introduction

Research organisations try to recognise and take entrepreneurs' needs into account in their research. The goal of their functioning is to use the results of their work in economic practice. The commercialisation of the results is becoming increasingly important. It is the key process connecting the spheres of research and business, allowing for practical application of innovative solutions in the economic activity.

The authors understand technology commercialisation as the design, development, manufacture, and marketing of products based on new technologies (Poteralska and Walasik, 2021). This is a broad definition that treats commercialisation as a process spanning all stages crucial to effectiveness and to the commercial success of new solutions marketed, including new products, services, and new technologies. Such an approach is in line with that discussed in the literature (Mitchell and Singh, 1996; Bhasin, 2023).

In particular, commercialisation led by scientific research organisations functioning in a research network (Research Network Organisations, RNOs) encompasses not only the development of new solutions, but also their effective transfer to industrial partners. It renders these organisations a bridge between the scientific community and the market.

Effective commercialisation depends on the competences of people involved in its processes. While analysing competences one has to take into consideration the competences indicated by researchers as indispensable to the commercialisation process realisation (Bayley *et al.,* 2018; Szulczewska-Remi and Nowak-Mizgalska, 2023; Canning and Szmigin, 2016; Hosung *et al.,* 2021), and enrich the analysis with competences adjusted to the needs of the future, called 21st century skills or future-oriented competences (Ioannidou and Erduran, 2022; Poteralska *et al.,* 2022; Voogt *et al.,* 2013), necessary to an effective management of dynamic innovative processes.

It is important to explain, from the perspective of this paper, why the study concentrates on RNOs. These types of organisations, owing to their structure and the cooperation networks they create, play a key role in the technology transfer and the commercialisation of research results. They have traits both of scientific research units and technology transfer centers, which makes them unique research cases.

Unlike other research institutions, RNOs cooperate closely both with the scientific and business sectors. This allows them to play an intermediary role in the commercialisation process. They offer a broad scope of support, from basic, developmental research, through prototype design, to introducing ready solutions to the market. They are a crucial link in building innovative ecosystems, owing to this versatility.

In addition, RNOs often function in national or international cooperation networks, which gives them access to varied technological, financial and human resources. This quality endows them with an extraordinary potential, as organisations, in scaling innovations and introducing them not only to regional and national, but also to international and global markets.

At the same time, commercialisation processes in RNOs are more complex than in traditional research organisations. They require highly developed competences, such as the capability to manage multidisciplinary projects, inter-sector communication, as well as the ability to recognise and adjust to changing market needs.

Examining RNO staff competences allows not only to better understand what abilities are needed to effectively commercialise, but also to identify potential competence gaps. This information can contribute to an improved design of training programmes and strategies supporting staff development in this type of organisations.

Thus, the paper raises the research questions:

- What competences are crucial for successfully leading commercialisation activities in research organisations functioning as part of research networks?
- What is the level of commercialisation competences among employees in research network organisations?

The analyses pertain to the competences of staff who directly participate in realising such operations. The paper aims to identify key commercialisation competences needed in a research network organisation and the level of their possession using the example of an institute that is part of the Łukasiewicz Research Network (Ł-RNO).

The research hypothesis has been formulated: *The higher the declared importance of competences, the greater the competence gaps in areas key to the commercialisation of research results.*

The paper is structured as follows: first, it draws on a literature review about competences needed for effective commercialisation. This is followed by a presentation of the method. A single case study is used. The methodology is based on two modules: an online survey followed by face-to-face and telephone interviews.

Research findings on key competences needed for effective commercialisation and the level of their possession by employees of a research network organisation involved in the commercialisation activities are presented. The findings are discussed. The paper is summarised with conclusions and an indication of future research directions.

2. Literature Review

The literature review is centered on identifying key competences for an effective commercialisation of research results in practice. First, the authors focus on the indication of commercialisation skills, second, on future-oriented competences important for more than just the needs of commercialisation. Although not new, future-oriented competences, also known as 21st-century competences (Voogt, 2013), are growing in importance and demand (Habets *et al.,* 2020).

This is due to factors such as changes in the labour market, a mismatch between employees' skills and employers' requirements, persistently high environmental uncertainty and an increased perceived risk of business activity (Dębkowska *et al.,* 2022). For these reasons, the authors of the paper concluded that this group of competences should be considered when identifying commercialisation competences.

Research papers indexed in the Web of Science and reports of recognised international organisations such as the OECD, JRC, and WEF are the sources of information. The WoS was searched in 2 streams. Firstly, the criterion "competences" was used and the authors searched among the results by the criterion "commercialisation".

At the first stage, abstracts were read and whole papers were roughly reviewed. 48 papers were initially skimmed, out of which 33 were selected for further reading. While searching WoS within the second stream, the criteria "future of work" and "future competences" were applied. 98 papers were initially viewed, out of them, 43 were selected for detailed reading.

They include those devoted to the topic of competences important in the future, but not too detailed, not referring to individual professions or related only to commercialisation activities.

The literature review implies that the competences necessary for effective commercialisation, strictly related to commercialisation activities, comprise, among others: commercially-oriented R&D competence, market analyses, entrepreneurial competences, network competence, knowledge mobilisation, the ability to evaluate the effects of the commercialisation process, to use tools and practices supporting commercialisation, and to create commercialisation strategies (Hosung *et al.,* 2021; Bayley *et al.,* 2018; Morris *et al.,* 2013; Szulczewska-Remi and Nowak-Mizgalska, 2023; Treanor *et al.,* 2021; Rasmussen *et al.,* 2011; Canning and Szmigin, 2016).

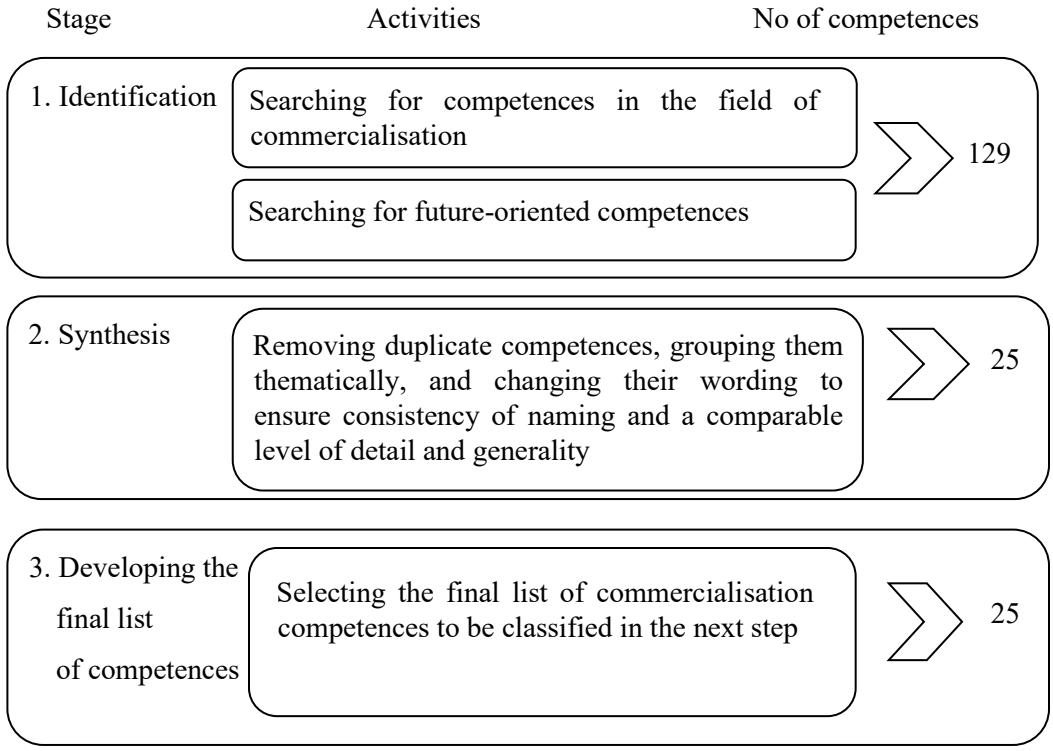
Future-oriented competences, related not only to commercialisation, but of a more general character, comprise two categories: STEM (Science, Technology, Engineering, and Maths) (Klowden and Lim, 2021) and 'soft skills', including: collaboration, communication, network management, creativity, flexibility,

entrepreneurial thinking, problem-solving skills, critical thinking, strategic thinking, complex critical-thinking, proactive thinking, and open mindedness (Habets *et al.,* 2020; Sala *et al.,* 2020).

Thus, competences necessary for effective commercialisation were first identified on the basis of the analysis of literature devoted to commercialisation activities. At this stage, a number of "soft skills" were identified, such as e.g., flexibility, creativity or cooperation skills. They accord with the list of competences indicated as indispensable for meeting the requirements of a turbulent market in the future (future-oriented competences).

Based on the state of the art review, competences for effective commercialisation are listed. The process of identifying commercialisation competences was carried out in three steps: identifying the competences, synthesising them, and developing the final list (Figure 1).

Figure 1. *The process of identifying and selecting commercialisation competences.*



Source: *Own study.*

The next step was to classify the identified competences. To this end, the authors analysed classifications applicable to competences in enterprises. This type of

classifications was chosen because research organisations should be treated as business entities operating in the knowledge and technology market. Here, research organisations must demonstrate their ability to adapt, be effective, and create value – analogous to enterprises competing for resources, partnerships, and the commercialisation of research results (Etzkowitz and Leydesdorff, 2000; Walasik, 2018).

The authors chose the Le Deist and Winterton (2005) classification of competences and, based on it, assigned the identified competences to four groups: (1) cognitive competences, (2) functional competences, (3) social competences and (4) metacompetences (Table 1).

Cognitive competences refer to the knowledge and understanding, both tacit and explicit, necessary to perform a specific professional role effectively. Functional competences refer to the practical skills required to carry out professional tasks. Social competences encompass behaviours, attitudes and personality traits that determine how an individual functions in the work environment.

Metacompetences are higher-order competences that encompass the ability to learn, reflect on oneself, think critically, and manage one's own professional development. Metacompetences provide a foundation for acquiring other types of competences (Le Deist, Winterton, 2005).

Table 1. *Competences required for the needs of effective commercialisation*

Competences	**Definition**	**Authors**
Cognitive competences		
Specialist competences	Specialist competences required in the industry where commercialisation is conducted.	Dębkowska et al., 2022
Commercially-oriented R&D competences	Commercially-oriented R&D competences including the development, acquisition and synthesis of scientific knowledge for commercialisation in the R&D field. The competences focus on adjusting research to market needs and on facilitating the process of innovation commercialisation.	Hosung et al., 2021 Bayley et al., 2018
Market analyses	The ability to analyse market trends, needs and behaviors to identify gaps, challenges and chances for 1) designating the area for the implementation of the commercialised products/ services and/or 2) the development of business models, products and/or services.	Munoz-Penas et al., 2024 Morris et al., 2013 Aarikka-Stenroos and Lehtimäki, 2013
Entrepreneurial competence	A set of knowledge, abilities and attitudes enabling the initiation, development, and continuation of economic activities (or enterprises).	Szulczewska-Remi and Nowak-Mizgalska, 2023 Treanor et al., 2021 Rasmussen et al., 2011

Financing sources analyses	The ability to identify external financing sources for commercialisation activities and to obtain funds from these sources.	Morris et al., 2013
Functional competences		
Economic analyses	The ability to conduct economic analyses supporting the commercialisation process, including the evaluation of innovation profitability and forecasting costs and revenue of launching a product, service or technology. These competences comprise financial and market data interpretation, business model design and preparation of analyses that support making decisions pertaining to commercialisation strategies.	Ballot et al., 2024, Aarikka-Stenroos and Lehtimäki, 2013
Creation of commercialisation strategy	The ability to design and create plans to introduce innovative products, services, technologies, systems or materials to the market. It considers the results of market potential analyses, identifying target groups, choosing appropriate technology transfer methods (e.g. licensing, spin-off), designing activities that minimise the risk and maximise chances of introducing solutions to economic practice, and choosing indicators to assess the efficiency of commercialisation strategy realisation.	Munoz-Penas et al., 2024
Creation of marketing strategy	The ability to create marketing strategies which successfully communicate the value of the product or technology being commercialised to appropriate target groups.	Aarikka-Stenroos and Lehtimäki, 2013
Creation of IP protection strategy	The ability to create IP protection strategies. The ability to choose appropriate methods of intellectual property protection, such as patents, trademarks or trade secrets, in order to secure and maximise the value of the solution being commercialised.	Ballot et al., 2024 Handbook on IP, 2019
Ability to analyse customer needs	The ability to identify, analyse and interpret the expectations, preferences and behaviour patterns of clients in order to understand their individual needs and adjust products, services to their requirements.	Munoz-Penas et al., 2024 Morris et al., 2013
Managing legal issues and IP	The ability to manage intellectual property through appropriately applying laws and commercialisation strategy. It encompasses the identification, protection, and use of intellectual resources as well as the choice and application of methods like licensing, spin-off creation, and other forms of technology transfer (IP trade) in order to maximise the value and benefits of the commercialisation process.	Munoz-Penas et al., 2024 Stasiak-Betlejewska, 2021 Bayley et al., 2018
Using tools and practices supporting commercialisation	The ability to identify, judge and apply tools, products and good practices in order to support commercialisation processes. The key tools in this area comprise Value Proposition Canvas, which allow to adjust products or services to market needs, and Business Model Canvas. Market analyses and benchmarking are used as well to	Bayley et al., 2018

	judge the market position and the potential of a solution being commercialised. The process is also supported by: ERP systems, project management systems, such as Agile, Lean Startup or SCRUM, which facilitate solution implementation, and key performance indicators (KPI), helping to monitor the results of the activities.	
Innovation popularisation	The ability to plan and introduce activities allowing to popularise innovation on a larger scale, simultaneously preserving its efficacy and value. It comprises the identification of key success factors, resource coordination, and the elimination of barriers hindering the expansion of market or technical/operational scope of an implementation.	Munoz-Penas et al., 2024
Social competences		
Network competence	The ability to create, develop, and foster stable relationships with internal and external stakeholders, based on utilising specialist knowledge and relational and interpersonal skills. These competences enable the effective creation and management of cooperation networks and facilitate reaching common goals.	Munoz-Penas et al., 2024 Bayley et al., 2018 Canning and Szmigin, 2016 Morris et al., 2013
Cooperation skills	The ability to effectively cooperate with others through group work focused on achieving common goals, realising team tasks, and solving problems together.	Munoz-Penas et al., 2024 Dębkowska et al., 2022 PARP, 2020 Czarnik et al., 2019 Felder et al., 2019
Communication	The ability to communicate with different stakeholders, both internal and external, individually and in teams. It includes creating effective interpersonal relationships.	Bayley et al., 2018 Phipps and Morton, 2013
Self-confidence	Confidence in one's own worth, a high esteem of oneself as a person capable of effectively preparing and conducting commercialisation. Competences in decision-making, coping with challenges, the ability to convince stakeholders and build credibility in commercialisation activities.	Szulczewska-Remi and Nowak-Mizgalska, 2023 Stetler et al., 2011
Metacompetences		
Prioritisation	The ability to prioritise commercialisation activities, the ability to select the most promising projects and activities with the maximum market potential, taking into consideration the time, financial, and resource limitations.	Ballot et al., 2024
Knowledge mobilisation	The ability to establish cooperation between researchers and persons or organisations who want to make decisions in the scope of public policy, professional practice, and social services. Societal and	Bayley et al., 2018

	environmental benefits are the main goals of this activity.	
Evaluating the impact of commercialisation	The ability to identify and catalogue the effects of the commercialisation process, such as: economic (including financial), technical, social, environmental or organisational benefits, as well as their measurement, monitoring and registering. It comprises the ability to assess/measure the commercialisation's effect on the organisation, stakeholders and the market environment, which allows to effectively manage commercialisation processes and their results.	Bayley et al., 2018
Advice	The ability to support the process of introducing a new solution to a client through active advice, negotiation and adjustment of the offered solutions to their specific needs, conditions and goals of their organisation. It involves the capability for creating agreement between parties, translating research results into practical application and successfully leading the client through the introduction process, assuring that expected effects would be reached and benefits of the introduced solution maximised.	Dębkowska et al., 2022 Bayley et al., 2018
Training and capacity building	The ability to train and to share good commercialisation practices in order to develop individual and organisational competences in the scope of knowledge mobilisation, i.e. to develop practical abilities allowing for an effective management of commercialisation processes.	Bayley et al., 2018
Change management	The ability to initiate, plan, and successfully conduct change processes in an organisation or organisational culture, taking into account the needs analysis, defining the change's goals, designing strategies of achieving it and monitoring developments. It involves creating the acceptance of change among (external, internal) stakeholders.	Munoz-Penas et al., 2024 Bayley et al., 2018
Creativity	The ability to generate new ideas and concepts, to create innovative connections between the existing solutions in order to support commercialisation processes and to adapt scientific knowledge to clients' needs and the requirements of market environment (KMb – Knowledge Mobility).	Szulczewska-Remi and Nowak-Mizgalska, 2023 Dębkowska et al., 2022 Klowden and Lim, 2021 Sala et al., 2020 PARP Report, 2020 Felder et al., 2019 Czarnik et al., 2019 OECD report, 2018 Phipps and Morton, 2013 Morris et al., 2013

Flexibility	The ability to adapt to the changing environment and to adjust activities to the needs and specific conditions of the entity introducing the commercialisation's object. The ability to react to unpredictable circumstances and modify commercialisation strategies in order to achieve the assumed commercialisation goals.	Sala et al., 2020 World Economic Forum, 2025 Felder et al., 2019 Phipps and Morton, 2013 Stetler et al., 2011

Source: *Authors' own work.*

The list of competences necessary in the commercialisation process based on the literature review was the starting point for the study, whose goal was to indicate key competences indispensable for effectively conducting commercialisation in research network organisations.

It is assumed the division used will allow for a more clear and orderly analysis of the competences, enabling the assessment of their importance and the level of their possession by employees. Above all, it will facilitate the determination which competences should be developed depending on the role in the organisation (research employees, support staff).

3. Research Methodology

The empirical part of the investigation is a single case study that presents key competences needed for effective commercialisation and the level of their possession by employees involved in the commercialisation activities at a research network organisation. The case study method was selected because it helps answer the question 'What?' in reference to a set of competences needed and possessed (Yin, 2018).

The case study method "explores a real-life, contemporary bounded system or real economic phenomenon (a case) (…) over time, through detailed, in-depth data collection involving multiple sources of information… and reports a case description and case themes" (Creswell, 2013), in order to formulate practical conclusions pertaining to the causes and effects of this phenomenon.

In the paper, a single case study is applied to a typical phenomenon (Grzegorczyk, 2015). This study pertains to a typical research institute engaged in the commercialisation of research results for economic practice, an institute functioning in a research network.

Using a single case study is in accordance with the approach of Yin (2003), indicating that it is better to make a single case study when the researcher wants to study a group of people. The paper focuses on competence analysis of a group of employees.

In the management science literature, three goals served by case studies can be discerned – theory-making, theory-testing, and practical (Grzegorczyk, 2015). This case study has a practical, applicable goal.

The results form the basis for managerial decisions in conditions similar to those presented in the case study, i.e. decisions pertaining to the development of commercialisation competences in research institutes being parts of research networks and the identification of key competences that one has to possess and develop to ascertain the efficacy of commercialisation processes.

The research was conducted in one of the 22 research institutes that constitute Łukasiewicz Research Network (Ł-RNO), the third largest research network in Europe after the Technical Research Centre of Finland Ltd (VTT) and the Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. The Łukasiewicz Research Network employs around 7,000 people, including 4,500 researchers.

The methodology of the study was based on two modules: an online survey followed by face-to-face or telephone interviews. The diagnostic survey method, survey and interview techniques were used. To this end, the survey and interview questionnaires were created, taking into account the results of the literature review.

In December 2024 and January 2025 the survey questionnaire was distributed electronically to all employees engaged in commercialisation processes in the investigated institute. The CAWI (Computer Assisted Web Interviewing) technique was used. The research sample consisted of 72 employees. The response rate was 100%.

The research covered the following two groups:

- Commercialisation employees (support division),
- R&D employees engaged in commercialisation (research division).

The survey consisted of two parts:

- Part A: Particulars – it included questions concerning demographic and professional details of the respondents, such as sex, age, education, job seniority and the characteristics of their work in the commercialisation field.
- Part B: Competences – an assessment of 25 competences (identified by the state of the art review) in two dimensions:

a) The importance of a competence in the commercialisation process (0-7) – a scale from “unimportant” (0) to “very important” (7).
b) The level of competence possession by the respondents (0-7) – a scale from “lack” (0) to “expert” (7).

In addition, CAPI (Computer Assisted Personal Interviewing) and CATI (Computer Assisted Telephone Interviewing) interviews were conducted in January 2025. Key employees engaged in commercialisation processes, including the heads of implementation projects and technology transfer managers with at least 10 years in that field, were the respondents.

The interviews were designed to acquire in-depth information on key commercialisation competences in research organisations. The interviews were partially structured (Żelazo, 2013) and encompassed two main sections:

- The identification of the main competences necessary in the commercialisation process, an analysis of their importance and methods of their development,
- The identification of difficulties with commercialisation activities and of needs related to organisational and training support.

During the interviews, the results of the survey on commercialisation competences were presented to the participants. The respondents had the chance to address the results, point out possible missing competences and discuss their importance and the development methods in the context of commercialisation practice.

The analysis of survey results allowed for determining key commercialisation competences, their importance to successfully implementing innovations, and the level of their possession by the employees of the research institute operating in a research network. The interviews' results provided valuable information on the key competences and challenges faced by specialists occupied with commercialisation.

The results of the online survey and the in-depth interviews form a complex image of the standard and importance of key competences in the commercialisation process.

The survey provided quantitative data, whereas the interviews allowed for a better understanding of the context and challenges faced by research organisations. Applying methodological triangulation increased the results' reliability and allowed to formulate more accurate recommendations.

According to the analytical generalisation approach (Yin, 2014), the results of a single case study (n = 72) referring to a typical institute within a research network can be applied to a broader organisational context of approximately 4,750 employees (4500 researchers and 250 support staff involved in commercialization in 22 institutes) in the Łukasiewicz Research Network.

However, it should be emphasised that this generalisation is theoretical, not statistical, referring to possible similarities in the analysed mechanisms and processes.

4. Research Results and Discussion

The results of an online survey and of face-to-face or telephone interviews with researchers and support staff involved in commercialisation are presented in separate sections. These are followed by a presentation of the statistical analysis and a discussion.

4.1 Survey Results

The first stage, a CAWI (Computer Assisted Web Interviewing), involved 72 respondents employed in the support and research divisions, who actively participate in the commercialisation of research results. 65% were female, 35% male. The largest age group consisted of persons from 31 to 40 years old (38%), and the least numerous, of above 60 years olds (8%). A majority of the respondents were university graduates (45%), including 15% with PhDs.

When it comes to job seniority, persons with 11 to 20 years of experience dominated (42%), whereas the experience in the area of research result commercialisation usually spanned 0-10 years (70%), which points to a relatively short practice in this field.

The survey results demonstrated some important differences between the research and support divisions regarding the perception and possession of key competences. Table 2 and 3 present the top-rated competence groups and the largest competence gaps in both analysed groups of employees.

Table 2. *Top-rated competences and largest competence gaps – Researchers (Research Division)*

Competence Group	Top-rated (mean importance /7)	Largest gap (importance – possession /7)
Cognitive competences	Entrepreneurial competence (5.24)	Entrepreneurial competence (1.50)
Functional competences	Ability to analyse customer needs (5.27)	Using tools and practices supporting commercialisation (2.85)
Social competences	Network competence (5.35)	Network competence (2.88)
Metacompetence	Change management (5.05)	Change management (2.60)

Source: *Authors' own work.*

Table 3. *Top-rated competences and largest gaps – Support Staff (Support Division)*

Competence Group	Top-rated (mean importance /7)	Largest gap (importance – possession /7)
Cognitive competences	Commercially-oriented R&D competences (5.05)	Entrepreneurial competence (0.45)
Functional competences	Managing legal issues and IP (5.44)	Economic analyses (2.64)
Social competences	Communication (5.52)	Communication (2.92)

Metacompetences	Change management (5.20)	Creativity (2.58)

Source: *Authors' own work.*

In the research division, top-rated competences include network competence (5.35), ability to analyse customer needs (5.27), entrepreneurial competence (5.24), and change management (5.05), when the largest gaps appear in many of the same domains: network competence (2.88), using tools and practices supporting commercialisation (2.85), entrepreneurial competence (0.50), and change management (2.60).

In the support division, communication (5.52), managing legal issues and IP (5.44), commercially-oriented R&D competences (5.05), and change management (5.20) were identified as the most important, with the largest competence gaps found in communication (2.92), economic analyses (2.64), entrepreneurial competence (0.45), and creativity (2.58).

The analysis revealed significant differences in perception and possession of key competences necessary for the effective commercialisation of research results concerning employees from the research and support divisions.

Researchers place particular emphasis on competences related to cooperation with the external environment and understanding the market. It indicates their focus on social and cognitive domains such as network and entrepreneurial competences. In contrast, the support division employees i.e. persons busy with commercialisation and not participating directly in research work, emphasise the importance of communication skills and managing legal and intellectual property issues. It corresponds with the operational, administrative, and legal nature of their activities.

The largest competence gaps among researchers concern implementation and entrepreneurial competences, indicating an insufficient willingness to engage actively in the technology transfer process, despite recognising its importance. Support division staff, however, demonstrate the greatest deficiencies in soft (social) and economic (functional) skills, which can hinder effective collaboration with researchers and external stakeholders.

4.2 Interview Results

To gain a thorough understanding of the causes and effects of the identified competence gaps, it is necessary to refer to the results of qualitative research. To this end, interviews were carried out with representatives of both groups (employed in the support and research divisions) using CAPI (Computer-Assisted Personal Interviewing) and CATI (Computer-Assisted Telephone Interviewing).

Seventeen key employees engaged in commercialisation processes participated in interviews. These employees included some heads of implementation projects and

technology transfer managers, all of whom had at least 10 years' experience in the field. Fifteen persons were respondents in the first part of the analysis (CAWI), 2 – new persons – were Łukasiewicz Centre employees. Łukasiewicz Centre performs a supervisory function over 22 Institutes forming Łukasiewicz Research Network.

The interviews were to verify the survey's results and identify the factors influencing the possession level of key competences. Thanks to the interviews the authors were able to capture the organisational context, barriers and practical difficulties related to developing and utilising key competences in the commercialisation process. The results of the interview served to confirm and enrich the key observations from the quantitative analysis by providing an organisational and qualitative context.

Several key conclusions emerged from the interviews. Firstly, the lack of system support and standardisation was repeatedly mentioned. Employees highlighted the absence of a company-wide commercialisation management system, resulting in fragmented, individual practices and a sense of incompetence. Secondly, the respondents emphasised that the competence gaps were not due to a lack of awareness, but rather a lack of practice.

Although they understood the importance of networking and intellectual property protection, they had limited opportunities to apply their knowledge effectively. Thirdly, the organisation lacked dedicated training paths and development programmes for building interdisciplinary competences, particularly those combining technical and business knowledge. Fourthly, the interviews confirmed that the division of responsibilities exacerbated the issue.

Researchers often perceived commercialisation as the responsibility of support division staff, limiting their own involvement in developing implementation competences. Importantly, the interviews also revealed new insights that were not fully captured in the quantitative data. One such insight was the underestimated role, in interviews, of metacompetences, such as creativity and change management, which were assessed in surveys as crucial for efficiently navigating the complex commercialisation process.

4.3 Statistical Analysis

A statistical analysis was carried out to determine the significance of the difference between importance assessment and possession level in the support and research divisions, to study the relationship between job seniority and competence level, and to identify the factors with the greatest impact on the development of commercialisation competences.

Four statistical analyses were conducted: (1) Student's t-tests to check the importance of the differences between the assessments of importance and the level

of competence possession in the support and research divisions; (2) Spearman's correlation analysis to determine the relationship between quantitative variables, such as job seniority and competence level; (3) multiple regression, indicating which factors have the largest impact on the competence level; and (4) chi-squared test, analysing the relationship between the division and the level of possession of specific competences (Table 4).

Table 4. *Statistical analysis results*

Statistical analysis	**Goal**	**Statistics**	**P-value**	**P-value's interpretation**
Student's t-test	Comparing the support and research divisions	3.05	0.038	< 0.05 statistically significant differences
Spearman's correlation	Job seniority vs competence level	0.878	0.021	< 0.05 statistical significance
Multiple regression – R^2	Factors affecting competence level: job seniority	0.699	0.001	< 0.001 very significant
Chi-squared test	Division vs competence level	6	0.306	> 0.05 no significance

Source: *Authors' own work.*

McDonald's ω was 0.760 (95% CI: 0.685–0.834) and Cronbach's α was 0.756 (95% CI: 0.670–0.824). Both coefficients exceed the 0.70 threshold, confirming good reliability and internal consistency of the scale.

The analysis confirmed the formulated research hypothesis: The higher the declared importance of competences, the greater the competence gaps in areas key to the commercialisation of research results. Respondents from both groups consistently emphasised that the areas they consider most important are also the areas in which they feel they lack practical tools, experience and support the most.

Student's t-test showed significant differences in the competence level between the divisions. The average level of competence possession in the support division was higher than in the research division ($t = 3.05$, $p = 0.038$).

This suggests that support employees developed practical abilities connected with commercialisation, although they assessed the importance of competences similarly to the research division employees. This result may be an indicator of a more pragmatic approach of the support division employees to implementation processes, which require both the knowledge of commercialisation tools and their actual utilisation in practice.

Spearman's correlation analysis demonstrated a strong positive correlation between job seniority and competence level ($r = 0.878$, $p = 0.021$). This indicates that the

greater the seniority, the higher the level of declared competences, which tallies with the assumption that professional experience influences practical abilities in the scope of innovation implementation.

However, it is worth emphasising that this correlation was stronger in the support than in the research division. It may mean competence development is more systematic and progressive in the support division, whereas in the research division competences connected with commercialisation are not necessarily strengthened as the seniority rises.

Multiple regression provided additional information about factors influencing the competence level. The regression model showed a high adjustment to data (R^2 = 0.699), which means that almost 70% of the competence level variability may be explained with the analysed variables.

Job seniority turned out to be the strongest endogenous variable ($\beta = 0.72$, $p < 0.001$), which means that every additional year of work increases the competence possession level by 0.72 point on a 0-7 scale on average, which confirms the earlier results of correlation analysis. In contrast, the division did not demonstrate any significant influence on the competence level ($p = 0.995$), which suggests that being a part of the support or research division is not a factor deciding the level of commercialisation competences.

The Chi-square test, which analysed the relationship between an employer's division and the level of specific competence possession ($\chi^2 = 6.00$, $p = 0.306$), yielded the most surprising results. They suggest that being formally a part of the research or support division does not influence the level of competence possession in a statistically significant way.

In other words, the differences between the divisions are more likely to stem from individual career paths, access to training or the specific nature of responsibilities than from the organisational structure itself. This may also be a result of frequent employee transitions between the research and support divisions.

In conclusion, the results suggest that the competence level in an organisation depends mostly on job seniority and the associated professional experience. Although the support division exhibits a higher level of competence possession than the research division, these differences may be a result of a more frequent exposure to tasks requiring practical applications of commercialisation knowledge.

Most importantly, the organisation should concentrate on strengthening a system approach to competence development, especially among the support division employees with most deficient competences. Additionally, the results indicate the need to create more structured professional development paths, which will facilitate a better integration of commercialisation competences and research practice. This

may significantly impact the efficiency of technology transfer processes and innovation implementation.

4.4 Discussion

Despite the acknowledgement of the significance of the research result commercialisation for economic practice (Aksoy *et al.,* 2022) and the key importance of human resources and their competences for an effective realisation of commercialisation processes (Poláková *et al.,* 2023; Grzegorczyk, 2021), a lack of understanding of competences specific to this area is still noticeable (Bayley *et al.,* 2018).

The literature identifies a number of soft competences, also called interpersonal and social competences, crucial to the commercialisation process (Bayley *et al.,* 2018; Phipps and Morton, 2013; Stetler *et al.,* 2011). The results presented in this article also highlight the importance of social competences, such as network competence, communication fluency or cooperation.

These competences are seen as key within technologically driven domains, in interdisciplinary and dynamic environments, especially commercialisation projects requiring the commitment of many stakeholders (Poláková *et al.,* 2023).

However, as some authors indicate (Phipps and Morton, 2013), job-related specialist and cognitive competences are analysed much less frequently than social competences. Our results address this aspect. We emphasise the vital role of cognitive competences, such as commercially oriented R&D competences and entrepreneurial competences.

These competences facilitate the identification of strategic gaps and market opportunities, supporting the development of business models and the adaptation of offerings to evolving customer needs. Functional competences such as economic analyses, managing legal issues and IP, and using tools and practices supporting commercialisation are equally important, yet are rarely considered in the literature in terms of their importance and the extent to which they are possessed by employees involved in commercialisation.

In addition, although the authors of earlier analyses, e.g. about knowledge mobilisation (KMb) (Bayley *et al.,* 2018), indicate commercialisation competences, they assume an understanding of commercialisation broader than these authors do. They presume that research results are subject to non-commercial, too, with emphasis on public policy, professional practice and social services for primarily social and/or environmental benefits.

The analyses here are focused on technology commercialisation. It means taking specific market needs and economic results into account, which better corresponds

to the specificity of research organisations operating at the junction of science and industry. Added to all that, most research (Poláková et al., 2023, Bayley et al., 2018) concentrates on the identification of required competences and skills, but overlooks how capable an individual is of performing a given skill.

Our analysis fills this gap, both providing key competence lists and presenting to what extent the competences are actually held by the respondents (how capable an individual is of performing a skill). This helps evidence-based managerial decision making.

5. Conclusions, Proposals, Recommendations

A list of competences necessary in the process of commercialisation, based on a literature review, became a starting point for a study designed to determine key competences required for an effective realisation of commercialisation processes in network research organisations. The results bring important information about competences required to transfer research results to business practice, especially in the context of organisations working at the interface of science and industry.

It should be stressed that commercialisation in organisations of this kind requires not only purely technical or specialist competences, but also interdisciplinary skills, including the ability to build and manage relationships with external partners (networking), customer needed analysis or intellectual property management. These elements emphasise the unique nature of commercialisation work for RNOs.

To systematise the analysis, 25 key commercialisation competences were identified and divided into four groups: cognitive competences, functional competences, social competences, and metacompetences.

This expanded approach, addressing both hard and soft skills, afford a more rounded view of commercialisation processes. This serves to better prepare staff for challenges associated with technology transfer, which is of particular importance to network organisations, which operate in a diverse international environment at work with a range of stakeholders.

Importantly, the results showed that researchers prioritised social competences (e.g. network competence) and cognitive competences (e.g., entrepreneurial competence), with the largest competence gaps relating to functional competences such as using tools and practices supporting commercialisation, as well as change management, which falls under the metacompetence group.

For support division staff, functional competences (e.g., managing legal issues and intellectual property, economic analyses) and social competences (e.g., communication), were deemed the most important, with competence gaps centring on social competences (communication) and functional competences (economic

analyses), as well as metacompetences (creativity, change management).

This detailed breakdown, consistent with the four-group framework of cognitive, functional, social, and metacompetences, provides a more precise understanding of both priority areas and critical gaps, and supports evidence-based management decisions on competence development.

These results form the basis for managerial decisions regarding the development of commercialisation competences in research institutes operating within the research network and the identification of key competences that should be possessed and developed to ensure the effectiveness of commercialisation activities. The recommendations for the managers of organisations involved in commercialisation focus on the aspects of strategic competence development that are key to the effectiveness of commercialisation processes.

It is suggested that organisations should focus on systematically identifying competence gaps and investing in the development of the skills of commercialisation teams, including dedicated training, mentoring and monitoring of progress. It is also recommended that organisations adopt an evidence-based approach to measure the effectiveness of activities and make more informed decisions about resource allocation and capability development, which may significantly contribute to the long-term success of organisations in the process of commercialising innovations.

The conducted research is characterised by some limitations. It suffers from its static nature, since staff competences at an isolated moment are analysed, which prevents addressing their changes and development over time and may not fully express the dynamics of commercialisation processes. Therefore, the study should be repeated at the end of training and development programmes designed to reduce the competence gap to assess their impact on the employee competences.

In addition, the research failed to include a detailed analysis of different competences required at the individual stages of the commercialisation process, such as prototyping, negotiations with business partners of innovation launching.

Continued research should undertake a more in-depth analysis of the competences with reference to the specific phases of the commercialisation process, which will allow for a more accurate strategy of human resources development and an improved effectiveness of implementation activities.

Added to all that, expanding the research to other research organisations would provide for a comparison of results and identification of some shares competence sets essential to the different models of research institutions' operation depending on the specific natures of their activities, the degree of their cooperation with industry, and the nature of their research.

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