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Proceedings of the 27th International Multiconference

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17. Mednarodna konferenca o prenosu tehnologij

17th International Technology Transfer Conference

Uredniki > Editors:

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9. oktober 2024 > Ljubljana, Slovenija / 9 October 2024 > Ljubljana, Slovenia

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PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2024

Leto 2024 je hkrati udarno in tradicionalno. Že sedaj, še bolj pa v prihodnosti bosta računalništvo, informatika (RI) in umetna inteligenca (UI) igrali ključno vlogo pri oblikovanju napredne in trajnostne družbe. Smo na pragu nove dobe, v kateri generativna umetna inteligenca, kot je ChatGPT, in drugi inovativni pristopi utirajo pot k superinteligenci in singularnosti, ključnim elementom, ki bodo definirali razcvet človeške civilizacije. Naša konferenca je zato hkrati tradicionalna znanstvena, pa tudi povsem akademsko odprta za nove pogumne ideje, inkubator novih pogledov in idej.

Letošnja konferenca ne le da analizira področja RI, temveč prinaša tudi osrednje razprave o perečih temah današnjega časa – ohranjanje okolja, demografski izzivi, zdravstvo in preobrazba družbenih struktur. Razvoj UI ponuja rešitve za skoraj vse izzive, s katerimi se soočamo, kar poudarja pomen sodelovanja med strokovnjaki, raziskovalci in odločevalci, da bi skupaj oblikovali strategije za prihodnost. Zavedamo se, da živimo v času velikih sprememb, kjer je ključno, da s poglobljenim znanjem in inovativnimi pristopi oblikujemo informacijsko družbo, ki bo varna, vključujoča in trajnostna.

Letos smo ponosni, da smo v okviru multikonference združili dvanajst izjemnih konferenc, ki odražajo širino in globino informacijskih ved: CHATMED v zdravstvu, Demografske in družinske analize, Digitalna preobrazba zdravstvene nege, Digitalna vključenost v informacijski družbi – DIGIN 2024, Kognitivna znanost, Konferenca o zdravi dolgoživosti, Legende računalništva in informatike, Mednarodna konferenca o prenosu tehnologij, Miti in resnice o varovanju okolja, Odkrivanje znanja in podatkovna skladišča – SIKDD 2024, Slovenska konferenca o umetni inteligenci, Vzgoja in izobraževanje v RI.

Poleg referatov bodo razprave na okroglih mizah in delavnicah omogočile poglobljeno izmenjavo mnenj, ki bo oblikovala prihodnjo informacijsko družbo. "Legende računalništva in informatike" predstavljajo slovenski "Hall of Fame" za odlične posameznike s tega področja, razširjeni referati, objavljeni v reviji *Informatica* z 48-letno tradicijo odličnosti, in sodelovanje s številnimi akademskimi institucijami in združenji, kot so ACM Slovenija, SLAIS in Inženirska akademija Slovenije, bodo še naprej spodbujali razvoj informacijske družbe. Skupaj bomo gradili temelje za prihodnost, ki bo oblikovana s tehnologijami, osredotočena na človeka in njegove potrebe.

S podelitvijo nagrad, še posebej z nagrado Michie-Turing, se avtonomna RI stroka vsakoletno opredeli do najbolj izstopajočih dosežkov. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe je prejel prof. dr. Borut Žalik. Priznanje za dosežek leta pripada prof. dr. Sašu Džeroskemu za izjemne raziskovalne dosežke. »Informacijsko limono« za najmanj primerno informacijsko tematiko je prejela nabava in razdeljevanjem osebnih računalnikov ministrstva, »informacijsko jagodo« kot najboljšo potezo pa so sprejeli organizatorji tekmovanja ACM Slovenija. Čestitke nagrajencem!

Naša vizija je jasna: prepoznati, izkoristiti in oblikovati priložnosti, ki jih prinaša digitalna preobrazba, ter ustvariti informacijsko družbo, ki bo koristila vsem njenim članom. Vsem sodelujočim se zahvaljujemo za njihov prispevek k tej viziji in se veselimo prihodnjih dosežkov, ki jih bo oblikovala ta konferenca.

Mojca Ciglarič, predsednica programskega odbora

Matjaž Gams, predsednik organizacijskega odbora

PREFACE TO THE MULTICONFERENCE INFORMATION SOCIETY 2024

The year 2024 is both ground-breaking and traditional. Now, and even more so in the future, computer science, informatics (CS/I), and artificial intelligence (AI) will play a crucial role in shaping an advanced and sustainable society. We are on the brink of a new era where generative artificial intelligence, such as ChatGPT, and other innovative approaches are paving the way for superintelligence and singularity—key elements that will define the flourishing of human civilization. Our conference is therefore both a traditional scientific gathering and an academically open incubator for bold new ideas and perspectives.

This year's conference analyzes key CS/I areas and brings forward central discussions on pressing contemporary issues—environmental preservation, demographic challenges, healthcare, and the transformation of social structures. AI development offers solutions to nearly all challenges we face, emphasizing the importance of collaboration between experts, researchers, and policymakers to shape future strategies collectively. We recognize that we live in times of significant change, where it is crucial to build an information society that is safe, inclusive, and sustainable, through deep knowledge and innovative approaches.

This year, we are proud to have brought together twelve exceptional conferences within the multiconference framework, reflecting the breadth and depth of information sciences:

- CHATMED in Healthcare
- Demographic and Family Analyses
- Digital Transformation of Healthcare Nursing
- Digital Inclusion in the Information Society – DIGIN 2024
- Cognitive Science
- Conference on Healthy Longevity
- Legends of Computer Science and Informatics
- International Conference on Technology Transfer
- Myths and Facts on Environmental Protection
- Data Mining and Data Warehouses – SIKDD 2024
- Slovenian Conference on Artificial Intelligence
- Education and Training in CS/IS.

In addition to papers, roundtable discussions and workshops will facilitate in-depth exchanges that will help shape the future information society. The “Legends of Computer Science and Informatics” represents Slovenia’s “Hall of Fame” for outstanding individuals in this field. At the same time, extended papers published in the Informatica journal, with over 48 years of excellence, and collaboration with numerous academic institutions and associations, such as ACM Slovenia, SLAIS, and the Slovenian Academy of Engineering, will continue to foster the development of the information society. Together, we will build the foundation for a future shaped by technology, yet focused on human needs.

The autonomous CS/IS community annually recognizes the most outstanding achievements through the awards ceremony. The Michie-Turing Award for an exceptional lifetime contribution to the development and promotion of the information society was awarded to Prof. Dr. Borut Žalik. The Achievement of the Year Award goes to Prof. Dr. Sašo Džeroski. The "Information Lemon" for the least appropriate information topic was given to the ministry's procurement and distribution of personal computers. At the same time, the "Information Strawberry" for the best initiative was awarded to the organizers of the ACM Slovenia competition. Congratulations to all the award winners!

Our vision is clear: to recognize, seize, and shape the opportunities brought by digital transformation and create an information society that benefits all its members. We thank all participants for their contributions and look forward to this conference's future achievements.

Mojca Ciglarič, Chair of the Program Committee

Matjaž Gams, Chair of the Organizing Committee

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FOREWORD / PREDGOVOR

Dear guests, experts, panelists, and participants,
Welcome to the 17th International Technology Transfer Conference (17ITTC). Since its inception, the Jožef Stefan Institute has proudly served as the initiator and main organizer of this esteemed event, advancing innovation and knowledge transfer in Slovenia. This year, we are honored to host the conference in collaboration with 13 public research organizations, representing two national consortia of knowledge transfer offices (KTOs). The event is co-financed and supported by the Ministry of Higher Education, Science, and Innovation, as part of the "Mesec znanosti" campaign.

The ITTC has established itself as a crucial platform for exchanging ideas and fostering collaboration between domestic and international stakeholders, significantly contributing to the development of Slovenia's national innovation ecosystem. The conference has been instrumental in helping Slovenian public research organizations address challenges such as securing funding for spin-outs, updating national legislation on research and innovation, and building robust consortia for KTOs.

Collaboration among KTOs, both within and across the two consortia continues through joint activities aimed at promoting KTO initiatives, raising awareness, and encouraging networking and the exchange of best practices. These efforts focus on enhancing the skills and capabilities of all stakeholders—from KTO employees and researchers to students—while improving the implementation of intellectual property (IP) marketing and protection. Additionally, coordinated efforts will establish common metrics and indicators, enabling effective monitoring and evaluation of knowledge valorization processes at public research organizations, ensuring long-term success.

This year's conference theme, "Self-Evaluation of Research Organizations to Support the Development and Strengthening of Knowledge Transfer," aligns with our goal of bolstering the role of KTOs and improving the commercialization of intellectual property, as well as to promote the wider social relevance of knowledge transfer and the outputs and impacts of KTO work on the well-being of society as a whole. The theme is being explored in a keynote address focuses on the role of institutional self-evaluation within the Framework of proposed amendments to the General Acts of the Slovenian Research and Innovation Agency (ARIS), followed by a round table discussion. The panel will feature representatives from the Ministry of Higher Education, Science, and Innovation, ARIS, the Slovenian Rectors' Conference, KOsRIS, Leiden University, the Institute for Economic Research, and the University of Colorado Boulder.

We present several prestigious awards during the conference, including the Conference Prize for the Best Innovation in 2024, which aims to promote the commercialization of innovative technologies developed at public research organizations. The WIPO National Award for Enterprises is awarded to a Slovenian enterprise that has successfully developed a strategy for commercializing university-based innovations. In addition, the WIPO National Award for Inventors honors an individual researcher or a team of researchers from a Slovenian public research institute whose patented invention has significantly contributed to Slovenia's economic and technological development.

The conference also features sessions on Opportunities Arising from Publicly Funded Research Projects, where researchers and KTO experts showcase successful scientific projects funded by the Slovenian Research Agency, highlighting their potential for innovation and commercialization. In the session on Connecting the Educational System with the Academic Sphere, presentations of selected research topics and collaboration proposals emphasize the importance of bridging the gap between academia and education, fostering greater cooperation and engagement.

We are especially excited about the ongoing growth of the conference, which, for the fifth consecutive year, includes peer-reviewed contributions from researchers specializing in knowledge and technology transfer. Since 2009, the entrepreneurial pitch competition for research teams and their inventions, evaluated by international teams of commercialization and investment experts, has remained a key feature, supporting over 100 research teams in developing business models, with more than 30 winners recognized to date.

Together, we look forward to exploring new opportunities, including collaborations with the Vesna DeepTech Fund, which plays a vital role in providing early-stage funding to spin-out companies emerging from public research organizations. Established by the EIF in partnership with Slovenian and Croatian development banks, the fund bridges the gap between research and commercialization, offering financial backing to help transform cutting-edge innovations into successful ventures. This collaboration fosters stronger partnerships between research institutions and industry, further boosting the commercialization of scientific discoveries.

Thank you for being part of this journey, and we look forward to an inspiring exchange of ideas at the 17ITTC.

Programme Committee of the 17ITTC

ACKNOWLEDGEMENTS

We would like to acknowledge the valuable contributions of the scientific programme committee to the scientific programme, review of the scientific papers on technology transfer and intellectual property, and selection of publications in the conference proceedings, and the efforts of the conference programme and organising committees for successful implementation of the 17th International Technology Transfer Conference.

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Intellectual Property as a Success Factor for Startups: Systematic Literature Review

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ABSTRACT

This paper presents a systematic literature review on the impact of intellectual property on startup success. By reviewing 21 relevant articles published in the last five years, sourced from Google Scholar, it analyses the influence of intellectual property on key business factors such as financing, growth, competitiveness, and innovation. The findings show that intellectual property plays a significant role in startup success, though results vary regarding formal (patents) and informal (market advantage, trade secrets) protection methods. A balanced approach to intellectual property management, tailored to startups' needs and developmental stages, is recommended. The article emphasizes the need for further research on different forms of intellectual property, considering regional contexts and long-term effects. Its value lies in offering both theoretical insights and practical recommendations, particularly for policymakers, investors, and startup owners seeking to promote innovation and growth through effective intellectual property management.

KEYWORDS

Intellectual property, startup, trademark, patent, innovation, growth, business success

1 INTRODUCTION

The purpose of our research is to systematically review the literature on the impact of intellectual property (hereinafter referred to as IP) on the business success of startup companies. Through an analysis of existing research results, we aim to explore how IP contributes to achieving these success criteria. Our objective is to determine whether, and how, IP influences the business success of startups, which is crucial for understanding their growth in a dynamic business environment.

In the modern economy, there is a notable impact that new companies have on innovation [9, 15], and the economy as a whole [4, 10]. In particular, startups drive innovation, create new jobs and introduce competitiveness into the business world [17]. The influence of IP is particularly interesting, as it can be crucial for their success.

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Globally, the number of new companies, known as startups, is rapidly increasing daily [18]. Such companies, especially innovative startups, often lack historical financial data or a track record, making it more difficult to establish a market reputation. Their innovative products or business processes also lack prior experience or comparative standards [2]. This presents challenges that can lead to the failure of companies due to inadequate or non-existent business models, and insufficient business growth [4].

Díaz-Santamaría and Bulchand-Gidumal identify several factors that can influence the success of startups [6]. The results of their research indicate that the success of a startup can be measured in two ways: the startup achieves significant revenue, and the startup receives funding. In the following sections, we also highlight other indicators for measuring the business success of a startup.

Despite numerous studies in recent years on the impact of innovative practices on the business development and success of startup companies, no comprehensive and systematic analysis of scientific literature has yet been conducted that specifically focuses on the influence of IP rights on the business success of startups. This gap in scientific research indicates the need for an in-depth review of existing scientific sources that would enable a holistic understanding of the impact of IP on the business success of startups.

The research question is, how are a startup's IP and business success connected, i.e., does IP affect business success, and how? In this way, we can better understand how IP contributes to the competitiveness and long-term success of startups.

2 METHOD

For this research, we used the systematic literature review method, conducted between January and April 2024. During this period, we reviewed foreign literature, focusing on the impact of IP on the success of startup companies. We examined professional, scientific, and research publications published in the last five years to ensure the most up-to-date data and discussions in this field. We used the international bibliographic database Google Scholar to collect information, which allows for the search of scientific literature and the ranking of documents in a manner used by researchers. To identify relevant sources, we used the following set of keywords: "Intellectual Property," "Startups," "Start-ups," "Patents," and "Trademark." In total, we obtained 30 relevant articles. After excluding 9 duplicates, we retained 21 suitable articles for further analysis. The four data collection strategies were used to ensure a thorough and comprehensive review of the relevant literature, tailored to the research question. Each strategy contributed to refining the search and eliminating irrelevant sources.

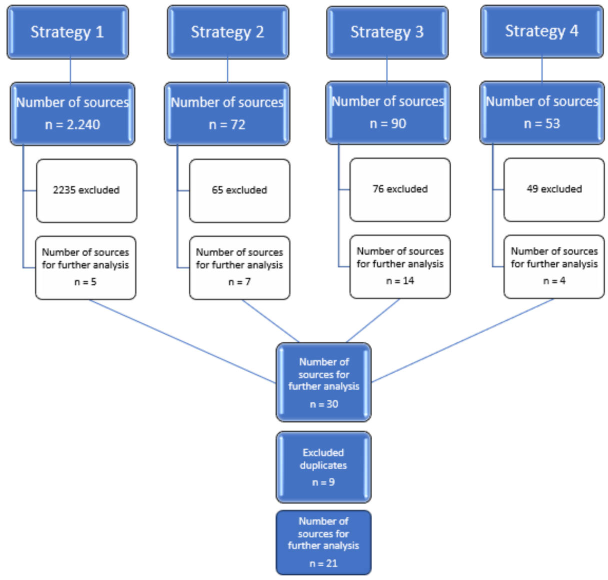

Figure 1: Diagram of the Results of the Systematic Literature Review

3 RESULTS AND DISCUSSION

Most research confirms that IP significantly influences the success of startup companies. Researchers have examined how IP affects various aspects of startups' operations, such as financing, growth, competitiveness, and innovation performance. Below, we summarise the key findings of these studies.

Hellström, Nilsson, Andersson, and Hakanson found that a combination of patents and secrecy positively influences the protection of innovations and market opportunities, thereby increasing companies' competitiveness [8]. Similarly, research by EPO-EUIPO reports that 29% of European startups invest in IP, which increases their chances of securing funding [7]. Krauss, Breitenbach-Koller, and Kuttenkeuler emphasise that IP is crucial for the success of biotech startups, as it enhances their value and attractiveness to investors [11].

The role of IP is particularly pronounced in international markets, where the protection of innovations is essential for the survival and growth of companies. Tula, Ofodile, Okoye, Nifise, and Odeyemi highlight that IP plays a key role in ensuring the business success of startups in a global context, as it prevents the copying and exploitation of innovations by competitors, with registered patents and trademarks serving as signals to investors of startups' innovation and credibility [23].

Brandt, Laibach, Kamrath, and Bröring also point out that IP increases the value of companies and attracts investors, which is crucial for success in corporate investments. Startups with well-protected IP find it easier to attract investors, as they perceive protected technology as a lower-risk investment with greater potential for profitability [3]. Additionally, IP enables startups to collaborate more easily with larger corporations, further strengthening their financial and strategic positions.

Schaberg explores various forms of IP protection and finds that startups with a diverse portfolio of protected rights grow and innovate more easily [19]. Various forms of protection, such as patents, trademarks and copyrights, provide comprehensive protection, increase investor confidence, and facilitate access to capital, which encourages further innovation. Ljungqvist, Hegde, and Raj add that the rapid granting of patents stimulates innovation and facilitates the acquisition of capital, while delays in patent granting negatively impact startups' growth [13].

Despite the numerous positive impacts of IP on startup companies, some research shows mixed results. Power and Reid caution that patents can negatively affect the success of startups, while trademarks and licensing have a positive impact [16]. Teixeira and Ferreira, as well as YunQi and Lin, find that formal methods such as patents often reduce companies' competitiveness, while informal mechanisms such as market advantage and trade secrets can improve competitiveness [22, 24].

Some studies recommend a balanced approach to IP management. Silva Júnior, Siluk, Neuenfeldt Júnior, Rosa, and Michelin believe that a combination of formal and informal protection mechanisms, such as patents, trademarks, and copyrights, is crucial for protecting innovations and enhancing competitive advantage [21]. Audretsch, Colombelli, Grilli, Minola, and Rasmussen emphasise that policies for innovation and IP protection must be tailored to the specific needs and stages of startups' development [1]. Chou adds that patents help in securing funding, but startups often face patent litigation, which reduces their productivity [5]. The solution lies in commercialisation patents, which would reduce the negative impacts of disputes and enable better protection and marketing of innovations.

Research by EPO-EUIPO, Krauss, Breitenbach-Koller, and Kuttenkeuler, Brandt, Laibach, Kamrath, and Bröring, Schaberg and Ljungqvist, Hegde and Raj emphasise the importance of effective IP management for startup success [7, 11, 3, 19, 13]. However, these studies primarily focus on specific sectors or particular cases and only certain forms of IP, which can lead to a limited understanding of the overall picture and strategies that would be beneficial for startups across different fields.

Some studies focus on specific countries or geographical areas, such as EPO-EUIPO on European startups or Li, Gan, and Zhang on Chinese startups [7, 12]. These studies highlight regional particularities in the use of IP, which can affect the innovation and competitiveness of companies in specific geographical environments.

University startups, as discussed by Shahidan, Latiff, and Wahab, represent a special category where innovation intertwines with academic knowledge [20]. These startups often face specific challenges in commercialising technologies, which can hinder the value creation process. Successful university startups must identify market opportunities, ensure entrepreneurial commitment, and continuously develop their technologies to meet market demands.

The inclusion of perspectives such as that proposed by Panagopoulos and Park, where patents serve as negotiation tools, highlights the potential for strategic use of IP in corporate negotiations, not just as a defensive mechanism [14].

Effective IP management generally has a positive impact on the success of startups, but some results indicate the need for a balanced approach that also includes informal protection methods. Therefore, it is essential that future research expands existing methodological frameworks and includes analyses that capture the complexity and interdependencies of different IP rights, including on an international level.

4 CONCLUSION

Based on the review of existing research, we can confirm that IP is an important factor in supporting innovation and competitiveness of startups. IP protects ideas and innovations and contributes to securing capital and sustainable growth of companies.

Although most research confirms the positive impact of IP, there are also studies that suggest a negative impact of certain forms. Further research is needed to clarify the impact of different types of IP on the success of startups, including an analysis of specific geographical contexts and the long-term effects on company survival.

With the doctoral dissertation currently in preparation, we will explore the impact of IP on the success of innovative startups that have received funding from the Slovenian Enterprise Fund in the P2 tender between 2008 and 2023, analysing their operations and registered IP. We will adopt a mixed-methods approach, combining quantitative and qualitative strategies. Primary and secondary data will be collected from recipients of the P2 grant (2008–2023), using IP databases (Espacenet, Global Brand Database, DesignView), and conducting in-depth interviews with selected companies. Quantitatively, we will analyse the IP portfolios of these startups and assess their business performance through statistical analysis in JASP and Excel, using univariate, bivariate, and multivariate methods. Qualitatively, we will conduct 20 in-depth interviews—10 with startups that have registered IP and 10 with those that have not—to uncover insights that quantitative methods cannot fully address. This mixed-methods approach will allow us to comprehensively explore the impact of IP on startup success, offering both statistical analysis and qualitative insights into the broader role of IP in innovation and business growth.

Future research will thus contribute to a better theoretical understanding and offer practical recommendations for policymakers, investors, and startup owners regarding the optimal use of IP to promote innovation and long-term growth.

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The Reversed European Paradox: do European Patents have a High Market Value but Low Impact?

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ABSTRACT

The U.S. research institutions often serve as role models for European research institutions in knowledge and technology transfer. This paper investigates the widely held belief that European technology transfer performance is inferior to that of the U.S. To explore this, an analysis of the quality of patents from leading U.S. and European universities and research institutes was done. The methodological approach involves a comparative analysis of key patent quality indicators: number of patent family members, forward citations, backward citations, and claims. Results indicate that the dominance of U.S. organizations is not as clear as commonly perceived. The study adds value by providing an additional understanding of the technology transfer landscape, challenging the assumption of U.S. superiority.

KEYWORDS

Patents, patent quality, patent valuation, public research organizations, research institutes, universities, Europe-U.S. comparison, number of patent family members, forward citations.

1 INTRODUCTION

The European paradox is a term coined to describe that Europe is strong in basic science but lags behind some other developed countries in technological applications in world markets [1], specifically in the commercialisation of scientific findings or what we call knowledge and technology transfer (KTT).

Many scholars have studied why some public research organisations (PROs) – which include universities and research institutes – are more successful in commercializing knowledge. Most of the research on university knowledge commercialization has been conducted in the U.S., often identified as pioneers in this area [2].

In Europe, most university or PROs' technology transfer offices are still young, with half of them being established after 2000 [3]. However, this is probably not the only reason why "Europe is perceived to lag behind the U.S. in converting its academic results into economic outcomes" [4]. This lag may affect the economic growth of European countries and also their global competitiveness in industries that rely on technological innovation.

The aim of this study is to contribute to existing studies which deal with different aspects of KTT in Europe, especially in comparison to the U.S. For example, Crespi et al. [1] focused on a comparison of European and U.S. academic patenting systems and discovered that there is a difference between PRO-owned and PRO-invented patents (inventions). They discovered that EU PROs lag behind the U.S. because 80% of patents with academic inventors are in the EU owned by private firms rather than PROs, and they are statistically not recognized as PRO patents.

On the contrary, this study is not focused on the quantity of the patents, such as Crespi's et al. [1], but on their quality. The top European and U.S. PROs will be compared according to the value of their patents by indicators of patent value.

The research question is: If we compare the patents of the top European and U.S. PROs by indicators of patent value, such as the number of patent family members and forward citations, are there any differences between Europe and the U.S.?

Understanding this research problem is important because the effective commercialization of scientific knowledge directly impacts economic growth and innovation. If European PROs can enhance their KTT performance, it could lead to increased competitiveness in global markets. By focusing on patent quality rather than quantity, this study aims to provide some insights into how Europe might overcome the perceived lag behind the U.S.

2 INDICATORS OF PATENT VALUE

Methods for patent valuation can be qualitative or quantitative [5]. We will focus only on quantitative and non-monetary methods, i.e., patent indicators [5]. Typical indicators are legal status, international and technological scope, number of forward citations and the existence of opposition and litigation [5]. Such valuation has many advantages: the method is fast, objective and inexpensive and can be fully automated once the valuation system is set up [5]. International scope (size of patent family) and forward citations (citations received from patents applied later) are probably the most frequent measures for assessing patent value. Patent valuation using forward citations has been increasingly used by practitioners when a patent's value has not been otherwise established [6].

*Article Title Footnote needs to be captured as Title Note
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Og et al. [7] divide patent value indicators into *ex-ante* indicators (family size, backward citations, backward references to non-patent literature, number of claims, and number of inventors) and *ex-post* indicators (forward citations).

We will consider the following indicators:

- Number of claims
- Number of patent family members
- Number of backward citations
- Number of forward citations

According to Squicciarini et al. [8], claims define the extent of the exclusive rights granted to a patent holder, as only the technologies or elements specified within these claims receive legal protection and can be enforced. Consequently, the scope of a patent's protection is determined by the number and specifics of its claims. Additionally, since patent fees typically depend on the number of claims included, having numerous claims can result in higher costs. Therefore, the number of claims in a patent can indicate not just its technological scope but also its anticipated market value: more claims often suggest a higher expected value for the patent [8].

Patent family size – the number of countries in which the same invention is patented – is a very important indicator of patent quality [9]. Due to the expenses associated with obtaining patents in various regions, patent holders typically choose to protect their most valuable inventions internationally. Besides considering raw family size, such as in this case, one variation of this method is to look at triadic patents, which cover an invention in the three principal markets: the U.S., Japan, and the European Patent Office (EPO). Alternatively, transnational patents, defined as patent families with at least one filing with the EPO or under the Patent Cooperation Treaty (PCT), can be considered [10].

Backward citations reveal the prior art or existing knowledge that a new patent builds upon. They are added by patent applicants, examiners, and also by third parties (e.g. during opposition proceedings), and are often used as measures of knowledge transfer [11]. A patent with numerous and relevant backward citations indicates that the patent applicants or inventors or attorneys and examiners conducted a comprehensive search of prior art. Such patents may also be less vulnerable to legal challenges and can be protected from being invalidated due to overlooked prior art. Additionally, if a patent references foundational and high-impact prior patents, it suggests that the patented invention is building on well-established and important technology, potentially indicating a higher-quality patent.

Forward citations are commonly used to measure the technological impact of innovation [11]. We can say that this indicator is the most understandable to us, as we are already familiar with it from scientific articles: when later patents quote an earlier one, it suggests that the earlier patent has contributed to new developments in the field. The more forward citations a patent receives, the more significant its impact on subsequent technological improvements.

Among these four indicators, the two most important can be considered: 1) patent family size for reflecting the potential commercial success of an invention and 2) forward citations, which indicate the technological/scientific impact of the invention.

3 METHOD

For this study, the first methodological question was, how to determine the most important or innovative European and U.S. PROs.

For the U.S., the Heartland Forward's report (2022) was used [12]. From this report, five top PROs were chosen:

- Carnegie Mellon University
- University of Florida
- Columbia University
- Stanford University
- Harvard University

For Europe, the European Research Ranking list (2020) was used [13]. From this list, five top PROs were chosen:

- Centre National de la Recherche Scientifique
- Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung E V
- Commissariat a L'energie Atomique
- Eidgenoessische Technische Hochschule Zuerich (ETH)
- University Of Copenhagen

Additionally, two not listed here PROs from Reuters' Top 100 report (2019) were selected [14].

For the U.S.:

- Massachusetts Institute of Technology (MIT) which was ranked at the world's second place in this report.

For Europe:

- KU Leuven (which was the top rank in Europe and took seventh place on the Reuters' Top 100 report).

To access indicators of patent value for these selected PROs the Orbis Intellectual Property database (Orbis IP) was used. Orbis IP contains over 145 million patents linked to detailed company information and ownership structures [15].

Excel was used to sort the data and draw the chart, and the open-source program JASP was used for statistical analysis. We used the Student's t-test (also called T-test) to compare the means between two groups [16], in the presented case, Europe and the U.S.

4 RESULTS

From the selected institutions, we can first notice that in Europe, there are three research institutes listed and three universities, while in the U.S., there are five universities and only one research institute.

Figure 1 below shows that selected European PROs outnumber the U.S. PROs in patents in the last at least 65 years. However, since there are no reliable and comparable data about these organisations' date of establishment, size and income (which can all affect the presented number of patents), it is not possible to make any comparisons or conclusions.

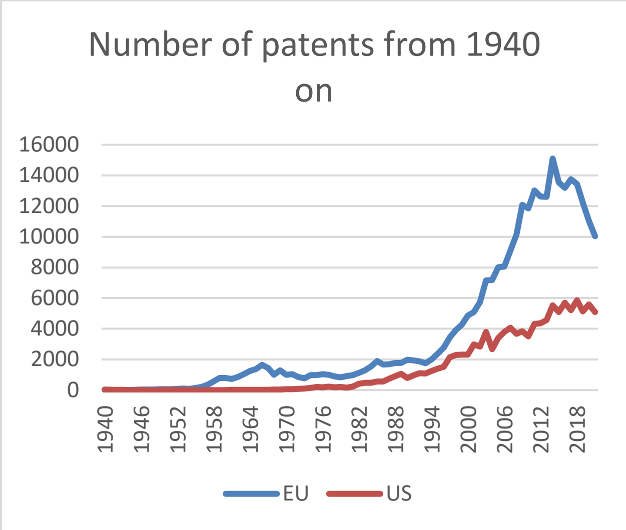

Figure 1: Comparison of no. of patents of current top PROs from 1940 on

Moreover, for the answer to the presented research question the past is not so important as in the current situation. Therefore, patents from these organisations only from the last ten years were selected, i.e., from 2014 on.

In Table 1 below, we can see the results of the T-test. All the differences in means are statistically significant ($p < 0,05$). Descriptive statistics in Table 2 show us that U.S. PROs are better than European in the number of claims and backward and forward citations. However, European PROs are better than the U.S. regarding the number of family members.

Table 1: Comparison of European and U.S. PROs (patents from 2014-2024)

Independent Samples T-test			
	t	**df**	**p**
Number of claims	-91,101	162668	< ,001
Number of family members	16,447	162668	< ,001
Number of backward citations	-40,025	162668	< ,001
Number of forward citations	-55,886	162668	< ,001

Table 2: Group descriptives (patents from 2014-2024)

	Group	**N**	**Mean**	**SD**	**SE**	**Coefficient of variation**
Number of claims	Europe	112918	14.082	13.774	0.041	0.978
	U.S.	49752	23.823	29.331	0.131	1.231
Number of family members	Europe	112918	10.099	18.835	0.056	1.865
	U.S.	49752	8.610	10.977	0.049	1.275
Number of backward citations	Europe	112918	3.027	9.733	0.029	3.215
	U.S.	49752	6.789	27.966	0.125	4.120
Number of forward citations	Europe	112918	0.806	3.649	0.011	4.526
	U.S.	49752	2.960	11.729	0.053	3.962

A closer look at individual PROs' patents reveals considerable differences between them. In the number of claims, MIT is the leading PRO with an average of 28 claims. In the number of family members (Table 3), Fraunhofer is the leader (with a mean of more than 17 family members), followed by KU Leuven (with more than 11 family members). PRO with the highest number of backward citations is MIT again, but the leading PRO in the number of forward citations (Table 4) is Carnegie Mellon University, with a mean of 4,18. The best European PRO in the number of forward citations is ETH, with a mean of 2,42.

Table 3: Descriptive statistics - Number of family members

	Atomique	**Carnegie**	**Center National**	**Columbia**	**Copenhagen**	**ETH**	**Florida**	**Fraunhofer**	**Harvard**	**Leuven**	**MIT**	**Stanford**
Valid	35282	2860	34168	8196	1427	26	10191	37257	236	4758	15640	12629
Mean	**5,035**	**4,144**	**7,328**	**8,590**	**8,473**	**9,846**	**6,076**	**17,335**	**11,169**	**11,387**	**9,539**	**10,481**
Std. deviation	3,680	4,733	7,298	10,217	9,001	7,412	6,777	29,953	11,778	15,114	13,095	11,641
Minimum	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Maximum	48,000	29,000	147,000	130,000	44,000	22,000	52,000	300,000	93,000	74,000	106,000	78,000

Table 4: Descriptive statistics - Number of forward citations

	Atomique	**Carnegie**	**Center National**	**Columbia**	**Copenhagen**	**ETH**	**Florida**	**Fraunhofer**	**Harvard**	**Leuven**	**MIT**	**Stanford**
Valid	35282	2860	34168	8196	1427	26	10191	37257	236	4758	15640	12629
Mean	**0,849**	**4,180**	**0,629**	**2,319**	**0,800**	**2,423**	**1,947**	**0,871**	**0,915**	**1,251**	**4,102**	**2,543**
Std. deviation	3,246	11,998	2,583	9,115	3,238	8,339	6,242	3,593	8,873	9,209	16,149	9,815
Minimum	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Maximum	162,000	260,000	117,000	232,000	53,000	41,000	181,000	126,000	130,000	396,000	410,000	259,000

5 DISCUSSION AND CONCLUSION

Results of this study show something quite the opposite of the European paradox, which suggests that while European scientific performance is on par with its main international competitors, Europe lags behind in converting research results into innovations and gaining a competitive advantage [17]. European paradox is a term that describes Europe's strength in basic science but its perceived lag in technological applications in the global market (for example, compared to the U.S.).

In this study, the top European and U.S. PROs were compared. Results show that the U.S. top PROs are much stronger in the scientific performance of their patents: in the last ten years, an average patent from top U.S. organisations received 3 forward citations while a patent from top European organisations received only 0,8. Therefore, the scientific or technological influence of U.S. patents is more than three times higher than that of Europe.

On the other hand, European PROs demonstrate larger patent families than those of the U.S., which indicates a stronger emphasis on protecting intellectual property across multiple jurisdictions and, thus, also a broader market potential for patented inventions. That said, European inventions are much more focused on commercialisation or “competitive advantage”.

U.S. PROs are also better than Europe’s in the number of claims and backward citations, but these indicators may not be so important for commercial and scientific/technological success.

To help European PROs improve in terms of the number of patent claims, as well as backward and forward citations, and reduce the gap with the U.S., drafting patents more carefully with more detected prior art can be suggested. This will result in more backward citations of a particular patent and also in forward citations of quoted patents. It is also important to encourage collaboration between different PROs and between PROs and industry. Partnerships can create more comprehensive and impactful patents that include more claims and are more frequently cited.

In conclusion, while the study highlights significant differences between European and U.S. PROs in terms of patent performance, it also points to areas where European PROs can enhance their impact. Future research should focus on investigating the underlying factors contributing to these disparities, particularly by examining how patent drafting practices, collaboration networks, and industry linkages affect patent quality and citation rates. It should also be noted that this study referred to the top six PROs from each continent, and different results might have been obtained if all PROs were considered. But in any case, a methodological approach which can combine quantitative analysis of patent metrics with case studies of successful collaborations could provide deeper insights into the mechanisms that drive patent performance. Additionally, exploring policy interventions and strategies to strengthen technology transfer offices and foster innovation ecosystems in Europe could offer actionable solutions to close the gap with the U.S. The U.S., on the other hand, may close the gap with Europe by filing and enforcing its patents in more countries.

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The Importance of Technology Transfer Offices in University Industry Collaboration: KTÜ TTM Example

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ABSTRACT

Within the scope of the research, interviews were conducted with the participants on the subject in order to answer the question "What is the place of technology transfer offices within the framework of university-industry collaboration?" This study evaluated the place of Karadeniz Technical University Technology Transfer Application and Research Center (KTÜ TTM) within the framework of university-industry collaboration. In the study, qualitative research technique was used and "phenomenology" was used as the research design. The data in this research was examined with the descriptive content analysis method. Analysis was conducted in RStudio in order to analyze the collected qualitative data and determine emotional tendencies. According to the analysis results; It was seen that KTÜ TTM made significant contributions to raising the bar of success by using the potential of the university and had a positive effect in general. When similar studies in the literature are examined, it is seen that TTOs play an important role in university-industry collaboration. This study supports the theoretical discussions in the literature with a practical example. Since the study provides an evaluation specific to KTÜ TTM, it makes a local and specific contribution to the literature by examining the effects of TTOs in a different university and geographical region. This could fill the gap in the literature on the functioning of TTOs across different institutions and regions.

KEYWORDS

Technology, technology transfer office, university industry cooperation, KTÜ TTM

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1.INTRODUCTION

Technology Transfer Offices (TTOs) are organizational structures that play a role in directing academic research towards national and international research projects, facilitating its transfer to industry, and commercializing it. In general, TTOs located within universities act as intermediaries between universities, research institutes, students, investors, and companies. They engage in activities such as establishing connections and making matchings according to the necessary needs.

In Türkiye, TTOs provide consultancy and support to all stakeholders throughout the entire process, from transforming knowledge into products, selecting industrial partners, identifying appropriate funding sources, project development activities, intellectual property and industrial property rights applications, to commercialization and/or the establishment of academic-based firms [10].

As intermediary organizations, TTOs operate according to various strategies based on the past experiences of academic and industrial actors and the quality of the information conveyed in the university-industry collaboration process. TTOs particularly focus on enhancing cognitive and organizational domains. They play a crucial role in bringing together actors with different visions, ways of interpreting life, and perspectives on the world [11].

The collaboration between two distinct entities, universities and industry, can contribute to national development; however, this is achievable only if the process is managed with sound and appropriate strategies. Nowadays, while collaborations between universities and industry can occur through various

communication channels apart from the support of technology transfer offices, the outcomes of these collaborations are often quite weak [7].
A review of the literature reveals that technology transfer offices (TTOs) play a significant role in enhancing and sustaining university-industry collaboration.

1.1 University Industry Collaboration

University industry collaboration ensures that the knowledge gained from research activities conducted at universities is not only published but also transformed into practical applications. It is a collaborative method aimed at and implementing the transfer of technological developments and knowledge to production stages according to industrial needs [13]. The cultural differences between universities and industry contribute to the diversification of research approaches [9]. Effective collaboration between industry and academia requires a special alignment; understanding mutual interests, setting common goals, and focusing on complementary skills form the basis for achieving successful collaboration [6].
As a result of collaboration, industry, whose goal is to increase profits and expand its volume, has seen developments that positively impact production through the adaptation of technologically evolving and renewing processes to existing systems. The aim of the university in collaborating with industry is to develop a qualified human resource and support research with a strong knowledge base, leading to the transformation of theoretical work into practical applications and resulting in some modifications [5]. Science plays an extremely important role in facilitating university-industry collaborations. It is a process born from the mutual supply and demand between the university, which produces science, and industry, which converts science into economic benefits [2].
University-industry collaboration highlights a partnership that offers significant benefits for both parties. Through these collaborations, universities strive to address global problems using academic knowledge. Industry, on the other hand, benefits from universities' research, expertise, and laboratories, leading to the development of innovative products and improvements to existing products. As a result of this partnership, mutual gains are achieved in areas such as employment, education, innovation, and economic growth, which significantly impact life. Thus, these partnerships provide mutual benefits to the parties involved and contribute to society and the economy. In addition to their research mission, universities also have educational and societal missions. While the educational mission is clear, societal missions have gained increasing importance in recent years. This is reflected in factors such as the role of universities in university-industry technology transfer [4].

1.2 University Industry Collaboration Activities of KTÜ TTM

In order to increase R&D and innovation capacity and strengthen university-industry cooperation activities, KTÜ TTM establishes contacts with many new companies every year and develops bilateral cooperation. These efforts are not limited to the region but extend to firms across the country through online and face-to-face meetings, integrating new companies into the collaboration ecosystem. During these meetings, R&D topics and requests are gathered, the needs of the firms are identified, and numerous firms are matched with academicians from KTÜ for collaborative projects, involving online meetings and discussions.
Meetings are also organized with the boards of Organized Industrial Zones to discuss activities within the framework of university-industry collaboration. Firms are prioritized and analyzed, and guidance is provided based on current calls for proposals. Information on academicians' research that can be applicable in the industry or discussions on potential collaborations with industrial organizations are conducted.
During the application phase of university-industry collaboration projects, the entire process of project review, preparation, and submission of application documents is carried out. Legal matters and contracts are prepared jointly with the university's legal counsel. Once a project is approved for funding, support such as accounting transactions, completion of documentation, and signature processes are provided to firms and academicians by the administrative and financial affairs unit established within KTÜ TTM.

2. METHODOLOGY

2.1 Research Methodology and Research Design

In this study, the role of KTÜ TTM within the framework of university-industry collaboration was evaluated. A qualitative research method was employed, and the research design was based on "phenomenology." The phenomenological design typically focuses on phenomena that are recognized but not deeply or thoroughly understood. Phenomenology is a method that concentrates on understanding and evaluating lived experiences [8]. This methodology aims to deeply examine and comprehend individuals' experiences.
Although phenomenological data are obtained from the experiences of a few individuals, the information gathered from these individuals provides detailed insights into the phenomenon. The fact that the phenomenon is experienced by different individuals contributes to the provision of information from various perspectives by the research participants, thereby aiding in understanding the phenomenon from a broad viewpoint. In this way, the data obtained from the experiences of different participants support a comprehensive understanding of the phenomenon [3]. For such research, the number of individuals to be included in the sample should generally not exceed ten. It is normal to limit the sample size in this type of research since the interviews often require long and sometimes multiple meetings. The limited number of individuals who have experienced the phenomenon under investigation may also sometimes result in a restricted number of people who can be included in the sample [12].
In addition, sentiment analysis was performed using RStudio to automatically detect and classify emotional expressions present in the texts. This analysis employs Natural Language Processing (NLP) techniques to determine whether the sentiments in the texts are positive, negative, or neutral. During this process, words and expressions within the texts are analyzed to identify the emotional content.
To visually understand the key themes, topics, and word distribution in the texts, a word cloud was generated in RStudio. Word clouds, commonly used as part of text mining and data visualization techniques, provide a quick representation of the frequency of words in a text or text corpus, indicating which words are used more frequently.

2.2 Universe and Sample of the Research

The universe of this research consists of approximately 50 faculty members working at KTÜ who have been involved in university industry collaboration processes. To align with the research objectives, the sample group was composed of 8 faculty members who have both participated in university industry collaboration processes and are knowledgeable about the KTÜ TTM. The academic titles, faculty and department affiliations, and the total number of projects funded by public and/or private sector capital for the faculty members included in the sample group are provided in Table 1.

2.3 Data Collection Processes and Interview Questions

Within the scope of the research, interviews were conducted with relevant participants to answer the question, "What is the role of KTÜ TTM in the context of university-industry collaboration?" Participants were informed that the interviews would be audio recorded by the researcher, but their personal data would not be shared with third parties. It was explained that the audio recordings would be used for the purpose of data collection and analysis. Initially, a pool of questions presumed to be relevant to the study topic was created. Subsequently, the questions within this pool were evaluated with experts deemed relevant to the research content, and the most appropriate eight questions for the study were finalized. The interview questions prepared for the participants are presented in Table 2. Before the interview questions were posed, a conversation with the participants was initiated to foster a mutual trust relationship. After the audio recordings were transcribed, with the permission of the participants, the next step was the analysis of the data. The collected data was analyzed using descriptive content analysis, and additionally, sentiment analysis was conducted, and a word cloud was generated using the RStudio program.

Table1: Characteristics of the Study Sample Group

Academic Title	Faculty/Departments	Number of Public /Private Sector Supported Projects
Professor	Forestry Faculty Forestry Industrial Engineering	10
Professor	Faculty of Engineering Mechanical Engineering	6
Professor	Faculty of Engineering Mechanical Engineering	2
Associate Professor	Faculty of Engineering Industrial Engineering	4
Assistant Professor	Faculty of Science Computer Science	6
Assistant Professor	Faculty of Science Computer Science	6
Assistant Professor	Vocational School of Health Services Medical Services and Techniques	3
Research assistant	Forestry Faculty Forestry Industrial Engineering	2

Table 2: İnterview Questions

No	İnterview Questions
1	What are your opinions about KTÜ TTM?
2	How would you define university industry collaboration?
3	Do you think KTÜ TTM is effective in the processes of university industry collaboration?
4	Why would you prefer KTÜ TTM to be an intermediary in university industry collaboration processes?
5	What are your expectations regarding KTÜ TTM's university industry collaboration module?
6	Is there any aspect of KTÜ TTM's university industry collaboration processes that you find lacking?
7	In your opinion, how could KTÜ TTM become more active in the context of university industry collaboration?
8	Has the solution/process of the problems you experienced in university-industry collaborations at KTÜ TTM become easier?

2.4 Research Findings

The findings of the study are summarized as follows:

KTÜ TTM has made significant contributions to raising the bar of success by utilizing the potential of the university. Active TTOs are essential units that every university must have. They are crucial in presenting the university as professional and institutional in industrial collaborations and play a critical role in reducing the risks researchers may encounter during the project development process.

KTÜ TTM has been highly effective in conducting one-on-one meetings with firms, matching academics, providing project writing support, analyzing industrial problems, and guiding both parties on the appropriate course of action throughout the process. It has also played a significant role in realizing many of the university's recent collaborations. However, it is observed that KTÜ TTM faces a disadvantage due to its location being far from major industrial areas. It is suggested that the center could become more effective by organizing events where industry professionals and academics can come together and by placing greater emphasis on institutionalization.

It is noted that KTÜ TTM is preferred as an intermediary because it instills confidence in the industrial sector during company visits and ensures that academics feel secure. Its professional and corporate identity during industry visits, which represents the university, leads to a more positive and moderate view of the project development processes among industrialists. Additionally, KTÜ TTM is favored for its objective approach to both academics and industry parties, its facilitation of smooth process progress, its role as a mediator, and its handling of accounting tasks.

KTÜ TTM is believed to be doing its best to achieve its goals. Additionally, there are expectations for bringing academics along on company visits, conducting matching processes more meticulously, collecting project topic requests from academics based on company activity areas, and matching academics with large-scale companies in the Technopolis where they have their firms.

It is generally believed that KTÜ TTM does not have significant shortcomings. However, suggestions have been made, including collecting R&D topic proposals from academics and forwarding them to companies, grouping companies sectorally to hold meetings with academics on specific days, providing support with sample project forms, and facilitating discussions and integration between academic entrepreneurs and companies.

To increase its activity, it is suggested that KTÜ TTM could increase its participation in fairs, fix the names of the companies it works with on its website, enhance materials for promoting TTO's module functions and staff, utilize international resources, and raise awareness among companies about TTO activities.

It is believed that TTO plays a facilitative role in reviewing and preparing contracts between academics and industrialists, managing financial obligations, handling bureaucratic processes, and establishing balances between the company and the academic. Additionally, it is noted that TTO helps eliminate problems by coordinating the project development processes for companies that are located far away.

The data obtained from the interviews was converted into a text file and sentiment analysis was performed using the RStudio program. The graph showing the sentiment scores obtained from the analysis is presented in Figure 1.

Subsequently, a word cloud was created using the Rstudio program to analyze frequently used words within the text. The resulting word cloud is presented in Figure 2.

Figure 1: Distribution of Sentiment Scores

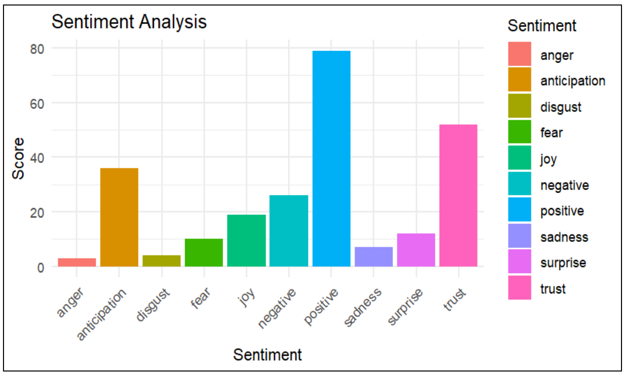

Figure 2: Word Cloud

3. CONCLUSION AND RECOMMENDATIONS

In conclusion, it has been observed that the activities carried out by the KTÜ TTM within the framework of university industry collaboration have yielded positive results, as noted by participants who are familiar with the structure and functioning of the TTO and have been involved in the university industry collaboration processes. Furthermore, it has been concluded that the TTO has positively influenced its corporate image. The study [1] supports this finding, as it concluded that TTOs positively impact the innovation capacity within firms, with 47% of firms' innovation capacity being provided by TTOs.

Upon evaluating the sentiment analysis scores presented in Figure 1, it is observed that a high score corresponds to a positive sentiment. This result indicates that the university-industry collaborations carried out with KTÜ TTM generally have a positive impact. It demonstrates that stakeholders being satisfied with the collaboration and experiencing positive outcomes.

The high level of trust indicates that KTÜ TTM has established a strong trust relationship between university and industry stakeholders and is recognized as a reliable partner. The high level of anticipation reflects the high expectations for future projects and potential opportunities in collaborations with KTÜ TTM.

Based on the sentiment analysis results, we can conclude that KTÜ TTM's role and significance in university industry collaboration are highly positive. The high levels of positive emotions and trust demonstrate that the collaborations are being conducted successfully and that stakeholders are satisfied, while the low levels of negative emotions suggest that the processes are running smoothly and are being managed effectively. This proves that KTÜ TTM is a reliable and effective interface that strengthens the collaboration between the university and industry.

In the word cloud presented in Figure 2, the words 'industry,' 'university,' and 'TTO' are prominently featured. The frequent occurrence of the word 'industry' indicates a strong focus on how KTÜ TTM interacts with and supports industrial partners. The frequent mention of the word 'university' underscores the importance of the academic side of the collaboration, suggesting that researchers view the university's role as critical in partnering with industry. The prominent presence of the abbreviation 'TTO' highlights the central role of KTÜ TTM in facilitating these collaborations. Overall, the word cloud demonstrates the significant role that KTÜ TTM plays in supporting and facilitating these interactions.

The current situation of KTÜ TTM has been evaluated, and the following recommendations have been proposed:

Increasing awareness of the services provided by TTO and conveying this awareness to the business ecosystem will enhance the sustainability of new collaborations. Organizing events that bring together universities and industry can foster more communication between them. The strong relationships established will increase the sense of trust, thereby creating opportunities for further collaboration. Additionally, such efforts will create internship and job opportunities for students trained at the university for the business world.

In future studies, the place of TTOs can be examined within the framework of commercialization of inventions within the university and/or increasing academic entrepreneurship. By increasing the number of study samples, the subject can be analyzed in depth with different analysis methods and theoretical frameworks can be tested. In addition, the role and impact of TTOs in different universities, regions and different countries in university-industry collaboration can be examined by conducting multiple case studies. It will be useful to compare different structures and operations of TTOs in terms of examining the impact of different regional and sectoral dynamics on collaboration processes.

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The Impact of International Networks on Grants, R&D, Knowledge and Technology Transfer - Case of COST Network and KTU

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ABSTRACT

It is essential that researchers collaborate with international colleagues and adhere to international standards to facilitate the transfer of technology resulting from their research. In order to participate in these projects, it is essential for researchers to have a broad international network and reliable collaborators to form international consortia. This study examines the strategy adopted by Karadeniz Technical University (KTU) in its pursuit of the COST (European Cooperation in Science and Technology) Programme and the subsequent results that enabled its researchers to engage in prestigious international consortia and access international funding sources. To increase the number of Karadeniz Technical University (KTU) members in the Management Committee (MC) and Working Group (WG) of COST Actions, which have limited slots, each Action was carefully reviewed, and individual meetings were held with researchers. Technical and administrative support was provided to facilitate researchers' participation in the Actions. A statistical analysis was conducted for researchers who participated in COST Actions over the past five years. The status of countries involved in the COST program from 2019 to 2023 was examined. Additionally, Türkiye's performance during this period was analyzed to assess the effectiveness of the developed strategy. As a result of these analyses, in COST Actions in which a limited number of KTU researchers were involved at the beginning of 2019, 252 researchers were involved in 528 actions by the end of 2023, becoming the first university in Türkiye in this context. Thanks to the researchers and activation included in the COST Programme, a 92.3% increase in the number of international project applications and a 366% increase in the number of project acceptances were observed between 2019 and 2023. The findings indicated that these exemplary practices could serve as an effective approach for the internationalisation of higher education institutions.

KEYWORDS

Technology Transfer, R&D, Internationalisation, COST

1 INTRODUCTION

The involvement of researchers in internationally funded projects presents a duality of opportunities and challenges. One of the most significant challenges encountered during this process is the formation of international consortia. Effective communication between researchers from different countries and disciplines is of great importance, as consortia require such a diverse group to come together [1]. Furthermore, operational challenges, including the sourcing of funding, the optimal utilisation of resources and the effective management of projects, represent significant obstacles in the context of such projects [2]. Nevertheless, the intricacy of these procedures and the presence of bureaucratic impediments can act as a deterrent for numerous researchers [3]. The existing literature frequently emphasises that participation in international projects has positive effects on researchers' career development, knowledge sharing and innovation [4]. In particular, the formation of international consortia hinges on the existence of reliable networks and cooperative networks, which are pivotal for the success of the projects. In this context, the effective utilisation of international cooperation networks facilitates the efficiency and sustainability of projects. Due to the inability of KTU researchers to engage in sufficient international cooperation, it was observed that the university was quantitatively and qualitatively insufficient in international projects, resulting in limited scientific output and weakened competitiveness at the global level. This deficiency prevented the university from fully exploiting its potential, especially in areas such as access to international funding, exchange of knowledge and experience, and development of innovative solutions. This study presents the internationalisation strategy of Karadeniz Technical University, which enables researchers to participate in qualified international consortia and access international funding sources, as exemplified by the COST programme.

The COST (European Cooperation in Science and Technology) programme was established in 1971 with the objective of promoting scientific and technological research in Europe. The objective of COST is to facilitate the exchange of knowledge and encourage innovation among researchers by fostering interdisciplinary networks. The principal objective of the programme is to facilitate international collaboration and enable researchers to collectively address global challenges. While COST does not provide direct support for research and development, it plays a significant role in facilitating the formation of international consortia, which allow researchers to collaborate on the advancement of their projects. Researchers may participate in the Actions in either the capacity of a member of the Management Committee (MC) or a member of a Working Group (WG). In these roles, they are afforded the opportunity to engage in in-depth strategic planning, project management, and the exploration of specific research topics. Those engaged in COST Actions enjoy significant advantages, including access to information and resources, opportunities for career development and the strengthening of leadership skills as part of an internationally recognised network. Such opportunities permit researchers to make significant progress in their careers and to become more prominent figures within the international scientific community. COST Actions facilitate the formation of new collaborative relationships and the expansion of existing networks, thereby enhancing the probability of securing additional funding and support for research projects. Furthermore, meetings, workshops and conferences organised by COST provide invaluable opportunities for researchers to disseminate their knowledge and experience [5].

2 METHODOLGY

In accordance with the internationalisation strategy for KTU to become more effective in the international arena, activities are being undertaken with the objective of enhancing international collaboration and increasing the quantity and calibre of project proposals submitted to international funding programmes. Given the crucial role that a broad international network plays in securing participation in internationally funded projects, concerted efforts have been made to direct students towards the COST Programme since late 2019, with ongoing initiatives still in place.

In this context, awareness-raising activities, which commenced with information events held at various locations across the university and its constituent departments, have yielded tangible outcomes through one-to-one interviews with academics. In this regard, the strategy pursued by KTU Technology Transfer Application and Research Center experts to enhance the involvement of researchers in COST Actions is outlined below.

- **Organisation of information events:**
- **Analysing current COST actions:** Existing COST actions are analysed and listed with details covering objectives, research areas, participation requirements, duration, etc.
- **Identification of researchers:** Researchers with fields of study compatible with COST actions are identified by analysing their academic profiles (research areas, project experiences, etc.).
-**Establishing contact with researchers:** The identified researchers are contacted and one-to-one interviews (telephone, e-mail or desk interviews) are conducted about the opportunities and benefits of participation in COST actions. It is assessed whether the researchers are suitable for the identified actions.
-**Providing technical support services:** Technical support is provided to researchers during the application process for COST actions (filling out the application form, preparation of necessary documents, follow-up of the application process, etc.) and the application evaluation process is followed.
-**Guidance to other COST-related support:** Researchers are provided with the opportunity to benefit not only from MC/WG assignments in actions, but also from other COST-related support such as Short-Term Scientific Visit (STSM) and ITC Conference Support. In addition, referrals were made to the COST 2515 Programme supported by TUBITAK, the COST National Coordinator in Türkiye, to provide R&D support to researchers.

The country-based data used in the study were obtained from the COST Annual Reports and the researcher-based data were obtained from the COST website.

In order to assess the status of the developed strategy, a mini survey with open-ended questions was conducted with KTU researchers participating in COST Actions. In the survey, the benefits of the participated actions for the academics were evaluated with questions such as to what extent they benefited from the action, what kind of effects it had at the academic level, what kind of activities they participated in.

3 RESULTS

The COST programme facilitates extensive involvement from a diverse array of countries, encompassing 41 member countries and cooperation countries. In addition to Europe's leading countries in science and research, such as Germany, France, Italy, Spain and the United Kingdom, Türkiye, Israel and some Western Balkan countries are also actively involved in this programme. Table 1 presents detailed data illustrating the status of active participation in the COST programme between 2019 and 2023 [6-10].

Table 1: Status of Countries in COST Programme

Indicator	2019	2020	2021	2022	2023
Runnig COST Action	294	291	289	302	269
New COST action launched	80	45	40	70	70
Average number of COST Members per Action	30	30.8	31	33	33
Average number of non-COST countries per Action	-	4.3	6	5	6
Articles	479	921	1501	1253	-
Percentage of spin-off H2020* proposals approved	37%	39%	32%	-	-
Average value of spin-off projects per Action (€)	6M	5.8M	3.9M	9.5M	5.2M

*Horizon 2020 was the EU's research and innovation funding programme from 2014-2020

Türkiye plays a significant role as an active participant in the COST programme. Türkiye's involvement in COST Actions between 2019 and 2023, along with a comprehensive account of its contributions and accomplishments, is presented in Table 2 [11-15].

Table 2: Türkiye's Position in COST Programme

Indicator	2019	2020	2021	2022	2023
Individual participation in all action activities	1075	-	20	1113	1849
Training school/hosted	1	12	0	4	10
Short-term scientific missions/hosted	14	103	8	12	23
Short-term scientific missions/participant	72	380	43	90	158
Trainess/participant	197	1001	33	219	310
Trainers/participant	7	58	1	23	48
Budget received (€)	0.9M	4.9M	0.3M	1.5M	2.3M

Türkiye demonstrates a notable level of involvement in the COST programme, exhibiting a discernible increase in participation on an annual basis. The number of individual participants increased from 1,649 in 2019 to 103 short-term scientific missions in 2020, with 380 participants being sent to these missions. Furthermore, 12 training schools were conducted in 2020, with 1,001 individuals undergoing training at these institutions. In 2021, participation declined as a consequence of the impact of the pandemic. However, in 2022, there was a revival in participation and a success was achieved as in 2020. This success continued to increase in the following years. As evidenced by the participation statistics provided by the COST Organisation, Türkiye achieved notable success in 2022 and 2023. In 2022, Türkiye achieved the distinction of becoming the third most participating country, with a participation rate of 99% in all active actions. Additionally, the country reached a notable number of members, with 3,084 individuals participating in Working Groups. In the same year, Türkiye was the fifth most successful country in terms of individual participation in COST network activities, with 1,113 participants, and the fourth country with the highest budget allocation of approximately EUR 1.5 million. Türkiye was the leading country in terms of participation by young researchers, with a rate of 52.8%. In 2023, Türkiye sustained its efficacy by participating in 99% of all actions, thereby attaining the distinction of being the country with the highest number of working group members, with 7,096 working group members. Türkiye was the third most successful country in terms of individual participation in COST network activities, with 1,849 participants, and the third most budgeted country, with approximately EUR 2.27 million.

As a consequence of the activities conducted throughout this process, there has been an enhancement in the awareness of researchers, as well as an increase in the number of researchers who have submitted applications on an individual basis. Moreover, the support provided by COST was not confined to KTU but was also extended to TTO units and researchers at other universities, thereby contributing to an increase in Türkiye's participation in the COST Programme.

As the number of researchers engaged in the COST Programme and active in its actions has grown, the graph below illustrates the change in the number of international project applications and acceptances submitted by KTU between 2019 and 2023 (Fig. 1).

Figure 1. Statistics of KTU projects with international funding (2019-2023)

4 DISCUSSION AND CONCLUSION

The formation of international networks plays a pivotal role in the establishment of dependable and collaborative international project consortia. This is achieved by the creation of scientific networks comprising researchers and institutions, which subsequently leads to an increase in the number of international project applications and acceptances.

This study examines the strategy employed in the process by which KTU researchers were directed to the COST Programme, an international organisation with the objective of uniting scientists who are experts in their respective fields throughout Europe in scientific networks. This strategy facilitates the integration of scientists engaged in national research projects into the international scientific community.

The strategy pursued has yielded notable results. At the inception of 2019, a modest number of KTU researchers were engaged in COST actions. By the conclusion of 2023, this number had grown to 252 researchers participating in 528 actions. With regard to the ongoing COST actions, KTU has been the most successful university in Türkiye, with 29 active members of the Management Committee. In the context of the ongoing actions, Türkiye is playing a pioneering role, with 252 researchers engaged in diverse academic pursuits. KTU has become a prominent hub for interdisciplinary studies, having participated in approximately 61% of the 305 actions initiated during its five-year internationalisation strategy.

The COST programme has been instrumental in facilitating a significant increase in the number of international project applications, with a 92.3% rise observed between 2019 and 2023. Additionally, there has been a notable surge in project acceptances, with a 366% increase during the same period.

Participation in COST Actions was not only associated with an increase in the number of project applications and acceptances, but also with the administration of surveys to KTU researchers who took part in the actions in 2021 and 2023. The objective was to ascertain the additional benefits that researchers derive from the COST Programme. The results of the surveys indicated that the researchers had participated in numerous training programmes, workshops and conferences, and had developed a network of contacts. They had also published more international collaborative papers, worked on multidisciplinary projects with researchers from other countries, and had access to research and laboratory facilities that would not otherwise have been available to them in their home countries. Furthermore, they had disseminated their work more widely.

The findings of this study demonstrate that the strategy employed by KTU has led to an increase in participation in COST actions. This, in turn, has resulted in KTU researchers establishing more robust international networks, which has directly influenced the number of international project applications and acceptances. In conclusion, the findings indicate that these exemplary practices may serve as an effective approach for the internationalisation of higher education institutions.

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The Effect of Evaluating Graduate Thesis Topics as Invention Notification Form on Industrial and Intellectual Property Applications: The Case of Karadeniz Technical University

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ABSTRACT

Industrial and intellectual property is an important structure that is popular all over the world. Each country has legal regulations in the field of intellectual and industrial property in order to protect one's invention. The 6769 Industrial and Intellectual Property Law, which entered into force in 2017, paved the way for universities in Türkiye to have rights in applications for inventions such as patents, utility models and designs. Thesis studies that young researchers start during their postgraduate period are focused solely on publication. The commercialization and patenting potential of theses determined without analyzing the needs of the industrial sector is low, and this makes the thesis work of many engineers inefficient. It is necessary for KTU that is the application authority, to develop new strategies to increase industrial property assets. This study aims to reveal the effect on the number of patent applications by Karadeniz Technical University (KTU) as a result of the evaluation of graduate thesis topics without request. Within the scope of the new strategy, a methodology was applied for the evaluation of patent and utility model application data in the KTÜ patent portfolio, the distribution of data by year, and patent registration documents. In this study, direct patent and utility model application data were evaluated. When the application data was examined, it was seen that the new strategy implemented increased the industrial property assets.

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KEYWORDS

Industrial rights, Intellectual rights, patent, utility model, 6769 law, KTU

1 INTRODUCTION

The concept of intellectual property refers to all rights that are the product of the human mind and have economic value even if they do not have a tangible equivalent. In other words, it includes ideas that arise as a result of the creative efforts of a person or organization, inventions, literary and artistic works, symbols, names, shapes and designs used for commercial purposes. With the application of an intellectual product, the absolute right provided to the inventor in material and spiritual terms is recognized for a certain period of time [1]. If these rights are defined in a different term, intellectual property rights (IPRs) can be defined as the rights that enable sanctions to be imposed on the products created by the human mind [2]. It is necessary to analyze the concept of intellectual property in two separate sections. The first of these concepts includes industrial property rights including inventions (patents and utility models), trademarks, industrial designs, integrated circuit topographies and geographical indications. The second concept includes all intellectual and artistic works, including works of art, works of science, works of literature, music and musical works, fine art and cinematographic works, depending on copyright [3]. Intellectual and industrial property rights give the inventor the ability to manage all commercial activities thanks to the absolute rights it gives to the inventor. Both the desire of the inventor to protect his/her invention and the desire to prevent imitation in commercial activities increase the number of applications of Intellectual and Industrial Rights in legal protection processes. Patent, utility model, trademark, etc. industrial assets and copyrights are subject to very serious court-based sanctions in case of infringement of the intellectual assets in question. [4]. Violations or infringements of rights by third parties have legal and criminal sanctions to protect the rights of right holders [5].

The purpose of patents is to provide protection that facilitates technological development. A patent not only gives the inventor exclusive rights to create an invention, but also provides incentives for the technological development and commercialization of that invention. Instead of obtaining a patent, the inventor publishes the technical specifications of the invention, enabling others to make different new inventions based on the invention. An increase in the number of patents in a country indicates a high level of technological development in the country. The transformation of industrial and intellectual assets into the economy through the sale of inventions, the production of inventions and the sale of products positively affects the welfare of the country.

This research aimed to determine if recognizing master's and doctoral theses as invention disclosure forms, without requiring additional notifications, would lead to an increase in the number of granted patents. Since Karadeniz Technical University is a research university, the number of industrial property assets is significant. It is necessary to develop new strategies to increase industrial property assets. When the application data was examined, it was seen that the new strategy implemented increased the industrial property assets.

2 METHODOLOGY

The application change status was revealed by using the patent and utility model application data of Karadeniz Technical University. In addition, the registration numbers were evaluated with a similar method. Among the patent applications in the KTU patent portfolio, applications between the years 2017-2023 were evaluated. In the relevant years, student applications (Master and PhD) were filtered from patent applications for each year and the effect of the developed strategy on the applications was revealed. When the application data were examined, it was seen that the new strategy applied increased the industrial property assets.

3 HISTORICAL DEVELOPMENT OF PATENT RIGHTS IN TÜRKİYE

The first important legal arrangement regarding patent rights in Türkiye was made in 1879 during the Ottoman Empire. The French Patent Law of that time was amended and translated into the Ottoman Patent Law enacted in 1879. In parallel with the developments in the world, valid patent laws could not be enacted in Türkiye until 1995, except for the international agreements signed, and the patent laws of the Ottoman Empire continued to be applied with some changes until 1995. Subsequently, Türkiye became a party to the Paris Convention in 1925 and signed the WIPO founding treaty in 1976. Furthermore, Türkiye acceded to the London amendment in 1956, Articles 13 through 30 of the Stockholm amendment in 1976 and Articles 1 through 12 of the Stockholm amendment in 1995 [6]. Türkiye signed the Customs Union Agreement in 1994. With this agreement, the "TRIPS" agreement, the "Strasbourg Agreement on the classification of patents" (IPC) and the "Patent Cooperation Agreement" (PCT) and the "Agreement Establishing the World Trade Organization" entered into force. Later on, the "Budapest Agreement" on the international protection of microorganisms entered into force, as well as the "Patent Law Treaty" (PLT) and the "European Patent Convention" (Munich Convention) [6].

Table 1 presents data on Türkiye's status as a party to the conventions on intellectual property rights to which Türkiye is a party [7].

Tablo 1: International Agreements to which Türkiye is a Party [7]

Agreements	First Signature Date	Türkiye's Membership	Participation Date
World Intellectual Property Organization WIPO Articles of Association	1967	YES	12.05.1976
Treaty Establishing the World Intellectual Property Organization (WIPO)	1995	YES	26.03.1995
European Patent Convention (EPC)	1973	YES	01.11.2000
Paris Convention for the Protection of Industrial Property	1883	YES (10.10.1925)	Stockholm (Articles 1-12) 01.02.1995 (Articles 13-30 16.05.1976)
Patent Law (PLT)	2000	Signed 02.06.200	
Trademark Law (TLT)	1994	YES	01.01.2005

Singapore Agreement on Trademark Law	2006	Signed 28.03.2006	The agreement has not yet entered into force
BUDAPESTE Agreement on the International Storage of Microorganisms	1977	YES	30.11.1998
LAHEY Agreement on the International Registration of Designs (Geneva Text!	1999	YES	1.01.2005
Protocol to the MADRID Agreement	1989	YES	01.01.1999
Patent Cooperation Treaty (PCT)	1970	YES	01.01.1996
LOCARNO Agreement on the Restriction of Designs	1968	YES	30.11.1998
NIS Agreement on the International Classification of Goods and Services in Trademark Registration	1957	YES	01.01.1996
STRASBORG Agreement on the International Classification of Patents (IPC)	1971	YES	01.10.1996
VIENNA Agreement on the Classification of Figurative Elements of Marks	1973	YES	01.01.1996

2.1 INDUSTRIAL PROPERTY LAW NO. 6769

In Turkish law, industrial property rights were first regulated by the Decree Law No. 551 on the Protection of Patent Rights, No. 554 on the Protection of Industrial Designs, No. 555 on the Protection of Geographical Indications and No. 556 on the Protection of Trademarks, which entered into force in 1995. These Decree Laws were repealed by the Industrial Property Law No. 6769 ("IPL"), which entered into force in 2017.

According to the IPL No. 6769, Articles 113-122 include the provisions on "Employee Inventions". Especially with Article 121, universities and public institutions are entitled to have rights in patent applications [10].

ARTICLE 121

(1) Without prejudice to the provisions of special laws and regulations under this article, the provisions regarding the inventions of employees shall apply to the inventions made as a result of scientific studies or research conducted in higher education institutions defined in subparagraph (c) of the first paragraph of Article 3 of Law No. 2547 and higher education institutions affiliated to the Ministry of National Defense and the Ministry of Interior.

(2) When an invention is realized as a result of scientific studies or research conducted in higher education institutions, the inventor is obliged to notify the higher education institution in writing and without delay. If a patent application has been made, the higher education institution shall be notified of the application.

(3) The higher education institution is obliged to file a patent application if it claims right ownership over the invention. Otherwise, the invention becomes a free invention

On this occasion, studies for the protection of the knowledge accumulation in universities with intellectual and industrial rights have been carried out as of 2017.

4 KARADENİZ TECHNICAL UNIVERSITY INDUSTRIAL PROPERTY NUMBERS

Founded in 1954, Karadeniz Technical University is the first technical university established in Anatolia in Türkiye. In addition, as of 2021, it continues to produce science in the Research University category. New generation universities are universities that transform the knowledge they produce into added value while producing knowledge, coordinate these processes, and involve every individual from students to faculty members in innovation-based commercialization activities. Karadeniz Technical University has assumed an important role in serving this basic mission with the Technology Transfer Application and Research Center (TTC).

With the Industrial Property Law No. 6769, which entered into force in 2017, Karadeniz Technical University has made a total of 262 industrial property applications with 166 national patents, 28 national utility models, 16 national designs and 52 international patent applications with access to more than 300 inventors and more than 3000 students. With these applications, 39 national patents, 20 national utility models, 16 national designs and 5 international patents were registered. In addition, 6 copyright registrations and 24 trademark applications were also carried out by Karadeniz Technical University [8].

5 A NEW STRATEGY for INVENTION DISCLOSURE

As stated in subparagraph c of Article 121 of the Industrial Property Law No. 6769, there is an obligation to notify the university of an invention made at the university before applying for industrial property. This notification is referred to as the invention disclosure form in the literature [9]. As of 2017, universities collect invention disclosure forms and make patent applications by evaluating these forms according to criteria such as patentability, commercialization, etc.

As of 2023, a new strategy was developed by Karadeniz Technical University Technology Transfer Application and Research Center and it was decided to consider the thesis subjects of graduate and doctoral students as invention disclosure forms without notification. With this decision, the technology and/or information of the relevant invention was protected at an early stage. The number of invention notifications received by Karadeniz Technical University since 2017 is shown in following figure 1.

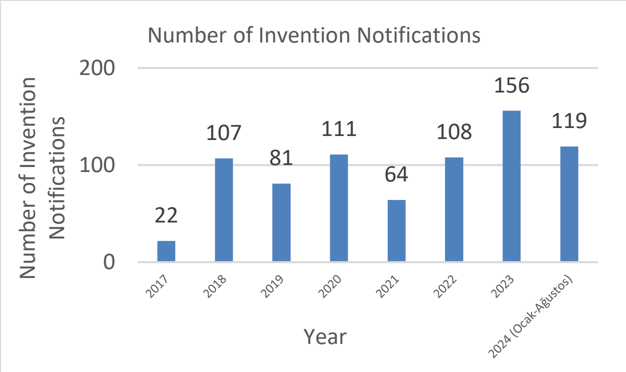

Figure 1 : Number of Invention Notifications Received at Karadeniz Technical University

The number of national patents, national utility model, national design and international patent applications applied as Karadeniz Technical University since 2017 is given in Figure 2.

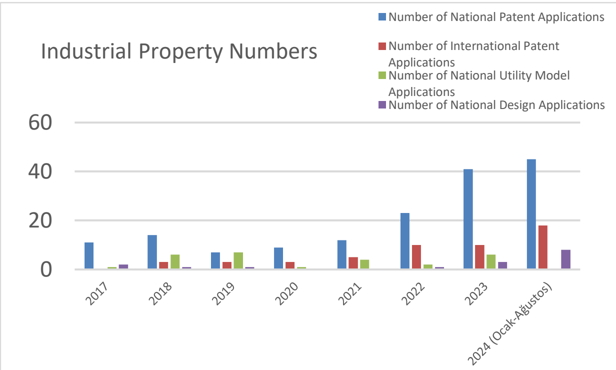

Figure 2: Karadeniz Technical University Industrial Property Numbers

Table 2 shows the comparative number of patent applications of Karadeniz Technical University compared to Trabzon province.

Table 2: Number of patents in Trabzon province - Karadeniz Technical University and the contribution of the university to the number of patents

		2017	2018	2019	2020	2021	2022	2023
Number of National Patent Applications	Trabzon (City)	48	28	29	24	28	51	51
	KTU	11	14	7	9	12	23	41
University Contribution		23%	50%	24,1 %	37,5 %	42,8 5%	45%	80,3 9%

6 CONCLUSION

Karadeniz Technical University continues its support in the field of Industrial Property with the 6769 IP Law published in 2017. Before 2017, the number of patents belonging to academicians at the university was 7, while 262 industrial property applications were realized under the university's ownership as of 2024.

In 2020, there was a global COVID-19 pandemic, the effects of which continued in 2021, and a national stagnation in industrial property applications in 2022-2021. However, even during these periods, the know-how at the university was transformed into industrial property assets. Figure 2 shows an increase in industrial assets with the normalization process after the pandemic.

The 25 national patent applications until 2022 increased to 31 national patent applications with the evaluation of the thesis subjects of master's and doctoral students in postgraduate education as invention disclosure forms without notification, which was put into effect in 2023. In the first 8 months of 2024, the number of national patent applications reached 45 applications, and 12 applications are based on given information from theses.

While international applications are examined, 18 international patent applications were submitted as of 2024.

In 2023, a new strategy was put into effect as a new strategy in which the thesis subjects of master's and doctoral students in postgraduate education were evaluated as invention disclosure forms without notification, and the knowledge accumulation at Karadeniz Technical University was protected at an early stage. It is thought that the use of this practice in all universities will produce positive results and increase the number of national and international patents.

The new strategy provides early awareness to young researchers and supports patent applications that adopt industrial needs and have high commercialization potential.

The strategy of evaluating theses as invention notifications was introduced to international partners (8 European Countries) as an example of good practice in the projects of strengthening technology transfer with innovative approaches, in which KTU is a partner, within the scope of the ERASMUS+ and INTERREG NEXT Programs.

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Using Open-Access Resources and Platforms to Create a Technology Transfer Ecosystem *

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ABSTRACT

Technology transfer is a complex process that requires up-to-date and reliable information on various aspects of a technological solution. Approaches to improving the efficiency of technology transfer systems through the use of open access resources and platforms are considered.

KEYWORDS

open access resources, open access services, digital ecosysytem, technology transfer office

1. INTRODUCTION

Improving the national innovation system is a key factor in increasing the country's competitiveness in the modern environment, often defined as a "knowledge economy" and focused on the commercialization of scientific results. Of particular importance in this context are studies aimed at improving technology transfer and organizing effective interaction between all participants.

Technology transfer is considered as one of the most important instruments for national and regional economic growth.

Much attention in Belarus is paid to improving the functioning of technology transfer offices (TTOs).

The activities of TTOs are aimed at commercializing the results of R&D, ensuring the acceleration of solutions for technical and technological problems of enterprises, improving the quality of their products, and mastering the production of new types of products.

The main activities of TTOs aimed at the implementation of a set of measures related to transferring innovations from the sphere of their development to the sphere of practical application. They include:

- conducting market research to identify opportunities for implementing innovations by universities, scientific and other organizations;
- performing work to ensure legal protection and introduction of innovations into civil circulation;
- providing engineering and consulting services.

The implementation of new technologies and research results from the scientific and technical sectors in industry is a traditional task, and often the main activity of technology transfer offices. There are several main approaches to technology transfer.

Business assistance: companies providing services on specific issues related to technology can be considered as specialized organizations working in the scientific and technical sectors. In order to correctly navigate among such companies, many TTOs have extensive databases.

Technology dissemination means the transfer of specific knowledge from research institutes to a group of small and medium-sized enterprises with common technology needs.

Technology search consists of analyzing the national and international market in order to acquire promising technologies and commercial opportunities that can be used by companies in a certain region.

This task is often carried out independently of specific industry needs.

In addition to these direct approaches to technology transfer, TTOs are increasingly focusing on the use of various indirect technology transfer mechanisms, such as technology exchange through networks of companies, technology and innovation support centers, product development centers, outsourcing, etc. This means that attention is paid not only to technology transfer from research institutes to industry, but also to stimulating technology exchange directly within industry.

Participation in network organizations allows TTOs:

- develop and maintain high standards for their services;
- significantly increase opportunities for finding partners for technology commercialization projects.
- implement innovation policy at the interregional and international levels.

TTOs, participating in the work of technology transfer networks, can more effectively provide their clients with the following services:

- search for partners for the joint implementation of technology commercialization projects for R&D, entry into new markets, etc;
- dissemination of technological information is a relevant service for scientific organizations that are interested in widely informing industry and companies about their research capabilities and competencies;
- promotion of technological projects using various networking tools;
- a primary analysis of supply and demand in certain subject areas of research.

The main role in the Belarusian technology transfer network infrastructure is played by the Republican Technology Transfer Center (RCTT).

The organizational structure of the RCTT network includes members, clients, partners and a coordinating organization.

Members of the network are research organizations, higher education institutions, enterprises and organizations of all forms of ownership that have TTOs or divisions responsible for

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technology transfer in their structure. Within the framework of the methodology adopted in the RCTT network, network members help their clients prepare proposals for cooperation, requests for the implementation of R&D. [1]. There are 3 options for disseminating them:

- they are posted by network members on the RCTT Internet portal;
- they are posted at the request of network members by the coordinating organization in foreign technology transfer networks;
- they are posted on the websites of foreign partners of the coordinating organization.

Network members help their clients prepare information on the products and services of the organization for posting them at a virtual exhibition on the Internet portal of the Russian Center for Technology Transfer. Network members also monitor external and internal markets to find the target consumers for the organizations. Clients of the network are suppliers and consumers of technologies (research and design organizations, educational institutions, enterprises and organizations of all forms of ownership).

The RCTT is a consortium for coordinating activities in the field of technology transfer, which includes

- head office in Minsk;
- 5 branches in the regions of the Republic of Belarus and 30 branches at research organizations, higher education institutions and enterprises of the Republic of Belarus;
- 97 foreign organizations in 23 countries.

The main objectives of the activities of the RCTT branches at manufacturing and industrial enterprises are:

improving the quality and reducing the cost of manufactured products;

assisting in the expansion of sales markets.

OPEN ACCESS SERVICES FOR INFORMATION SUPPORT OF TTOs

TTOs use various information system and resources to effectively manage and transfer technologies. Some of them are:

- Patent and invention databases: these resources help track and manage intellectual property.
- Scientific publications databases: these resources allow TTOs to stay abreast of the latest advances and innovations in various fields.
- Collaboration and knowledge sharing platforms: such platforms help researchers and developers exchange ideas, find partners, and collaborate on projects.
- Project management information systems: these systems help coordinate project work.
- Marketing and analytics tools: these tools are used to analyze the market and identify needs and opportunities for the commercialization of technologies.

To operate effectively TTOs need high-quality and timely information.

Although patent information has become more accessible in recent years, including through services provided via the Internet on a paid or free basis, the coverage and availability of patent data in some countries, including Belarus, remain limited.

Taking into account such limitations, in 2009 the World Intellectual Property Organization (WIPO) launched an international project to create a network of Technology and Innovation Support Centers (TISCs), the purpose of which is to simplify access to technical knowledge and improve the efficiency of using patent information.

The National Intellectual Property Center (NIPC) is creating a network of TISCs in the Republic of Belarus in accordance with the Agreement between WIPO and NIPC dated October 10, 2016. As part of its implementation, NIPC performs the functions of a coordinating body.

Currently, there are 29 TISCs operating in the Republic of Belarus.

The creation of the TISCs has improved information and scientific-methodological support for information and patent activities, increasing the efficiency of using IP objects.

High-quality scientific information is also one of the most important factors facilitating technology transfer.

Underdeveloped information infrastructure and the lack of objective data on advanced scientific knowledge and developments create serious barriers to the further development of science and its commercialization, significantly reducing the efficiency of TTOs. The so-called "serial publication crisis" [2] has a negative impact on the quality of information support for TTOs, caused by the fact that the traditional commercial economic model of scientific communication leads to a rapid increase in subscription prices with relatively unchanged budgets for organizations. The problem is that both TTOs specialists and researchers working in various subject areas face significant difficulties in the process of searching, obtaining and using information. In the context of the constant growth of scientific output and the simultaneous increase in the cost of access to information resources due to the fact that publishers seek to maximize their profits through the sale of subscriptions to scientific journals, scientists and other consumers of scientific information experience serious difficulties when it is necessary to find a potentially useful scientific result and get acquainted with it [3]. The deficit of high-quality scientific information resources deprives specialists of the opportunity to analyze and objectively evaluate the quality of research and development results.

The important place in the activities of the technology transfer offices is occupied by legal problems and issues of protecting intellectual property, including problems of legislative and judicial protection of copyright. The lack of relevant and up-to-date information in this area significantly reduces the effectiveness of the commercialization of scientific research [4].

To overcome these challenges, we suggest to use open access resources and platforms for facilitating information support of business processes during transfer knowledge and technology.

Open Access (OA) as a movement has been steadily gaining strength for roughly the last two decades. This is due to the following factors:

The number of publications in open access reaches 47% [5].

Research funding programs and foundations require that research results must be published in the OA repositories or OA journals.

Many organizations support the requirements for the openness of primary data and research results.

The citation rate of OA scientific publications is higher than that of those distributed by subscription [6].

Open access resources are increasingly considered like an option to replace expensive commercial databases necessary for the information services of TTOs [7].
Using OA resources can significantly improve the efficiency of Technology Transfer Offices (TTOs). Below are some of the ways in which they can be used.
1. Access to scientific publications. Open access provides free and unrestricted access to scientific articles and research. This allows TTOs to stay up-to-date with the latest advances and innovations in various fields of science and technology.
2. Analysis of patent information. Many patent databases also provide open access to information. This helps TTOs track new patents, analyze trends, and find potential partners for licensing and commercializing technologies. For example, Espacenet provides free access to millions of patents worldwide
3. Collaboration and knowledge sharing. OA platforms facilitate collaboration between researchers and developers. This allows TTOs to find partners for joint projects and share ideas. Examples of such platforms include ResearchGate and Academia.edu.
4. Training and professional development. OA resources can also be used for the training and professional development of TTOs. Online courses and webinars available on platforms such as Coursera and edX help TTOs staff stay up-to-date with new techniques and technologies.
5. Market Research. Using open data and analytics tools helps TTOs conduct market research. This allows for a better understanding of the needs and opportunities for commercializing technologies. Examples of such tools include Google Scholar and Microsoft Academia.
There are many integrated platforms and services for facilitating OA resources usage.
OpenAIRE (the Open Access Infrastructure for Research in Europe) enables the search, discovery and monitoring of the publications and datasets from 100,000+ research projects.
OpenAIRE actively supports the Open Science initiative. On the one hand, OpenAIRE is the network of dedicated Open Science experts promoting and providing training for Open Science.
On the other hand, OpenAIRE is a technical infrastructure harvesting research output from connected data providers. OpenAIRE aims to establish an open and sustainable scholarly communication infrastructure responsible for the overall management, analysis, manipulation, provision, monitoring and cross-linking of all research outcomes.
This combination of knowledge and a pan-European Research Information platform enables OpenAIRE to provide services for researchers, research support organizations, funders, content providers and TTOs such as:

- Integrate scientific information.
- Monitor and report on research outcomes for funders and partners.
- Train and support on all subjects related to OA.
- Discovery of OA output per project, funder, and data provider.

AMiner is a new generation of scientific and technological intelligence analysis and mining platform with completely independent intellectual property rights. It was established by a team led by Professor Tang Jie from the Department of Computer Science and Technology of Tsinghua University.
AMiner's scientific research data includes 331 million papers, 135 million scholars, 1.122 billion paper citation relationships and 8.79 million knowledge entities (this data is in dynamic change).
AMiner integrates academic data from multiple sources by data mining and social network analysis and mining technology to catch paper indexes.
AMiner cooperates with scholars and academic institutions to share papers and scholar data and purchase copyright.
CORE provides access to the world's largest collection of open access scholarly papers by collecting and indexing research from repositories and journals. It is a non-profit service dedicated to the open access mission and a signatory to the Principles for Open Scholarly Infrastructures (POSI) [8]. CORE serves a global network of repositories and journals by improving discoverability and preventing misuse of their content; ensuring that metadata records are uniquely identified; supporting data providers in applying best practices by providing tools for metadata validation, content management, enrichment, and OA compliance; and facilitating machine access to open research. CORE's mission is to index all open access research worldwide and make it accessible to all. In doing so, CORE:

- enriches scientific data using modern text and data mining technologies to make it easier to find;
- enables others to develop new tools and use cases based on the CORE platform;
- supports the network of OA repositories and journals with innovative technical solutions;
- promotes the creation of a scalable and cost-effective way to provide open scientific information.

CORE aggregates research papers from data providers around the world, including institutional and subject repositories and journal publishers. This process, also called data harvesting, enables CORE to offer search, text mining, and analysis capabilities not only on metadata but also on the full text of research articles, making CORE a unique service in the research community.
BASE is one of the largest search engines in the world, particularly for academic web resources. BASE provides over 300 million documents from over 10,000 content providers. Full texts of about 60% of indexed documents are available free of charge [9]. BASE indexes the metadata of all types of academically significant resources (journals, institutional repositories, digital collections, etc.) that provide an OAI interface and use OAI-PMH to provide their content. The index is constantly being expanded by integrating new sources/content providers. Database managers can integrate the BASE index into their local infrastructure (e.g., metasearch engines, library catalogs).
International research collaborations can bring TTOs new opportunities for collaborative research, increase the impact of their research, and boost the commercialization of scientific results. For instance, knowing which institutions globally work on similar research can help identify new partnership opportunities. Identifying existing connections among researchers between those institutions can help drive development opportunities. These data have come through costly subscriptions to restricted databases. OpenAlex now provides the data required for international intelligence freely to all users across the globe [10].

CONCLUSION

Open access platforms and services provide technology transfer offices with effective tools for searching, disseminating and using scientific publications for the purposes of commercializing research. Their use contributes to the acceleration of technology transfer and the increase in the efficiency of innovation activities. OA resources may be integrated using API into the structures of the digital ecosystem of technology transfer, which includes agents (scientific organizations and teams), objects (information and knowledge) and infrastructure (services and information systems).

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Fostering Open Innovation and Technology Transfer: Insights from the Euro-Mediterranean Innovation Camp (EMIC)

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ABSTRACT / POVZETEK

The global marketplace is rapidly evolving, demanding innovative approaches to technology transfer that can bridge the gap between research and commercial application. The Euro-Mediterranean region, with its diverse socio-economic landscape, presents both challenges and opportunities for such endeavors. This paper presents the Euro-Mediterranean Innovation Camp (EMIC) as a successful model for implementing open innovation and technology transfer, particularly within the strategic framework of the Jožef Stefan Institute (JSI) and its partner institutions. The analysis not only draws on the outcomes of the recent EMIC initiatives but also aligns these practical insights with the theoretical foundations of open innovation as discussed in the doctoral disposition on technology transfer.

KEYWORDS / KLJUČNE BESEDE

Open Innovation, Technology Transfer, Euro-Mediterranean Region, EMIC, Jožef Stefan Institute

1 INTRODUCTION

The global marketplace is rapidly evolving, demanding innovative approaches to technology transfer that can bridge the gap between research and commercial application. The Euro-Mediterranean region, with its diverse socio-economic landscape, presents both challenges and opportunities for such endeavors. This paper presents the Euro-Mediterranean Innovation Camp (EMIC) as a successful model for implementing open innovation and technology transfer, particularly within the strategic framework of the Jožef Stefan Institute (JSI) and its partner institutions. The analysis not only draws on the outcomes of the recent EMIC initiatives but also aligns these practical insights with the theoretical foundations of open innovation, as discussed in the doctoral disposition on technology transfer. The main purpose of the paper is to examine the application of open innovation and technology transfer within the Euro-Mediterranean region, using the Euro-Mediterranean Innovation Camp (EMIC) as a case study. The paper explores how EMIC serves as a successful model for bridging the gap between academic research and commercial applications in a region that presents both challenges and opportunities due to its socio-economic diversity. Overall, the paper contributes to the literature on technology transfer by providing a detailed exploration of how structured innovation programs like EMIC can drive economic growth, address pressing global challenges, and create marketable solutions, particularly in the complex and diverse Euro-Mediterranean context.

The EMIC initiative has attracted applicants from over 17 countries, with a significant portion of the applications coming from Egypt and Jordan. The charts below illustrate the diversity and distribution of applicants by country of residence across the two seasons of the program.

(1)

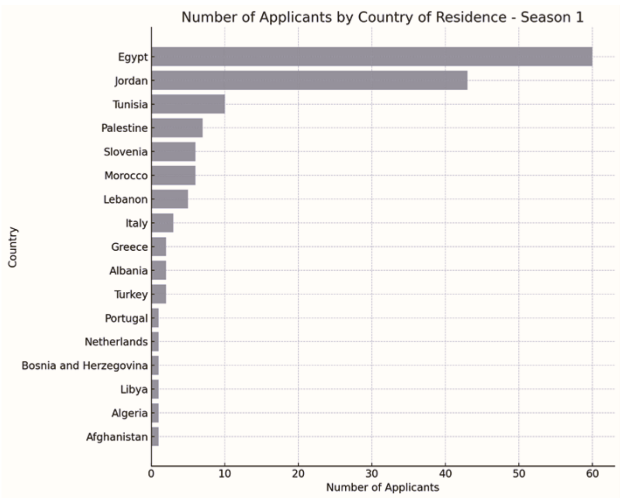

Figure 1: Number of applicants by country of residence – Season 1

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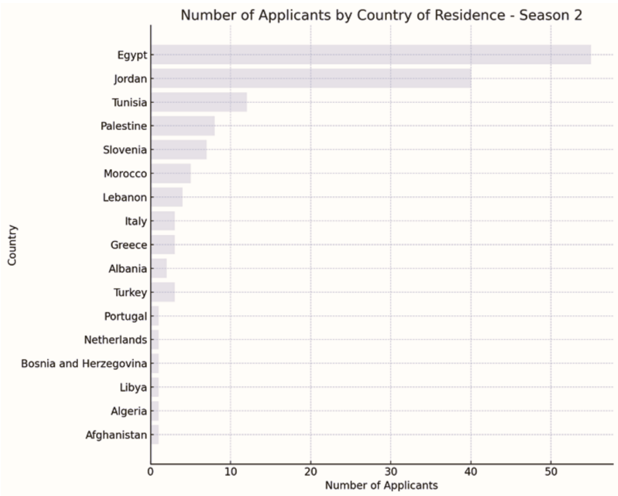

Figure 2: Number of applicants by country of residence – Season 2

Theoretical Foundations: Open Innovation and Technology Transfer

Open innovation, a concept popularized by Henry Chesbrough, has significantly reshaped our understanding of how innovation occurs in the modern business environment. Unlike traditional closed innovation models where companies rely solely on internal resources for R&D, open innovation promotes the use of both internal and external knowledge sources. This approach accelerates the innovation process and expands the potential market for new technologies (Chesbrough, 2005a). In the context of technology transfer, open innovation facilitates the commercialization of intellectual property (IP) through various channels, including licensing, joint ventures, and spin-offs, thus driving economic growth and enhancing competitiveness (Chesbrough, 2003b).

The Euro-Mediterranean region is a fertile ground for applying open innovation principles. However, the integration of public research outputs with industry needs has been a persistent challenge. Slovenia, for instance, excels in scientific output, ranking high in terms of research publications. Yet, as the OECD's 2012 report highlights, the country struggles with the commercialization of research findings, particularly in converting scientific discoveries into marketable products and services. This gap underscores the critical role of initiatives like EMIC, which aim to bridge the divide between academic research and industrial application through structured innovation programs.

The thematic focus of the EMIC projects aligns well with global challenges, as evidenced by the distribution of project types: 45% focused on health, 35% on renewable energy, and 20% on environmental issues, reflecting the alignment of participant interests with critical global needs.

The Euro-Mediterranean Innovation Camp (EMIC): A Model of Open Innovation

The Euro-Mediterranean Innovation Camp (EMIC) is a flagship initiative that embodies the principles of open innovation within the Euro-Mediterranean region. Launched by the Euro-Mediterranean University (EMUNI) in collaboration with the JSI and the EuroMed University of Fes (UEMF), EMIC provides a platform for young innovators to develop and showcase their ideas in response to pressing global challenges. The camp focuses on three critical areas: health, renewable energy, and climate change—fields that are not only relevant to the region but also globally significant.

The EMIC initiative is structured to promote iterative learning and development. Participants, who are selected through a rigorous process, receive mentorship and technical support from experts in their respective fields. This support is crucial in helping them refine their ideas and develop viable prototypes. The average age of participants was 24 years, with the youngest being 18 and the oldest 35, showcasing the youthful energy driving innovation in the Euro-Mediterranean region.

Selection Process of EMIC

The Euro-Mediterranean Innovation Camp (EMIC) follows a rigorous and multi-stage selection process to identify and support the most promising young innovators from across the Euro-Mediterranean region. Here's an overview of the selection process:

1. **Application Submission:**
    - **Eligibility:** Applicants must be between 18 and 35 years old, reside in one of the Euro-Mediterranean countries, and possess at least a high school diploma. The innovation they propose must address one of the three thematic areas: Health, Renewable Energy, or Environment (including Climate Change) and must be capable of being converted into a prototype within three months.
    - **Application Process:** Interested candidates submit their applications through an online form available on the EMUNI website. The application requires a detailed description of the innovative idea or invention, highlighting its novelty, feasibility, and potential for commercialization.
2. **Initial Screening:**
    - A panel of experts reviews all submitted applications. The review process evaluates the novelty of the idea, its practical applicability, and the feasibility of implementation within the specified timeframe.
    - **Shortlisting:** Based on the initial screening, a subset of applicants is shortlisted to advance to the next phase. For instance, in Season 2, out of 124 applications, approximately 40 candidates were

shortlisted for the online pitching phase (EMUNI).

3. **Online Pitching:**
   - **Pitch Preparation:** Shortlisted candidates prepare a pitch presentation, which they deliver via an online platform. During this phase, they present their ideas to a jury comprising experts from relevant fields.
   - **Jury Evaluation:** The jury evaluates the pitches based on several criteria, including innovation, feasibility, potential impact, and the candidate's ability to articulate and defend their idea. The most innovative and viable projects are selected to move forward.
4. **Innovation Bootcamp:**
   - **Workshops and Mentorship:** The selected finalists, known as the "Innovation Squad," are invited to participate in a 10-week bootcamp held at facilities like the Jožef Stefan Institute in Slovenia or the EuroMed University of Fes in Morocco. During this period, they receive technical assistance, mentorship from subject matter experts, and support in refining their prototypes.
   - **Elimination Stages:** Throughout the bootcamp, participants go through multiple elimination stages. These stages are designed to progressively challenge the innovators, focusing on proof of concept, engineering, prototyping/testing, and customer validation. The best performers in each stage advance to the next round (EMUNI).
5. **The Finale:**
   - **Final Presentation:** The competition culminates in a live finale event where the remaining candidates present their fully developed prototypes. This event is attended by a live audience, including mentors, representatives from partner institutions, and other stakeholders.
   - **Scoring:** Final scores are determined by both the jury and audience voting, with each accounting for 50% of the final score. The winners are announced based on the combined results of these evaluations (EMUNI).

This selection process is designed to ensure that the most innovative and feasible ideas are given the support they need to develop into successful market-ready products. It also emphasizes the importance of mentorship and iterative development, helping young innovators turn their ideas into impactful solutions.

Case Studies: Innovations from EMIC Season 2

The impact of EMIC is best illustrated through the success stories of its participants. The most recent season of EMIC, concluded in June 2024, showcased a range of groundbreaking innovations that have the potential to address significant challenges in health and sustainability.

The Euro-Mediterranean Innovation Camp (EMIC) Season 2 brought together some of the brightest minds across the region to develop innovative solutions addressing critical challenges. This section highlights the top three projects that stood out for their creativity, technical expertise, and potential for real-world impact.

1. **Muhammad Mounir (Egypt) – "SugarHeal"**
   - **Project Overview:** Muhammad Mounir, a Molecular Biotechnology student from Galala University, developed "SugarHeal," an innovative wound dressing material designed to accelerate the healing process of chronic and acute wounds. During his time at the Jožef Stefan Institute (JSI), Muhammad explored two main fabrication techniques:
     - **Electrospinning:** He created a cellulose-based solution with antibacterial properties for electrospinning, resulting in a biodegradable wound dressing that promotes faster healing.
     - **3D Bioprinting:** Muhammad also developed a cellulose-based ink enriched with natural antibacterial extracts, which was used in 3D bioprinting to produce customizable wound patches.
   - **Current Stage:** Muhammad has successfully developed prototypes of the wound dressing through 3D bioprinting, which have shown promising results in terms of mechanical stability and biological response. His next steps include further optimization and exploring commercial applications (EMUNI).
2. **Rahma M. Tolba (Egypt) – "Interactive Augmented Reality for Lisp Correction"**
   - **Project Overview:** Rahma Tolba, a PhD researcher from Ain Shams University, developed an interactive Augmented Reality (AR) application designed to assist in speech therapy for individuals with a lisp. Her project focuses on improving phonetic learning through the use of 3D animated models that demonstrate correct tongue movements. The app guides users through pronunciation exercises, providing real-time feedback through an AI-based Automatic Speech Recognition (ASR) system.
   - **Current Stage:** Rahma has developed a fully functional prototype for Android devices, which has been tested on a small group of individuals. The next steps involve gathering user feedback from speech therapists and phoniatricians to refine the design and functionality (EMUNI).
3. **Med Aziz Mhalla (Tunisia) – "Drowsy Driver Detection System"**
   - **Project Overview:** Med Aziz Mhalla, an electronics engineering student from the National Engineering School of Sousse,

created the "Drowsy Driver Detection System" (DDDS). This system leverages machine learning, computer vision, and embedded hardware to monitor drivers in real-time, detecting signs of drowsiness, distraction, and sleep onset. The system uses a Convolutional Neural Network (CNN) model to classify eye states and detect blinks and yawns, which are key indicators of drowsiness.

  - **Current Stage:** Med Aziz has successfully developed a proof of concept and prototype that has been tested in controlled environments and on a laptop. He is currently optimizing the system for real-time performance using NVIDIA Jetson Nano and preparing for on-road testing (Med Aziz - Drowsy Driver…).

These projects not only exemplify the innovative spirit fostered by EMIC but also demonstrate the potential for significant contributions to healthcare, road safety, and speech therapy. Each of these top three finalists utilized the mentorship and resources provided during the EMIC bootcamp to bring their ideas closer to real-world application.

The diversity of innovations emerging from EMIC highlights the program's success in fostering creativity across different fields. These projects are not just theoretical exercises; they represent tangible solutions that can have a real-world impact, addressing some of the most pressing challenges in the Euro-Mediterranean region and beyond.

Challenges in Implementing Open Innovation

Despite its successes, the implementation of open innovation within the EMIC framework has not been without challenges. One of the primary challenges is the alignment of the diverse objectives of the program's international partners. The Euro-Mediterranean region encompasses a wide range of economic, social, and political contexts, each with its unique set of challenges. Coordinating efforts across such a diverse region requires careful planning and robust frameworks for collaboration.

Intellectual property (IP) management is another critical challenge in open innovation environments. While open innovation encourages the sharing of ideas and resources, it also raises questions about how IP is managed and protected. In the context of EMIC, ensuring that participants retain control over their innovations while still benefiting from the collaborative environment is crucial. This requires clear guidelines and agreements on IP management, which can be complex to negotiate across different legal and regulatory frameworks.

Another challenge is the scalability of the solutions developed through EMIC. While the innovations produced during the camp are often groundbreaking, bringing these solutions to market on a larger scale requires resources that may not be immediately available to the participants. This is where the support of institutions like JSI and the involvement of industry partners become critical. By providing continued support beyond the initial stages of development, these institutions can help ensure that the innovations produced at EMIC reach their full potential.

Opportunities for Enhancing Open Innovation

Despite these challenges, the EMIC model also presents significant opportunities for enhancing open innovation in the Euro-Mediterranean region. One of the key opportunities lies in the potential for cross-border collaboration. By bringing together participants from different countries and backgrounds, EMIC fosters a rich exchange of ideas and approaches. This diversity is a strength as it allows for the development of solutions that are informed by a wide range of perspectives and experiences.

The full cycle of open innovation and technology transfer has yet to be fully achieved, as both processes require more than just innovative ideas and technological breakthroughs. For these cycles to reach their full potential, business entities must engage early and consistently, starting from the initial stages of research and development. Their investment and involvement are crucial in ensuring that ideas and technologies not only progress beyond the conceptual phase but also successfully transition from labs to the market. Without the proactive participation of businesses, the promise of open innovation and effective technology transfer may remain unfulfilled, with many promising projects never realizing their full impact.

The collaborative model of EMIC, supported by the JSI's extensive research infrastructure, offers valuable insights into how open innovation can be effectively implemented in a complex and diverse region. The partnerships between academic institutions, industry players, and government bodies are crucial in providing the necessary resources for young innovators to translate their ideas into impactful technologies. These partnerships also help to ensure that the innovations produced at EMIC are aligned with market needs, increasing their chances of success.

Another opportunity for enhancing open innovation in the Euro-Mediterranean region is through the development of stronger networks and ecosystems. By fostering closer ties between research institutions, industry, and government, it is possible to create a more supportive environment for innovation. This includes not only providing funding and resources but also creating opportunities for mentorship, networking, and collaboration. Such ecosystems can help to sustain the momentum generated by initiatives like EMIC, ensuring that the innovations produced continue to evolve and have a lasting impact.

Conclusion

The Euro-Mediterranean Innovation Camp (EMIC) serves as a compelling example of how open innovation can be successfully implemented within a structured technology transfer framework. By leveraging the strengths of regional partnerships and focusing on critical areas such as renewable energy, health, and climate change, EMIC has successfully fostered a culture of innovation across the Euro-Mediterranean region. The initiative has not only provided a platform for young innovators to develop their ideas but has also facilitated the transfer of these ideas from research to market, demonstrating the potential of open innovation to drive economic growth and address global challenges.

Moving forward, it will be crucial to address the challenges of IP management and resource allocation to sustain the momentum generated by these initiatives. The ongoing collaboration between academic institutions like JSI, industry partners, and government bodies will be key to enhancing the commercial viability of the innovations emerging from EMIC. As Slovenia and the broader Euro-Mediterranean region continue to refine their approaches to technology transfer, the lessons learned from EMIC will serve as a valuable guide for future innovation policies and practices.

The success of EMIC highlights the importance of fostering innovation among young people across the Mediterranean region. By providing the necessary support and resources, initiatives like EMIC can help to unlock the full potential of the region's young innovators, driving economic growth and addressing some of the most pressing challenges of our time. As we look to the future, it is clear that open innovation will continue to play a critical role in shaping the global innovation landscape, and initiatives like EMIC will be at the forefront of this exciting journey.

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Research Organisation-Industry Cooperation and State Aid Rules in Slovenia and Europe

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ABSTRACT

This study provides an international comparative view on state aid regulation in infrastructure use and intellectual property rights transfer in cooperative research and development projects within the European Research and Innovation Ecosystem. Technology transfer officers or similar profiles at research organisations were interviewed. Additionally, a desk research was performed. Annual reports were studied in order to identify the differentiation of economic and non-economic activity as well as good practices. Desk research included also rulebooks and related Slovenian & EU legislature in the field of contract and collaborative research.

KEYWORDS

research organisation – industry cooperation, research services, intellectual property rights transfer, state aid rules, Slovenian and European research organisations, research and innovation ecosystem

INTRODUCTION

The European Commission has set specific rules in the field of research, development, and innovation (R&D&I) to prevent market distortion. These rules are described in the European Framework for State aid for R&D&I (2022/C 414/01 [1]) and relate to the Article 107 (1) Treaty on the Functioning of the European Union.

We believe that knowledge and implementation of state aid rules regarding research services (economic activity), collaboration projects (non-economic activity) and intellectual property rights (IPR) are insufficient and could be improved, which was identified also by other authors [2], [3].

1 METHODOLOGY

In order to understand how state aid rules in academia-industry cooperation work in practice, we have performed a detailed analysis with an international comparative view. Experience and good practices have been collected from different types of groups, i.e. researchers, industry, technology transfer managers, contract research managers and accounting officers. We have focused on Slovenian research organisations, in addition to which we included two European research organisations in order to make international comparison. In spring 2024 we concluded 8 in-person or online semi-structured interviews with R&D managers from 7 research organisations.

2 DESK RESEARCH RESULTS

2.1 Share of economic activity, rulebooks and pricelists

Our study comprised 13 Slovenian, 1 Czech and 1 Italian public research organisation (Table 1). As foreseen in articles 16 (ff) and 19 of EC Communication (2022/C 414/01), the research organisation has to account for the costs and the revenues of the economic activities separately. Different practices on how to do this exist among European research organisations. It was observed that most research organisations generate up to 20% of their revenues from economic activities. This correlates well with the maximum 20% capacity limit as foreseen in 2022/C 414/01 (it should however be noted that % of income may differ from % of capacity, which is the actual threshold value).

Some organisations in the study have around 50% of their activities classified as economic in nature. They most likely surpass 20% of economic activities' capacity limit. For this reason, they as whole cannot be considered as research organisations according to 2022/C 414/01. Only departments, laboratories or similar subunits of such organisations which do not surpass 20% of economic activities' capacity limit can be considered 'research organisations'.

In Slovenia, the new Law on Scientific Research and Innovation Activities (ZZrID) entered into force on 1 January 2022 [15]. In the same period, a Rulebook on procedures for implementing the budget of the Republic of Slovenia was updated. Article 119(b) requires each public research organisation to have an internal rulebook and pricelist regarding sale of products and services, i.e. economic activity [16]. Up to date, several Slovenian research organisations have prepared their rulebooks and pricelists, while many have not yet (at least they are not publicly available).

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The sizes of analysed organisations vary a lot, i.e. from 58 to 9560 employees. This strongly affects the organisational structure and extent of experience in a specific organisation.

Table 1: Selected Slovenian and European research organisations and their info on economic activities.

Organisation	Country	Share of economic activity in 2023	Rulebook for sale of products and services	Pricelist of products and services	Number of employees in 2023	Source
Slovenian National Building and Civil Engineering Institute	SI	53.6%	16.08.2022	11.01.2022	254	[4], [5]
University of Ljubljana, Faculty of Medicine	SI	48.2%	unpublished / under preparation	unpublished / under preparation	829	[4]
Agricultural Institute of Slovenia	SI	23.7%	unpublished / under preparation	28.11.2023	258	[4], [6]
Geological Survey of Slovenia	SI	15.0%	11.08.2022	23.02.2023	124	[4], [7]
Institute of Metals and Technology	SI	14.9%	unpublished / under preparation	unpublished / under preparation	58	[4]
University of Ljubljana, Faculty of Electrical Engineering	SI	12.0%	unpublished / under preparation	unpublished / under preparation	362	[4]
Jožef Stefan Institute	SI	10.2%	under preparation	unpublished, to be updated	1206	[4]
University of Ljubljana, Faculty of Mechanical Engineering	SI	10.0%	unpublished / under preparation	unpublished / under preparation	433	[4]
National Institute of Biology	SI	8.7%	3.11.2023	9.02.2023	194	[4], [8]
Czech Academy of Sciences	CZ	7.4%	different guidelines, decentralised	not identified, decentralised	9560	[9], [10]
University of Ljubljana, Faculty of Pharmacy	SI	6.2%	unpublished / under preparation	unpublished	199	[4]
National Institute of Chemistry	SI	5.0%	24.08.2022	24.08.2022	437	[4], [11]
University of Maribor	SI	4.5%	unpublished / under preparation	6.11.2023 (UM-FVV), decentralised	2121	[4], [12]
Consiglio Nazionale delle Ricerche	IT	0.47%	not identified, decentralised	not identified	8457 (year 2022)	[13], [14]
Faculty of Information Studies in Novo mesto	SI	0.03%	under preparation	under preparation	82	[4]

2.2 Good and bad examples of transparent bookkeeping and economic activity management

The transparency of studied research organisations is good. Yearly reports support this observation. However, due to differentiation in the reports' structure, the comparison is sometimes difficult. An additional challenge is the lack of standardisation in terminology.

One of the important messages of EC Communication 2022/C 414/01 is the requirement to differentiate economic (such as research service) and non-economic activities (such as collaborative research and knowledge transfer activities). It should be noted that in the Slovenian legislature and consequently other documents, terminology 'market activity' is used, which is not well defined. Sometimes it is used as 'economic activity' and sometimes as activity on the 'market', with again different interpretations ('market' as everything outside Slovenian Research and Innovation Agency – ARIS; or everything related to for-profit organisations).

Several Slovenian institutes, such as National Institute of Biology, Institute of Metals and Technology, Slovenian National Building and Civil Engineering Institute, National Institute of Chemistry, and Agricultural Institute of Slovenia present their contract and collaborative research activities well. Some unclarity persists, which is also highlighted below in the translated sections of the annual reports. We assume that this is caused due to the use of vague terminology, as explained above, and the lack of differentiation between economic and non-economic activities.

The Consiglio Nazionale delle Ricerche defines its income and outcome well, but unlike other annual reports, its annual report is not supplemented with qualitative description. The annual report of the Czech Academy of Sciences (CAS) is very informative. Subunits (i.e, institutes of CAS) have their own annual reports, which present their technology transfer activities well, while contract and collaborative research are inadequately described. Additionally, the financial part contains non-machine readable text, which cannot be easily translated.

Examples

At the Jožef Stefan Institute, Horizon 2020 and Horizon Europe projects were classified as market projects, which were changed in 2022. From the total number of market activities' income, it was thus unclear which activities were economic and which non-economic.

At the National Institute of Chemistry, royalties and other revenues from patents are classified as a group of market revenues instead of a group of non-economic activities. In the case that market revenues are considered economic activities, this classification is false.

At the National Institute of Biology as well as some other Slovenian research organisations, collaboration projects with industry such as ARIS applied projects (TRL1-4) are classified as a market activity in the annual report 2023. However, it is not clear from the annual report that this is a non-economic activity.

In Table 2, we can see a very good delimitation between contract research ('laboratory services') and collaborative research ('research projects with industry'). However, these two categories are later wrongly joined into one category, 'income from goods and services on the market' (Table 3). We believe this is not an isolated case among research organisations.

Table 2. Income from market activity of the Institute of Metals and Technology (IMT). Annual report of IMT for 2023, p. 99 [1].

	2023
Laboratory services	326,756.14
Research projects with industry	325,486.68
The rest	9,267.83
Market together	661,510.65

Table 3. Statement of income and expenses of the Institute of Metals and Technology (IMT). Annual report of IMT for 2023, p. 80 [1].

Breakdown of subgroups of accounts	Account subgroup name	Label for AOP	Amount	
			AMOUNT-Income and implementation expenses public services	AMOUNT-Income and sales expenses goods and services on the market
1	2	3	4	5
	A) INCOME FROM BUSINESS (661+662-663+664)	660	3,668,755	652,828
760	INCOME FROM THE SALE OF PRODUCTS AND SERVICES	661	3,668,755	652,828
	INCREASE IN THE VALUE OF INVENTORIES OF PRODUCTS AND WORK IN PROGRESS	662	0	0

3 QUALITATIVE ANALYSIS

Awareness and knowledge about state aid legislation varied among the interviewees. Most of them are well acquainted with EC Communication 2022/C 414/01, especially those whose main profession is technology transfer or accounting. In accounting, managers get familiar with state aid rules when there are investments in bigger infrastructure and financer monitors the economic/non-economic activities of the unit using the infrastructure.

During the semi-structured interviews, the organisational structure of academia – industry cooperation management was discussed. Intellectual property management (patenting, licensing etc.) is often centralized, even at large research organisations such as Consiglio Nazionale delle Ricerche, University of Ljubljana and University of Maribor. On the contrary, contract research is decentralised and managed in smaller units. Comprehensive and standardised management, established rulebooks and pricelists often lack at the institutions that have a very low percentage of contract research. The management is often left to departments which leads to different approaches in price setting etc. Interestingly, there are still some researchers that are surprised to hear that economic activity is allowed to be performed, and accountants that believe there should be no margin included in prices of public research organisations' services.

3.1 Contract research

Different approaches to establish a pricelist of services and goods exist. They can be structured using either a cost based approach or market based approach. In a market based approach, organisations observe the prices of other service providers, while in a cost based approach, the costs are summed up and a margin is added.

In a cost based approach, direct costs are sometimes joined in cost blocks composed of work costs, depreciation of the cost of the infrastructure, costs for maintenance and running of the infrastructure (electricity, water, heating, ventilation ...) and materials. Such cost blocks are then multiplied based on the number of samples or complexity of the task. Some organisations add direct costs in % of work, while others in % of all direct costs. Both options can be found in public funded calls.

Prices are often established and then regulated by the inflation rate or other changes in cost structure. Sometimes this does not take place, especially when the activities are less important for the department or institute.

3.2 Intellectual property in collaboration projects and start-up companies

Management of intellectual property rights (IPR) in collaboration projects was discussed with technology transfer managers. In most cases it is advised to discuss and agree to IPR in advance. Sometimes even the IPR' price is evaluated in advance. Internal policy of one interviewed research organisation regarding the 2022/C 414/01 article 29(c) is that a company can be co-owner of invention or other IPR only when they provide intellectual contribution, not financial or other in-kind contribution such as equipment usage. Another research institute has interpreted this article in a way that a financial contribution of the company to the project, for example 25% in cash, can result in an automated 25% co-ownership of IPR, generated in the project. It is important to note that this institute has a policy that in case of IPR exploitation, the co-owner has to (financially) compensate the other co-owner(s).

The most common procedure to conclude a licence or sale agreement is thus to use arm's length negotiations – article 30(c). The licence agreement commonly involves lump sum and royalties. One research organisation mentioned that they negotiate with their spin-out companies in the same manner as with other companies, which is fair. However, the specific characteristics of start-up companies should be taken into consideration.

With the implementation of the new Law on Scientific Research and Innovation Activities, research organisations in Slovenia are now permitted to establish spin-off companies, which they enter into ownership with equity. To our knowledge, no such companies have yet been established in Slovenia. In the last 2 years, CAS has established 5 such companies encountering many difficulties throughout the process. One of the main concerns is the accuracy and changeability of IPR price.

4 CONCLUSIONS

Differentiation between contract research and collaborative research in Slovenian research organisations is not well known and could be improved. There are many projects between research organisations and companies that fall somewhere between contract research and collaborative research. For example, different methodologies in literature were tested ([17], [18]), which produced two different results for the same project. Nevertheless, due to the obligation to account for the economic activities separately, each such project should be labelled as either (i) a contract research or (ii) a collaborative research. According to our discussion, this happens only rarely. As discussed above, the activities in Slovenia are divided into public service and market activities which makes it more complicated to introduce another set of classification. Label 'economic activity' or 'non-economic activity' should be assigned during the process of bookkeeping, i.e. when the invoice is issued or contract concluded. A more significant, but important change of replacing wording 'public service/market activity' with 'economic/non-economic activity' in Slovenian legislation should be made. We communicated this with representatives from the Slovenian Ministry of Higher Education, Science and Innovation, which will consider this recommendation.

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Feasibility Analysis for the New Mechanism of Knowledge Transfer within the INDUSAC Project

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ABSTRACT

In September 2022, the Horizon Europe INDUSAC project introduced a novel mechanism for knowledge transfer, extending the usual company-researcher partnerships to include students as well. Between March and May 2024, thirteen co-creation projects involving international teams of students and researchers solving companies' challenges, were carried out. This study describes results of surveys given to companies, students and researchers about their experience in the projects, and the level of usefulness of solutions made possible by the collaboration. We analyzed data collected from 10 companies, 57 students and 4 researchers. Measured on the Likert scale, satisfaction of companies with technical aspects of the methodology ranged from average to good (average values between 3.1 and 4.2), whereas their satisfaction with the solution to their challenge, and with the work done by the team, had a narrower range between 3.2 and 3.8. Financial support to student members of co-creation teams, in the amount of up to 1,000 EUR gross per student, was perceived as sufficient by 67% of students. Initial results indicate that the INDUSAC mechanism is relatively well accepted among companies, with room for improvement in certain aspects such as the user-friendliness of the platform and the time allowed to solve a challenge. Overall, around 30 % of co-creation projects have demonstrated true value to the company involved, and there is potential in the further 50 %. Selected testimonials from companies, complimenting the work of students and expressing their own belief that the students are richer for the experience as well, demonstrate that the INDUSAC mechanism shows promise in knowledge transfer.

KEYWORDS

INDUSAC project, international cooperation, student-industry cooperation, knowledge transfer

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1 INTRODUCTION

In September 2022, the Horizon Europe INDUSAC project (www.indusac.eu; EU project number 101070297) introduced a novel mechanism for knowledge transfer, extending the usual company-researcher partnerships to include students as well. It comprises a methodology that would allow for a streamlined facilitation of collaboration between industry and academia, and an online platform to support that methodology [1]. In November 2023, the INDUSAC project, coordinated by the Jožef Stefan Institute, commenced its piloting phase wherein universities, public research organisations, and companies were invited by the international project consortium to join the project. The idea behind the methodology is to bring together a company and an international team of 3-6 students and/or researchers to solve a company challenge within 4-8 weeks, with the company providing assistance during regular meetings with the team. The team delivers results in the form of pre-defined types of deliverables specific for the type of challenge, and the deliverables are evaluated by companies. Being the main target audience, during the project, special attention was given to students / researchers from EU widening countries, and geographical and gender balance was ensured by the criteria that team members must be from at least three different countries, and must include representatives of at least two gender groups; student members of the co-creation teams were financially rewarded for successfully completing the project. First such collaborations started in March 2024 and wrapped up in May 2024. This study describes results of surveys given to companies, students and researchers about their experience in the project, and the level of usefulness of solutions made possible by the collaboration. Implications for the feasibility of this concept of knowledge transfer are discussed.

2 METHODS

As per the methodology of the project, students and researchers were surveyed before they started working on the solution to the company's challenge, and after they finished. Topics in the survey, relevant to the scope of this study, included the students' feedback on how the collaboration affects social impact, and how appropriate the funding is. In addition, companies were surveyed after the project, mainly about the quality of work performed by the students / researchers, and the impact that their work has. All surveyed individuals were asked to provide short testimonials about their impressions and satisfaction. Students / researchers were asked to fill in separate surveys for separate co-creation projects (maximum three) and companies were likewise asked to fill in separate surveys for each team they worked with. Further details are indicated in the Results section. In this study, we analyzed data collected from 10 companies, 57 students and 4 researchers.

3 RESULTS

In the first round of the INDUSAC co-creation projects, taking place between March and May 2024, thirteen co-creation projects took place that resulted in proposed solutions, two of which were rejected and eleven approved by companies. Companies' overall satisfaction with the INDUSAC process after the projects, expressed as various aspects of the methodology, is shown in Figure 1. Satisfaction was evaluated on a Likert scale from 1 to 5. On average, the processes of registering on the platform, publishing Challenges, and reviewing Motivation Letters (ie., students' applications) ranked highest at 4.0, 4.0, and 4.2, respectively, while the user-friendliness of the INDUSAC platform and the time allowed to solve a challenge ranked lowest, each at 3.1.

Companies' overall satisfaction with the solution to their challenge, and with the work done by the team, expressed as various attributes, is shown in Figure 2. Satisfaction was evaluated on a Likert scale from 1 to 5. On average, relevance of the solution, quality of work of the team, and satisfaction with the work of the team ranked highest at 3.8 each, while the market potential of the solution ranked lowest, at 3.2.

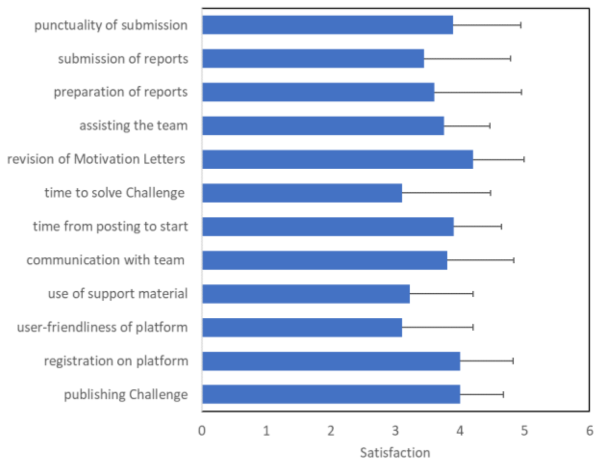

Figure 1: Satisfaction of companies with technical aspects of the methodology. Average values ± sd are shown (n = 8 for assistance to the team, n = 9 for support material, submission of deliverables and punctuality of submission, and n = 10 for the other nine categories). Satisfaction was measured on a Likert scale: 1 – very poor, 2- poor, 3 – average, 4 – good, 5- very good.

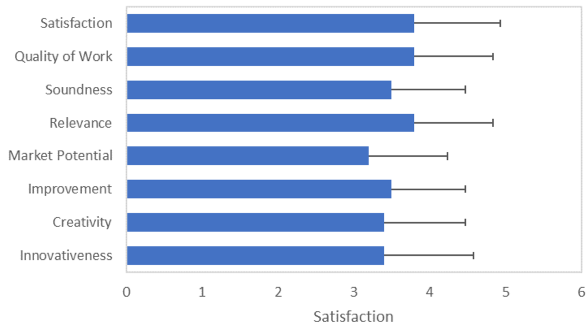

Figure 2: Satisfaction of companies with work of the co-creation team and the solution delivered. Average values ± sd are shown (n = 10). Of the categories surveyed, Satisfaction, Quality of Work, and Soundness refer to the work done by the co-creation team, whereas Relevance, Market Potential, Improvement over existing solutions, Creativity, and Innovativeness refer to the solution delivered. Satisfaction was measured on a Likert scale: 1 – very poor, 2- poor, 3 – average, 4 – good, 5- very good.

In terms of delivery of results, the companies have reported that all requested deliverables had been delivered by the co-creation teams in all cases except one (representing one of the projects where the solution was rejected). In terms of follow-up on the solution within the company, indicating its usefulness, two companies have already started, a third company has confirmed that they will follow up on the solution, while 5 have not yet decided and in two cases it will probably not happen.

Since the INDUSAC project put a fair amount of emphasis on social aspects such as geographically and gender-balanced collaboration, the survey for students and researchers included questions on agreement with (i) incorporation by the co-creation process of customer research and insights to understand the end-users' needs and preferences, (ii) solutions that specifically addressed gender-related issues or considerations, and (iii) successful prioritisation of the human aspect (Inclusivity, Gender dimension, Interdisciplinarity, User Perspective, Collaboration, Iterative Feedback, Ethical Considerations) and creation of a meaningful and inclusive environment. Results are shown in Figure 3. Agreement was evaluated on a Likert scale from 1 to 5. On average, all three categories ranked fairly high, between 4.0 and 4.5.

Lastly, questions about the adequateness of financial support to students, were also included in the survey. As per the INDUSAC methodology, each student received up to 1.000 EUR gross for a successfully finished project, and this amount was reduced as the number of students per team increased, as each team received up to 3.000 EUR gross. Results, demonstrated as distribution of opinions among different geographical groups (ie., EU member states, widening countries, and EU associated countries), are given in Figure 4, and indicate that overall, between 58% and 70% of students agree that funding was sufficient.

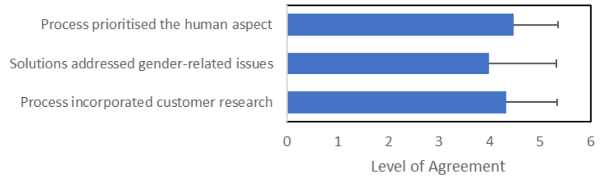

Figure 3: Agreement of students / researchers with incorporation of customer-oriented and human-focused elements in the projects. Average values ± sd are shown (n = 61). Agreement was measured on a Likert scale: 1 – very poor, 2- poor, 3 – average, 4 – good, 5- very good.

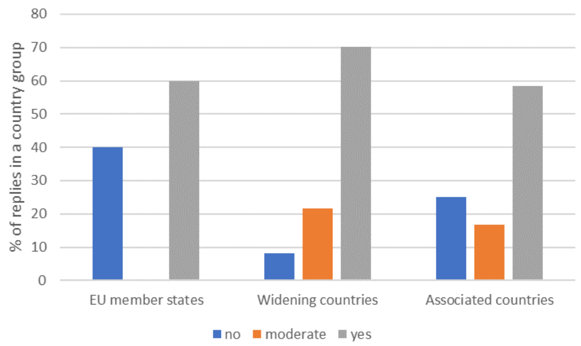

Figure 4: Perception of adequacy of funding within the scheme in the INUDSAC project, as surveyed among students and researchers from different countries of residency. Within EU member states, there were no opinions towards [moderate]. Total number of individuals responding was 5 in EU Member States, 37 in widening countries, and 12 in associated countries.

4 DISCUSSION

The INDUSAC approach set out to bring several advantages to the existing landscape of knowledge transfer practices, such as inclusiveness represented by gender balance, international cooperation by mandatory geographical diversity, enhanced support to widening countries by mandatory representation in the teams, and expansion to include students via mandatory participation of at least one student per team solving companies' challenges; some of these have already shown to be advantageous for companies [2-4]. Our results point to initial indications that the INDUSAC mechanism, comprising the methodology and the platform, is relatively well accepted among companies (Figure 1), with room for improvement in certain aspects such as the user-friendliness of the platform and the time allowed to solve a challenge. The latter points to a general enthusiasm among companies to engage in finding solutions for more serious challenges as well, which is encouraging – in two cases, work is already under way to continue with the projects, and overall, around 30 % of co-creation projects have demonstrated true value to the company involved, and there is potential in the further 50 %. So even with the constraints given, and taking two out of thirteen solutions rejected into account, companies have expressed a fair level of general satisfaction with the solutions and the work done by the teams (Figure 2). It is likely that this was aided by the methodology sections which defined interim reviews and evaluation steps (eg., reviews of challenges before publishing, reviews of Motivation Letters before starting, etc.), and regular communication between companies and co-creation teams during the project. In all except in one case, all deliverables were satisfactorily produced by the teams, indicating that the supporting documents that comprised the deliverables, and which were developed within the INDUSAC consortium, served as useful guidelines for particular type of challenge.

Having the project open to a wide range of challenge types also proved beneficial as among the 13 projects for which solutions were provided, seven out of nine possible challenge types were represented, and distribution among different challenge types was fairly even, with 'Marketing campaigns' and 'Service and product ideas' being most preferred.

An additional advantage was presented by the fact that the efforts to facilitate knowledge transfer between industry and academia are financially supported within the INDUSAC scheme. This type of support is particularly welcome, as the lack of funding is a frequent barrier for student-industry collaboration [5,6]. Around two thirds of surveyed students found funding to be adequate, and the largest percentage of this opinion was found among students from widening countries (Figure 4) indicating that the funding scheme shows promise for the major target group of the project.

There is, however, room for improvement – not least based on comments given by the companies themselves. Geographical balance, for example, may in some cases be an obstacle, as, in one company's opinion, having a team with members from different countries can make it difficult to work on projects that require physical experience with a product. It is likewise important to be able to streamline the process, which needs to be backed by a reliably functioning platform, as well as to unify the working space, as it was, in one company's opinion, difficult to keep track which information they received from which platform. Lastly, as mentioned, companies have expressed interest in a more flexible data management, as the project's timeline may prove too rigid. In terms of funding, one student pointed out that it would have been preferable to receive funding during the project rather than after, to allow for traveling to companies and collecting data. The problem of limited mobility was also perceived by companies, two of which stated that the biggest challenge in projects related to physical products was that the participants cannot get to know and test the products live, and that creativity may be limited due to the lack of face-to-face interaction with products and colleagues.

5 FUTURE PERSPECTIVES

The INDUSAC project set out to show that companies benefit from a particular type of knowledge transfer in the form of creative young minds, that this knowledge transfer brings satisfactory results and useful solutions, and that the gender and geographical balance, as well as the inclusion of social elements

(Figure 3) have a positive effect on the overall process (satisfaction by teams, satisfaction by companies). While we did not perform any control studies (for example, with single-gender teams) to truly test the effect of gender balance, there was a slight positive effect of (i) number of team members and (ii) ratio of female-vs-male team members, on company's satisfaction with results and quality of work (unpublished data). Other results and selected testimonials from companies, complimenting the work of students and expressing their own belief that the students are richer for the experience as well, demonstrate that the INDUSAC mechanism shows promise in knowledge transfer, and the rejected solutions stand as reminders that even following the careful process of team assembly and selection, monitoring of the work done needs to be vigilant for it to lead to satisfactory results. With this in mind, the INDUSAC methodology is continuously improving and mechanisms are put in place to minimize such occurrences. The challenges that remain also include attracting larger numbers of companies and students / researchers to engage into cooperation, but the level of success described here represents a strong starting point.

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Approaches to Monitoring and Impact Assessment in Research Infrastructures

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ABSTRACT

Impact assessment is a critical process in understanding the broader effects of research infrastructures (RI) on various sectors such as science, society, the economy, and policy-making. It helps RI identify their strengths, weaknesses, and areas for improvement. The paper addresses the challenges of monitoring and evaluating the impact of RI, focusing on the distinction between performance monitoring and impact assessment. It emphasizes the importance of demonstrating the broader societal, economic, and scientific impacts of RIs to inform public policy and secure funding. In the article we address different methodological approaches to impact assessment and self-evaluation of RIs as well as the possible challenges in these processes. The paper advances the integration of multiple evaluation approaches to provide a robust and detailed assessment of the contributions RIs make to society, the economy, and scientific development.

KEYWORDS

Impact assessment, monitoring, research infrastructures

1 INTRODUCTION

Research Infrastructures (RIs) are essential facilities that offer resources and services to research communities, enabling them to conduct research and drive innovation. Beyond their primary role in research, these infrastructures can also support education, public services, and other non-research activities. They may take various forms, including single site, distributed, or virtual setups. RIs encompass human resources, major equipment, and/or sets of instruments, as well as resources containing knowledge, such as collections, archives, and databases. They are used by scientists from various disciplines – e.g. astronomy, biology, chemistry, physics, human and social sciences, etc. RIs can maintain their competitive advantage only if they keep pace with the latest advancements in relevant scientific fields and the newest techniques and technologies. Therefore, it is crucial for RIs to connect with the research community and industry to stay aligned with developments in both science and technology. [1]

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In recent decades the significance of research infrastructures has become increasingly evident across all fields.

Although RIs are primarily designed to meet research needs, their influence extends well beyond promoting scientific excellence. The advanced technological capabilities and concentration of skilled expertise they provide can stimulate innovation, create or expand markets, attract foreign investment, boost economic activity, and potentially enrich the social and cultural life of a region. [2]

RIs necessitate relatively large and long-term financial investments, making it crucial for investors, policymakers, and other stakeholders to ensure that these infrastructures operate successfully and effectively, contributing to scientific advancement and addressing societal and economic challenges.

Although reflections and publications on defining and measuring impact have increased in recent years, there is still no unified framework or consensus on how to assess the impact of RIs. Therefore, it is crucial to explore the potential for developing such a framework and investigating its practical application.

2 PERFORMANCE MONITORING AND IMPACT ASSESSMENT

To this end, various solutions have been developed to enable stakeholders to monitor performance and evaluate the impact of RIs. However, there is a distinction between these two activities, which this paper aims to clarify. The concepts of performance monitoring and impact assessment represent two distinct yet related processes for evaluating the activities of institutions. Although both processes involve data collection and analysis of RI performance outcomes, their focus, scope, and objectives differ.

Performance monitoring, often simply referred to as "monitoring", involves the systematic and regular collection and analysis of data related to activities and outcomes. This process is crucial for assessing progress toward predefined goals, identifying areas where activities are achieving success, and pinpointing areas that require improvement. Typically, performance monitoring focuses on tracking key performance indicators (KPIs), which serve as measurable values that reflect the effectiveness and efficiency of the activities being evaluated (e.g. Number of publications, Number of master and PhD students using the RI, Outreach through media, ...).

Impact assessment, in contrast, focuses on identifying and evaluating the changes within the broader ecosystem that result from the activities and outcomes of RIs. This process aims to determine which specific RI activities lead to impacts across various domains. A well-established approach, developed through European initiatives (such as the RI-PATHS [3] project), is the concept of "impact pathways". This method enables evaluators to trace the different routes through which activities translate into impacts at various socio-economic levels.

Impact assessments can be conducted either before or after the implementation of RI. When carried out during the planning phase, this process is known as an "ex-ante" impact assessment. Its purpose is to forecast the potential impacts of the RI, anticipate its effects, and inform strategic planning to ensure those outcomes are realized. This type of assessment is largely conceptual and, to some degree, abstract. Once the RI is established and fully operational, an "ex-post impact assessment" is conducted to evaluate whether the RI has successfully met its intended objectives.

When determining criteria and indicators for monitoring and evaluating (e.g., research infrastructures, measures, programs, policies), it is crucial to recognize the differing roles of these two processes. Monitoring focuses on real-time oversight of implementation: as a funder, one needs to know the current status, whether progress is on track, whether funds have been appropriately allocated, whether a sufficient number of target audiences has been engaged, etc. While monitoring can alert us that things are not proceeding as planned, it does not reveal the causes of deviations nor provide adequate information for making necessary corrective actions [4].

On the other hand, the role of evaluation is to explain how the institution/measure/program/policy functioned, how successful it was in achieving its objectives, and what its impacts were. Evaluation allows us to determine success, identify what worked and what did not, and, if not, what changes need to be made in future planning. The focus of evaluation may be on assessing the degree to which objectives are achieved, or it may focus on the process of implementing the instrument/program/policy itself.

Impact assessment is beneficial for RIs when used to evaluate and enhance their functioning. It plays a crucial role in the strategic planning of an RI by informing decisions on internal resource allocation and driving continuous improvement and alignment of services with the needs of users and other stakeholders. Additionally, impact assessment fosters accountability and transparency, thereby enhancing the legitimacy, visibility, and overall value of the RI. Furthermore, it serves as a platform for meaningful dialogue and exchange among relevant stakeholders regarding the objectives, direction, and operations of RIs, which can be exceptionally valuable. [5]

The OECD defines impact as "the extent to which an intervention has produced, or is expected to produce, positive or negative, intended or unintended effects at a higher level." [5] The European Commission mandates the implementation of impact assessments for every policy intervention or law (including investments in research infrastructure and their activities) expected to cause significant effects or require substantial financial resources. Impacts represent all "direct or indirect changes" relative to the baseline scenario. Such impacts may occur over different time periods, affect different stakeholders, and be relevant at different levels (local, regional, national, and EU) [6].

2.1 Defining Areas for Impact Assessment

Impact assessment becomes especially crucial in times of limited public funding for science. By highlighting the effects of RIs on science, society, the environment, the economy, and other sectors, impact assessments can demonstrate the value of both potential and actual investments in RIs. This analysis helps to underscore the relevance of these investments in addressing societal needs. Moreover, impact assessments provide policymakers with a clear picture of the broader benefits that RI activities offer, thereby supporting the development of informed public policies and decision-making.

Impact assessment is closely tied to the goals of RIs and the expectations they set. The ESFRI [1] working group on RI performance monitoring has identified nine objectives which are relevant to RIs [7], and largely correspond to the following five impact areas:

- **Contribution to Scientific Excellence**: At the heart of every RI is the drive for scientific excellence. RIs contribute in numerous ways, including data collection and preservation, providing access to infrastructure and databases, sample collection and dissemination, facilitating analytical experiments, offering software, and providing general support to researchers. These activities are fundamental to the research process, fostering scientific progress by advancing innovative research, expanding the frontiers of knowledge, and generating new insights and discoveries.
- **Addressing Societal Challenges**: In recent years, addressing societal challenges has become an increasingly important focus for RIs. Their impact ranges from contributing to the United Nations' Sustainable Development Goals and the European Green Deal to enhancing public understanding of science.
- **Contribution to Innovation and Economic Development**: Given the substantial financial investments required by RIs, it is crucial to highlight their role in driving innovation and economic growth. This can be reflected in job creation, economic development, or increased competitiveness, particularly at local, regional, and national levels. Large RIs, in particular, employ a significant workforce and, in some cases, make substantial investments in constructing and offering high-value-added components.
- **Contribution to Policy-Making**: Research facilitated by RIs can significantly inform policy-making across various thematic areas. This is especially important for organizations responsible for policy development at the European or national level.
- **Contribution to Human Resource Development**: Many RIs also focus on education and training, often dedicating significant resources to these efforts. As centers of scientific excellence, they play a crucial role in developing human resources and training the next generation of scientists. They impact their users and their careers through enhanced scientific excellence, productivity, networking, and training opportunities.

[1] European Strategy Forum on Research Infrastructures

Listed areas are not relevant only to RIs, but can be relevant also to other research organizations.

3 METHODS AND APPROACHES FOR MEASURING IMPACT

In the RI-PATHS project [3] a comprehensive review of literature was conducted on methodologies for evaluating and measuring the socio-economic impacts of RIs. The project focused on ex-post impact evaluation methodologies, which are employed during the operation of RIs when it is possible to ascertain whether they are creating certain impacts and in what manner. The effectiveness of the analysis is demonstrated quantitatively (e.g., through indicators) or qualitatively (e.g., through case studies). [8]

Six main approaches/methods for measuring impact based on the literature review were identified:

1. Socio-economic assessment based on impact multipliers: This approach evaluates the socio-economic impact of a policy or project by quantifying the effects on various economic sectors. The assessment is based on impact multipliers that estimate the indirect effects of the policy or project on the economy. This approach expresses impacts on aggregated macroeconomic variables such as GDP, gross value added, or employment. The main advantage of this methodology, which is grounded in a well-established theory and uses input/output analysis tools, is its reliability in producing reproducible and comparable project results. However, its limitation is its restricted validity, as it often cannot reliably measure non-monetary effects (e.g., cultural, social, and environmental).

2. Methodologies utilizing the knowledge production function: This approach focuses on the impact of research and development activities on the economy. The knowledge production function method quantifies the relationship between research and development investments and economic growth. The approach focuses on only a small portion of the expected socio-economic impacts of RIs.

3. Cost-benefit analysis (CBA): This approach compares the advantages and disadvantages of a policy or project and determines whether the benefits outweigh the costs. The analysis considers both quantitative and qualitative factors to enable well-informed decision-making. All costs or benefits are monetized, even if the effects are not solely financial. Governments and economists frequently use this approach to assess the impact of various investment projects. It is reliable for comparing positive and negative effects and can capture numerous RI impacts. However, it can be expensive and time-consuming and has limited causal explanatory power. Additionally, it may not always capture all drawbacks.

4. Multi-methods multiple partial indicators: This approach combines multiple methods and indicators to evaluate the impact of policies or projects. Methods can include surveys, focus groups, and statistical analysis, while indicators encompass economic, social, and environmental factors. An example of this approach is the OECD framework for socio-economic impacts, which includes a list of 25 essential impact indicators and 58 additional standard indicators.

5. Theory-based approaches: These approaches rely on established economic or social theories to evaluate the impact of a policy or project. They depend on theoretical models and empirical evidence to predict impact. A typical example is the “logical framework/model”, which is based on a logical sequence of steps from inputs to impacts. Theory-based approaches share common features such as considering the broader context and external factors that can affect success and defining “impact pathways”. The impact pathway approach was further developed in the RI-PATHS project, which explores more details than the logical framework and provides a descriptive vision with more information on causes and effects.

6. Case studies: This approach involves an in-depth analysis of a specific case to understand the effectiveness of a policy or project. The analysis focuses on the specific context, identifying factors contributing to success or failure and deriving lessons that can be applied to future policies and projects. When used in impact evaluations, case studies aim to better reflect the uniqueness and complexity of RIs.

It is evident that some approaches are more suitable for assessing economic rather than social or scientific impact, and vice versa. In general, these approaches can complement each other—some are more quantitative, such as macroeconomic modelling or cost-benefit analysis (CBA), while others are more qualitative, like case study descriptions.

The RI-PATHS project systematically evaluated each of the mentioned approaches using criteria such as reliability, validity, precision, cost and time efficiency, and relevance to both policymakers and research infrastructure managers. It is evident that no single methodological approach can comprehensively address all the questions intended for impact evaluation. However, combining different approaches can offer greater value and effectiveness compared to relying on existing methods alone.

4 IMPACT PATHWAYS AND INDICATORS

While there is not a universally accepted approach to impact assessments in RIs, the work of the RI PATHS project has, as mentioned, become well established in Europe. Indeed, results from the survey conducted by ESFRI among RIs [7] show that impact pathways have become a common method for impact assessments among European RIs. Several RIs have conducted their impact assessments with the help of impact pathways as part of the RI-PATHS pilot exercises (for example, ALBA, ELIXIR, EATRIS) [9]. Identifying impact pathways was also an integral component of the impact assessment of ICOS [10].

The mechanism of impact pathways is recommended as a way to demonstrate causal links between inputs, various activities and outputs of RIs, and their identifiable impacts [3] [11]. These can be both intended or unintended – while impact pathways always have a clear origin in one or few related activities, which are under control of RIs, these activities branch out into different directions and trigger effects in different areas, which can be outside the sphere of influence of RIs. An example of exploring impact pathways according to spheres of control, influence, and interest can be seen in AnaEE’s position paper [12], which sought to build a framework that would specify AnaEE’s position in the chain of actors generating impact in its scientific field.

In order to map the path from activities of RIs to outcomes and impacts, it is crucial to systematically collect data. This is recommended for both performance monitoring and impact assessment. Several lists of indicators have been proposed in recent years (OECD, RI PATHS, ESFRI WG). The indicators can vary – from those that primarily measure performance, also known as key performance indicators (KPIs) [5], and those which are focused on impact (e.g. OECD prepared a list of impact indicators) [13]. The purpose of impact indicators is to create a link to strategic objectives of RI, as well as to different areas of impact that RIs create. In addition to the connection of indicators with strategic goals, the OECD recommends that the indicators provide information related to operational issues and that the data is measured in a specific time frame.

Impact indicators can be quantitative or qualitative, e.g. in form of “narratives”. This information is usually collected via tailored methods, such as interviews, surveys, or case studies. These indicators are more difficult to be standardised and must be tailored for specific RIs and depend on the context. These methods can help RIs to report on intangible impacts.

5 INTERNAL AND EXTERNAL IMPACT EVALUATION

Both external and internal evaluations are relevant for assessing the impact of RIs, each with its advantages and disadvantages. External evaluations are conducted by independent evaluators who assess the institution's impact. This approach ensures an objective and impartial assessment, as external evaluators are not affiliated with the evaluated institution and are, therefore, less likely to be influenced by internal biases or personal interests. Additionally, external evaluations can provide new perspectives and insights that are not available to internal evaluators. However, external evaluations are often costly and time-consuming and may sometimes fail to account for the contextual nuances and priorities of the evaluated institution.

In contrast, internal impact evaluations rely on an evaluation process conducted by the institution's staff or stakeholders. This approach is more cost-effective and efficient, as internal evaluators are already familiar with the institution and its operations. Internal evaluations may also better consider the institution's contexts and priorities and be more adaptable to changes in RI goals. However, internal evaluations may be biased due to internal motivations and conflicts of interest and may lack the objectivity and independence of external evaluations. Moreover, internal evaluators may be limited by their knowledge and expertise, reducing their ability to bring new insights and perspectives.

The choice between external and internal evaluation often depends on internal capabilities, available resources, evaluation objectives, and so on. To ensure a comprehensive and balanced assessment, it is beneficial to combine both approaches. It is also increasingly common for institutions (including RIs) to periodically self-evaluate, thereby preparing for external evaluation.

6 CHALLENGES AND OBSTACLES

There are several challenges that RIs encounter while conducting impact assessments. Some of them were outlined by respondents to an ESFRI survey among RIs (2023). According to the survey, a recurring challenge was to identify an appropriate method or framework or finding appropriate indicators. Other respondents mentioned the amount of resources required and the time frame needed to properly evaluate the impacts of their infrastructure. In general, some RIs are concerned that impacts may not be properly detected. This is a similar issue to what was described in the ERIC forum’s “Report on Socio-economic impact framework” [14] as a “traceability” problem – there is uncertainty about how to link RI activities or data generated within an RI to their subsequent use. One of the RIs responded that measuring innovation or social impacts could take several decades.

It is important to note that some challenges may be specific (or more common) to a certain type of RI or to certain thematic areas they cover. To address this challenge, the recommendation is to avoid directly comparing impacts of RIs, and to consider the diversity of RIs. When deciding on a methodology, it is advisable to tailor the selected methodology to each RI, and first establish a consensus between RIs, funders, governments and other relevant stakeholders. This agreement should establish clear expectations regarding the objectives of the RI and the assessment itself. However, all RIs should strive to demonstrate impact in the field of scientific progress, while considering various other socio-economic impacts.
Providing adequate resources for the implementation of an impact assessment is indeed challenging, in particular as it is necessary to adopt a long-term plan for evaluation in order to capture impacts that take years to reveal. At the same time the data collection needs to be done systematically and begin early enough, which can be more resource intensive although also helps to lower the amount of “ad-hoc” data collection when conducting impact assessments.

In spite of these challenges, impact assessments provide important information for all RI stakeholders, as well as the general public, as they allow RIs to demonstrate their contributions to science, society and the economy, and help improve their performance. As such, they can be used as means to communicate about RI activities. Promoting and disseminating the results of these evaluations can subsequently help promote positive RI development and funding.

7 CONCLUSIONS

Despite the growing focus on this area, there remain significant challenges in developing a unified and comprehensive framework for evaluating such impacts, particularly when accounting for both economic and non-economic factors. There is a reason for that – the unified methodology cannot adequately address all aspects of variety of RIs and the diversity of fields where they operate. There is a number of methods which can be applied, and future work could explore how combinations of different methods (e.g. quantitative, such as macroeconomic modeling and cost-benefit analyses and qualitative such as case studies or theory-based assessments) can be effectively balanced. This could provide more holistic view on RI impacts, especially in understanding intangible impacts like societal and environmental changes.

There are already lists of indicators suggested to be used for impact assessment, nevertheless the selection of indicators should be done with a great deal of prudence and not to be used to compare RIs, given the diversity in their structure and objectives.

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Intellectual Property Valuation in the Cyber Security Sector

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ABSTRACT / POVZETEK

This paper explores the applicability of intellectual property rights (IPR) valuation methods in cyber security by using the criteria of the Artificial Intelligence development phase model. After analysis of the interconnections and interdependency in cyber security products, an approach to data quality is proposed. It is worth emphasizing that the process of valuating IPRs is highly contextual and requires professional judgment based on the experience of the appraiser, now also in terms of data management. This issue has not been discussed in the literature, an article is a contribution to the discussion on the importance of valuation in the cyber sector, given the specific characteristics of cyber start-ups using AI and machine learning solutions. Despite all these difficulties, IPR valuation will become increasingly necessary and induce further questions regarding the valuation of a given intellectual property (IP). Firstly, how to value a patent with Artificial Intelligence (AI), secondly how to assess the level of sophistication of model training, and thirdly how to rate and value data quality, or more broadly data sets. The findings can help practitioners, especially from Technology Transfer Offices, to develop roadmaps for IP valuation in the cyber security industry.

KEYWORDS / KLJUČNE BESEDE

IPR valuation, IP in cyber security, data quality in AI model

1. CYBER SECURITY SPECIFICITY VERSUS IPR VALUATION

1.1 Introduction

The growth in importance of IPR is unquestionable, in every sector of the economy, and in those key to the digital transformation an undisputed. The IPR valuation is gaining in importance and reliable valuation is relevant in the cyber security sector. The valuation approach dedicated to the cyber market is not described in the literature and represents an unexplored research question. In IPR valuation, whatever the method, the essential characteristics of an intellectual asset should be taken into account. There is a fundamental complication arising from the difficulty of determining the essential characteristics of IP, the scope of protection, and the need to consider source data related to potential cyber exploitation on an unprecedented scale. IP assets can be independently identified, are transferrable, protected and that protection can be enforced. In the case of cyber, they have an economic lifespan, defined by their characteristics. Depending on the nature of intangible assets, there are different legal instruments by which protection is possible and ultimately benefit from using them. It is important to understand the economic value of cyber IP assets by carrying out an IP valuation. The article addresses a topic specific and relevant to the digital economy, the literature abounds with methodologies for different approaches to valuing IPR [9], [1], but there is no guidance on how to consider the importance of data, learning models, and all aspects of AI in new inventions. The challenges faced by the cyber security sector are defensive AI and machine learning technology, sophisticated cyber attacks, reinforcement learning-based cyber attacks, AI-enabled malware, the vulnerability of IoT technology, cloud security issues, and the involvement of cryptography. However, future directions, in cyber security, such as quantum-secure encryption, biometric authentication, advanced artificial intelligence, and machine learning, may be able to address these issues.

1.2 Cyber security products

According to the American Authorities, precisely Cyber Security and Infrastructure Security Agency, cyber security is "the art of protecting networks, devices, and data from unauthorized access or criminal use and the practice of ensuring confidentiality, integrity, and availability of information" [2]. The current cyber security situation is characterized by the regular emergence of new cyber threats. The most common types of cyber threats include malware, phishing attacks, ransomware, threats against data or availability, disinformation, supply chain targeting, and distributed denial of service (DDoS) attacks. The level of digital resilience varies from different industries and countries, however, effective cyber security remedies use security technologies and techniques such as intrusion detection and prevention systems, firewalls, antivirus software, and encryption [8]. Cyber attackers are constantly evolving their approach to penetrate the computer systems of enterprises which means that organizations must continuously monitor their networks against potential attack vectors, using a broad array of cybersecurity solutions to protect the entire ecosystem, including clouds and several applications [8].

Typical products are software for stopping the biggest, bandwidth-busting DDoS attacks, software that proactively reduces attack surfaces, Edge DNS, authentication services, clouds for protecting customers and providing data security, which reduce friction during registration, authentication, and sign-ins while making it easy for customers to control their accounts from any device. Products are, on the one hand, closely related to IT or ICT. On the other hand, they use the latest developments in biometrics, behaviorism, psychology, and the sociology of human behavior. They use, as in criminology, knowledge about human behavior, but the implementation of knowledge is strictly technical, in a digital world.

2. MULTIDIMENSIONAL IP PROTECTION

2.1 Impact of cyber product features on IP protection

The development of new solutions to combat or prevent cybercrime requires the proactive action and the creation of new inventions combating the criminal incidents. Since AI is widely used in cyberspace, AI-based products are also tools for mitigating attacks. Ransomware and phishing attacks encrypt critical data, demand high ransoms, and disrupt a wide range of operations. The growing use of Internet of Things devices is introducing new security vulnerabilities, while cyber attacks targeting the software supply chain are exploiting third-party vulnerabilities to gain access to sensitive information. Artificial intelligence technologies enable cybercriminals to launch sophisticated attacks. These AI-based threats are often not subject to traditional security measures, making them difficult to detect and mitigate. The World Intellectual Property Organization (WIPO), the United Nations agency that serves the world's innovators, is following the trend of consumer interest in AI in various economic, social, and cultural sectors, having published some very interesting and important reports on AI over the past few years. [6], [10]. WIPO Technology Trends 2019 – Artificial Intelligence reveals trends in patenting of artificial intelligence innovations [10]. AI-related patents disclose AI techniques and applications and refer to an application field or industry. WIPO analysis shows that many sectors and industries are exploring the commercial exploitation of AI, telecommunications (mentioned in 15 % of all identified patent documents), transportation (15 %), life and medical sciences (12 %), and personal devices, computing and human-computer interaction (11 %), the rest - other sectors including banking and security. In the WIPO patent landscape report on Generative AI, there are the latest patent trends for GenAI with a comprehensive and up-to-date understanding of the GenAI patent landscape, alongside insights into its future applications and potential impact. The report explores patents relating to the different modes, models, and industrial application areas of GenAI. Deep neural networks can be adapted to be either discriminative or generative tasks, which has led to the development of various types of GenAI models, which can support different types of input and output data. This opens up a new perspective on the protection of inventions and products.

There is a need to answer the threshold question of whether such AI-related inventions qualify for patent protection. The United States Patent and Trademark Office (USPTO) has issued guidelines to clarify the requirements for patenting AI-assisted inventions. For an invention to be patentable, there must be significant human input into its conception. Human inventors must make a significant contribution to the invention that goes beyond the mere use of AI tools. Otherwise, the invention is not eligible for patent protection. In addition, the USPTO has created five principles for evaluating AI-assisted inventions, the fifth is worth mentioning here - namely, merely owning or supervising an AI system does not qualify a person as an inventor without a significant contribution to the concept of the invention [7]. This principle ensures that human ingenuity remains at the heart of patentable inventions while recognizing the supporting role of AI in the inventive process. In the cyber industry, solutions can be protected by patents and then there is a need to value IPR in the form of a patent on an AI-related property. The number of cyber security patent applications per year shows that the amount of investment going into finding new ways to help prevent cyber attacks is huge. However, it is usually a bundle of different IPs that is valued. Apart from the fact that AI-related IP problems appear numerous, including AI inventorship, patent eligibility, and AI-related copyright issues, particularly important are data issues.

2.2. FLDX system – an example of IPR protection

An example of a cyber security product is the FLDX system, patent protected by NASK, a Polish National Research Institute, whose mission is to develop and implement solutions that facilitate the development of information and communication networks in Poland, in addition to improving their effectiveness and security. Patent – PL241005-*Method and system for adaptive creation of network traffic filtering rules on a network device spontaneously detecting anomalies and automatically suppressing volumetric attacks (DDoS)* protects digital services and network devices from DDoS attacks and a sudden and unpredictable increase in user activity. Sudden and unexpected bursts of Internet traffic can saturate network links or overloading application servers. Therefore, protecting networks and digital services from intentional attacks must go along with fair distribution of network resources. The FLDX system is a fast and extremely effective way to protect the availability of services on the network - whether the source of the threat is a volumetric DDoS attack or a sudden increase in user activity. Maintaining a fair distribution of network bandwidth is the primary goal of the FLDX system, achieved in a time of up to 10 seconds. Unlike the solutions currently offered in the anti-DDoS market, the FLDX system is not based on a database of signatures and static rules. It dynamically self-adjusts filters to the current situation. This approach allows us to react extremely quickly to the observed changes in network load, as well as forecast them. The FLDX system is therefore not only a protection tool - it is also a network knowledge discovery tool. The object of the invention is a method for adaptively creating network traffic filtering rules on a network device spontaneously detecting anomalies and automatically suppressing volumetric attacks (DDoS).

That FLDX example may illustrate the challenges of protecting IPR in this area. The speed and precision of the FLDX system are the result of years of scientific research in the fields of control theory and adaptive signal processing, the IP behind the solution is not only a patent, but also a copyright protecting the software and the user's system, trade secret, the implicit knowledge of the implementation as well as the knowledge contained in the technical documentation. Solutions are sporadically planned to be patent-protected, due to non-compliance with requirements for implementations of mathematical theorems or new applications of functional analysis. However, even an obtained exclusive right is not sufficient protection in the market. It is necessary, as with other software-based products, to supplement protection not only with copyright protection due to the nature of the solution but also to keep in secret any know-how resulting from the implementation and to circumvent technical problems arising from software development and installation in the cloud or at the customer's site.

3. IPR VALUATION ISSUES

3.1 Valuation approach selection

Valuation of IPR regardless of the subject of valuation strictly depends on the potential area of application of the protected technology. In the cyber sector, the issue of the valuation of IP goods is becoming increasingly challenging, for several reasons. First, this is due to the obvious development of the cyber market and the growing demand for all kinds of services and products protecting digital assets. Secondly, AI technologies are finding applications in this sector, which makes the valuation problem more complicated, and thirdly, a complex method of product IPR protection is common. The issue of IPR valuation in high-growth sectors, for new technologies, and cutting-edge technologies, has been addressed in the literature for years. Major researchers (such as Damodaran) describe the challenges of estimating value for technology [1], [9]. However, the growing cyber market introduces a significant level of complexity to the subject, due to the dynamics of development, key development trends, market estimation, and the scalability and adaptability of solutions in this market.

Depending on the nature of intangible assets, various legal instruments are offered to protect and ultimately profit from them. IP management is a key element of the business strategy of entities developing cyber services. The linkage of copyright protection, patent, trade secret, and confidential know-how protection makes IP valuation difficult. Trade secrets may be preferable to patents in several circumstances, such as when the patentability requirements may not be satisfied; the cost of pursuing patent protection outweighs the benefits; and/or the need for IPR protection extends beyond the available patent term [9].

Regardless of the method used, the valuation process requires gathering a lot of information about intellectual property assets, as well as an in-depth understanding of the economy, industry, and specific businesses that directly affect their value. It is well known that there are three basic categories of valuation methods for evaluating intellectual property and intellectual property rights: income-based, market-based, and cost-based. The choice of the appropriate method for valuing intellectual property depends on the type of intellectual property, the stage of development, the purpose of the valuation, and the available data. The cost method establishes the value of an IP asset by calculating the cost of a similar (or exact) IP asset. The cost method is particularly useful when the IP asset can be easily reproduced and when the economic benefits of the asset cannot be accurately quantified. This method does not account for wasted costs, nor does it consider any unique or novel characteristics of the asset. Although a cost-based method is used for software value estimation, the combination of various elements of protection makes one think about the wisdom of choosing a revenue-based method [9]. The income method values the IP asset based on the amount of economic income that it is expected to generate, adjusted to its present-day value. This method is easiest to use for IP assets with positive cash flows, for those whose cash flows can be estimated with some degree of reliability for future periods, and where a proxy for risk can be used to obtain discount rates. The market method is based on a comparison with the actual price paid for the transfer of rights to a similar IP asset under comparable circumstances. This method has the advantage of being simple and based on market information, so it is often used to establish approximate values for use in determining royalty rates and inputs for the income method. For cyber industry this type of approach can be highly problematic, since products in the cyber crime market are evolving very quickly and there is considerable difficulty in comparing them. Often, it is only possible to make inferences on the level of effects offered, i.e. expected rather than concrete results, due to the widespread confidentiality of information. Companies do not necessarily boast about the ineffectiveness of protecting their computers, resources, or access to the cloud.

While one approach may seem particularly well-suited, the final value estimation should merge the value indications obtained under different approaches [1], [9]. Irrespective of the choice of valuation approach, in the situation of innovation, patent, or AI-related know-how, there is an issue directly related to the understanding of the operation and use of AI models [4].

3.2. Data in Artificial Intelligence model

During training, the artificial intelligence model is exposed to a prepared dataset and tries to learn the patterns and relationships present in the data. This process involves adjusting the internal parameters of the model based on the input data and the desired outcome. In a situation where AI is used, another problem arises. When is the product in question completed? AI models need to be taught. What does AI model training include?

AI model training includes three main aspects:

a) data collection

There are ready-to-use open-source data sets. Data collection and other resources are also collected and used. Internal data collection provides access to proprietary information and control over data quality. Web scraping is the process of extracting data from websites using various tools. Automation eliminates the need for manual data collection, which in itself is impractical when it comes to training AI models. Regardless of the data collection technique, the data should be relevant, accurate, consistent, presentable, and complete. Such data increases the accuracy of the AI model, reduces bias, and increases user confidence and trust in the AI model.

b) data processing

Having a rich data set, it is necessary to validate the data. Data validation involves preparing the data to match the requirements of the specific learning mechanism used by the artificial intelligence model. Each learning technique requires the data to be presented in a specific way. An artificial intelligence model incorporating algorithms that learn through supervised learning aims to predict or classify new data points. So, to select data for an artificial intelligence model equipped with supervised learning algorithms, label your data. Then divide the selected data into training, validation, and test sets. Using the training set is needed to teach the artificial intelligence model, the validation set to evaluate performance, and the test set to evaluate the final model. For unsupervised learning, the artificial intelligence model aims to reveal underlying structures, group similar data, and discover patterns without the help of labels. The model needs to understand the data by finding commonalities and understanding the features that define a particular dataset. In this case, feature-based clustering of the data is required. This makes it easier for the AI model to navigate and learn from unlabelled data. The situation becomes a little more complicated taking into account reinforcement learning (learning through interaction) [5]. Artificial intelligence models involving reinforcement learning learn by exploring the specifics of a task in a particular environment and performing functions by trial and error. In reinforcement learning, an environment must be simulated for the AI model to interact with. However, another level of complication relates to deep learning (neural networks and beyond) , it is an advanced learning mechanism that drives the AI model and enables it to handle complex actions. AI models with deep learning algorithms require large-scale data collection based on what the model is supposed to do. As deep learning algorithms use multiple layers of learning, the goal is to have different versions of large data sets.

c) providing selected data to the AI model and iterative refinement

Once the data has been structured based on the AI model's learning technique, the data is fed into the AI model. The model learns from the algorithms on which it is built. During the learning stage, the capabilities of the model should be explored for refinement. Without iteration, the model cannot adapt to changing data and cannot improve its performance when exposed to other data sets.

This raises further questions regarding the valuation of a given IP. Firstly, how to value a patent with AI, secondly how to assess the level of sophistication of model training, and thirdly how to assess and value the quality of training and validation data, or more broadly data sets. In addition, in the cyber area, matters are further complicated by the use of sensitive or confidential data, such as tools for detecting illegal, offensive or harmful content based on data from law enforcement agencies. An additional legal complication arises.

4. RECOMMENDATIONS AND CHALLENGES OF VALUATION IN CYBER SECURITY SECTOR

4.1 Exploring difficulties

Nowadays, cyber security plays a crucial role in the global economy. The risk of cyber threats becomes more prevalent and cyber attacks can have devastating consequences leading to financial losses, reputational damage, and national security breaches. Therefore, it is imperative that governments prioritize cyber security measures to safeguard their interests. In addition to economic implications, cyber attacks also pose significant risks to national security. Governments around the world are increasingly concerned about hacking activities that aim to steal sensitive information or disrupt critical infrastructure systems.

Cyber attacks usually modify, access, or destroy sensitive information, extort users' money, or disrupt normal business processes. In 2024, the cyber security industry is expecting a paradigm shift in a more coherent and business-involved approach that reflects a better understanding and management of cyber threats [8]. This shift concerns the latest technology adoption and revolution, associated liability, maturity, integration, regulatory, quantification, communication, and behavioral shifts. As the market grows, there will undoubtedly be an increased demand for intellectual solutions to support the fight against cyber crime. Hence, the growth in importance of IPR will be indisputable, which in turn will result in a significant increase in the valuation of IP and its need in the market [3]. Therefore, IP valuation is an important issue, and reliable valuation is important for multinational corporations involved in IP transactions. IP valuation guidelines and regulations are also changing around the world due to different statutory provisions in each country. Valuing intellectual property involves assigning a monetary value to the intangible assets of a business entity. However, the intangible nature of intellectual property means that it is often difficult to value and define, making it challenging to set a fair price.

4.2 Recommendations

The most challenging tasks are determining the scale of the valuation portfolio, determining the role of AI in an invention, patent, or confidential know-how, determining the strength of a patent using AI and comparing it to other similar solutions, and determining the extent of model validation and database quality. Of course, issues related to the market, comparison of coverage, the scale of adaptation, etc. are also in force. However, completely new problems are gaining importance, the valuation of IPR in the cyber sector will be a further stage of complication and will require knowledge of a great level of AI invention protection and data management. A large part of everyday life is based on technology; personal, sensitive, and business data are stored on computers, smartphones, and tablets, so an extensive range of concepts are covered by cyber security - from communication to transport, and shopping to healthcare. It is crucial to consider the interrelationships and relationships between the different types of IP. Depending on the business needs, an appropriate valuation method should be chosen, taking into account whether the IP relates to AI. When analyzing an AI-related patent, the relationship to the data, the individual datasets, and the way the models are taught should be explored. Particular care should be taken to analyze the quality of the data and to understand the principles of data management (from collection, description, sharing, archiving, etc., including the FAIR principle – it is an acronym for Findable, Accessible, Interoperable, and Reusable). In addition, the origin of the data in the cyber sector should be taken into consideration. Moreover, in the cyber area, further complications are caused by using sensitive or confidential data, such as tools for detecting illegal, offensive, or harmful content based on data from law enforcement agencies.

Without high data quality, even the most advanced artificial intelligence models will fail. Data quality in the new era of AI highlights the key role of data quality in shaping effective data strategies. The task of the IPR evaluator in cyber products or solutions is to evaluate the AI model, and assess how each dataset is used, how the evaluation process works, which IPRs use it, and to what extent, and what parameters influence the business aspect of the entire evaluation process. The process of valuing IPRs is highly contextual and requires professional judgment based on the experience of the appraiser, now also in terms of data management and understanding of AI development and application phase.

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The Challenge of Licensing Artificial Intelligence Technology for Cybersecurity Applications

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ABSTRACT

The central question of this article is whether the transfer of cyber security technology based on neural networks into a production environment poses significant challenges due to the complexity and time variation of the technical environment, constantly evolving threats, and regulatory requirements.

The article uses observational research techniques for cybercrime activities, and experimental research for product management since 2011.

The article presents an application case study of behavioural biometrics and artificial intelligence (AI) techniques to detect remote desktop attacks, and technology transfer adaptations to changing conditions.

The added value of the paper is to draw conclusions from a real business case observed in internal business activities.

KEYWORDS

Cybersecurity, Artificial Intelligence, software licensing, software development, low compliance, behavioral biometric, AI licensing.

1 INTRODUCTION

NASK activities are focused on issues of security in cyberspace.

One of the areas of influence on cyberspace [6] is the provision of new technologies for counteract cybercrime and transfer them to commercial IT products. The goal is to increase resilience of the banking services and key services supplier [1].

The banking sector is particularly vulnerable to the activities of commercially motivated criminals [7], who are believed to be personally motivated in their criminal activities. These are criminals who directly seek to make a profit by seizing the funds of electronic banking users.

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It's difficult to quantify the impact of cybercrime on the banking sector, but public data from the US[17] and the EU [16] suggest it is around €4 billion each. The criminals are highly effective in the search for the optimal strategy of action in order to steal money from Internet users, while at the same time minimizing the legal risk and the resources (effort) involved **Error! Reference source not found.**

The criminal'ss resources involved are the use of a technical method, a socio-technical method, or both, leading to a successful theft [5].

2 METHODOLOGY

Since 2007, cybercrime data has been based on natural observations. NASK provides Computer Emergency Response Team (CERT) services at the national level and commercial threat intelligence services to the main financial institutions in Poland.
The case study is an original commercialisation case provided as part of the BotSense product offered by NASK.

3 THE BANKS, THE THIEVES AND EVEN THE SCIENTISTS

Poland has a population of about 38 million and in the first quarter of 2024, the Polish banking sector operates approximately 43,5 million accounts retail accounts with contracts allowing access to internet banking. About 23 million accounts are actively accessed via internet banking and about 22 million users access via mobile applications [15]. Since 2007, NASK has been working with the Polish banking sector to identify and counteract theft from Internet banking users. Over the years, with the improvement of technical methods of protecting electronic banking, both on the side of the banks and on the side of the end user, attacks based on vulnerabilities of IT systems, have been significantly reduced [2] [3]. They required sophisticated technical knowledge, considerable technical resources and centralised malware management, making such criminal infrastructure vulnerable to law enforcement.

Socio-technical attacks , on the other hand, have experienced a renaissance, using voice communication techniques to persuade the victim to provide the criminal with login and authentication credentials for banking transactions and, crucially, to give the criminal access to their device's desktop via a legal remote access application.

As a result, the attack scenario does not require any specialist IT knowledge [9], which has made this method of criminal activity accessible to a wider group of criminals, resulting in a sharp increase in the number of remote desktop attacks.

At the same time, in a social engineering and remote desktop attack scenario, there is virtually no event that can be classified as technically incorrect. The user voluntarily provides his or her credentials to the criminal, voluntarily agrees to open a remote desktop connection, and is often persuaded by the criminal to deliver the final blow by turning off the monitor. This means that no cybersecurity incident occurs in the data transmission channel between the endpoint and the bank's server.

Analyzing the above, it can be said that a dynamic market model is emerging in which criminals are effectively and efficiently adapting to the limitation of increasing the resistance of information systems to cyber-attacks. Criminals are creatively and rationally searching for new effective techniques and crime scenarios to carry out successful theft. The specific type of attacks mentioned above are those carried out with the unwitting participation of the victim.

However, banking institutions in particular, burdened by legislation [11], are forced to search for ever new technical solutions to identify electronic banking sessions compromised by criminals.

From a technology transfer perspective, this raises the non-obvious problem of how to organize the process of technology transfer to combat criminals.

4 Case Study - Behavioral biometrics and artificial intelligence techniques to detect a access via Remote Desktop

NASK set up an internal research project to work on an AI model capable of analysing how an end user uses a keyboard to identify themselves. In a laboratory environment, this is a task that requires a certain number of experiments, the construction of relevant data sets and the application of technical expertise, but in principle the level of scientific risk is limited. However, when it comes to transferring the developed technology to a production application that is expected to operate at a certain minimum level of effectiveness for the entire population using e-banking, the issue becomes much more complicated.

Even if the expected level of efficacy is auxiliary, e.g. 70%, and unrepresentative individuals are discarded from the user population.

4.1 The cybersecurity technology ecosystem

Cybersecurity technologies require deep and precise technical integration with the environment to be protected. For example, tracking the use of a keyboard via a web browser, as a function of the time can be disrupted by the security mechanism embedded in that web browser. One of the security mechanism implemented by vendors is randomization of selected user behavior data and disrupt the time line data.

If we take the oversimplification of identifying the main layers of the environment in which cybersecurity technology must operate, we can distinguish between technical layers: device category, hardware, operating system, components of operating system, web browser.

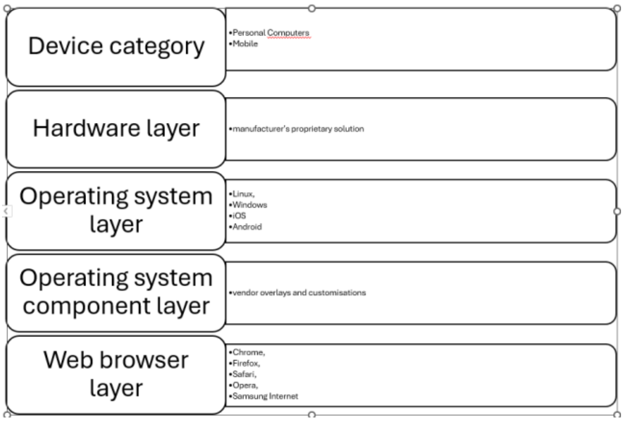

Figure 1: Technical layers

However, overcoming the additional complications posed by the diversity of devices, operating systems and web browsers does not guarantee the achievement of a stable, transferable technology. The whole technical environment described above is evolving. For example, the major web browsers, Chrome [13] and Firefox [14], are released on a monthly basis. This means that, the technical conditions under which cybersecurity technology should operate are constantly changing.

It should also be noted that changes affecting the security of the operating system and web browser may be made between the scheduled release dates of new versions and may involve unpredictable technical changes.

In addition, there are other elements in the formal-legal field [11] that we should consider, such as: international and national legislation, technical legislation, standards, norms, recommendations and internal company regulations.

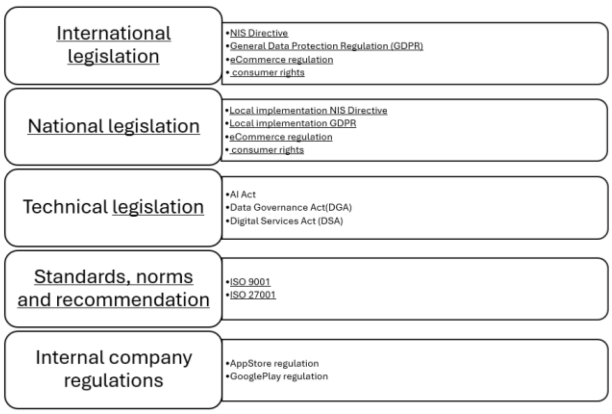

Figure 2: Formal layers

We are also seeing dynamic changes in the way criminals operate: variability of attack scenario and variability of tools.

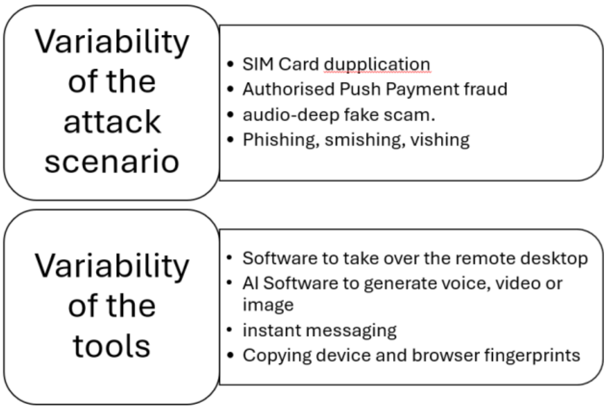

Figure 3: Criminal activity

And, of course, criminals are constantly identifying banking security techniques and bypassing or neutralising them [10].

We can think of cyber technology as a black box influenced by the forces of many independent parameters.

As in physics, the degrees of freedom (DOF) of a mechanical system is the number of independent parameters that define its configuration or state.

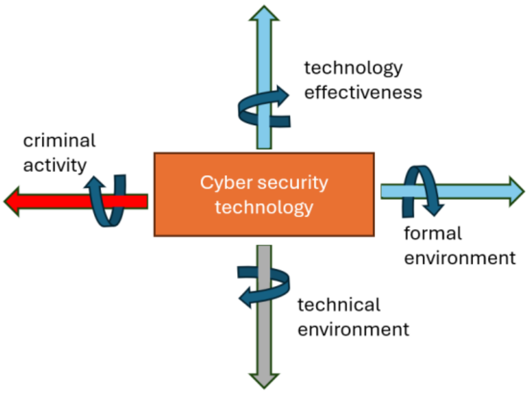

Figure 4: Forces affecting cyber security technology

A useful technology should be in balance between these parameters. If one vector increases, it means there's a need for action.

A multi-layered dynamic model of the variability of the environment is thus created, which seeks an equilibrium that includes the success rate of attacks. The stimulating (agonistic) factor is the activity of criminals and the antagonistic (inhibitory) factor is the development of security technologies. Another two parameters, which can be both agonistic and inhibitory, are changes in the technical or formal domain. Both can improve or reduce the effectiveness of cybersecurity technology. What is certain, however, is that all of these parameters create a need for constant review and adaptation of the technology.

4.2 The challenge of licensing

As a result, a solution developed in the laboratory will either start to fail immediately when deployed on the entire population, or it will start to fail over a finite period of time (as a function of time). This phenomenon has no risk characteristics, but is an inherent feature of the cybersecurity technology ecosystem.

The question is how to structure the process of technology transfer and licensing in this dynamic ecosystem?

In the process of technology transfer, we can distinguish:

1. Stage I - licensing the results of the R&D team and transferring them to the product development team (in this case software),
2. Stage II - advising the product development team on how to incorporate the innovation into the manufacturing environment.

Such an approach is not rational and will fail if we apply it to the transfer of cybersecurity technology.

This is because there is a high probability that the transferred technology will need to be modified before it is fully implemented in the product.

This will make the whole process infeasible and banks will start looking for non-IT methods to fight crime.

4.3 Practices applied

For technology transfer in the cyber domain, the NASK has adopted its own specific operating procedures.

First, the cybersecurity technologies developed in the NASK R&D teams are transferred to internal development teams.

By technology, we mean the form of a method, algorithm or learned AI model. The development team then builds a finished software component on top of it.

After that, the R&D team still, support and develop technology. The R&D teams are prepared for long-term development of the technology for detection of specific types of attacks, including its modification in the event of a change in the conditions of the technical environment in which the technology is to operate (e.g. loss of access to data relevant for detection).

Such organisation of technology production and preparation for transfer enables the temporary licensing of the finished software component, which allows the use of the cybersecurity technology for implementation in software. The license contains a number of specific conditions tailored to the cybersecurity ecosystem, the main ones are:

1. an assurance that the licensee will adapt the technology to changes in the technological environment,
2. an obligation on the licensee to improve the technology in the event of a decline in the effectiveness of attack detection,
3. an limitation of the licensor's liability for failure to adapt the technology to changes in the technological environment or to changes in the activity patterns of the perpetrators.

These points are almost impossible to define precisely. They are declarative in nature, with no strict guarantees from either party. The technology provider cannot reliably guarantee the effectiveness, cost or time it will take to modify its technology, and the recipient cannot guarantee the conditions under which it expects the technology to be effective.

In other words, the factor that determines the balance between the technology provider and the technology recipient is a common rational economic interest. And the basis for deciding on such a cooperation model should not be so much an assessment of the effectiveness of the technology at the time of its production, but rather the ability of the technology provider to modify and develop the technology to keep pace with changes in the application environment within a reasonable period of time.

5 Conclusion

The transfer of ICT technologies for cybersecurity may force a different way of thinking about building a collaborative model with business [12]. Thinking of collaboration with business as a one-off design phenomenon may prove to be a dead end. To ensure a steady flow of solutions for business in a rapidly changing environment, it is worth considering a process model of collaboration [4].

The example case study analyses the behavioral biometrics project and the AI technology used. However, the issue seems relevant to any application of technology or methodology in an unstable cyberspace environment.

The fundamental value of collaboration is to ensure the ability to solve a class of research problems within a reasonable time and cost. The process for sharing further technologies developed on the basis of the first project should be proposed in advance. The initial project or technology licensing is therefore only a starting point for long-term collaboration. It's also necessary to rethink the organisation of technology transfer agreements. Towards a collaborative framework and the definition of a dynamic research process.

For future work, it is possible to approach techniques to assist in predicting the effects of the changing environment.

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Technology Transfer: Revenues Estimation in the Cyber Security Sector

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ABSTRACT

This study investigates the complexities of technology transfer within the cyber security sector, focusing on the financial and operational challenges posed by its dynamic nature. The primary research problem is understanding how to define final cyber product and estimate associated costs, particularly in the context of both traditional and new economy revenue models. Preliminary findings reveal significant discrepancies in cost estimation and revenue forecasting, particularly due to the non-linear contributions of scientists, which complicate the creation of effective license agreements. The paper offers a framework to better align technology transfer processes with the unique characteristics of cyber security innovations, thus improving the accuracy of cost projections and licensing strategies.

KEYWORDS

Technology transfer, cyber security sector, revenue estimation, AI models, new economy, science contribution, license agreements

1 UNCERTAINTIES IN CYBER SECURITY TOOLS SPECIFICATION

Cyber security is a term with widely varying definitions that are frequently subjective and, in some cases, lack precision. According to the America's Cyber Defense Agency (CISA), it is defined as *the art of protecting networks, devices, and data from unauthorized access or criminal use and the practice of ensuring confidentiality, integrity, and availability of information* [11]. The absence of a clear, universally accepted definition that encapsulates the multidimensional nature of cyber security hinders progress in technology and science [6]. This is because it reinforces a technical perspective on cyber security, while simultaneously isolating disciplines that should be collaborating to address complex cyber security challenges effectively. The complexities involved significantly affect the determination of what constitutes a cyber security product, the criteria for deeming it complete, and the estimation of production costs within defined timeframes and budgetary constraints.

[†]Author Footnote to be captured as Author Note

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1.1 Defining cyber security product

Given the multidisciplinary nature of cyber security and its widespread impact on society, it is essential to establish, utilize, and elaborate a standardized terminology and develop a comprehensive, shared understanding of what constitutes cyber security product and economic risks associated with it [7].

In defining a cyber security product, it is crucial to recognize the role of interdisciplinary contributions, ranging from computer science and engineering to law, economics, and human factors. For instance, a cyber security product may include not only technical components, such as encryption algorithms or intrusion detection systems, but also legal frameworks and organizational practices that enhance security. The integration of these diverse elements requires a standardized terminology that can be universally understood across disciplines, enabling effective communication and collaboration.

Moreover, the definition of a cyber security product must account for its intended purpose and scope. Products may vary significantly in their focus - some are designed to prevent unauthorized access, others to detect intrusions, and yet others to respond to or recover from cyber incidents. This diversity necessitates a clear classification system that categorizes products based on their functionality, target environment, and the specific threats they address. For example, network security tools, endpoint protection software, and identity management systems each serve different purposes but collectively contribute to a comprehensive cyber security strategy.

Economic considerations also play a critical role in defining cyber security products. The value of a cyber security product is often measured by its effectiveness in mitigating risks, which are themselves subject to economic assessment. The economic impact of cyber threats, the cost of deploying and maintaining cyber security products, and the return on investment are all factors that influence how a cyber security product is defined and evaluated. This underscores the importance of aligning technical definitions with economic realities to ensure that cyber security investments are both effective and sustainable.

Furthermore, the lifecycle of a cyber security product must be clearly delineated, from initial development through deployment, operation, and eventual decommissioning. A comprehensive understanding of this lifecycle is necessary to establish criteria for when a product can be considered complete and to identify potential risks and vulnerabilities that may arise at various stages. This lifecycle approach also highlights the importance of adaptability in cyber security products, as they must evolve to address emerging threats and changing environments.

In summary, defining a cyber security product requires a multidisciplinary approach that integrates technical, legal, economic, and operational perspectives. Standardized terminology and clear classification systems are essential to fostering a shared understanding across disciplines, while economic considerations and lifecycle management provide the framework for evaluating the effectiveness and sustainability of cyber security products.

1.2 Estimating cyber product costs

A standardized method for measuring and managing the costs associated with implementing cyber security programs has yet to be established. To advance research and practice in this field, various cost estimation frameworks related to the development and deployment of cyber security products have emerged in recent years [9]. Estimating the costs associated with cyber security products is a critical aspect of cyber security planning and management. However, this task is fraught with uncertainties due to the dynamic and evolving nature of cyber threats, the complexity of cyber security products, and the diverse environments in which they are deployed [8]. Unlike traditional products, cyber security products must continuously adapt to an evolving threat landscape, where new vulnerabilities and attack vectors emerge regularly. This requires ongoing updates, patches, and upgrades, leading to unpredictable and often escalating operational costs over time.

Cost estimation for cyber security products involves several key components: development costs, deployment costs, operational costs, and decommissioning costs. Each of these components must be carefully assessed to provide an accurate estimate of the total cost of ownership (TCO) for a cyber security product.

1. **Development Costs:** These include the expenses incurred during the design and creation of the cyber security product. Development costs can vary widely depending on the complexity of the product, the technologies involved, and the level of expertise required. For example, developing an advanced threat detection system may involve significant investment in research and development, including the use of machine learning algorithms, data analysis tools, and security protocols. Additionally, the need for compliance with industry standards and regulations can add to development costs, as products must be designed to meet specific security requirements.
2. **Deployment Costs:** Once a cyber security product is developed, it must be deployed within the target environment. Deployment costs include the expenses related to integrating the product with existing systems, configuring it to meet organizational needs, and training personnel to use it effectively. In some cases, deployment may also involve significant infrastructure upgrades, such as installing new hardware or enhancing network capabilities. These costs can be substantial, particularly in large or complex organizations with extensive IT environments.
3. **Operational Costs:** The ongoing operation of a cyber security product generates costs related to maintenance, monitoring, and updates. Cyber security products must be continuously updated to address new threats and vulnerabilities, which can involve both software patches and hardware upgrades. Additionally, operational costs include the resources required to monitor the product's performance, respond to security incidents, and conduct regular security assessments. The need for highly skilled personnel to manage these tasks further contributes to operational costs, as cyber security expertise is often in high demand and short supply.
4. **Decommissioning Costs:** At the end of its lifecycle, a cyber security product must be decommissioned, which involves safely removing it from the environment and ensuring that no residual vulnerabilities remain. Decommissioning costs may include data migration, system reconfiguration, and the disposal of outdated hardware. Additionally, organizations may need to invest in new cyber security products to replace those being decommissioned, adding to the overall cost.

Estimating these costs is complicated by several factors, including the unpredictability of cyber threats, the rapid pace of technological change, and the variability in organizational needs and environments [10]. It means that a cyber security product may require extensive customization and integration efforts, which further complicates cost estimation. For example, the introduction of disruptive technologies, such as quantum computing, can render existing cyber security products obsolete, necessitating additional investments.

The need for specialized personnel to manage and maintain cyber security products, combined with the scarcity of cyber security expertise, adds another layer of complexity to cost forecasting. Furthermore, the consequences of underestimating the costs must be carefully considered, as they are often significant and far-reaching, potentially resulting in insufficient protection and increased risk exposure. This contrasts with other products, where cost overruns might primarily affect financial performance without posing immediate security risks. Therefore, the cost estimation of cyber security products must account for not only the tangible costs of development, deployment, and maintenance but also the intangible costs associated with risk management and the potential impact of cyber incidents.

To address these uncertainties, organizations must adopt a flexible and adaptive approach to cost estimation. This may involve using scenario analysis, which considers different potential future states and their impact on costs, as well as incorporating risk assessments to identify and quantify potential cost drivers. Additionally, organizations should consider the total cost of ownership over the entire lifecycle of the cyber security product, rather than focusing solely on upfront costs. This approach ensures that all relevant costs are accounted for and provides a more accurate estimate of the long-term financial commitment required to maintain cyber security.

2 METHODOLOGY

To address issues, this study employs a mixed-method approach. An extensive literature review is conducted. Relevant academic journals, industry reports, and government publications are examined. Additionally, qualitative data is collected through semi-structured interviews with key specialists and experts.

3 REVENUE ESTIMATION AND COMPANIES VALUATION

Cyber security is the practice of protecting individuals' and organizations' systems, networks, applications, computing devices, sensitive data, and financial assets against any digital attacks [3]. It refers to any technology, measure, or practice for preventing cyberattacks or mitigating their impact. We could categorize the main components of cyber security into the following areas: cyber security Governance, Policies, and Procedures, User Identity and Access Management, Network Security, Application Security, Data Protection, Business Continuity and Disaster Recovery Plan, Education. The number of fields results in miscellaneous cyber security business models, reflecting various comprehensive solutions in the evolving landscape of cyber threats and swift pace of technological advancement. The differences are both in revenue streams, cost structures and scalability.

3.1 Cyber security business models

We can distinguish three basic revenue streams: subscriptions, professional services, and licensing [5]. In first case cyber security firms offer their services on a subscription basis, providing continuous protection with regular updates and support in exchange for a recurring fee. This model ensures a steady and predictable revenue flow, development of customer relationships, mutually beneficial vendor relationships with major focus on customer procurement. Cyber security companies focused on professional services as business model often offer consulting, threat assessment, and response services. These include penetration testing, incident response teams and security audits. Finally, many companies operate under licensing model - selling licenses for proprietary security software or technology solution could be significant revenue stream, creates an easier entry into foreign markets, does not require capital investment or presence of the licensor in new geographical regions.

3.2 Classic technology valuation

Tech spending as a percentage of revenue has increased from 3.28% in 2016 to 5.49% in 2023 [4]. With bigger budgets often comes increased oversight and expectations from the business-tech leaders are becoming thoughtful about allocating capital for tech investments. 2023 Deloitte research shows that 6 in 10 executives struggle with measuring the value of these investments. The choice of an appropriate valuation method depends on the circumstances, scope, and purpose of the valuation – the three main approaches concentrate on the cost, market, and income.

Cost methods determine the value of intellectual property based on the historical cost of production or the estimated cost of replacement with assets of comparable utility. These methods involve considering any expenses that need to be incurred to remanufacture the asset or replace it with an asset comparable to the one being valued. Cost methods are applied mostly to unfinished or easily manufactured technologies. It is possible to imagine situations in which a relatively considerable sum of money has been spent on a technology that does not produce the anticipated benefits. In such a case, the valuation of technology by the cost method may significantly overestimate its value, and income methods will come to the rescue.

The income method of technology valuation is grounded in the belief that for a potential investor, a particular asset is worth as much as he can get income from that asset. The risk of the business and the time value of money should be considered. Valuation of technology using the income approach requires determination of the period of economic usefulness of the valued technology. It is done based on projected cash flows discounted at an appropriate discount rate. The income method is most often indicated as the most appropriate for valuing technology for which there is a high degree of confidence in the forecasts of operating income.

Market (comparative) methods of valuing intellectual property, on the other hand, involve estimating the value of technology based on a comparison to market transactions for similar assets. However, information on transactions for the purchase or sale of intellectual property is rarely publicly available. Therefore, the method often uses an analogy with the valuation of technology companies, whose value depends largely or entirely on the technology they own. The main shortcoming of this method is the inability to identify comparable technology. As a rule, each innovative technology is unique and has specific parameters, which leads to limited possibilities of comparison to existing solutions known to date.

3.3 Companies' valuation in cyber security sector

The Market Multiples method is a key tool for valuing companies in the cyber security industry. This approach involves valuing a firm by comparing it to similar private or recently acquired companies in the sector. Specifically, it focuses on two primary types of multiples: Revenue Multiple and EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) Multiple. For startups (especially those that are pre-profit) the Revenue Multiple is often more relevant. It compares the company's value to its revenue, offering a perspective on how the market values the revenue generated. For more mature companies (with significant earnings), the EBITDA Multiple provides a view of the company's value relative to its profitability before accounting for financial and accounting factors.

Applying the Market Multiples method effectively requires a deep understanding of market trends and financial metrics specific to the cyber security sector. The rapidly evolving nature of cyber security, with frequent technological innovations and varying threat landscapes combined with investor confidence in the sector's growth can significantly influence these multiples.

The most common purpose of technology valuation is the needs for commercialization of completed development work in R&D Units. It is determined as part of the commercialization of technology, the value of the sale to an external investor or in-kind contribution to a special purpose vehicle (SPV or Spin-off). Prior to the commercialization of intellectual property, there is often a need to determine the value of these intangible assets and whole company. Another reason, also encountered, for the valuation of technology is the need to recognize the fair value in the accounting books. Less common are cases of estimating the value of technology for litigation, where it is required to determine the value of the subject matter of the dispute or under collateral for financial instruments. In the case of cyber security technology and company valuations, it is useful to define the circumstances valuation determines purpose: accounting, market (for the current owners or new investors) or liquidation. It would be desirable to strike a balance between qualitative and quantitative measures.

4 IMPLICATIONS FOR TECHNOLOGY TRANSFER OFFICES

From the point of view of technology transfer and commercialization of scientific results, managing the process of new solution building using AI models is particularly difficult. The problematic question of revenue estimation implies further issues related to the creation of licensing or distribution agreements; additional complications also arise from the very characteristics of AI models. First, there are several problems associated with the application and obtaining Intellectual Property Rights (IPR) protection for such solutions. Secondly, cooperation with scientists is done in close cooperation with software developers, and scientific input is expected not in the entire process. Third, the solutions for specific markets generate several difficulties in shaping models for licensing agreements for the cyber security industry.

4.1 Intellectual Property Rights protection

When considering patenting AI-related inventions, there is a need to answer the fundamental questions of whether inventions qualify for patent protection. In European system, while a computer program or software may not be patentable, artificial intelligence and machine learning that serve or achieve a technical purpose may be a desirable alternative. The newest EPO guidelines [2], require the mathematical methods and training data used by an AI-related invention to be disclosed in sufficient detail to reproduce the technical effect of the invention over the whole scope of the claims. To address these issues and prepare a commercialization plan for the cyber security market, Technology Transfer Offices should identify the territories for patent protection for their AI inventions and assess whether such inventions meet the relevant subject matter eligibility criteria. If AI-related patent protection seems unfeasible and ineligible, TTO should consider protection using trade secrets or other alternatives. Protecting rights to training data, AI output, and other crucial training data requires attention, awareness, and careful action.

4.2 Relations with scientists

AI is forcing a change in the attitude of scientists, from that of a strict researcher to one that is far more oriented toward creating a working IT system. In terms of describing the types of scientists according to the Science Council, one can explain the change in attitude of the Explorer Scientist to the Developer Scientist [1]. This reflects a commitment to the area of creating AI solutions for specific and demanding markets. *"The Explorer Scientists rarely focus on a particular outcome or impact, rather they want to know the next piece of the jigsaw of scientific understanding and knowledge. [...] The Investigator Scientist digs into the unknown observing, mapping, understanding, and piecing together in-depth knowledge and data, setting out the landscape for others to translate and develop"* [1]. The scientist is needed at specific moments, the innovation forces seasonal involvement, the product is created more as a result of collaboration with programmers and software developers, and there is no space for discovering independent universal truths in the sense of breakthrough ideas or inventions. We observe the non-linear contribution of the researcher to the development of the cyber security product. For TTOs, this is an additional complication, the connection of the author to his work is strong, and the cyber security market forces not only close teamwork but also IT and data professionals themselves are gaining in importance. Data stewards have a significant impact on the development of AI models and thus cyber products. For TTO is a difficulty related to the progress and commercialization plans for a specific solution.

4.3 Risks in license agreement

Forming a license agreement for a product or solution using an AI model requires considering the strict characteristics of training AI models, the difficulty of determining milestones for model development, and the system of subscription or license fees depending on the stage of learning or re-learning the model. The fundamental difficulty in estimating and establishing profit or revenue models depending on the development of machine learning lies in the indefiniteness of the solution itself. Models need successive iterations, the cost of software development changes, and the demand for certain solutions also changes, which makes it exceedingly difficult to forecast profits and build a model of fees and payments in a license agreement. The described problem of revenue estimation forces the adaptation of cyber security solutions using AI models of licensing agreements and billing systems, a thorough reflection is needed in the society of technology transfer professionals on this subject.

5 CONCLUSION

Developing a more precise and universally accepted definition of cyber security products is essential for standardizing cost and revenue estimation processes. Authors will focus on robust methodologies to account for the non-linear contributions of R&D teams in cyber security, as current models are inadequate. These areas will dictate the trajectory of future research, reducing uncertainties in product finalization and financial forecasting.

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Prospects for the Use of AI Tools in the Republican Centre for Technology Transfer Network

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ABSTRACT

The paper informs about services and information resources provided by the Republican Centre for Technology Transfer (RCTT) to innovation activity agents and prospects for the use of AI tools in the RCTT Network in order to improve the quality and speed of preparing profiles (technology offers/requests, business offers/requests and R&D requests), creating promotion and marketing content to find potential partners, drafting contracts, etc.

KEYWORDS

Technology transfer (TT), AI, generative AI, technology transfer offices (TTOs)

1 INTRODUCTION

"Will AI be replacing people in the near future?" "It looks to me like, and for a while, AI is much better at doing tasks than doing jobs. It can do these little pieces super well, but sometimes it goes off the rails. It can't keep very long coherence. So, people are instead just able to do their existing jobs way more productively, but you really still need the human there today." Sam Altman, CEO of Open AI.

As noted in the UNECE White Paper on the use of Artificial Intelligence in Trade Facilitation [1], artificial intelligence (AI) is an enabling technology impacting the global economy and international trade. Combined with business-process-oriented automation and more efficient data flow exchanges, AI further promises to lift barriers to international trade, stimulate growth in global electronic commerce and allow for better predictions and associations to inform policy decisions.

The benefits of AI-based systems include:

– reducing the time spent on working with one document by more than 80%;

– reducing the number of errors in procedures;

– creating centralized repositories of information and documentation associated with files that will remain accessible even several years after the file is closed (the data is the property of the client);

– automation of interaction between all participants in international cooperation;

– direct access to file information from anywhere where there is an Internet connection, even from mobile devices and smartphones.

United Nations System White Paper on AI Governance [2] suggests an increasing recognition of AI's role in amplifying the work of governments and international bodies. Additionally, Gartner predicts a staggering 80% of project management tasks will use AI by 2030 [3], a testament to the growing reliability and trust in AI technologies within structured operational frameworks.

Since 2023 the use of AI in the work of technology transfer offices (TTOs) has been regularly discussed at webinars of the Association of University Technology Managers (AUTM).

On May 5, 2023, a webinar "Generative AI has Arrived: Essential Knowledge for TTOs" was held, which explained: What is generative AI? Why should you care? The current state of AI and applications, such as ChatGPT, that are already at your disposal. How you can implement these tools in your office, some of the most pressing risks and concerns your office might face, and a look into what's coming next.

On March 3, 2024, a webinar "The AI Enabled TTO" was held, where the use of AI by TTOs to improve the efficiency of their work was discussed, in particular to: automate routine tasks, analyze market trends, assess competitors, assess intangible assets, speed up decision-making and optimize resources.

On May 2, 2024, a webinar "Tailoring Your AI Tools for Tech Transfer Transformation" was held. This webinar explores customizing AI tools to better support unique tech transfer processes and goals.

Video recordings and presentations of these webinars can be found on the Internet portal of AUTM [4].

Participation in the above webinars, as well as the analysis of publications [1–6] shows that, AI can be used in the work of the TTOs to:

– improve the quality of profiles (technology offers/requests, business offers/requests and R&D requests) published in the TT networks;

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– analyze big data to identify potential technologies for TT, as well as to predict market trends and demand;

– monitor patents and publications – AI can monitor publications and patents related to a particular technology to assess interest from the scientific community and industry;

– search for technologies – use machine learning algorithms to search for and compare technologies, patents and research results that can be commercialized or licensed;

– automate processes – AI can help automate routine tasks such as technology and intangible asset assessment, document management and licensing processes;

– predict risks – analyze risks and possible obstacles in technology transfer using machine learning methods to predict the likelihood of project success;

– improving communication – using chatbots or neural networks to interact with potential partners and clients.

2 SERVICES AND INFORMATION RESOURCES PROVIDED BY THE REPUBLICAN CENTER FOR TECHNOLOGY TRANSFER TO INNOVATION ACTIVITY AGENTS

Tasks set for RCTT:

– create and maintain information databases meant for serving clients in the technology transfer sector;

– provide RCTT clients with access to foreign technology transfer networks;

– assist innovation activity agents in development and promotion of their innovation and investment projects;

– train specialists in research- and innovation-related entrepreneurship;

– establish RCTT offices across the country, to create a unified national network of technology transfer centers;

– promote international technical and scientific cooperation and exchange of experts.

RCTT is a consortium with the headquarters in Minsk that comprises [7, 8]:

– 5 regional offices and 30 branch offices at research organizations, institutes, universities, enterprises in Brest, Vitsebsk, Homel, Hrodna, Lida, Minsk, Mahileu, Novapolatsk and other cities and towns across Belarus;

– 98 foreign partners in 23 countries: Armenia (3), Azerbaijan (2), China (25), the Czech Republic (2), Denmark (1), Germany (4), Georgia (1), India (1), Iran (1), Italy (1), Kazakhstan (6), Lithuania (1), Moldova (1), Poland (3), Russia (25), South Africa (1), South Korea (4), Sweden (1), UK (2), the USA (3), Ukraine (7), Uzbekistan (1), Vietnam (2);

– 2 overseas field offices in China.

RCTT has implemented over 400 projects, including over 100 international projects funded by UNDP, UNIDO, CEI, EU, the Swedish Institute, etc.

RCTT experts are certified members of 14 foreign technology transfer networks.

RCTT offers its services to innovation activity agents in Belarus as well as foreign companies and investors.

RCTT has a web-portal [9], with several subject sections and databases such as: "Virtual exhibition of the NAS of Belarus"; "Catalogue of innovation offers by organizations of the NAS of Belarus"; "New partnership opportunities", to present in real-time offers and requests from RCTT, NATT, AUTM and EEN networks; "Catalogs"; "Manuals"; "Media"; "Commercialization", with subsections "IP auctions", "Investment and venture funds", "Crowdfunding" and "Technoparks of Belarus"; "IP insurance"; "Legislation", covering the laws and regulations applicable to innovation activity in Belarus and foreign countries, and others.

RCTT provide services to more than 250 Belarusian state organizations, private enterprises and individuals. The National Academy of Sciences, Belarusian State University, Belarusian National Technical University are among its clients. In 2003–2024 with the support from RCTT more than 8500+ persons improved their skills in the filed of technology transfer at 650+ national and international events (workshops, conferences, exhibitions).

RCTT is the coordinator of the Republican Center for Technology Transfer Network which contains more than 3000 technology offers, technology requests, business offers, business requests, and offers for cross-border R&D collaboration of Belarusian enterprises and organizations.

As of August 2024 the Internet portal of RCTT contains:

– 1120+ cooperation offers from NASB organizations in Russian language and 1010+ in English language,

– 45+ catalogs, presenting services and products of organizations of the National Academy of Sciences of Belarus in Russian, English and Chinese,

– information about 250+ exhibitions, 50+ brokerage events, 210+ webinars and events in the field of intellectual property management, transfer and commercialization of technologies where organizations of the NAS of Belarus took part (will take part) in 2019–2024,

– 50+ educational materials in the field of IP management, technology transfer and commercialization.

3 PROSPECTS FOR THE USE OF AI TOOLS IN THE RCTT NETWORK

RCTT plans to use AI tools to solve the following problems:

– automation and improvement of the quality of profile preparation (technology offers/requests, business offers/requests and R&D requests);

– creation of promotion and marketing content to find partners;

– automatic scanning and analysis of Internet resources, scientific publications, patents, catalogs and other data sources to identify competitors and potentially valuable technologies;

– identification of technologies that can be successfully commercialized by matching the proposed technologies and services with market needs;

– determination of optimal product promotion channels and optimization of marketing strategies;

– support of the negotiation process by providing information on market prices, transaction terms, etc.;

– monitoring and management of the commercialization process. After a contract is concluded, AI can be used to track progress in commercializing the technology and identify possible problems or opportunities;

– improvement of communication – use of chatbots or neural networks to interact with potential partners and clients. A chatbot is created to build a dialogue with the user. It simulates a conversation between real people and can respond briefly to a simple request or construct a complex conversation with a high level of personalization. Neural networks are a type of machine learning in which a computer program works on the principle of the human brain, using various neural connections. A neural network can be either a learning or self-learning system.

As part of the modernization and development of the automated system of information support for innovation activities and technology transfer in the NAS of Belarus (ASIS IATT), commissioned in December 2021 [10], on the basis of which the RCTT network operates, the following work is planned:

1. Analysis, selection and adaptation of AI models for carrying out work aimed at integrating the selected AI models into the ASIS IATT subsystems;

2. Integration of AI tools into the subsystems of the ASIS IATT.

Here are some examples of generative AI tools that can be used when preparing profiles, creating promotion and marketing content, scanning and analyzing Internet resources, and solving other problems:

a) AI tools for profile descriptions and other texts could be:

– OpenAI GPT-3 or Generative Pre-trained Transformer 3 is a powerful neural network model capable of generating text based on provided contextual data. It can be used to automatically generate technology descriptions, technical concepts, and other text materials;

– IBM Watson Natural Language Generator is a tool that allows you to automatically generate text based on specified templates and parameters. It can be used to create descriptions of technology features, product specifications, and other technical materials;

– Copy.ai is a platform that provides a wide range of tools for generating text content, including descriptions, headlines, articles, and more. It can be used to create excellent descriptions of technologies and products;

– Jasper (Adobe's AI Copywriting Assistant) is a tool that uses AI to generate text that can be used to create technology descriptions, blogs, and advertising materials;

– ChatGPT by OpenAI is a generative neural network model that can hold a conversation and generate text content based on user input. It can be used to chat with the user, provide information about technology, and answer questions;

– Writesonic is another AI-powered writing assistant that enables users to generate a variety of content types quickly and efficiently;

– ShortlyAI is an AI writing assistant focused on helping users generate long-form content efficiently.

b) There are a number of AI and machine learning tools available to automatically scan, analyze, and identify competitors and potentially valuable technologies. Here are some of them:

– Scite.ai is a platform for analyzing research articles and academic publications using AI. It allows you to identify connections between studies, evaluate their reliability, and find new technological directions;

– PatSnap is an AI-powered patent and intellectual property scanning tool that helps you research competitors, identify new technologies, and assess their business potential;

– Dataminr is a platform for monitoring news and social media using machine learning. It allows you to discover events, trends and competitors that may be important for a specific business or research;

– Crayon is an online competitor and technology monitoring platform. It uses machine learning to automatically scan websites, social media, and other data sources to provide insights into the competitive landscape and emerging technologies;

– Cortico is a data analysis tool that uses artificial intelligence to process and classify information from various sources, such as the Internet, news articles, and social media. It can help identify trends, competitors, and new technologies.

Integration of AI tools into the ASIS IATT subsystems will reduce time, labor, and technological costs and improve the quality and speed of preparing profiles, creating promotion and marketing content to find potential partners, and preparing contracts in the RCTT Network.

4 CONCLUSIONS

The paper informs about prospects for the use of AI tools in the RCTT Network for reduce time, labor, and technological costs, improve the quality and speed of services provided.

Examples of generative AI tools, that planned to be used in the RCTT Network for preparing profiles, creating promotion and marketing content, scanning and analyzing Internet resources, preparing contracts, and solving other problems are given.

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17. Mednarodna konferenca o prenosu tehnologij

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