INFORMACIJSKA DRUŽBA

Zbornik 26. mednarodne multikonference
Zvezek E

INFORMATION SOCIETY

Proceedings of the 26th International Multiconference
Volume E

16. Mednarodna konferenca o prenosu tehnologij

16th International Technology Transfer Conference

Uredniki • Editors:
Tinkara Mlinar, Špela Stres

11. in 13. oktober 2023 | Ljubljana, Slovenija • 11 and 13 October 2023 | Ljubljana, Slovenia

IS2023

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http://is.ijs.si

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Dostop do e-publikacije:
http://library.ijs.si/Stacks/Proceedings/InformationSociety

Ljubljana, oktober 2023

Informacijska družba
ISSN 2630-371X

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID 170891779
ISBN 978-961-264-283-9 (PDF)

PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2023

Šestindvajseta multikonferenca Informacijska družba se odvija v obdobju izjemnega razvoja za umetno inteligenco, računalništvo in informatiko, za celotno informacijsko družbo. Generativna umetna inteligenca je s programi kot ChatGPT dosegla izjemen napredek na poti k superinteligenci, k singularnosti in razcvetu človeške civilizacije. Uresničujejo se napovedi strokovnjakov, da bodo omenjena področna ključna za obstoj in razvoj človeštva, zato moramo pozornost usmeriti na njih, jih hitro uvesti v osnovno in srednje šolstvo in vsakdan posameznika in skupnosti.

Po drugi strani se poleg lažnih novic pojavljajo tudi lažne enciklopedije, lažne znanosti ter »ploščate Zemlje«, nadaljuje se zapostavljanje znanstvenih spoznanj, metod, zmanjševanje človekovih pravic in družbenih vrednot. Na vseh nas je, da izzive današnjice primerno obravnavamo, predvsem pa pomagamo pri uvajanju znanstvenih spoznanj in razčiščevanju zmot. Ena pogosto omenjanih v zadnjem letu je eksistencialna nevarnost umetne inteligence, ki naj bi ogrožala človeštvo tako kot jedrske vojne. Hkrati pa nihče ne poda vsaj za silo smiselnega scenarija, kako naj bi se to zgodilo – recimo, kako naj bi 100x pametnejši GPT ogrozil ljudi.

Letošnja konferenca poleg čisto tehnoloških izpostavlja pomembne integralne teme, kot so okolje, zdravstvo, politika depopulacije, ter rešitve, ki jih za skoraj vse probleme prinaša umetna inteligenca. V takšnem okolju je ključnega pomena poglobljena analiza in diskurz, ki lahko oblikujeta najboljše pristope k upravljanju in izkoriščanju tehnologij. Imamo veliko srečo, da gostimo vrsto izjemnih mislecev, znanstvenikov in strokovnjakov, ki skupaj v delovnem in akademsko odprtem okolju prinašajo bogastvo znanja in dialoga. Verjamemo, da je njihova prisotnost in udeležba ključna za oblikovanje bolj inkluzivne, varne in trajnostne informacijske družbe. Za razcvet.

Letos smo v multikonferenco povezali deset odličnih neodvisnih konferenc, med njimi »Legende računalništva«, s katero postavljamo nov mehanizem promocije informacijske družbe. IS 2023 zajema okoli 160 predstavitev, povzetkov in referatov v okviru samostojnih konferenc in delavnic, skupaj pa se je konference udeležilo okrog 500 udeležencev. Prireditev so spremljale okrogle mize in razprave ter posebni dogodki, kot je svečana podelitev nagrad. Izbrani prispevki bodo izšli tudi v posebni številki revije Informatica (http://www.informatica.si/), ki se ponaša s 46-letno tradicijo odlične znanstvene revije. Multikonferenco Informacijska družba 2023 sestavljajo naslednje samostojne konference:

- Odkrivanje znanja in podatkovna središča
- Demografske in družinske analize
- Legende računalništva in informatike
- Konferenca o zdravi dolgoživosti
- Miti in resnice o varovanju okolja
- Mednarodna konferenca o prenosu tehnologij
- Digitalna vključenost v informacijski družbi – DIGIN 2023
- Slovenska konferenca o umetni inteligenci + DATASCIENCE
- Kognitivna znanost
- Vzgoja in izobraževanje v informacijski družbi
- Zaključna svečana prireditev konference

Soorganizatorji in podporniki konference so različne raziskovalne institucije in združenja, med njimi ACM Slovenija, SLAIS za umetno inteligenco, DKZ za kognitivno znanost in Inženirska akademija Slovenije (IAS). V imenu organizatorjev konference se zahvaljujemo združenjem in institucijam, še posebej pa udeležencem za njihove dragocene prispevke in priložnost, da z nami delijo svoje izkušnje o informacijski družbi. Zahvaljujemo se tudi recenzentom za njihovo pomoč pri recenziranju.

S podelitvijo nagrad, še posebej z nagrado Michie-Turing, se avtonomna stroka s področja opredeli do najbolj izstopajočih dosežkov. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe je prejel prof. dr. Andrej Brodnik. Priznanje za dosežek leta pripada Benjaminu Bajdu za zlato medaljo na računalniški olimpijadi. »Informacijsko limono« za najmanj primerno informacijsko tematiko je prejela nekompatibilnost zdravstvenih sistemov v Sloveniji, »informacijsko jagodo« kot najboljšo potezo pa dobi ekipa RTV za portal dostopno.si. Čestitke nagrajencem!

Mojca Ciglarič, predsednica programskega odbora
Matjaž Gams, predsednik organizacijskega odbora

FOREWORD - INFORMATION SOCIETY 2023

The twenty-sixth Information Society multi-conference is taking place during a period of exceptional development for artificial intelligence, computing, and informatics, encompassing the entire information society. Generative artificial intelligence has made significant progress towards superintelligence, towards singularity, and the flourishing of human civilization with programs like ChatGPT. Experts' predictions are coming true, asserting that the mentioned fields are crucial for humanity's existence and development. Hence, we must direct our attention to them, swiftly integrating them into primary, secondary education, and the daily lives of individuals and communities.

On the other hand, alongside fake news, we witness the emergence of false encyclopaedias, pseudo-sciences, and flat Earth theories, along with the continuing neglect of scientific insights and methods, the diminishing of human rights, and societal values. It is upon all of us to appropriately address today's challenges, mainly assisting in the introduction of scientific knowledge and clearing up misconceptions. A frequently mentioned concern over the past year is the existential threat posed by artificial intelligence, supposedly endangering humanity as nuclear wars do. Yet, nobody provides a reasonably coherent scenario of how this might happen, say, how a 100x smarter GPT could endanger people.

This year's conference, besides purely technological aspects, highlights important integral themes like the environment, healthcare, depopulation policies, and solutions brought by artificial intelligence to almost all problems. In such an environment, in-depth analysis and discourse are crucial, shaping the best approaches to managing and exploiting technologies. We are fortunate to host a series of exceptional thinkers, scientists, and experts who bring a wealth of knowledge and dialogue in a collaborative and academically open environment. We believe their presence and participation are key to shaping a more inclusive, safe, and sustainable information society. For flourishing.

This year, we connected ten excellent independent conferences into the multi-conference, including "Legends of Computing", which introduces a new mechanism for promoting the information society. IS 2023 encompasses around 160 presentations, abstracts, and papers within standalone conferences and workshops. In total about 500 participants attended the conference. The event was accompanied by panel discussions, debates, and special events like the award ceremony. Selected contributions will also be published in a special issue of the journal Informatica (http://www.informatica.si/), boasting a 46-year tradition of being an excellent scientific journal. The Information Society 2023 multi-conference consists of the following independent conferences:

- Data Mining and Data Warehouse - SIKDD
- Demographic and Family Analysis
- Legends of Computing and Informatics
- Healthy Longevity Conference
- Myths and Truths about Environmental Protection
- International Conference on Technology Transfer
- Digital Inclusion in the Information Society - DIGIN 2023
- Slovenian Conference on Artificial Intelligence + DATASCIENCE
- Cognitive Science
- Education and Training in the Information Society
- Closing Conference Ceremony

Co-organizers and supporters of the conference include various research institutions and associations, among them ACM Slovenia, SLAIS for Artificial Intelligence, DKZ for Cognitive Science, and the Engineering Academy of Slovenia (IAS). On behalf of the conference organizers, we thank the associations and institutions, and especially the participants for their valuable contributions and the opportunity to share their experiences about the information society with us. We also thank the reviewers for their assistance in reviewing.

With the awarding of prizes, especially the Michie-Turing Award, the autonomous profession from the field identifies the most outstanding achievements. Prof. Dr. Andrej Brodnik received the Michie-Turing Award for his exceptional lifetime contribution to the development and promotion of the information society. The Achievement of the Year award goes to Benjamin Bajd, gold medal winner at the Computer Olympiad. The "Information Lemon" for the least appropriate information move was awarded to the incompatibility of information systems in the Slovenian healthcare, while the "Information Strawberry" for the best move goes to the RTV SLO team for portal dostopno.si. Congratulations to the winners!

Mojca Ciglarič, Chair of the Program Committee
Matjaž Gams, Chair of the Organizing Committee

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PREDGOVOR / FOREWORD

Dear guests, experts, panellists, participants,

It is a great honour to welcome you to the national event of the European Union campaign to boost knowledge valorisation, which takes place during this year's Science Month and the traditional 16th International Technology Transfer Conference.

We gathered today as a community of professionals, whose everyday work is closely intertwined with science and research, as well as innovation. One of the main missions of the Jožef Stefan Institute is the accumulation and dissemination of knowledge at the frontiers of natural sciences, life sciences and engineering. Equally important is our ambition to turn research results into sustainable products and solutions to improve the quality of life, including environmental benefits, as we contribute to the development of several key enabling technologies, such as quantum and nanotechnologies, biotechnologies, new materials, communication and computer technologies, and nuclear engineering, to mention some of them. Every day, we are faced with many new challenges, and as scientists, we are entrusted to deliver appropriate answers and solutions, either on a national or global level. It is important we do not betray this trust.

Throughout the years, especially since the organisation of the 1st International Technology Transfer Conference, we have been continuously learning from our friends in esteemed institutions across the world, which importantly contributed to the development of the technology transfer system within the Jožef Stefan Institute. Additionally, the new gained knowledge enabled us to become an active partner in building a national support innovation system in close collaboration with the competent ministries, agencies, support organizations, and partner public research organizations. We helped address numerous challenges, such as securing funding sources for innovation within spin-out companies during the proof of concept phases, proposing changes in national legislation related to research and innovation, spin-out development, and establishing and coordinating two consecutive consortia of technology transfer offices at leading Slovenian research institutions and universities. Looking ahead, the Central and Eastern European Technology Transfer (CEETT) initiative presents a promising investment program in collaboration with the EIF, and Slovenian and Croatian development banks. This initiative will offer spin-out teams the unique opportunity to secure investment pre-incorporation. Furthermore, we celebrate a significant legislative milestone with the incorporation of spin-outs into the new national Act on Scientific Research and Innovation. Since 2022, Slovenian public research organizations can take equity in their spin-outs, marking a pivotal recognition of spin-outs in national law. This breakthrough, while promising, necessitates practical implementation, offering both challenges and opportunities that we shall explore in our discussions.

At the commencement of the 16th International Conference on Technology Transfer, we eagerly anticipate reflecting on the journey taken. Many participants from the Conference and especially at the competition for the best innovation from public research institutions have embarked on the initial stages of commercialization and some of them successfully established spin-out companies based on technologies and inventions developed within their research institutions. The entrepreneurial researchers' pitch competition emerged as a pivotal platform, often marking the teams' initial exposure to the prospect of establishing their own ventures. The competition guided them through the vital stages of developing their first business model and crafting an impactful pitch. To date, nearly 100 entrepreneurial research teams have engaged in the competitions, resulting in the awarding of 30 winners. We also take immense pleasure in the growth of the conference in the last three years, notably through the inclusion of peer-reviewed contributions from researchers specializing in the field of technology transfer. This expansion augments the knowledge base and elevates awareness surrounding the transfer of technologies and innovations.

Finally, let's reflect on the evolving organizational structure of the technology transfer organization and cooperation with industry at the Jožef Stefan Institute. The team of dedicated individuals over the past decade and a half has stabilized the Institute's support for researchers in the commercialisation and advancement of their innovations.

Thank you for being a part of this incredible journey, and here's to the promising future that lies ahead.

Organizing Committee of the 16th ITTC

ORGANIZACIJSKI ODBOR, PARTNERJI IN SPONZORJI / ORGANIZING COMMITTE, PARTNERS AND FINANCERS

The main organizer of the 16th ITTC Conference is Jožef Stefan Institute.

Jožef Stefan
Institute
Ljubljana, Slovenia

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Scientific papers on technology transfer and intellectual property

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Prof. Alexandru Marin, University POLITEHNICA of Bucharest

Co-financing

The event is organized and co-financed in the frame of the Enterprise Europe Network (GA project number 101052776).

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Collaboration

The 16th ITTC is organized in collaboration with the International multiconference Information Society (IS2023).

EUROPEAN UNION CAMPAIGN TO BOOST KNOWLEDGE VALORISATION

The 16th ITTC is taking place under the umbrella of the EU campaign to boost knowledge valorisation.

THE SCIENCE MONTH

The 16th ITTC is organised within the Science Month that is coordinated by the Ministry of Higher Education, Science and Innovation.

Associated Partners

Agriculture Institute of Slovenia

Faculty of Information Studies

Geološki zavod Slovenije

National Institute of Biology

Rudolfovo – Science and Technology Centre Novo mesto

University of Ljubljana

University of Maribor

University of Primorska

Promotion Partners

Centre of excellence for integrated approaches in chemistry and biology of proteins

LUI - Ljubljana University Incubator

RRA Koroška – the Regional Development Agency for Koroška

ZRS Bistra Ptuj – Scientific Research Centre Bistra Ptuj

ACKNOWLEDGEMENTS

The editors and organizing committee of the Conference would like to express cordial thanks to all who helped make the 16th International Technology Transfer Conference a success.

We would like to acknowledge the valuable contributions of the members of the scientific programme committee:

- Niko Schlamberger, President of Slovenian Society INFORMATIKA
- Doc. Tamara Besednjak Valič, Faculty of Information Studies in Novo Mesto
- Prof. Alexandru Marin, Politehnica University of Bucharest

for their contribution to the scientific programme, review of the scientific contributions, and selection for publication in these Conference proceedings.

Our special thanks go to the evaluation commission members:

- Alexandre Massart, Managing Partner Blend Ventures Ltd.
- Ioannis Sagias, Deputy Head of Unit for Valorisation Policies and IPR DG for Research and Innovation, EC
- Jure Tomc, CEO Cresco Innovation & CEO JT Business Development
- Andrea Di Anselmo, President of META Group

for their evaluation of written technology commercialization proposals and selection of winning teams, authors of inventive technologies with the best potential for commercialization of the technologies, developed at Public Research Organizations.

Research Infrastructures and Coopeation with Industry

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ABSTRACT

The paper addresses the experience of European Strategic Framework on Research Infrastructure (ESFRI) Landmarks in their work with partners from industry. While the main mission of the RIs is to provide infrastructure support to scientific work, they are also cooperating intensively with the industry. Our survey among 42 ESFRI Landmarks showed that as many as 82% of them have a strong and well-established cooperation with partners. However, there are still several barriers to cooperation on both sides, with the management of intellectual property being an important one.

KEYWORDS

Research infrastructures, industry, cooperation, barriers, intellectual property.

1 INTRODUCTION

One of the most important achievements of the European Research Area (ERA) has been the establishment of research infrastructures (RIs) at the European level. With coordination efforts of European Strategic Forum on Research Infrastructures (ESFRI), the roadmaps of EU RIs have been developed[1], a set of Working Groups[2] formed to support the work of RIs as well as help provided by the ESFRI and EC to meet fully the objectives of RIs. The RIs are essential pillars supporting European basic research, yet their impact extends beyond the scientific community. They are facilities that provide resources and services for all research communities to conduct research and foster innovation, suggesting that they intensively cooperate with industry as well. The cooperation includes also transfer of knowledge/ technology developed jointly with using equipment or/ and data or/and testing facilities of the Ris.

In their cooperation with industry, RIs often encounter similar problems as we can observe in the relationship between public research organizations (PROs) and private sector [3]. To identify the level and type of cooperation between RIs and industry, we prepared a special survey, sent to ESFRI Landmarks. The survey had the ambition to also identify main barriers to closer cooperation and suggest possible policy actions to stimulate this important cooperation. The findings of the survey were presented at the ESFRI Forum in Brno, 2022 [4] as well as by the ESFRI Drafting Group on RI – industry cooperation. Some of the observations and findings from the discussion at these fora have been integrated into the text as well. The end objective of our analysis was to contribute to the implementation of ERA Action 8 [5], and in this way to the creation of competitive innovation ecosystem at EU level.

Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia

2 THE SURVEY

The survey on RIs industry cooperation was prepared by the support team to ESFRI Chair in 2022[6]. The questionnaire was sent to 43 ESFRI Landmarks. 35 replies were received. Of these, 49% Landmarks responded that they regularly cooperate with industry, while 34% do so occasionally [7]. This confirmed our initial assumption that the cooperation between RIs and industry is well established. It mostly takes place at national level [8]. Most common form of cooperation is joint research projects, which are either financed at the EU level or by the national research funds. RIs offer industry access to their equipment, offer them various services, access to data, etc. They believe that cooperation with industry is beneficial to them and plan to expand it: 72% of the respondents actively stimulate the cooperation. The tools to promote cooperation are various. RIs involve industrial partners in decision-making bodies as members of strategic/ scientific boards. Several reported on the establishment of specialized offices, which serve as contact points for industry. Another way to promote cooperation is the preparation of special industry- focused days to present the potential forms of cooperation and services they can offer. It is interesting that RIs are engaged in so many different activities to promote cooperation although it is not very important in terms of revenue. At best, according to our survey, the RIs state that no more than 10% of their revenues are derived from industry. In part, the reasons for this may lie in unclear regulations as to commercial activities of publicly- financed infrastructures in some countries.

The importance of cooperation is reflected in the high percentage of responses on the future plans to intensify the cooperation: as many as 92% of the RI respondents wish to expand the cooperation and plan to actively engage in this. One of the motivation factors is the fact that RIs can complement traditionally insufficient financial resources received from the government(s) with the money from business sector. This may enable them to invest in appropriate new research equipment as well as maintain the existing infrastructure, either directly relevant for the research cooperation or expanding the options for basic research. In times of increasing costs of investment in sophisticated research equipment this is becoming increasingly important factor.

Among the factors which may hinder cooperation the lack of interest on the side of industrial partners in their area of work was most often cited by the RIs. However, several suggestions were provided as to the needed activities at the policy level as well as at the level of RIs to promote and ease the cooperation, with a clear objective to make transfer of knowledge from RIs to industry smoother.

3 ACTIVITIES TO PROMOTE COOPERATION

3.1 At RI's level

To promote cooperation with industry, RIs themselves have indicated that they should do more to increase the visibility of the services they are capable of offering. Various activities were proposed by the respondents. Let us share the most interesting proposals.

The appointment of an industry liaison officer was identified as an important action to bridge the communication gap between scientists working in RIs and the researchers from industry. As several other studies on cooperation between public research organisations (institutes or/and universities) have identified (among others, see [9] Bučar and Rojec, 2019; [10] Jensen et al., 2010; [11] Arvanitis and Bolli, 2009), the objectives of the researchers in the public research organisations (PROs) and the representatives of the industry are often highly different. While the criteria in many countries for successful research are based on the publication record and this has significant impact on the funding, the industrial research is focused on more immediate goal of finding optimal solutions to the business processes, be it in manufacturing or in services. The trend in PROs is towards open science and many of the funding agencies require the results of the research to be available widely and free of costs. On the other hand, industry needs to protect the findings as their intellectual property. Careful balancing on how to meet the requirements of the two different approaches and at the same time reach a working arrangement for both parties is needed. It seems that some RIs have been more successful in this than the others, thus sharing of the experiences may ease the cooperation for others.

Also, the already mentioned involvement of industrial representatives in different RI's decision-making bodies should be systematically encouraged. The latter would be important in shaping the RIs development strategy since input from industry would indicate which research fields are considered as most relevant for the RIs to focus on.

Additional dilemma faced by RIs is how to communicate with partners from industry. Differences in the objectives of participating in cooperation need to be openly discussed and at least initially, this may take some time. A clear understanding of each other's objectives, and respect for these, need to be a starting point in establishing the cooperation. This is often achieved best by regular exchange of personnel or by close interaction of the key personnel from both partners working on a particular issue. Here, the issue of motivation on the side of individual researchers working in RIs, was identified as possible issue that needs special attention. The so called "liaison officer" in RI would need to be specifically stimulated to engage in cooperation with the industry, since this could mean that the traditional path of career progress through publications and citations would be slowed down. To cooperate with industry especially in the area of knowledge/ technology transfer, specialised staff is needed, which is often not available in Ris.

3.2 At the policy level

Issues related to financing of the cooperation were identified as a barrier to cooperation. On one hand, some RIs mentioned that it is sometimes expected that since they receive public financing, they should not be charging industrial partners for their services. On the other hand, the regulations in some cases make it too complicated to carry out commercialization of services to industry. The lack of suitable business models de- stimulates some of the RIs to pursue cooperation more actively, so it was suggested that a special platform, where sharing good practices and successful modes of cooperation are shared among RIs. This would help less experienced ones to learn from those with extensive practice of working with industry. Samples of agreements on sharing intellectual property benefits would be helpful as well.

The respondents to the survey proposed that such a platform should be established by EC so as to serve to RIs in all member states. It could be used to share good practices in all areas of cooperation: from legal and financial issues, overall appropriate business models, negotiations on intellectual property issues, personnel issues, etc.

Other policy measures suggested to support the cooperation include:

a) Financing of joint research projects, where the cooperation between RIs and industry could be recognized as a positive characteristic of project application;
b) Encouragement of exchange of personnel and/or hosting of researchers from industry by RIs (for example, to carry out Ph.D. research);
c) Special grants to SMEs to co-finance some of the costs of using the services of RIs;
d) The cooperation of RIs and industry should be actively promoted both at EC level a well as at the level of Member States, with specific resources available for such a promotion.

4 CONCLUDING OBSERVATIONS

The survey findings aligned closely with our initial assumptions concerning the collaborative engagement between RIs and industry. There is significant interest on the side of RIs to expand such cooperation. Recognized barriers, including the misalignment of objectives between RIs and industrial partners, have already been subject to policy interventions at various levels. There are several measures at national and EC level [12], which could be utilized to support such cooperation, yet it often seems that the awareness of their existence is still limited, especially among the SMEs.

Overall, the survey underscored transformative potential of RI-industry collaboration in fostering a competitive innovation ecosystem across the European union, bearing an important significance in the context of the ERA's overarching objectives. The imperative role of ESFRI in promoting the cooperation of RIs and industry and addressing barriers therein cannot be overstated. Within the policy discussions on European innovation ecosystems, the role and extent of cooperation of RIs with industry needs to be appropriately recognized. This is particularly significant if the enhancement of knowledge/ technology transfer from public research to industry is to be implemented, thereby contributing to the competitiveness of the European industry.

In summary, RIs have the pivotal role as enablers of scientific progress and innovation in Europe. However, the evolving cooperation between RIs and industry shows the potential for mutual benefit, both in designing appropriate research questions as by further development of technology transfer from Ris to industry. This is calling for continuous efforts at both the operational and policy levels, where the role of ESFRI is of high importance in order to nurture a competitive innovation ecosystem across the European Union.

ACKNOWLEDGMENTS

The research was supported by Slovenian research agency, grant number V5-2283.
The authors wish to thank the EC ESFRI Secretariat for the help in the implementation of the survey. Valuable comments to the draft questionnaire were provided by the members of the Executive Board of ESFRI and its Chairperson, Jana Kolar.

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Randomized Optimization: From Algorithmic Studies to Industrial Applications

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ABSTRACT

As opposed to deterministic optimization techniques, randomized optimization algorithms rely on random choices when searching for good solutions to a given problem. They represent a viable alternative for solving real-world problems whose properties are usually unknown and their complexity too high to be solved with deterministic techniques. In our research group, we are specialized in studying and designing randomized optimization algorithms and deploying them in practice. In this paper we report on our algorithmic studies that have led to successful industrial applications. We illustrate these with two case studies from engineering design and production process optimization.

KEYWORDS

optimization, black-box problems, randomized algorithms, numerical simulation, visualization, engineering design, production

1 INTRODUCTION

Many problems in science, engineering and business can be formulated as optimization problems, where the task is to find the best solution among the possible alternatives with respect to a given criterion. Mathematics and, in particular, operation research provide various optimization methods that are applicable given that the problems meet certain preconditions, such as linearity, continuity, existence of derivatives, etc. Unfortunately, real-world problems rarely comply with these requirements. Frequently, their structure and properties are unknown, they may involve several possibly conflicting objectives as well as constraints. This makes them intractable for traditional mathematical optimization methods. However, with the rise of computing power, a new class of optimizers, called randomized or stochastic optimization algorithms [17] has emerged. Their key characteristic is that, unlike in deterministic mathematical methods, certain algorithm steps depend on random choices. Randomized algorithms search for good solutions according to some heuristic and handle the problems in a black-box manner, i.e., without dealing with their structure and properties. Many of them are population-based, as is the case, for example, with evolutionary algorithms [5].

In the Computational Intelligence Group of the Department of Intelligent Systems at the Jožef Stefan Institute, we have decades of experience in studying, designing and deploying randomized optimization algorithms. In this paper we report on our algorithmic studies that have led to successful industrial applications. The paper is further organized as follows. Section 2 outlines the research topics dealt with and the proposed algorithms. The next two sections present cases studies from their practical applications. Section 3 overviews our work in engineering design and focuses on the recent use case of designing an electric motor for the automotive industry. Section 4 lists the applications in production process optimization and presents a system developed to tune the parameters of a metallurgical production process. Section 5 summarizes our work and provides ideas for future development.

Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia

2 ALGORITHMIC STUDIES

Our interest in randomized optimization was inspired by the introduction of genetic algorithms as a method to perform search, optimization, and machine learning [13]. After the initial experiments on test problems and first attempts at solving real-world problems, we specialized in evolutionary multiobjective optimization [2]. Our early achievement in this area was the design of the Differential Evolution for Multiobjective Optimization (DEMO) algorithm [16], which combines the search mechanism of single-objective Differential Evolution [18] with the concepts of multiobjective optimization from the NSGA-II algorithm [3] and finds multiple trade-off solutions in a single algorithm run.

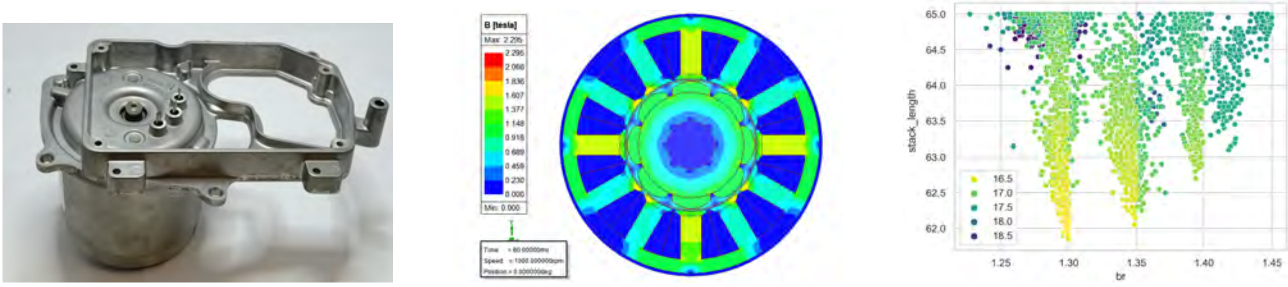
The algorithm was later extended to Asynchronous Master-Slave DEMO (AMS-DEMO) [4] suitable for solving computationally demanding problems, as it is parallelized and adjusted for both homogeneous and heterogeneous multiprocessor architectures. Another modification of the basic algorithm was DEMO based on Gaussian Process models (GP-DEMO) [15], which incorporates two practically relevant approaches: surrogate models for faster evaluation of solutions and newly defined relations for comparing solutions under uncertainty to minimize the effect of errors due to inaccurate surrogate model approximations.

Significant attention was also paid to the visualization of optimization results. This turned out to be useful in solving both artificial test problems and real-world problems as it helped better understand the problems themselves as well as the working of the algorithms. We introduced a method for visualizing fronts of nondominated solutions called visualization with prosections [19] and created a taxonomy of the existing visualization methods for multiobjective optimization [8].

3 ENGINEERING DESIGN OPTIMIZATION

We have approached several engineering design optimization problems using randomized algorithms. The addressed devices and the related optimization tasks were as follows:

- Electric motor for home appliances – determining the geometry of its rotor and stator such that the power losses are minimal [21];
- Energy supply system based on renewable sources – finding its configuration, i.e., the type and the number of its components (photovoltaic panels, batteries, etc.), such that both the proportion of unsupplied energy and the costs of the system construction and operation are minimal [6];



(a) (b) (c)

Figure 1: An electric motor for the automotive steering system: (a) a product example (source: MAHLE archive), (b) numerical simulation of the magnetic field (source: MAHLE archive), (c) visualization of candidate designs with respect to selected characteristics.

- Cyclone dust separator (a device for removing dust particles from gas streams, widely used in industry) – determining, through a number of design variables, its shape such that the device operates with maximum collection efficiency and minimum pressure drop [23].

A recent engineering design challenge we dealt with was the development of an electric motor for the automotive steering system [20] carried out for MAHLE Electric Drives Slovenija, an internationally recognized producer of components for the automotive industry. Specifically, a synchronous electric motor with surface-mounted magnets was considered. An example of the product is shown in Figure 1(a).

In the optimization problem formulation, both technical and economic aspects were involved. The task was to determine the geometry characteristics of the electric motor and the material properties of its components in such a way that the motor meets the technical requirements specified by the customer and its price is as low as possible. There are 13 design variables and seven constraints referring to the technical characteristics of the electric motor, given in the form of either minimum or maximum value to be respected. The optimization objective to be minimized is the total price of the electric motor, resulting predominantly from the costs of the magnets and the copper winding.

In design tasks of this kind, a numerical simulator capable of evaluating possible solutions (designs) is crucial for the automation of the design procedure. MAHLE uses the Ansys Maxwell simulator [1] based on the finite element method that, given the values of design variables, calculates the values of the regarded technical characteristics and the optimization objective (Figure 1(b) shows the result of the magnetic field simulation). This makes it possible to approach the problem in a black-box manner, where the designs are iteratively evaluated and improved. However, as numerical simulations are time-consuming, the key challenge is to set up the optimization process in such a way that it can find good solutions in acceptable time. To solve this design optimization problem, we implemented a prototype software environment incorporating measures to speed-up the optimization process, while additionally ensuring the robustness of solutions and supporting the design process with visualization.

The measures taken to speed-up the optimization process were the following:

- As an optimization algorithm, a specific version of the covariance matrix adaptation evolution strategy (CMA-ES) called lq-CMA-ES [14] was used, which partially replaces costly simulation-based solution evaluations with fast-calculating surrogate models.
- Solution evaluation was carried out through a custom-designed five-step procedure performing a sequence of solution checks and eliminating a large proportion of infeasible solutions without running the costly simulations.
- The most complex step of the solution evaluation procedure, the detailed numerical simulation, was parallelized to take advantage of the available multicore processors.

Robustness of electric motor designs is related to the limitations of manufacturing where the matching of products with the optimized design can only be ensured within certain tolerances. For this reason, the designs are required to be robust in that small changes in design variables, within the tolerances, do not significantly affect the characteristics of the electric motors. In the design process, this was checked by simulating a variety of designs slightly differing from the original one.

Finally, in addition to producing numerical results in the form of the optimized values of design variables and the related electric motor characteristics, the procedure was also required to provide insight into the solution space. For this purpose, the methods for data analysis and visualization were applied. Figure 1(c) shows an example of visualization where, for a chosen pair of design variables, the value of a selected electric motor characteristic is indicated by color.

The project resulted in a design of the considered electric motor model substantially outperforming the prototype initially developed by the company using a simpler optimization procedure. As the key achievement, the price of the product was reduced by 10% compared to the price of the initial version. Given that large series are manufactured, this represents substantial savings for the company and considerably improves their competitiveness in the market.

4 PRODUCTION PROCESS OPTIMIZATION

Our practically oriented studies and applied projects in production process optimization refer to the following processes and the related optimization tasks:

- Deep drawing (a particular kind of sheet metal forming used, for example, in the automotive industry for the manufacturing of car body parts) – increasing the process stability by tuning the input parameter values [12];
- Clothing production – finding an optimal sequence of steps in the processing of work orders to minimize the production preparation costs [11];

(a) (b) (c)

Figure 2: Continuous casting of steel: (a) pouring of molten steel into the mold where the casting process starts, (b) casting device (source: Štore Steel archive), (c) cooling of billets.

- Continuous casting of steel (a key process in steel production) – determining the values of process parameters such that the conflicting criteria for process safety, productivity, and product quality are fulfilled [9, 7].

Among these, the largest amount of our work was devoted to the optimization of steel casting. In this process, molten steel extracted from the furnace passes through a sequence of rolls and water sprays in the casting machine where it is cooled and shaped into semi-finished products. Of crucial importance for the quality of cast steel is the control of metal flow and heat extraction during casting. They depend on numerous process parameters, such as the casting speed and coolant flows. Finding the optimal values of process parameters is not trivial as the number of possible parameter settings grows exponentially with the number of parameters, and trial-and-error parameter tuning is unattainable in practice. Fortunately, numerical simulators of the process exist that, integrated with efficient optimizers, allow for automated computer-aided parameter tuning.

We were dealing with various problem formulations for several steel producers. Here we present an optimization system developed for and installed at Štore Steel, a steel company best known for their production of spring steels for the automotive industry. A new casting device at the plant was considered and the quality of cast steel was of primary concern. Figure 2 shows the initial stage of the continuous casting process, the casting device, and the outcome, i.e, cast steel in the form of billets.

The optimization problem was formulated to include six input variables (process parameters) subject to boundary constraints and three output variables indicating the process suitability and, consequently, the expected steel quality. For output variables, boundary constraints and target values were specified in advance. The goal of optimization was to find the values of process parameters such that the resulting values of output variables respect the boundary constraints and their deviations from the respective target values are as small as possible.

Starting with this problem formulation, we designed and implemented a software system to automate the process parameter tuning [10]. The system consists of the following components:

- An optimization algorithm to search the space of parameter settings and identify the settings representing tradeoffs between the objectives;
- An interface to the numerical simulator of the continuous casting process to evaluate the parameter settings encountered by the optimization algorithm;
- A visualization method to present the optimization results and support their analysis.

The optimization algorithm used is Differential Evolution for Multiobjective Optimization (DEMO) [16]. While exploring the process parameter space using population-based search, it invokes the simulator to assess the quality of candidate parameter settings. Progressively, it converges to a set of trade-of solutions.

As a simulator, a numerical model of the steel casting process based on a meshless method [22] is deployed, designed and calibrated for the considered casting machine during its introduction into production. Given the values of input variables, the simulator numerically evaluates the casting process and returns the values of output variables.

Visualization of solutions (process parameter settings) resulting from the optimization procedure is done in parallel coordinates. This is a method suitable for visualizing multidimensional spaces. Each dimension corresponds to a parallel axis and a solution is represented as a polyline through the related vertices on the axes. As illustrated in Figure 3, both input and output values of solutions are shown in a single plot. Moreover, the user can interactively analyze the solutions depending on the requirements for a particular product order. By indicating the intervals for selected variables (as shown in the figure for the first two output variables), one can see what input values are required and how they affect the remaining output values.

The practical importance of this optimization system is in that it automates the process parameter optimization and in this way replaces the time consuming trial-and-error experiments carried out previously when only the numerical simulator was available. The automation is particularly beneficial as parameter tuning has to be performed individually for each steel grade. As a result, the company is more flexible in responding to customer requests and achieves a higher quality of their products.

5 CONCLUSION

Randomized optimization is the primary research topic of our research group. We have contributed to the field with new algorithms exhibiting competitive performance on multiobjective optimization problems, as well as with the methodological insights into visualization of solutions for this type of problems.

Potential industrial users often see the fact that randomized optimization algorithms generally return suboptimal solutions and produce different results over repeated runs as their critical disadvantage. However, for problems not amenable to mathematical treatment these algorithms may be the only viable approach. As frequently found in practice and confirmed by our case studies as well, substantial gains may result from their deployment.

Our further research efforts are directed towards shifting from black-box to gray-box problem handling, where the idea is to

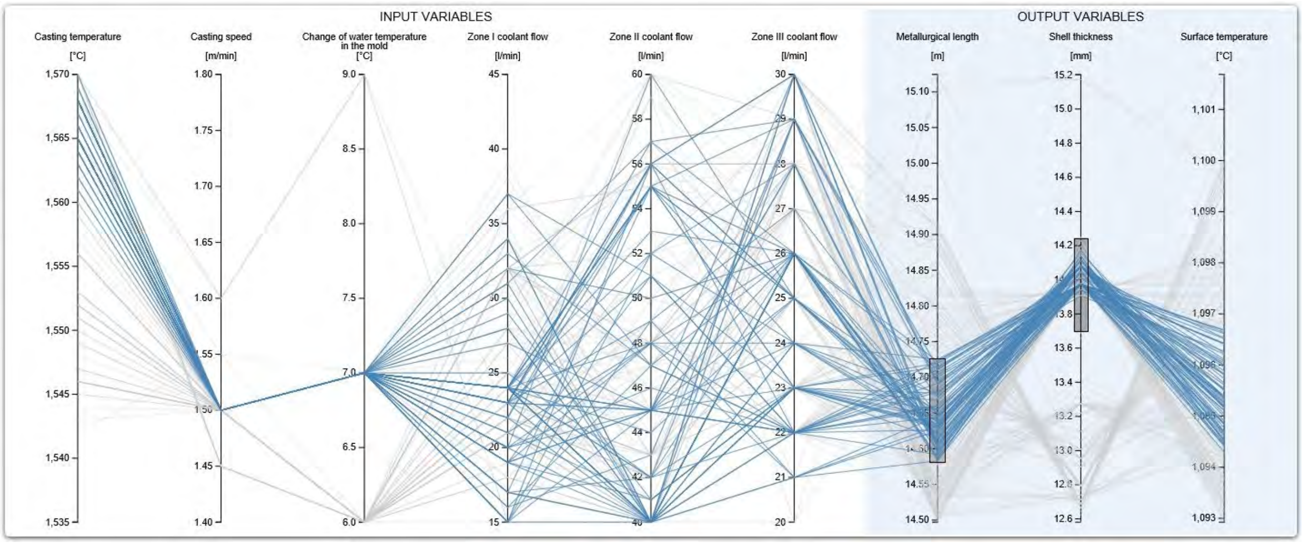


Figure 3: Visualization of optimized process parameter settings in parallel coordinates (blue color indicates solutions selected by the user).

characterize the problems with features extracted from the samples of their solutions and then use these features to better understand the problems [24]. As a future step, problem features will be matched with algorithm performance to help select the most efficient algorithm for a given problem. Moreover, in the applied work we plan to expand from solving specific problems to providing optimization environments capable of solving sets of related problems and offering more flexibility to the users.

ACKNOWLEDGEMENTS

We acknowledge the financial support from the Slovenian Research and Innovation Agency (research core funding No. P2-0209 and project No. N2-0254) and the funding from our industry partners Štore Steel d.o.o. and MAHLE Electric Drives Slovenija d.o.o. We also acknowledge the support from the Office for Substantive Project Support, Technology Transfer and Innovation and the Office for Industrial Liaison at the Jožef Stefan Institute in forming the partnerships and managing intellectual property rights.

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Creating Conditions for an Active Role of Public Administrations in Academia-Industry Cooperation: an Overview of Critical Points Through the ExSACT Project

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ABSTRACT
The ATTRACT European Scientific Research Infrastructures (ERIs) have formed an ERI Innovation Ecosystem (ERI-IE) as an essential tool in boosting academia-industry collaboration. The state administration encourages academia-industry (co)operation with financial incentives. However, it still encounters rules and legislation to protect competition in the free market imposed within state aid limitations. Due to limited recognition of state aid practices, the allocation of funding and intellectual property rights (IPR) needs management given state aid restrictions. Ambiguities result in state investments into academia-industry collaboration or research/technology infrastructure (RI/TI) usage needing improvement and simplification. This status quo, therefore, necessitates an examination of this field – to explore the effect of the state administration on financing research, RI/TI and IPR transfer procedures through state aid rules abiding (RI/TI and IPR) management. The following paper presents existing conditions and the most common challenges for creating conditions for an active role of public administrations to mitigate risks in academia-industry cooperation (in the EU). It concludes with state-of-the-art results obtained through the project ExSACT.

KEYWORDS
IPR, Protection, Public Administration, Role, Technology Transfer, Challenges, EU, ExSACT

1 INTRODUCTION

1.1 The Baseline and Status Quo

The ATTRACT European Scientific Research Infrastructures (ERIs) have formed an ERI Innovation Ecosystem (ERI-IE) as an essential tool in boosting academia-industry collaboration. ERI-IE operates in the global competitive environment wherein technological development is one of the few competitive levers capable of added value creation [1, 2].

The state administration encourages academia-industry (co)operation with financial incentives. Still, it encounters rules and legislation to protect competition in the free market imposed within state aid rules. The regulations, however, do allow the granting of aid within substantive exceptions (e.g., particular importance for development), special conditions (advance notification of state aid to the European Commission (EC) and its consent), or in a simplified form up to a certain amount (de minimis rule). Due to limited recognition of the state aid rules, the allocation of funding and IPR needs management given state aid restrictions. Ambiguities result in state investments into academia-industry collaboration or limited and complicated research/technology infrastructure (RI/TI) usage. The provision of state aid and understanding or lack of knowledge thereof may thus support or slow down such investments and the smooth transition of technology through the technology readiness level (TRL) with the involvement of the ERI-IE [1, 2]. Improving the understanding the state aid rules in financing research, RI/TI's use, and IPR transfer procedures within ERIs collaborative projects with industry would improve incentives efficiency for research to the economy transition. To address the current status quo, the following research question(s) have been defined to guide research in the ExSACT project (Enable State Administration to be an Active Contributor in the Process of risk Absorption and Risk Reduction Through IPR and State Aid):

How to simplify and optimise public investments (into):

a) research and technology infrastructures;
b) background and foreground IPR;
c) when academia-industry collaboration is in question, must state aid regulations be considered?

The research will, therefore, in the domain of crucial objective, explore the state administration's effect on financing research, RI/TI, and IPR transfer procedures through the state aid rules abiding (RI/TI and IPR) management. After successfully addressing the crucial objective, a seamlessly integrated ERI supporting research and economy from knowledge creation through defining IP to commercialisation with proper funding, given state aid limitations, would:

a) enhance investments;
b) lower risk; and
c) enable involved stakeholders to bring more science to everyday use.

A better understanding of RI/TI use and IPR contractual issues concerning state aid rules will be easier to implement by the state administrations of the ERI-IEs.

2 METHODOLOGY

To achieve the crucial objective and for a better understanding of RI/TI use and IPR contractual issues concerning state aid rules and more straightforward implementation by the state administrations of the ERI-IEs, quantitative and qualitative research has been carried out, namely:

1. analysis of the critical points of RI/TI and IPR management;
2. preparation of a review of systems for valuing transferring IPR in collaborative projects in the ERI-IE;
3. preparation of a review of the regulation of the state aid system in RI/TI and IPR management;
4. preparation of a proposal for a sustainable system and changes to be implemented for more effective financial support of the innovation system, following and properly manifesting the EU state aid rules in the ERI-IE of ATTRACT.

A quantitative and qualitative analysis of critical points for the transfer of IPR and the development of guidelines for the management of IPR in joint research and development (R&D) projects has been carried out based on secondary data and primary data, obtained through semi-structured interviews. The research includes:

1. an international comparative review of systems for valuing the market value of IP rights in collaborative projects and a comprehensive process of detection registration of IP as an intangible asset and IP valuation;
2. a review of the regulation of the state aid system and a proposal for a sustainable system of the state aid system and the changes.

3 PRELIMINARY RESULTS

3.1 RI/TI and IPR Management Critical Points

Research infrastructures (RIs) are the scientific community's facilities, resources, and services to conduct top-level research. They can be single-sited, distributed, or virtual. RIs include major scientific equipment or sets of instruments, collections, archives or scientific data, computing systems and communication networks, and any other research and innovation infrastructure of a unique nature that is open to external users. RIs are organised and financed at the regional, national and European levels [1].

Technology infrastructures (TIs) are similar to RIs. Still, they are primarily intended for industrial users, including small and medium enterprises (SMEs), which seek support to develop and integrate innovative technologies to commercialise new products, processes, and services. TIs can have public, semi-public, or private status. Like RIs, TIs are organised and funded on different levels [3].

Although there are some differences between RIs and TIs, many infrastructures fit into both groups. The primary objective of an RI is to establish and operate on a non-economic basis. However, they can carry out limited economic activities if closely related to their principal task and not jeopardise their achievement.

The primary goal of a TI is to support SMEs and industry to develop the technologies with its help. In the case of TIs, economic activities are encouraged. However, these are sometimes partially financially supported by public means.

RIs and TIs should share information about their resources and services publicly. The price for using RIs and TIs can be set on a non-economic basis, using the cost approach, or on an economic basis, using the market approach, the cost approach, or the income approach.

Public higher education and public research institutes may, as stated in Article 21 of the Slovenian Employment Inventions Act (ZPILDR), establish: (i) organisational infrastructures necessary for dealing with inventions; (ii) the rulebook, which regulates the process of taking over official inventions in a way that is adapted to the needs of scientific research work and the publication of scientific achievements; (iii) the shares determined by the regulations, which belong to the institution, the unit of the institution in which the inventor is employed, and the inventor(s), in the exploitation of the invention, whereby the share of the award to the inventors must not amount to less than 20% of the gross license fee that the institution receives from exploitation of the invention. Pursuant to Article 21 of the Act on Inventions from the Employment Relationship, upon fulfilment of the above conditions (i, ii, iii), the state is specifically obliged to provide funds for the organisational infrastructure necessary to deal with inventions according to the provisions of this Act and for their effective exploitation [4].

The EC recommends that public research organisations should have technology transfer strategic missions and policies. IP should be suitably managed by promoting its identification, exploitation and, where appropriate, protection in line with the strategy and mission of the public research organisation and to maximise socioeconomic benefits [5]. To this end, different strategies may be adopted – possibly differentiated in the respective scientific/technical areas – for instance, the ‘public domain’ approach or the ‘open innovation’ approach. Appropriate incentives should be provided to ensure that all relevant staff play an active role in implementing the IP policy.

The Slovenian ZPILDR does not envisage organisational infrastructure and financing for companies, only those intended to prepare, protect, and market IP [4].

Large companies often have their own departments with experts in IP management, while small companies mostly outsource legal, financial and accounting support related to IP. SMEs aware of IP protection often turn to patent attorneys for help preparing and protecting IP. Both companies and public research organisations (ROs) usually hire external patent attorneys to conduct IP protection procedures at the IP offices. Bigger companies that file many patent applications normally also have internal patent attorneys.

Research & technological infrastructures and suitably protected IP rights are key elements that support successful technology transfer from research organisations to industry. In this way, science returns benefits to the economy as the public budget generator. Cooperation of ROs with the economy in general is divided into the following activities [6]:

1. contractual cooperation with the economy, which includes consulting, contract research and collaborative research;
2. commercialisation of IP by establishing spin-off/spin-out companies;
3. licensing and sale of RO's IPR;
4. communication through public announcements and events;

5. teaching;
6. exchange and transfer of personnel.

EC has set rules on state aid regarding cooperation between academia and industry, more specifically in collaborative research, contract research/research service, licensing and consultancy – COMMUNICATION FROM THE COMMISSION, Framework for State aid for research and development and innovation (2022/C 414/01) [7]. In order to understand these rules and use them in practice, different guidelines and examples have been presented [8, 9]. We however believe that the awareness of these rules is insufficient. Public administrations could be more actively involved by providing educational materials, organizing info days and similar. Relevant stakeholders like technology transfer offices, financial offices, decision-makers in research organizations and companies should be involved.

3.2 Quantitative Analysis of IPR Transfer

As part of the ExSACT project within the ATTRACT phase 2 initiative, a survey was administered to 18 participating research & development & innovation (R&D&I) project partners. Responses from 29 individuals representing 16 different European projects were collected between April and June 2023. The majority of respondents were affiliated with start-ups (10), followed by universities (8), research institutes (5), small enterprises (5), micro-enterprises (3), large enterprises (3), and spin-off companies (2). Notably, seven individuals were employed at two separate institutions. More than 90% of the R&D&I projects our respondents are part of use their own IP. However, less than 25% of them successfully licensed it to other organisations. This implies that organisations are aware of the importance of IP. However, they need substantially more encouragement and assistance in licencing, for example, through better collaboration with their technology transfer offices. Almost 80% of respondents reported that individuals or offices for handling IP are well known in the involved organisations. More than half of the organisations highlight IP as part of their marketing strategies. However, only half of them consistently reward the inventors for the successful commercialisation of inventions. This, coupled with the fact that only 45% of individuals had a positive experience in managing IP rights in collaborative projects involving research organisations and companies, and even less (34%) of them had a positive experience in valuation and determination of the price value of said IP, might discourage employees from seeking appropriate IP registration and commercialisation.

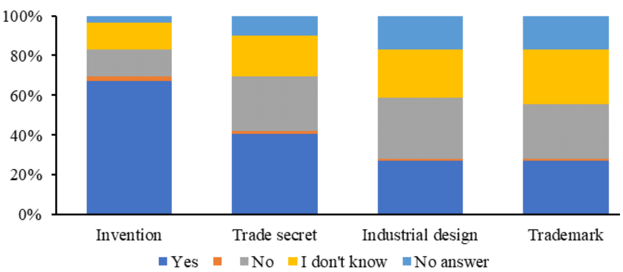

Figure 1: Transparency of procedures for the internal registration of IP.

Internal IP registration procedures in the involved organisations are most transparently regulated for inventions (69%) and trade secrets (41%), such as software and secret know-how, as seen in Figure 1. It is also apparent from the results that certain forms of IP, such as industrial design and trademark, are poorly represented and constitute a potential source of previously unprotected IP. In the involved organisations, the largest share (55%) of marketing is devoted to products and services, followed by marketing of IP (41%). Additionally, more than half of the involved organisations search for market connections through market and potential partner monitoring. Based on our survey results, organisations do not sufficiently encourage joint national or EU project applications (34%) or the joining of consortia (28%).

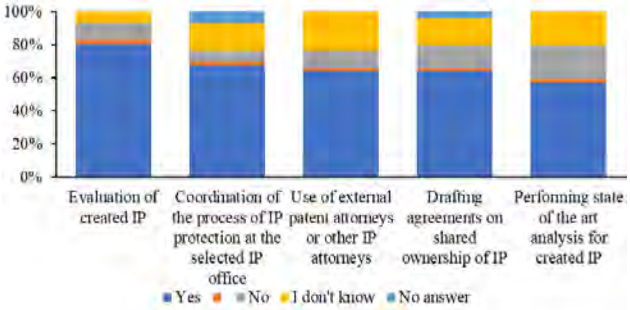

Figure 2: The most well-known offered IPR-related services.

The most common (83%) and well-known offered IP-related process in the involved organisations is the evaluation of created IP. The least common (21%) is the use of patent or IP attorneys, as seen in Figures 2 and 3. Given the frequent occurrence of IP in these projects and organisations, there appears to be great potential for multilevel IP analysis, thereby improving its quality.

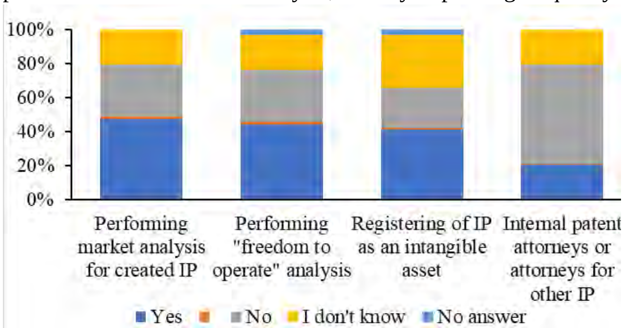

Figure 3: The least known offered IP-related services.

The level of uncertainty about whether a particular IP-related service is offered at included organisations was, except for evaluation of created IP, coordination of IP protection processes and drafting agreements on shared ownership of IP, such as inventions, more than 20%. Notably, 31% of survey participants were uncertain whether their technology transfer office handles IP registration as intangible assets. This could be resolved by better promoting IP-related processes by the designated technology transfer offices.

3.3 Qualitative Analysis of IP and State Aid Rules Within the ATTRACT Project

Five ATTRACT project partners from different R&D&I projects participated in semi-structured interviews, collectively providing insights into various topics related to IP and the application of state aid regulations. Interviewees were mostly researchers and group leaders from research organizations and companies. The prevailing IP form anticipated to emerge from these projects are patents, followed by secret know-how and trade secrets. While all interviewees exhibited familiarity with the EC's regulations about state aid for R&D, a notable point of consensus among them was their shared frustration regarding these rules. They noted how these regulations force them to set an excessively high market price for their products, making them less appealing to potential investors and hindering their progress.

Technology transfer offices are common within academic institutions, whereas start-ups, spin-offs, and SMEs rely on external IP attorneys.

Our interviewees noted a prevalent issue within university technology transfer offices, namely, their understaffing. As a result, the researchers often need to perform specific time-consuming tasks, such as conducting state-of-the-art analyses. Furthermore, a noteworthy observation made by one of our interviewees was the existing disparity between laboratory research and the process of bringing innovations to the market. The absence of direct communication channels between scientists and the industrial sector exacerbates this gap. Interviewees with ties to the academic world expressed frustration over the extended duration of the patent application process. In some cases, they deemed it more advantageous to prioritise publishing research papers to earn recognition for career advancement over safeguarding their IP, particularly when dealing with patents of limited or negligible exploitable potential. Furthermore, laboratories or SMEs occasionally preferred maintaining their developed IP as a trade secret rather than pursuing patent protection, ensuring their knowledge remained concealed.

4 CONCLUSION

Public funding for R&D is subject to critical scrutiny by the public and state-level decision-makers about the effectiveness and rationale for increasing funding for science. The impacts of science on social well-being are long-term and primarily indirect. If we recall – the EC recommends that public ROs should have technology transfer strategic missions and policies. IP should be suitably managed by promoting its identification, exploitation and, where appropriate, protection in line with the strategy and mission of the public ROs and to maximise socioeconomic benefits. To this end, different strategies may be adopted – possibly differentiated in the respective scientific/technical areas – for instance, the 'public domain' approach or the 'open innovation' approach. Appropriate incentives should be provided to ensure that all relevant staff play an active role in implementing the IP policy.

As seen from the preliminary results of the ExSACT project, they are already an essential source of feedback for public administrations on state aid for R&D. The current recognition of familiarity with the EC's regulations about state aid for R&D is particularly crucial. In our sample, most of the interviewees are familiar with these rules, but their detailed familiarity can be questionable. As observed by interviewees, it is important that supportive units such as technology transfer and financial offices, which (should) understand state aid rules, support academia-industry cooperation. We recommend that all staff of these offices are properly trained and enough manpower is provided to these offices. The preliminary results dictate our future work, which will also focus on those points that we did not initially expect to be given such high priority by the interviewees. In future, a comprehensive overview of awareness in public research organisations and companies about the state aid rules will be a subject of research, including a larger actual sample of organizations and offices. An internationally comparative view on the regulation of the state aid system in infrastructure use and IPR transfer in cooperative R&D projects in the ERI-IE based on good practices of the general procedure for using the state aid system will be prepared to guide the users and the state administrations of the ERI-IE countries for maximum impact delivery with least friction among the stakeholders possible.

5 ACKNOWLEDGEMENTS

The authors equally participated in all stages of preparing, establishing, and framing the paper. All authors read and approved the final paper.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101004462.

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Technology Transfer Office as a Support Structure for Innovation Management: The Experience of Latvia

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ABSTRACT

The study describes a support structure – technology transfer office for knowledge and technology management in Latvia between 2007 and 2023. The analysis is based on the operational programme of the Latvia for 2007–2013, 2014–2020, and 2021–2027.

KEYWORDS

Innovation management, Technology transfer office, TTO, Strategy.

1 INTRODUCTION

The analysis of the role of technology transfer offices in university-industry cooperation has received much attention in academic literature, especially as an interdisciplinary topic. It is important to point out that knowledge and technology transfer processes are influenced by personnel capacity and experience, university resources, legal framework, institutional arrangements, political and other issues [1].

In Latvia, technology transfer offices have existed for more than 15 years. The first six Technology Transfer Offices (TTOs) were already established in 2005, funded under the support programme established by the Ministry of Economics. Three years later, during the 2007–2013 programming period of the EU funds, the activities of the TTOs were supported by the Operational Programme "Entrepreneurship and Innovation", under which eight TTO projects were approved and implemented in the period 2008–2013 in Latvian scientific institutions and universities [2]. The main performance indicators of the programme were related to the implementation of the classical forms of TTO tasks, such as the number of contracts for commissioned research, provision of research services and sale of industrial property or rights to use it, the number of applications for industrial property objects, the number of commercialisation offers, as well as revenues from contract research and/or licensing agreements [2].

At the end of the 2013 programming period, targeted public funding for TTO activities was reallocated to various activities to promote knowledge and technology transfer. During the programming period, a new support unit was created in the technology transfer system – Technology Scouts. The Scouts were active at the University of Latvia, Riga Technical University and in the following sectors: bioeconomy, smart materials and information and communication technology (the following sectors were planned: bioeconomy, smart energy, biomedicine, smart materials, information and communication technologies). The aim of Technology Scouts is to foster cooperation between researchers and entrepreneurs by helping to find the right research organisation and researcher to solve a problem [3]. From the analysis of the programming documents, no information is available on whether the Scouts will be supported in the next programming period.

2 CASE STUDIES

In 2023, an analysis of the planning documents shows that in Latvia, technology transfer offices or more developed units of them are operating in science universities (in one case with transformation features). The objectives of the science university are also related to technology transfer – to develop research, study, innovation, technology transfer and business incubation processes that ensure dynamic development of the economy and the emergence of new, modern economic sectors [4].

The strategies of universities and research institutes indicate an important role for knowledge and technology transfer activities. Riga Technical University has indicated in its 2023–2027 Strategy that the development of the Science and Innovation Centre will be supported, including the scaling-up of the operational model by providing for a binding second-level strategic planning document – Innovation Development Strategy, the implementation of which is the responsibility of the Vice Rector of Innovations [5]. In turn, the 2021–2027 Strategy [6] of the University of Latvia sets out a number of tasks, such as: to establish a support system for know-how and technology transfer; to expand the involvement of entrepreneurs as research cooperation partners in all areas of science; to develop entrepreneurial skills and expand students' involvement in creating innovations; to develop an open science approach. It should be noted that the Institute of Solid-State Physics, University of Latvia, also pays significant attention to knowledge and technology transfer activities, which is also indicated in the 2017–2026 Strategy [7].

The 2022–2027 Strategy [8] of Rīga Stradiņš University states that the growth of internationally high-quality scientific results should be promoted by organising the development of research and innovation in research centres of excellence and innovation. As well as increasing the revenues of scientific activities from the private sector, from which the author concludes – both performance indicators of TTOs are included, as well as revenues from the licensing or sale of contract research and industrial property.

On the other hand, the 2023–2027 Strategy of Latvia University of Life Sciences and Technologies describes technology transfer in this science university in great detail. Knowledge and technology transfer is one of the priority tasks for which a Knowledge and Technology Management Plan has also been developed, with tasks such as promoting the commercialisation of intellectual property through performance indicators, developing innovation and entrepreneurial skills of personnel [9].

The analysed science university strategies foresee knowledge and technology transfer activities which will be organised directly or indirectly by the relevant competent bodies – TTOs or similar innovation management structures. It is noticeable that in the 15 years of development of the TTO, there has been a significant accumulation of experience in the organisation of commissioned research with industry, in the marketing of science, in the development of a strategy for the commercialisation of scientific developments and in the organisation of the licensing process, including a strategy for the registration of intellectual property rights, in those scientific institutions that continued to fund TTO activities in the 2013–2017 programming period and beyond.

It is important to note that TTOs have established networks, e.g., the Baltic TTO Network was established in 2022 with the support of WIPO with the aim of promoting the exchange of knowledge and technology transfer experiences and practices between Latvia, Lithuania and Estonia, as, for example, the regulatory framework for knowledge valorisation is relatively similar.

However, during the development of the TTO, a stable funding stream is needed to enable the TTO to be self-financing after a certain period of time. As the implementation of RIS3 in Latvia also requires the development and accessibility of knowledge and technology transfer and the commercialisation of research results in all RIS3 specialisation areas and in the social sciences and humanities as an area with horizontal implications for RIS3 implementation, the Ministry of Education and Science ensures targeted investment in the development of the R&D system as well as RIS3 monitoring, while the Ministry of Economics should provide business sector analytics [10]. In parallel with the development of programmes for technology transfer, commercialisation of research results and development of new products and services, e.g., “Regulations for the implementation of measure 1.2.1.2 “Support for the improvement of the technology transfer system” of the specific support objective 1.2.1 “Increase private sector investment in R&D” of the Operational Programme “Growth and Employment”.

Within the framework of the Recovery and Resilience Facility activity 5.1.1.1.i. “Development and continuous operation of a fully-fledged innovation system governance model”, the project implements a new innovation governance model in RIS3 areas, fostering the development of innovation ecosystems in RIS3 areas, for example by fostering knowledge and technology transfer between ecosystem actors, i.e., through triple-helix, which led to the creation of 5 RIS3 Steering Groups in October 2022: Biomedicine, Medical Technologies, Pharmaceuticals; Information and Communication Technologies; Photonics, Smart Materials, Technologies and Engineering Systems; Knowledge Intensive Bioeconomy; Smart Energy and Mobility, aiming to create a dialogue between stakeholders in the RIS3 value chain ecosystems – companies, research organisations, policymakers (sector ministries) and implementers, industry associations, various networks, investors, universities, etc.[11].

In view of the above, a direct publicly funded support mechanism for TTO and technology scouting activities in scientific institutions is not planned to be introduced in the planning period from 2024, thus leaving the maintenance of administrative activities for knowledge and technology transfer to the responsibility of scientific institutions.

3 CONCLUSIONS

In Latvia, there is a very pronounced institutional gap in the organisation of knowledge and technology transfer processes. Strong innovation management centres are emerging in some universities and research institutions, combining publicly funded support instruments with private institutional resources to develop organisational and legal issues of knowledge and technology transfer, build a strong panel of experts, and develop international relations with the industry. In scientific institutions and universities without the financial resources to provide focal points, the coordination of TTO activities is reallocated within existing human resources, thus not creating strong centres for TTO development.

ACKNOWLEDGMENTS

Research have funded by project "Support for involving doctoral students in scientific research and studies". Project No. 8.2.2.0/20/I/004.

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A Statutory Model for Organising the Process of Intellectual Property Protection and Commercialisation in Polish Public Universities *

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ABSTRACT/POVZETEK

For almost two decades, the Polish legislator has been encouraging the spread of the idea of entrepreneurship in the academic environment, delineating the scope of organisation of the process of protection and commercialisation of the R&D results created by university employees. As part of successive amendments to the Act - Law on Higher Education, it has proposed the introduction of internal regulations governing the management of intellectual property rights and the principles of commercialisation, the establishment of organiational units responsible for supporting the commercialisation process, and incentives such as additional remuneration for the implementation of the so-called third mission of the university. The aim of the conference paper is to show how the statutory model of intellectual property management at Polish public universities looks like. The final conclusions will take into account the results of research carried out in 2023-2024 under the project entitled: "Transfer of R & D results from universities of Podlaskie voivodeship to the economic and social environment", funded by the Ministry of Education and Science.

KEYWORDS / KLJUČNE BESEDE

commercialization, public universities, technology transfer units, internal regulations

OPENING REMARKS

It is important to note at the outset that this paper refers only to public universities, of which there are currently 133 in Poland [1]. The main legal act regulating their functioning is The Act of 20 July 2018 - The Law on Higher Education and Science [2]. It explicitly indicates that the mission of the higher education system and science is to provide the highest quality of education and scientific activity, to shape citizenship, and to participate in social development and the creation of an economy based on innovation (art. 2). Thus, it can be assumed that Polish universities are obliged to fulfil the so-called „third mission", that is seen by many as crucial for making universities more responsive to societal needs. The idea behind it is that universities should not only serve their students but also engage with society, industries, and local communities to contribute to social development and economic growth. It often requires universities to work more closely with various external stakeholders and to develop new partnerships and collaborations outside the traditional academic sphere [3].

Through two decades of successive revisions of the Act - Law on Higher Education, the polish legislature has advocated the adoption of internal regulations governing the management of intellectual property rights and the principles of commercialisation, the establishment of organizational units dedicated to oversee those processes, and the implementation of incentives, including supplementary compensation, to bolster the realization of universities' "third mission." Currently, the Act of 20 July 2018 - the Law on Higher Education and Science contains a separate section „Commercialisation of research results and know-how".

REGULATIONS GOVERNING THE MANAGEMENT OF INTELLECTUAL PROPERTY RIGHTS AND THE PRINCIPLES OF COMMERCIALISATION

At the level of statutory provisions, legislator assumes that the senate of public university shall establish regulations governing the management of copyright, related rights and industrial property rights as well as the principles of commercialisation. It shall specify in particular:

1) the rights and obligations of university, employees, doctoral students and students with regard to the protection and use of IP rights,
2) the rules for the remuneration of authors,
3) the rules and procedures for commercialisation,
4) the rules for the use of a university's assets used for commercialisation and the provision of services in the field of scientific activity;
5) the rules for the distribution of funds obtained from commercialisation between an author who is an employee of a university and that institution
6) the rules and of mode of providing a university by employees, doctoral students and students with information on the research results and know-how related to them, information on the commercialisation funds obtained by the employee and the rules and mode of

*Article Title Footnote needs to be captured as Title Note
†Author Footnote to be captured as Author Note

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provision by an employee of a part of the funds obtained from commercialisation to the institution;

7) the rules and mode of providing an employee by a university with information on the decisions concerning commercialisation or non-commercialisation and the part of the funds derived from commercialisation they are entitled to (*cf.* art. 152).

THE DECISION-MAKING PROCESS FOR THE COMMERCIALISATION OF R&D RESULTS

It is worth noting that the further described obligations related to the process of protection and commercialisation concern R&D results created by university employees. With regard to students and doctoral students, the university may define rules for dealing with the results of their creative work and support them in securing their resources. However, given the general principles of intellectual property law, in the absence of a separate agreement, it is the student/doctoral student who remains the subject of rights and retain the freedom to dispose of the R&D results.

Furthermore, the procedure discussed below relates only to:

1) scientific research being an invention, utility model, industrial design or integrated circuit topography, grown or discovered and developed plant variety,

2) development works,

3) artistic creation – created under the performance of duties resulting from the employment relationship by an employee of a university, and the know-how related to such results (art. 153).

It should be also clearly stated that the current statutory regulation does not define the process of commercialisation of R&D results (in this respect generally applicable acts of law are in force, including: Act of 15 September 2000 Commercial Companies Code [4], Act of 23 August 1964 Civil Code [5], the Act of 30 June 2000 – Industrial Property Law [6], the Act of 4 February 1994 on copyright and related rights [7]), however, obliges the university to decide whether it will undertake the commercialisation of R&D results or transfer the rights back to the employee.

The first step required of an employee is to provide a university with information on the research results and know-how relating to them. In the case of an employee's declaration of interest in the transfer of rights to those results and the related know-how, the higher education institution shall decide on their commercialisation within 3 months.

Where a university decides not to undertake commercialisation or after the expiry of the 3 months' time limit, the higher education institution shall, within 30 days, make an offer to the employee to conclude an unconditional and paid agreement for the transfer of the rights to the research results and the related know-how, together with the information, works, including the ownership of the media on which they are recorded, and technical experiments. The agreement shall be concluded in writing; otherwise, it shall be null and void. The remuneration payable to a university for the transfer of rights may not be higher than 5% of the average remuneration in the national economy in the previous year, as published by the President of Statistics Poland. In 2022 the amount was 317.30 PLN [8].

If the employee does not accept the offer to conclude the agreement the rights to the research results and the related know-how, together with the information, works, including the ownership of the media on which they are recorded, and technical experiments, shall remain with the university.

It should be emphasised that the aforementioned rules of procedure and time limits shall not apply if the research was conducted:

1) under an agreement with the party financing or co-financing such research, providing for an obligation to transfer the rights to the research results to that party or to an entity other than a contracting party;

2) with the use of financial resources, the rules for the granting or use of which specify a different way of disposing of the research results and the related know-how.

It is also worth pointing out that upon receipt of information from an employee on the research results and the related know-how, a university and an employee may, in a manner other than provided above, determine the rights to such results or the manner of their commercialisation by way of anagreement (art. 157).

EMPLOYEE'S OBLIGATIONS

Beyond doubt, academics play a multifaceted role in technology transfer, contributing their expertise, research, innovation, collaboration, and industry partnerships to bring university-developed technologies from the lab to practical applications that benefit society and the economy.They collaborate with colleagues within their own institutions and across other universities, research institutions, industries, and government organisations. These networks facilitate the exchange of ideas, resources, and expertise, accelerating the technology transfer process. Effective communication and engagement with these stakeholders are crucial for securing funding, support, and resources for technology transfer initiatives.

Employee's input is critical in the commercialization of technologies. By actively engaging in activities such as licensing agreements, startup creation, and technology spin-offs, they ensure that the technologies are properly transferred to the private sector for further development and market penetration.

In view of the above, the legislator has formulated a catalogue of obligations to be observed in the process of protection and commercialisation of R&D results. An employee of a public university shall be obliged to:

1) preserve the confidentiality of the research results and related know-how,

2) provide the higher education institution with all its information, works, together with the ownership of the media on which they were recorded, and the technical experience needed for commercialisation,

3) refrain from any action aimed at the implementation of the results,

4) cooperate in the commercialisation process, including the proceedings aimed at obtaining exclusive rights - not longer

than for the period in which the rights of the higher education institution apply.

These obligations are formulated in very general terms and should be made more specific in the IP internal management regulations and/or in the employee's contract.

EMPLOYEE'S RIGHTS

As can be seen from the above, the process of protection and commercialisation is formalized and very involving and time-consuming. The statutory model does not balance these challenges by establishing an incentive system, in fact it only provides for additional remuneration for successful commercialisation.

Art. 155 states that, in the case of commercialisation, an employee shall be entitled to no less than 50% of the value of funds obtained by the university from direct commercialization/ by the special purpose vehicle as a result of a given indirect commercialisation, reduced by no more than 25% of the costs directly related to such commercialisation, which were incurred by the university or the special purpose vehicle.

It is worth noting that also in the reverse situation, in the case of commercialisation by an employee, a university shall be entitled to 25% of the value of funds obtained by the employee from commercialisation, reduced by no more than 25% of the costs directly related to such commercialisation which were incurred by the employee.

Costs directly related to commercialisation shall be understood as external costs, in particular the costs of legal protection, expert opinions, valuation of the subject of commercialisation and official fees. These costs shall not include the costs incurred before the decision to commercialise and the remuneration payable to a higher education institution for the transfer of rights.

The regulation acknowledges the role of researchers and innovators in generating valuable ideas, inventions, or discoveries that can be translated into products, services, or `technologies. By offering employees a share of the value obtained from commercialization, the regulation provides a direct financial incentive for researchers and innovators to engage in activities that could lead to valuable outcomes with commercial potential. This can motivate researchers to explore practical applications for their work and actively participate in technology transfer and commercialization efforts.

KEY ACADEMIC UNITS INVOLVED IN THE TRANSFER OF R&D RESULTS

For obvious reasons, the process of protecting and commercialising knowledge cannot rest on the shoulders of academics, specialised units are established that are crucial in bridging the gap between academia and industry. If these offices are not effective, well-staffed, or properly funded, the commercialization process may falter.

Law on Higher Education and Science indicates which units may be set up by public universities to support entrepreneurship and the process of transferring R&D results into the economy. Art. 148 stipulates, that higher education institutions may operate academic business incubators (hereinafter referred to as a ABI) and technology transfer centers (hereinafter referred to as a TTC). These units are differentiated by their structure and scope of action.

An ABI shall be established to support the business activities of the employees, doctoral students and students. It can operate in the form of a general university unit (under regulations approved by the senate) or a capital company.

A TTC shall be established for the purpose of direct commercialisation, consisting in the sale of research results or know-how related to these results, or to the provision of these results or know-how for use, in particular on the basis of a license, rental and lease agreement. It may be established as a general university unit and shall operate under regulations approved by the senate.

The law requires that the director of an ABI in the form of a general university unit or a TTC shall be employed by the rector after consultation with the senate from among candidates presented by their supervisory boards.

According to art. 149 a higher education institution may also, for the purpose of indirect commercialisation, consisting in taking up or acquiring shares in companies or taking up subscription warrants entitling it to subscribe for or take up shares in companies, in order to implement or prepare for the implementation of the research results or know- -how related to those results, establish only single-member capital companies (hereinafter referred to as a „special purpose vehicle"). To finance the share capital of a special purpose vehicle, the higher education institution may make a contribution in kind (in whole or in part) in the form of research results and know-how related to those results. A special purpose vehicle shall be established by the rector with the consent of the senate. The university may, by way of an agreement, entrust a special purpose vehicle with:

1) the management of rights to the results or know-how in the scope of direct commercialisation;

2) the management of research infrastructure.

A special purpose vehicle may additionally conduct business activity separated in terms of organisation and finance from the activity referred above.

The university shall allocate the dividend paid to a special purpose vehicle to the performance of its basic statutory tasks.

Art. 150 underlines that only higher education institutions may be partners or shareholders of a special purpose vehicle. A special purpose vehicle may be established by several public higher education institutions. A public university may join a special purpose vehicle established by another public higher education institution.

All the institutions indicated above may operate, but are not an obligatory units within the structure of public universities. In fact, ABIs, TTCs and SPVs are the core of the IP protection and knowledge commercialisation model. They work in collaboration, seeking to share experience and develop best practices. To amplify these effects the Polish Association of Centers for Technology Transfer (PACTT.pl) was established in 2015. It is a voluntary association of representative units of Polish universities responsible for the protection, management and commercialization of university intellectual property. Among its objectives, it has adopted:

- the integration and development of the professionals dealing with the knowledge and technology transfer in academic ecosystem;
- exchange of knowledge, experience, standards and good practices;
- cooperation in the field of commercialization of research results
- joint representation of the members of PACTT.pl before public administration bodies, employers' associations and other entities operating toward innovation and cooperation between science and business. This representation applies, in particular, to such actions as: initiating pro-innovation activities of national character, preparing and giving opinions on legal changes and issuing opinions on strategic documents and actions taken by authorized bodies in the area of national innovation policy [9].

A year earlier the Polish Association of University Knowledge Transfer Companies (PSC) was appointed. The Association is a forum for cooperation of 34 university special purpose vehicles, established to commercialize scientific research results from universities and research institutes and carry out applied research commissioned by enterprises.Shows the real importance of SPVs that cooperate with investors, business angels, and innovative entities ready to implement science-based technologies, are vehicles supporting the creation of spin-off companies [10].

CONCLUSIONS

The commercialization process at Polish universities, like in many other countries, faces challenges despite having laws and bylaws in place. A one-size-fits-all approach does not guarantee success. Different fields and research areas require customized strategies and support. Currently, the legal and administrative processes is cumbersome, slow, and complicated, deterring both researchers and potential industry partners from engaging in collaborative ventures.

Cultural barriers exist both at the side of academia, as well as at the industry. The prevailing academic culture prioritizes traditional research and publishing over commercialization. It takes a shift in mindset to view research not just as an intellectual pursuit but also as a potential commercial product. Academics lack the necessary skills or understanding of market dynamics, business planning, and entrepreneurship required to transform research into a marketable product. Research is conducted in areas that don't align with current market needs or industry interests, leading to a gap between the creation of IP and its practical application. If universities do not provide proper incentives, recognition for commercialization efforts, researchers may see little personal benefit in pursuing these paths.

There is also insufficient funding to support the development, protection, and commercialization of R&D results. Polish science is underfunded. The share of higher education and science expenditure in GDP in 2023 was only 1.1 per cent. Not enough money for R&D activities and lack of dedicated resources for commercialization hinder the process of technology transfer. Without a robust ecosystem of venture capital and private investment, it can be challenging to secure the funding needed to scale up a commercial venture.

Placing the burden on universities to build a model for commercialisation of research and development results can be assessed as a solution for adapting it to the specifics of each university and a manifestation of broadening the scope of self-determination of scientific institutions. However, it is not justifiable at this stage, as shown by research carried out in individual regions. Preliminary research carried out in 2023 under the project entitled: "Transfer of R & D results from universities of Podlaskie voivodeship to the economic and social environment", funded by the Ministry of Education and Science., confirmed that Polish universities still avoid innovative and risky ventures in favour of safe and standard activities. They have little experience in the commercialisation of research results and have not developed procedures to deal with their transfer . Universities fulfil the requirements set out in the Act - The Law on Higher Education and Science as obligations imposed by the legislator and not to achieve developmental goals .

We are therefore still left with the conclusion that addressing all the challenges requires a comprehensive approach involving fostering an entrepreneurial culture, promoting collaboration between academia and industry, simplifying regulatory processes, and improving access to funding and investment.

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A Comprehensive Analysis of Portuguese National and Regional Policy Instruments for Technology Transfer Offices*

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ABSTRACT / POVZETEK

In the rapidly evolving landscape of global technological advancement, the process of transferring technological insights from academic settings to industrial and commercial areas – known as Technology Transfer (TT) – is paramount. This research examines the national and regional mechanisms that Portugal employs in the TT domain, with a specific focus on instruments targeting academic Technology Transfer Offices (TTOs). Particularly, the research assesses the implemented policy instruments, emphasizing their respective significance and operational dynamics for the benefit of TTOs. This paper offers a comprehensive understanding of Portugal's ambition and strategy for translating academic knowledge into tangible industrial benefits. The findings illuminate not only Portugal's strategic trajectory in TT but also offer critical insights for policymakers, academia, and industry stakeholders, exploring and highlighting the instrumental role of TTOs in bridging the gap between innovation and commercialization.

KEYWORDS / KLJUČNE BESEDE

Technology Transfer; Science, Technology and Innovation Policy; Higher Education Institutions; Technology Transfer Offices

1 Introduction

Historically, Higher Education Institutions (HEIs) have continually evolved in response to changing governmental visions and dominant socioeconomic influences[1]. A notable shift post-1990 was the intersection of education and research, highlighting the importance of knowledge dissemination and technological progress [1]–[3].

In today's landscape, HEIs are increasingly driven by applied research, positioning them at the forefront of technological innovations with marketable potential[4]. The modern role of HEIs integrates their primary educational and research missions into a holistic "third mission," which envelopes technology transfer, entrepreneurship, and industry partnerships [5]–[9] At the heart of this value creation are technological breakthroughs, which are secured through Intellectual Property Rights (IPR), positioning Technology Transfer Offices (TTOs) as central figures[10], [11].

TTOs serve as pivotal conduits, connecting academia to industry. They meticulously review academic discoveries, guiding researchers toward identifying and presenting market-ready innovations. In defining their roles, responsibilities in patent decision-making, commercial potential assessment, and active marketing of inventions. Simultaneously, TTOs have a role in bridging information voids between industry and academia, particularly in valuing inventions [12], [13].

TTO efficacy hinges on available resources[13]–[15]. These resources, as highlighted vary across institutions and their effectiveness. Resources can be grouped into financial, infrastructural, human, and organizational capacities. Notably, seasoned TTOs often excel over their newer peers due to the extensive learning curve involved in mastering technology transfer[16].

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Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia

To bolster this, HEIs have broadened their financial funds, focusing on translational research and the emergence of academic spin-offs [17]. Current discourse places emphasis on two mechanisms: Proof-of-Concept (PoC) programs[18], [19]and University Seed Funds (USFs)[14], [20].

Portugal's trajectory in R&D investment has historically been uneven, swayed by socio-political dynamics and economic downturns[21]. These fluctuations sometimes led to inconsistent support for TTOs, causing variances in their efficacy. While some Portuguese HEIs have blossomed into innovation hubs with proficient TTOs, others, especially those distant from urban centers, grapple with forming industry ties and securing steady funds. Contemporary barriers, such as challenges in promoting interdisciplinary research amidst bureaucratic limitations, funding, and capacity building further exacerbate these historical differences.

The crux of this paper is an examination of public funding's role in the evolution and sustenance of TTOs in Portugal, spotlighting government backing. Specifically, we delve into public financial structures that have engendered “gap funding” models[17], focusing on Portuguese HEIs deeply reliant on state support.

2 The Role of National and Regional Policy Instruments in Portugal's TTO Landscape

2.1 Direct Financial Support: A Catalytic Support for the Establishment of Portuguese TTOs

One of the pivotal strategies within the “third mission” of HEIs in Portugal has been the establishment of TTOs, which serve to sustain the interactions between HEIs, the industry, and the wider society.

In 2001, the Intellectual Property Support Offices (GAPI), spearheaded by the National Institute of Industrial Property (INPI), was introduced. They were co-funded by public schemes such as the Operational Programme for the Economy and the Incentive Program for the Modernisation of the Economy. These GAPIs aimed to guide researchers and academics regarding patentable knowledge.

By 2006, the Innovation Agency (ADI) launched the Technology and Knowledge Transfer Offices (OTICs), designed to streamline the transfer of knowledge and technology to businesses. Over time, the roles of GAPIs and OTICs began to intertwine, leading to their eventual integration into the unified TTOs (Table 1).

More recently, between 2016 and 2022, public funding (Regional Operational Programmes of Portugal 2020) was provided for the establishment of three additional TTOs in the Lisbon Region. These include a center at the NOVA University of Lisbon focusing on Social Innovation, aiming to be the first national infrastructure promoting a university-business-organization interface for innovative R&D projects addressing diverse social issues. At the University of Lisbon, the TTC@ULisboa acts as a facilitator for technology transfer and entrepreneurship, offering a strategically located space for young entrepreneurial students, researchers, and businesses. Lastly, the ISCTE - University Institute of Lisbon established a new TTO, leveraging its existing R&D structure, advanced training, and innovation, creating a hub for new ideas focusing on society and the challenges of digital transformation.

Table 1: Portuguese Higher Education Institutions with Technology Transfer Offices

Higher Education Institution	Type Funded Operation
Instituto Superior Técnico	GAPI
University of the Azores	GAPI
University of the Algarve	GAPI & OTIC
University of Coimbra	GAPI & OTIC
University of Évora	GAPI & OTIC
University of Beira Interior	GAPI & OTIC
University of Trás-os-Montes and Alto Douro	GAPI & OTIC
University of Porto	GAPI & OTIC
University of Minho	GAPI & OTIC
Polytechnic Institute of Setúbal	OTIC
Polytechnic Institute of Tomar	OTIC
Polytechnic Institute of Porto	OTIC
Polytechnic Institute of Leiria	OTIC
Polytechnic Institute of Beja	OTIC
Polytechnic Institute of Castelo Branco	OTIC
Polytechnic Institute of Portalegre	GAPI & OTIC
Polytechnic Institute of Viana do Castelo	OTIC
Technical University of Lisbon	OTIC
Portuguese Catholic University – School of Biotechnology	OTIC
New University of Lisbon	OTIC & Regional Operational Programs of Portugal 2020
Lusíada University of Vila Nova de Famalicão	OTIC
University of Aveiro	GAPI & OTIC
University of Lisbon	GAPI & OTIC & Regional Operational

University of Madeira	Programs of Portugal 2020 OTIC
ISCTE - University Institute of Lisbon	GAPI & Regional Operational Programs of Portugal 2020

Source: List of Approved QREN and Portugal 2020 Operations

2.2 Capacity Building: Shaping TTOs Ecosystem

2.2.1 University Technology Enterprise Network (UTEN)

In response to the fragmented interactions between Portuguese HEIs and industry, the Portuguese Foundation for Science and Technology (FCT) collaborated with the IC2 Institute of the University of Texas at Austin to establish the University Technology Enterprise Network (UTEN) in March 2007[22].

UTEN's primary objective was to develop a network proficient in transferring and commercializing science and technology. This network encompassed public Portuguese HEIs, an affiliated private institution, related TTOs, research centers, and occasionally, technological parks[23].

UTEN offered specialized training by internationally renowned experts, emphasizing the commercialization of Portuguese academic innovation[23]. From 2007-2010, UTEN facilitated international internships for technology transfer officers[22], [24]–[26].

2.2.2 TTO Network

Research indicates that academic TTOs evolve through experimentation, failure, and the mutual exchange of experiences [27], [28]. Yet, barriers persist in sharing best practices among TTOs. Initiated in 2018, the TTO Network represents National Innovation Agency's (ANI), previously ADI, commitment to fostering innovation, technology transfer, and knowledge commercialization within HEIs. In 2022, ANI commenced a two-year initiative to enhance TTO Network capacities.

In addressing the challenges Portuguese TTOs faced in capitalizing on their IP assets, an initiative was set in motion: the implementation of specialized training. The purpose behind this specialized training was twofold: it was structured to empower TTOs with the tools for effective collaboration, technology scouting methodologies, precise market analysis, industry trend discernment, and the evaluation of technologies with high commercial potential. Moreover, the collaboration with international experts provided these TTOs with the strategic insight required to effectively manage their respective HEI's IP portfolios.

For each HEI was developed a comprehensive IP Portfolio, which integrates patents, trademarks, copyrights, and trade secrets, stands as a testament to an HEI's intellectual competence.

As part of this initiative, in the first semester of 2023 were introduced open innovation challenges. Rooted in the ethos of managing knowledge assets through open innovation [29], [30], these challenges encouraged companies to present real-world challenges they faced, incentivizing TTOs to respond with innovative technology solutions drawn from their IP portfolios.

2.3 Funding instruments for technology transfer: How TTOs support their activities?

The Portuguese government's support, although invaluable, primarily targets the creation and capacity-building of TTOs without explicitly supporting the daily operations of TT activities such PoCs and USFs. The primary onus, therefore, falls on TTOs themselves. These operations, characterized by collaborations with companies, demand for innovative solutions, and training initiatives, are not merely cost-intensive but also necessitate continuous financial inflow [14], [17], [18], [19], [20]. To address this, and in line with their "third mission", Portuguese TTOs often resort to regional Operational Programmes, emphasizing the critical role such programs play in bridging the financial and operational gaps (Table 2).

Table 2: Overview of Funding Mechanisms for TT Activities Across Portuguese HEIs

Higher Education Institution	Funded Operation	Total Eligible Expenditure (in euros)	Operational Program	Type of Mechanism
Algarve University	TT 2.0	552 155,8	Algarve Regional Operational Program	PoC
Aveiro University	CAMPUS TEC	286733	Center Regional Operational Program	PoC and USFs

Católica University	3Boost	999960,89	Operational Programme for Competitiveness and Internationalization	PoC
Coimbra University	INOV C 2020	1627614,39	Center Regional Operational Program	PoC
Coimbra University	InovC+	3393755,86	Center Regional Operational Program	PoC
Polytechnic Institute of Leira	Knowledge Circle	477810,74	Operational Programme for Competitiveness and Internationalization	PoC
Trás os Montes and Alto Douro University	INOV@UTAD	754145,62	North Regional Operational Program	PoC and USFs
Trás os Trás os Montes and Alto Douro University	Lab2Business	506902,74	North Regional Operational Program	PoC
Trás os Montes and Alto Douro University	UI-Transfer	824056,95	Operational Programme for Competitiveness and Internationalization	PoC

Source: List of Approved Operations for Portugal 2020 as of June 30, 2023

3 Discussion and Conclusion

The introduction of the GAPI in 2001 marked a significant turning point in Portugal's commitment to fostering TT. With the formation of GAPIs and later the OTICs, the institutional structure for technology transfer was solidified. The involvement in UTEN activities expanded, and the focus shifted from just patenting to a more comprehensive TT ecosystem, encompassing patenting, licensing, start-ups, and industry collaborations.

Portugal's strategic approach to TTOs, seen through initiatives like TTO Network, is praiseworthy concerning the extensive learning curve involved in mastering tech transfer activities[16].

Out of the 26 HEIs that were funded to create the TTO, only 8 displayed consistent activity in TT funded by the Operational Programmes between 2016 and 2022. It's evident that more established and well-resourced institutions dominate TT activities, aligning with the observations from the literature. The appearance of Coimbra University twice could be attributed to multiple funding sources or different TTO initiatives undertaken at different periods. Such overlapping engagements aren't uncommon, especially in more established HEI.

The significant funding allocated by Operational Programmes for USFs and PoCs activities underscores their indispensable role. However, the persisting challenges, primarily the "funding gap" and the operational complexities, indicate the need for continuous adaptation and a synergistic approach involving policymakers, academia, and industry stakeholders to continue improving the funding programs.

This paper provides an insightful analysis of Portugal's approach to TT. When analyzing Portugal's historical and contemporary policy instruments, we uncover the commitment to building an ecosystem that fosters innovation, addresses funding challenges, and bridges the gap between academia and industry. The initiatives – from the establishment of TTOs, and capacity-building networks, to funding mechanisms – demonstrate a holistic strategy.

As Portugal continues its journey in the global TT landscape, the insights from this analysis can inform similar ecosystems globally, emphasizing the universality of the challenges and the importance of a coordinated approach to surmount them.

ACKNOWLEDGMENTS / ZAHVALA

The authors would like to acknowledge the National Innovation Agency for their unwavering support throughout this research.

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Compulsory Licensing in Belarus

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ABSTRACT

The paper informs on the state of compulsory licensing in Belarus and recent changes restricting IP rights.

KEYWORDS

Intellectual property law, patent law, compulsory licenses.

1 INTRODUCTION

The term compulsory licensing refers to a situation where a court or government enforces a non-exclusive license to the protected intellectual property (IP) without the wishes and the consent of the IP owner. It can be dated back to Article 5A (2) of the Paris Convention for the Protection of Industrial Property (Paris, 1883), stating: "Each country of the Union shall have the right to take legislative measures providing for the grant of compulsory licenses to prevent the abuses which might result from the exercise of the exclusive rights conferred by the patent, for example, failure to work" [1].

The world practice has developed three main types of compulsory licenses: 1) for non-working or insufficient working of patented invention; 2) for dependent inventions; 3) in public interest, such as "national emergency" or "public health" [2-9].

The international legal basis for compulsory licensing is found in the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (1995) (TRIPS Agreement) and the Doha Declaration on the TRIPS Agreement and Public Health (2001). Due to the national character of intellectual property rights (IPRs) countries may implement their own systems of compulsory licenses (CL).

2 COMPULSORY LICENSING IN BELARUS

The compulsory licensing of industrial property in Belarus has been regulated by Articles 10 and 38 of the patent law (the Law "On patents for inventions, utility models, and industrial designs" dated December 16, 2002, No. 160-3) [2, 10].

Article 10 "Actions not recognized as infringement of the exclusive right of the patent owner" addresses the use of patented inventions under extraordinary circumstances (natural disasters, catastrophes, accidents, epidemics, epizootics, etc.) with notification of the patent owner of such use as soon as possible and payment of corresponding compensation.

For example, based on Article 10 during epidemic any person may, without authorization organize both the production and import of generic medicines. The weakness for the person is that the patent owner may at any time challenge the very legitimacy of such use, its scope and duration, as well as disagree with the amount of compensation offered to him.

In this case the granting of CL would be preferable, since the person in whose interests it is granted understands for what period of time, to what extent and under what conditions the patent-protected subject matter may be used.

Article 38 "Compulsory license" addresses the non-working or insufficient working (1) and dependent inventions (2) types of CL and describes the legal procedure for obtaining a CL by a third party, which is done by filing a claim with the Judicial Collegium for IP of the Supreme Court.

The patent law of Belarus does not use all options in terms of compulsory licensing, which are implemented in other countries. This concern primarily compulsory licensing in "public health" interest.

When opting for the issuance of a compulsory license in the "public health" interest, it is advisable that preference be given to the administrative procedure as it is much simpler and faster [6, 7].

3 AMENDMENTS TO THE PATENT LAW

Although Belarus is not a WTO member the above-mentioned gap has been closed by the law "On amendments to laws on the legal protection of intellectual property" dated January 9, 2023, No 243-3 that introduced amendments to patent law.

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Table 1: Compulsory licensing of industrial property in Belarus

#	Grounds for granting a CL, legislative act	Procedure	Conditions
Invention, Utility model			
1	Non-working or insufficient working by the patent owner within 3 years from the publication date, leading to insufficient supply of relevant goods, works or services on the market (patent law, Article 38 (1)).	Legal	* Refusal of the patent owner to conclude a license agreement on terms consistent with established practice. * The interested party has the ability to use the invention. * Absence of valid reasons for non-working proven by the patent owner.
2	A patented invention cannot be worked without exploiting an earlier patented invention (utility model) (patent law, Article 38 (2)).	Legal	* The invention is dependent on a patent for an invention (utility model). * The invention is an important technical achievement. * The invention has significant advantages over the original invention (utility model) patent. * Refusal of the patent owner to conclude a license agreement on terms consistent with established practice.
3	The need to ensure national security, state defence, safety and security of people's lives and health (patent law, Article 38 (3)).	Admini-strative	
Design			
4	Non-working or insufficient working by the patent owner within 3 years from the publication date, leading to insufficient supply of relevant goods, works or services on the market (patent law, Article 38 (1)).	Legal	As 1.
5	The need to ensure national security, state defence, safety and security of people's lives and health (patent law, Article 38 (3)).	Admini-strative	
Plant variety			
6	Non-working or insufficient working by the patent owner of a plant variety within 3 years from the registration date in the State Register of Protected Plant Varieties (law "On plant varieties", Article 31).	Legal	* Refusal of the patent owner to conclude a license agreement. * The interested party has the ability to use the plant variety. * Absence of valid reasons for non-working or insufficient working, proven by the patent owner.
Topography			
7	Non-working or insufficient working of the topography by the right owner within 3 years from the publication date in the official bulletin of information about the registration of the topography, leading to an insufficient supply of relevant products (goods) (Law "On protection of integrated circuit topographies", Article 22 (1)).	Legal	* Refusal of the patent owner to conclude a license agreement on terms consistent with established practice. * The interested party has the ability to use the protected topography. * Absence of valid reasons for non-working or insufficient working, proven by the rights owner.

The newly added Article 38 (3) of the patent law describes "public health" type of CL, which is granted by the decision of the Council of Ministers. The decision specifies:

1. Last name, first name, patronymic (if any) of the individual, or the legal entity to which CL is granted.
2. The period for which a compulsory simple (non-exclusive) license is granted.
3. Usage rights of a person who has been granted a CL.
4. A government agency that within 30 days from the date of the decision to grant a CL must notify the patent owner about the decision.
5. The procedure for notification of a government agency by an individual or legal entity that is granted a CL about the payment or impossibility of paying the compensation to the patent owner.
6. Amount and procedure for payment of compensation.

Table 1 summarizes procedures for granting CL for industrial property after the amendments.

4 RESTRICTIONS OF IP RIGHTS

The law "On restriction of exclusive rights to intellectual property objects" dated January 3, 2023, No. 241-3.

Articles (1) and (2) of the law allow the use of software, audio/visual works, music and broadcasts without the consent of the rights owner or the organization for collective management of property rights if they are from the foreign countries committing unfriendly actions against Belarusian legal entities or persons. The Council of Ministers appoints state authorities for managing the lists of corresponding rights owners.

The user of above mentioned IP pays remuneration that is credited to the bank account of the national IP office (the National Center of Intellectual Property). Together with payment the information on IP use and calculation of remuneration shall be provided. The amount of remuneration assigns the Council of Ministers.

The remuneration will be kept on the bank account of national IP office for three years from the moment of deposit and during that period can be claimed by the rights owner. The national IP office can use up to 20% of the remuneration to cover its management expenses.

After three years, the unclaimed remuneration will be transferred within three months to the republican budget.

Articles (3) and (4) of the law allow import from any foreign country of goods from the List of goods (group of goods) vital for domestic market, if there is critical shortage (i.e. parallel import). The Council of Ministers appoints state authority for managing the list.

If imported goods include IP, it will be temporary excluded from the National customs register of IP objects. The notification letter will be sent at the address of the rights owner within two days of the decision to exclude the IP from the register.

The articles of the law are valid until the end of 2024.

5 CONCLUSIONS

Most countries provide for compulsory licensing to advance nation's technological development by encouraging the production and use of patented goods and increase access to advanced technologies [5–9].

The compulsory licensing in Belarus before 2023 was not applicable to medicines (new or expensive) since grounds for compulsory licensing did not include "protection of human life and health". Introduction of the Law No. 243-3 on January 9, 2023, updated the legislation for all options allowed by international laws. When granting compulsory licenses in "public health" interest an administrative procedure is applied.

Compulsory licenses in Belarus are not agreements and as such should not be registered with the National Center of Intellectual Property.

ACKNOWLEDGMENTS

We would like to thank the National Academy of Sciences of Belarus and the State Committee on Science and Technology of the Republic of Belarus for their constant support of RCTT activities and express gratitude to all our colleagues who work in technology transfer for their help and advice.

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Assessing the Contribution of Hubs to Uganda's Innovation Ecosystem

A Case Study on the Role of Innovation Hubs in Kampala

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ABSTRACT / POVZETEK

This paper focuses on assessing the role of hubs in facilitating innovation for economic development.

It analyzes the ability of innovation hubs in Kampala to provide three critical elements for innovation - financial support, business development services and networking opportunities.

The paper also explores the development focus of these hubs, as well as the challenges they face in facilitating innovation.

Based on the results of this analysis, it is recommended that comprehensive instruments be developed to facilitate the integration of the different pathways for innovation, and the collaboration of actors in the National System of Innovation (NSI)

This paper emphasizes the need for innovators based outside of research and academic establishments to acquire good understanding of intellectual property assets in order to benefit from the knowledge economy, It is proposed that innovation hubs in the informal innovation pathway address not just the awareness gap that exists, but also the limited capacity in identifying, protecting and diffusing research products and intellectual property generated.

KEYWORDS / KLJUČNE BESEDE

Innovation, innovation pathway, development, Intellectual Property Management

1 INTRODUCTION

In a metanalysis utilizing data from 115 countries, Fagerberg and Srholec (2008) identified the development of an innovation system to be one of the top four out of twenty-five factors, critical for the economic development of any nation [1].

National Systems of Innovation, though comprising of a multitude of actors, often feature two distinct pathways: the formal innovation pathway which features state-supported activities conducted by actors in academia, research institutes and industry, and the informal pathway where players from civil society and grass root organizations take on self-financed innovation activities [2].

Innovation enablers in the informal pathway (i.e private-owned incubators, accelerators and technology hubs) often offer a variety of business-related services including: office/ lab space, product development mentorship and business coaching in addition to networking opportunities, industry linkages, and in some case, seed funding.

What they seldom focus on, especially in the case of Uganda, are services directed at the exploration and management of intangible assets such as intellectual property (IP).

Intellectual Property is a critical component of any innovation ecosystem. IP assets can act as a safety net for innovators in developing economies like Uganda where approximately 75% of start-ups fail to reach the first anniversary of their business operations [3].

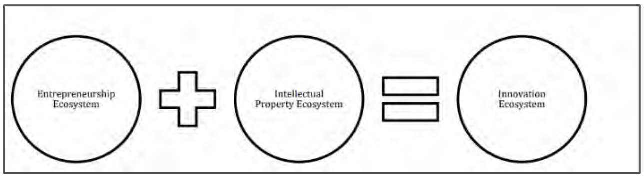

Figure 1: The link between entrepreneurship, intellectual property and innovation [4]

Systems required to facilitate innovation activities are complex and often call for collaboration among various stakeholders in bringing together inputs such as infrastructure, finances and expertise needed for innovation processes such as prototyping and IP registration [5].

While innovators in academic and research institutes may be privy to information on and the benefits of IP, the same cannot be said for actors in the informal innovation pathway.

In order to facilitate consolidated development of the National System of Innovation (NSI) in Uganda, this paper assessed the role of innovation hubs in greater Kampala and her neighbouring suburbs.

Specifically, the study sought to

i assess the provision of three key elements for innovation, that is, financial support, business development services and networks;

ii identify the development challenges addressed and the innovation focus in innovation hubs and;

iii provide recommendations for further development of the NSI.

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2 METHODOLOGY

2.1 Research Design

Purposive sampling and snow balling were utilized in identifying and approaching participants based in innovation hubs in Kampala.

These participants, ten (10) in total, categorized their establishments as incubators, technology transfer offices, accelerators and technology hubs based on the following descriptions:

- Incubator (IN) – an independent co-working innovation space that creates and develops start-up companies for at least 12 months.
- Technology Transfer Office (TTO) – a facility affiliated to a university or research institution that assists researchers in IP protection, licensing and commercialization.
- Accelerator (ACC) – an entity focused on accelerating or scaling up companies for a few months through structured programmes and funding.
- Science Park (SP) – an entity promoting innovation and competitiveness of associated businesses and knowledge-based institutions in a given community.
- Technology Hub (TH) – a facility focused on generating contacts or leads and/or providing motivation, exposure and self-belief for innovators.
- Co-working Space (CWS) – a facility providing only hot desking, office spaces, boardroom facilities or events to start-up companies.

Depending on the nature of operations and the innovation programmes hosted in their establishments, many participants identified their spaces to fall in more than one category.

Table 1: Innovation hubs by year, category and beneficiaries

Name of Innovation Hub	Year of Establishment	Category	Beneficiaries Supported (24 mon
StartHub Africa	2017	IN, ACC, TH, Others	>200
NARO Incubation Centre	1992	IN, TTO, ACC, TH	51-100
Women In Technology Uganda (WITU)	2012	IN, TTO, ACC, TH	>200
MoTIV	2020	CWS, IN, ACC	>200
Response Innovation Lab	2018	ACC	101-200
NFT Mawazo	2005	IN, ACC, TH	>200
Makerere Innovation and Incubation Center	2016	IN, ACC, TH	51-100
TechBuzz Hub	2016	CWS, IN, TH	>200
KQ Hub Africa	2018	Other	101-200
Design without Borders Africa	2014	Other	>200

2.2 Data collection and analysis

The data collection process constituted: a physical assessment of innovation establishments in Kampala; a desk review of information on the innovation hubs identified and; designing and administering a survey tool to assess innovation support.

Three elements were assessed: financial support, business development services and networking opportunities. Data analysis was then conducted in MS Excel and SPSS 26.

3 RESULTS AND DISCUSSION

3.1 Descriptives

The most commonly addressed development challenges, based on the SDGs were: Decent Work and Economic Growth (8); Industry, Innovation and Infrastructure (9) and No Poverty (1) and the least addressed were: Life below Water (14) and Life on Land (15).

The most supported themes in the innovation hubs were: Education and Skills Development while least supported themes were Transport and Infrastructure and Democracy and Governance. The average quantum of funding provided by hubs was USD $10,000 - $50,000

3.2 Provision of financial support

Financial support adversely influences an institution's decisions, ability to engage in innovative activities and the nature of outcomes of their innovation processes [6].

Results indicated that six of the ten innovation hubs were subject to financial constraints as the quantum of funding required by their beneficiaries was greater than the quantum of funding they provided.

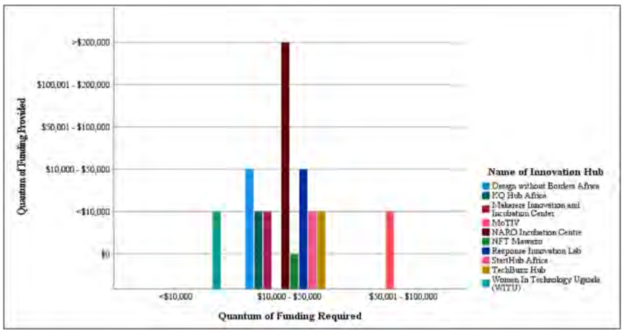

Figure 2: Quantum of funding provided against requirement

3.3 Provision of business development services

All ten of the participating innovation hubs provided at least two support services required for business development as presented in Figure 3.

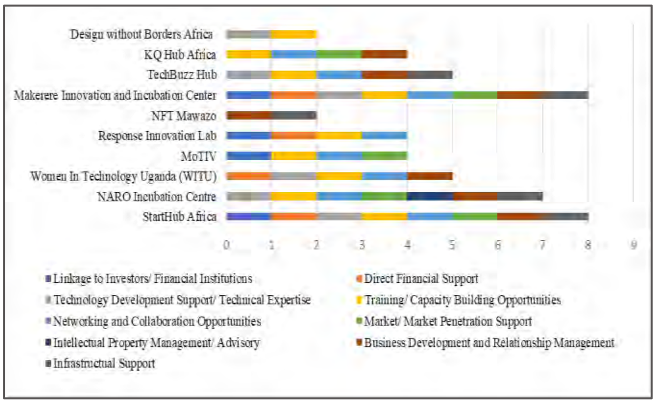

Figure 3: Business support services supported by innovation enablers

Services such as training and capacity building were the most common - provided by nine out of ten of the hubs, followed by networking opportunities, and business development and relationship management.
Intellectual Property Management (IPM)/ Advisory was the least supported service, only available at the NARO Incubation Centre.

While the protection of IP assets by registration can be viewed as a means to obtaining economic reward for innovation [7], many establishments supporting innovators, especially from the tech industry, are not keen on providing IPM support because of the rapid changes in the industry [8]. With a few modifications, a technology that is innovated today can quickly become irrelevant tomorrow. This could be a reason for no IPM services in some of the participating hubs.

Other possible arguments for the absence of this service could be the slow progress in developing markets for IP assets in Uganda, and the presence of a national IPM authority - the Uganda Registration Services Bureau (URSB) which would render in-house IPM services redundant in many of the hubs.

3.4 Opportunities for collaboration and networking

Findings from the component of affiliation to academic or research institutes, as well as networking and collaboration opportunities supported by the ten innovation hubs are presented in Figure 4.

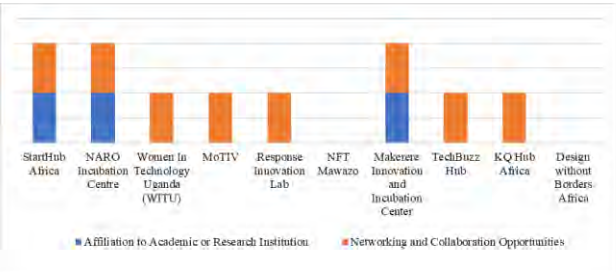

Figure 4: Networking and collaboration opportunities

There is evidence that innovation hubs derive more successful outcomes when they have links of any sort to larger entities including universities, private-sector actors, branches of government, development donors, and with other hubs [8].

Regardless of whether an innovation space is based at a tertiary institution, access to and integration between an innovation hub and a university or an academic/research institute can be mutually beneficial to both entities, as each learns progressively from the other [8].

To further explain the benefits of these affiliations, Bank *et al.* (2018) assert that academic institutions tend to form and maintain more sustainable networks and relationships with both international and local communities [9]. This may be through the establishment of the International Relations Office or through the Technology Transfer or IPM function.
Either way, these support structures can be a source of opportunities including mobility and exchange programmes, scholarship opportunities and seed funding for innovators.
In turn, innovation hubs can be a source of knowledge and human capital in these relationships.

Peer-to-peer engagement amongst innovation hubs especially through clusters and networks can be beneficial in testing assumptions, combining different competences [10] and in diffusing knowledge [8]. Particularly, the interdependence created by innovation clusters, especially in Science and Technology Parks creates opportunities for exchange and collaboration and could even allow for sharing of infrastructure and services, improving production efficiency in the long run.

Links to parent companies and international collaborations are argued to provide access to better technology and infrastructure as well as more financial and knowledge resources [10].

It was clear that providing networking and collaboration opportunities was essential for many of the participating innovation hubs; What could be improved is the affiliation to research and academic institutions for the benefits afore mentioned.

3.5 Limitations to innovation

Innovation hubs experience diverse challenges in their work, depending on their interests and objectives, level/scale of operations and the prevailing socio-economic conditions.
However, many of the factors that inhibit innovation on the African continent, in some way, relate to the economic infrastructure, local institutions, domestic capabilities and the policy context that supports the NSI [11].

Some of the challenges highlighted by the participating hubs included:

i) Limited technical skills in product development among young innovators.
ii) Lack of early-stage investment for start-ups.
iii) Weak IP enforcement.
iv) A small and disinterested private sector with limited (human and financial) capacity to absorb the generated technologies.
v) Little to no knowledge on business development and management for incubatees.
vi) Inefficient follow up with innovators after programme exit.
vii) Unsatisfactory sustainability plans presented by innovators.
viii) High risk aversion towards novel ideas in the NSI.
ix) Discrepancies in appropriate technology versus advanced technology.
x) Lack of investment readiness programmes for innovators.
xi) Low quality ideas/ innovations.

xii) Limited research potential for some projects.
xiii) Limited market potential for some innovations.
xiv) Obstructive government regulations and taxes.
xv) Rigidity in adaptation to changes in the ecosystem.
xvi) A lack of understanding and appreciation for design innovations in the ecosystem.

In terms of the limited absorption capacity of innovations by industry, it can be argued that the nature of investment in innovations is often long term with uncertain returns, which can repel some investors.
Ayalew and Xianzhi (2019) also reason that the issue of reluctance to reveal innovative ideas could be to the detriment of many innovation firms as it reduces financers willingness to grant loans or capital [6].

Evidence from the participating hubs suggests that protection through IP registration is not a top priority. Innovators are more likely to rely on 'secrecy' as a protection mechanism yet investors are looking to understand where they are placing their money.

As such, there is a need to bridge the gap between the expectations of investors with the liberties of innovators in Intellectual Property Management.

4 CONCLUSION AND RECOMMENDATIONS

Innovation hubs can be viewed as conduits through which inputs are often aggregated to create optimum conditions for the innovation process [8]. The nature of interaction of the inputs provided by these hubs ultimately determines the outcome of the product development chain. There is therefore a need to develop and sustain mechanisms and instruments to support these innovation enablers for innovation-led development.

The lack of financially-backed appreciation for innovation within larger societal operations is a common phenomenon in sub-Saharan Africa.
Better engagement with academic institutions, companies and local communities is required to influence more youth and individuals to participate in knowledge generation and more technical support along the innovation cycle, particularly in product development and intellectual property management is needed.
Companies and firms can be better encouraged to absorb local innovations developed in the NSI, through subsidies and tax exemptions.

Examples of successful networks and clusters of innovation hubs exist in developing nations such as South Africa [10]. The Government of South Africa has ensured that innovation hubs are far reaching in different townships, diffusing incubation services to stakeholders in all parts of the country.

While clustering is beneficial, adopting a similar decentralized approach, as in South Africa, could increase the reach and level of interest in innovation in the different regions in Uganda, especially outside of the capital - Kampala.

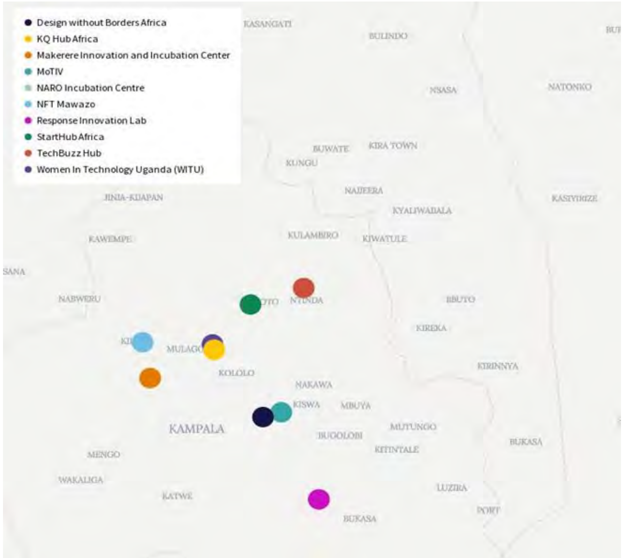

Figure 5: The participating innovation hubs by location

'The functioning of an innovation system depends on its components – the organizations/actors and relations among the components which perform various innovation system activities [11]
System integration that allows national and regional systems of innovation to intersect with sectoral and technological innovation systems, especially through interactive learning among stakeholders in different pathways should be fostered to develop a NSI that is accommodative of and beneficial to Ugandans.

ACKNOWLEDGMENTS / ZAHVALA

This paper is evidence of the openness and willingness of the innovation hubs in Kampala to engage with other actors.
I am truly grateful to the teams at Design Without Borders Africa, KQ Hub Africa, Makerere Innovation and Incubation Centre, MoTIV, NARO Incubation Centre, NFT Mawazo, Response Innovation Hub, StartHub Africa, TechBuzz Hub and WITU, for sharing their stories of passion and perseverance in facilitating innovation.

Special thanks also to Dr McLean Sibanda, Mr Ronald Jjagwe, Ms Sakina Salem (and the Code for Africa team) and the WIPO Professional Development Program for supporting me in conducting the analysis and in producing this paper.

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The Importance and Benefits of the Technology Transfer Ecosystem (TTE)

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ABSTRACT

Creating and maintaining the technology transfer ecosystem is a foundation on which many (future) technology transfers (TTs) are built. Having a good invention/technology is usually not enough, if you do not have either a buyer or a partner on the other side ready to assist you. It is important to establish and maintain (strong) relationships with the industry in order for them to give you the opportunity to present, when the opportunity presents itself, for example in the form of tender/call, innovation, research collaboration etc.

KEYWORDS

Technology transfer, ecosystem, marketing channel, innovate or die, EU, projects, venture capital.

1 INTRODUCTION

The problem, that not so few academic researches institutions face, is the lack of collaboration with the industry. Some even believe that the TT is failing endeavor [1]. There are certain projects that try to stimulate this cooperation/transfer.

One thing, that the Office for industrial liaison (SPOG) at the Jožef Stefan Institute (JSI) observed, that might be responsible for relatively low number of technology transfers, is the lack of "standby" relationships with the industry. This means that it might not be enough to seek for companies when certain tender/call/opportunity presents itself but the organization (or its TT office; TTO) must begin with this (much) sooner.

What SPOG at JSI identified, is that, predictably, the more companies that it visits, the greater the chance for a success story with the benefits for all parties. For example, even if a visited company might not be willing to spend the money on research directly, their topics of potential cooperation are still identified and written down. Also, their skills/areas are cataloged. Then (much) later certain funding opportunities might arise and the SPOG might see the opportunity to connect certain companies with the appropriate researcher or a research team. Some examples of collaborations grew (albeit slowly) from rather small projects like: KET4CP, DIH-World, DIH4AI but through this (small) collaborations, the teams (of researchers and companies) got to know each other and then later applied for or entered into greater projects together.

One of the building blocks of the TT ecosystem (TTE), that we are building at the Project and Innovation Support units (consisting of: Office for substantive project support, technology transfer and innovation (CTT) – U7, Office for industrial liaison (SPOG) – U8, Office for project informatics, organization of thematic events and conferences (SPIK) – U9) at the Jožef Stefan Institute, are certain thematic projects (Enterprise Europe Network, European Digital Innovation Hub – EDIH, KET4CP,…) in which we are involved with precisely this purpose: to help companies in other areas or rather, we are involved in those projects precisely for the reason of helping companies with the cascade financing to cooperate with the Jožef Stefan Institute or in the area of technology transfer. This means that we are actively building (or adding to) our TT ecosystem.

2 THE ECOSYSTEM

Once ecosystem is relatively large enough, further benefits arise. For example, if we successfully connect two companies, they form a partnership agreement (PA) and a stronger/bigger relationship develops as a result. Benefits of a PA, for the company, is an increase in sales abroad, for example, which strengthens the company and its ability to operate more developmentally and innovatively in the future, which then enables the company in the ecosystem to cooperate with a research institution. If this PA was a result of certain project (Enterprise Europe Network for example), then this same project allows the established partnership to be promoted (without any additional charge for the companies) as a success story, which then brings new recognition for all parties (the project itself, companies, project partner) and new opportunities could arise that could (later) involve also the project partner which made the PA of two companies possible. Further developments/opportunities/partnership can arise from either way.

At the Project and Innovation Support units (at the JSI) we are constantly monitoring for new calls/tenders/projects with the objective/question in mind if they can benefit the companies and the researchers. Ideally, they would help with funding, but sometimes they can help even better, by giving them the opportunity or recognition to expand, through connecting certain partners together. It is important to see the whole picture, all of

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the benefits of the ecosystem, the full deck or the full checkerboard in order to be motivated to do certain things that might not give/provide/promise direct/immediate benefit(s) in the first step(s); to the Jožef Stefan Institute in our case. For example, one might ask what's in it for the Institute, to connect certain companies together in the partnership agreement, that might not include the Institute itself. The answer is in the future (probability) of involving the researchers from the JSI in some project, even much later. There are existing cases that speak about this and that can show how further opportunities were developed because of this ecosystem. Opportunities that one might/could not even envision so much in advance. One example of further benefits for the JSI is, since companies are aware of the (EU) funds, they are also monitoring certain project/funding opportunities and since the focus of the (EU) projects is (more and more) on international/abroad cooperation among the companies and involvement of the academia/institutes in a consortium for example, if certain companies would like to either apply for certain project, they would need to involve some (public) research organization for example and if this is the very same organization that helped them (in some ways) before, then there is a greater chance they will contact/include it. The idea/key is to see the potential down the road, to invest time and effort in certain steps that might not yet give direct/immediate benefit. Of course, not every path will lead to new opportunities/partnership but it is important to see it like from a venture capitalists' point of view; if few success stories outweigh the many unsuccessful trials/paths, it was all worth it, in an economic and satisfactory way.

The major problem is the different focus that the parties might have. Researchers in Academia have focus on research and writing/publishing of scientific articles that brings them credits/points that are used for promotion etc. But the industry has a different focus, they (usually) see things from the perspective of ROI (Return of Investment) etc. in a certain period (within 3 years for example). In not so rare cases, both parties could benefit but they need a guidance, case studies, a different overview, for them to see the synergies without any real downsides. For example, the industry could invest (or gain funds for) in something that might be for rather direct application down the line, while the researcher could focus more on a fundamental/part of certain subject. In this way, both parties gain. Scientists/researchers could still be "true to their cause" by researching in fundamental science but the company can then narrow it down to the application. As a result of this collaboration, a new IP (Intellectual Property) might arise and a patent application could get filed, hoping to get to the granted patent (up to 20 times or more research points for the researchers). Based on this IP, in parallel to patent application, the researchers can also write (scientific) article on the very same subject, what is in fact promoted (but a patent application must of course be filed before the publication of the scientific article). So in the end, the researchers could get scientific/publishing credits (for article(s) and patent (application(s)), industry could get the (cutting edge) innovation (and maybe granted patent) that could lead them to more profits and, if all goes very well, the new (foreground) IP could get licensed to the third parties (plural). But it all begins with the proper "selling" to all parties of why they should start to collaborate in the first place and to convince them that they are not on different sides but on the same plane.

3 MULTIPLE ANGLE APPROACH

Transferring technology, into the industry in particular, is a difficult endeavor Companies receive a lot of emails/offers daily and it is difficult to get pass the basic filter/screening and gain their attention, especially for the technologies on a lower technology readiness level (TRL).

It helps to try to establish the relationship with the company first, to know a few people, to recognize the key people, decisions makers, to show them the value of such relationship and then, (much) later, introduce them to new technologies that have a potential but need funding in order to raise its' TRL. And one way of doing exactly that is by presenting/giving the company benefits of some project that is specifically designed to help them in some way. One such project is the Enterprise Europe Network that is founded by the European Commission and its' purpose is to connect the companies together, across the border. It promotes/stimulates collaboration between companies internationally. The connection can happen through connecting them on the business side; via so-called BR – Business Request or BO – Business Offer (one company is ordering/offering services to the other) or connecting them through the particular technology (via so-called TR – Technology Request, TO – Technology offer). Once the companies see the benefit of this, through the established partnership agreements (PA), then their interest increases, relationship deepens and the connector (Jožef Stefan Institute in particular case, that is a Hub in the Enterprise Europe Network) has the option to promote its's services and technology to the companies it helped. Therefore, all the companies, its services, projects, people, become part of the bigger picture, so-called ecosystem. And every (good) system is more than the sum of its parts or greater than the sum of its parts. That might be truer in the case of the ecosystem.

It is of most importance to see the difference between the (isolated) product/service and the ecosystem. One practical example of this is the mobile phone analogy. There are certain phone brands that are of higher price and when comparing just their physical product alone, by specifications, with the competitive products, they might seem high in price. But the important thing here to consider is the additional/surrounding services that are built/integrated with the device: stores, music service, cloud storage, synchronization, backup, location service, … With this different overview, the mobile product is not just a (overpriced, comparing just by physical) device but it is the (part of a) mobile ecosystem. Similarly, if one views technology-transfer office (TTO) just as a "forwarding service", that forwards certain email/inquiry and establish contact, it might be harder for them to justify its size/function but if one sees the full spectrum of benefits of the TTO, then they will almost not want to do the contact/service themselves.

Sometimes researchers think that it would be better to contact certain company directly and not via TTO, especially if that is allowed in the organization. But this might show problems down the road, especially if there is a higher money involved. Particular field when something might get wrong is the legal field, when drafting/signing the contract of potential collaboration. If the relationship between organizations is established without the contract, that has its own problems since many things are undefined (for example use of logo/brand/name, background IP etc.). Also, it is important to have companies on stand-by, for certain tenders/opportunities which are hardly maintained by individuals and this is where the TT ecosystem comes in play.

As we see, it is important to have a established (organic) ecosystem of technology transfer with all the essentials, such us: legal assistance (drafting the contracts, managing the signing procedures), intellectual property (IP) rights guidance/management, informing companies of certain funding/financing and networking opportunities, organizing brokerage events, publishing and promoting profiles (offers, requests) online for the companies that are in need of product/service/research/technology or are looking to sell product/service/technology, mediating/stimulating negotiations (which is very critical in the beginning stages), mediating or "translating" between academia/researchers and companies/industry since there is a usually a very different language/focus between the two, etc.

4 RESULTS AND DISCUSSION

It appears that one of the more effective ways, for the industry and academia to meet, is building and maintaining the TT ecosystem with promoting of value added for all parties. The researchers might get (scientific) credits while the industry (companies) can increase their profits, either directly (by optimizing certain parameters in certain areas: production, logistics, material use etc.) or by gaining some technological advantage (through innovation) in the market.

The innovation is still one of the leading forces of progress or marketing advantage. "Innovate or die" is the motto by which many high-tech companies are driven by. The "host" for this collaboration is a so-called TT ecosystem in which the relationship between academia (and basic science institutes) are formed, maintained and stimulated. It is important to have as much industry and researchers identified/catalogued and connected as possible. Not unusually, the collaboration starts even years after the first contact, when the right opportunity arises or something/management change. It is important to design the organization around the idea of the importance of the TT ecosystem. [2]. At the Jožef Stefan Institute there is a mentioned group of support units, known as Project and Innovation Support, that help to promote the TT idea itself and that also do (bi)weekly visits to Slovenian companies, that are pre-identified/screened as having (the research department/potential) with witch the group try to identify topics of possible cooperation and then try to match it with the researches at the Jožef Stefan Institute or, if there is no match at the JSI, with the potential partners abroad. Potential topics/opportunities get forwarded, with the help of Enterprise Europe Network project, to other organization (abroad) due to the lack of resources at the Jožef Stefan Institute. At the first glance, this would seem as an opportunity wasted but due to this TT ecosystem idea, not so few times, the opportunity (later) comes from a different path. For example, the company that we connected with the company/Institute abroad, later came back with the request for a direct research cooperation or with the invitation to certain tender/call. The company, although had no direct relationship with the Jožef Stefan Institute itself, later realized the value added of the Institute and reached it for another opportunities. The important thing is to keep ecosystem alive, to circle ideas and opportunities and sooner or later, due to pure statistics - if nothing else, the seed of (another) opportunity begin to sprout in the soil of the originator.

5 BEST PRACTICES

One of the recent good examples or best practices, is the successful collaboration (that is ongoing and is evolving) between the researchers from JSI and Slovenian company with registered research group under the Slovenian Research Agency: ARIS. On the other side were the researchers from JSI. The whole collaboration started when the TTO/TTE sent particular funding opportunity to sourced companies that they believe would be suitable. Once the company expressed interest and the technology needed by the SME was defined, the TTO/TTE located the appropriate researchers at the JSI. After the meeting, they agreed to apply for particular project together. After they won the project and completed it, they later applied for a different project of similar size. By this time, they got to know each other quite well and they started to think/brainstorm, during one particular teleconference (TTO was guiding it), that maybe they should not just be looking/applying for certain projects, now that they found they are a good research consortium, but to propose it/them. The idea then gained track, they filed a proposal for a fundamental project and won it. The company got the funds, the researchers got the funds but also, due to fundamental project, researches will have the benefit to work on the fundamental research, which is their main purpose at the institute, to publish, to get research credits etc. The company got the material/base that they can upgrade to more applicable/marketable version of the subject. All parties win. All this all due to the organic progress of relationship between the Institute and the company. With such established relationship, specially with the ongoing support from the TTE, the possibilities/options increased greatly and also there is a potential for the foreground Intellectual Property (IP), further commercialization of joined (secret)know-how or IP etc.

6 CONCLUSIONS

Benefits of the Technology transfer ecosystem are hard to envision at first but the more one work with(in) it, the greater the benefits presented. Many ask what is the purpose for a (basic) research institute to connect the companies and opportunities (specially abroad) but at the end there are many. By visiting companies, identifying their challenges, connecting them with other companies/institutions (abroad), that could solve their challenges, every once in a while, those companies (either domestic or abroad) remembers the originator (the Jožef Stefan Institute in this example) and enters into a research partnership or apply together for great(er) projects in (fundamental) research with the potential for further direct applications. Therefore, everyone gains. EU also seem to support Improved technology transfer ecosystem and networks across Europe [3].

ACKNOWLEDGMENTS

We acknowledge the colleagues at the Project and Innovation Support, Director's Office U1 and Information Society for all the support of contributing and organizing this event – ITTC16.

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The Interconnection of Property Technology and Intellectual Property: Literature Review

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ABSTRACT / POVZETEK

This paper presents a systematic literature review on the link between property technology and intellectual property. Property technology or PropTech is technology and innovation which improves various aspects of the real estate industry, etc. the optimization of the way people buy, sell and manage property. It may for example refer to property management platforms, smart home technology, and data analytics for market insights, virtual property tools etc. Innovative technologies and solutions developed in the PropTech sector often require legal protection through various intellectual property mechanisms, however, our analysis shows, that there is not a single study analysing the interconnection between intellectual property and PropTech innovation.

KEYWORDS / KLJUČNE BESEDE

Property technology, PropTech, patents, intellectual property, IoT, Blockchain, GreenTech, FinTech, Startups, literature review

1 INTRODUCTION

The aim of this study is to explore the interconnection between property technology and intellectual property. So first we must explain and define both terms.

1.1. Property technology (PropTech)

Property Technology or PropTech refers to the use of technology to streamline and improve the processes involved in the real estate industry. PropTech means any technological solution in the real estate sector, be it 3D visualization, a platform to connect buyers and sellers of real estate, crowdfunding, FinTech, GreenTech the sharing economy, smart cities, smart homes, smart contracts or BIM (building information modeling). FinTech refers to the integration of technology into offerings by financial services companies to improve their use and delivery to consumers. ConTech is the construction technology that is used for all the work that is done within the construction industry. GreenTech was developed in response to climate change and the COVID-19 pandemic.

We can see, there are different areas in technology, especially areas (niches) in PropTech.

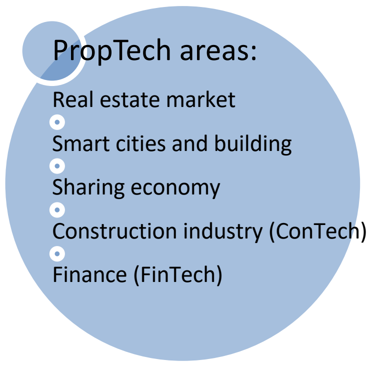

Figure 1: PropTech is currently developing in several areas (PropTech in the narrowest sense)

We have three generations of PropTech (Baum, 2017), while the fourth generation is already mentioned (Ascendix Tech, 2023). The current generation, PropTech 3.0 includes different IT solutions: AI, IoT, Cloud Computing, Blockchain. A blockchain is a distributed database or ledger shared among a computer network's nodes. They are best known for their crucial role in cryptocurrency systems for maintaining a secure and decentralized record of transactions, but they are not limited to cryptocurrency uses.

The real estate industry faces the challenges of reducing carbon emissions (Tan, 2023). Siniak et al (2020) say that the concept of "PropTech 3.0: Real Estate of the Future" was developed in 2017 at the University of Oxford. Consequently, PropTech has become part of the digital transformations of the property industry, in terms of driving the property market and promoting radically new approaches to property acquisition and management. The Croatian Chamber of Architects (2023) has developed Building Information Modeling, a process of creating projects in the field of construction through the creation of a virtual three-dimensional information model of the building, with a strong emphasis on the cooperation of all participants in the design

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process and participants in construction. This can be called as innovation in PropTech (ConTech).

PropTech is a new trend set to grow over time. The purpose of PropTech is to transform the built world and make it more digital, more climate conscious and more efficient by applying innovative solutions. It encompasses a wide range of technologies such as software, hardware and data analytics that are used to improve various aspects of the real estate sector, including property management, construction, investment, and sales. PropTech has experienced a huge expansion in the last ten years.

1.1. Intellectual property (IP)

IP refers to any intellectual creation, such as literary works, artistic works, inventions, designs, symbols, names, images, computer code, etc. IP law exists in order to protect the creators and inventors and covers areas of copyrights, trade secret**s**, trademarks, industrial designs and patents. There are also other forms of IP, such as geographical indicators, but we will focus only to forms which may be relevant to property technology.

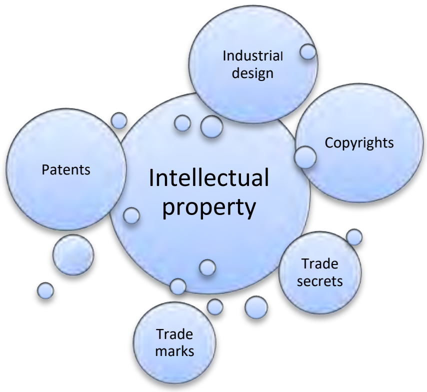

Figure 2: PropTech and intellectual property can be complementary in several ways

1.2.1 Patents: PropTech often involves the development of novel hardware or software solutions that address specific challenges in the real estate industry. These solutions may include unique devices, algorithms, or methods for property management, data analytics, energy efficiency, and more. Companies in the PropTech space may seek patents to protect their inventions from being copied or used without permission. Patents provide exclusive rights to the inventor for a specific period, allowing them to control the use and commercialization of their technology.

1.2.2 Copyrights: PropTech companies develop software applications, platforms, websites, and other digital assets to offer services such as property searches, virtual tours, and data analysis. Copyright protection may apply to the source code, user interfaces, graphics, and other creative elements of these digital products. Copyrights prevent unauthorized copying or distribution of these works.

1.2.3 Trade Secrets: PropTech firms often create proprietary algorithms, databases, business processes, and other confidential information that give them a competitive edge. Trade secret protection is crucial to safeguard these valuable assets from being misappropriated by competitors.

1.2.4 Trademarks: PropTech companies develop brands and logos to distinguish their products and services in the market.

1.2.5 Industrial designs: It can be assumed that PropTech companies involved in architecture and home interior design often register industrial design as a form of intellectual property.

In the last three years, as companies rapidly develop new innovative, technological solutions, the question arises whether such IP is worth protecting and in what way? How is PropTech and IP connected? While (material) property in a business sense presents a tangible asset, IP is an intangible asset, the successful exploitation of which can be a valuable foundation and contribution to business. The purpose of this paper is to provide a systematic literature review of existing research on this topic.

2 METHODOLOGY

Using Google Scholar on 06/24/2023, we found 149 results that referenced ProptTech and intellectual property (I also try to search for specific form of IL) in the same article.

The searches were determined in this way:

- “intellectual property” AND “property technology” OR PropTech
- patent OR patents AND “property technology” OR PropTech
- copyright OR copyrights AND “property technology” OR “PropTech”
- “industrial design” OR “industrial designs” AND “property technology” OR PropTech
- “trade secret” OR “trade secrets” AND “property technology” OR PropTech
- trademark OR trademarks AND “property technology” OR PropTech

Where the quotation marks specify that a specific phrase should be selected and not each word individually.

Then I carefully selected 30 scientific articles that mentioned Real Estate Technology and IP or IP forms more than 3 times in article. Then I analyzed all of 30 scientific aricles (see attachment: Systematic data analysis). I excluded all articles that unrelatedly mention IP and technology (Real Estate, PropTech, building technology etc.) I determined the most important papers and examined them in further detail based on the number of times a paper mentions IP (or patents, copyrights, etc.). At the end I have selected only 9 articles that have a link on IP with the possibility of application in some of the real estate technologies. These articles are listed in the last column as articles of high importance.

3 RESULTS

Here is a summary of these 9 relevant articles:

3.1 IP as Patents, Trademarks, Industrial designs, Trade Secrets and Copyright in Technology

3.1.1. Non-fungible token (NFT). NFTs provide proof of ownership and the corresponding asset can only have one owner at any given time (Zhang, 2023). Today, they are widely used by artists, musicians and brands to secure their copyrights and IP. Based on the presented data, it can be concluded that blockchain-supported technologies are highly represented in published articles and journals, but lack innovation, which is reflected in the number of published patents. Mixed reality technologies show strong maturity through published articles but have limited research and development as indicated by the small number of patents. On the other hand, artificial intelligence (AI) technologies show a balance between the number of published patents and articles Edge computing and smart contracts have proven themselves great research interest and development due to the number of published patents. Namely, there are many published one articles on non-fungible tokens, but a relatively small number of patents, which may be a consequence overlapping with other technologies or due to the novelty of the technology itself. It is possible notice that there is a significantly higher number of published articles on AI technologies in relation to the number of published patents.

A non-fungible token (NFT) is a unique digital identifier that is recorded on a blockchain and is used to certify ownership and authenticity. There is insufficient research on the use of NFTs in matters such as IP. Application for a patent and trademark is not only a time-consuming process, but also extremely expensive (Mojtaba and others, 2022).

3.1.2 Trade secrets and patents. One of the explanations is that FinTech (Imerman & Fabozzi, 2020) are used proprietary to generate profit, but when IP patented, it has been published in the public domain and is therefore no longer a "trade secret". Another source of risk in FinTech stems from legal issues. Legal issues in FinTech is particularly tricky because there is significant IP components associated with these technologies, but financial services companies are not known to obtain patents for their technologies.

3.1.3 Copyright. IP (Van Erp, 2019) law deal with problems, such as copyright and database law in European Union. There are several problems to solve at a more theoretical level on the way how to express such rights as copyright. Technical developments go incredibly fast and IT developers seem to overrun the law with their rallying cry that “computer code is law”.

4 DISCUSSION

From the systematic literature review we can conclude that even scientific papers on PropTech are very new (very rare before 2018). Despite enormous potential, PropTech remains largely unexplored by the academic community (Friedman, 2020). Moreover, most of the literature on the real estate development process explains more about the construction process technology and financial technology, while other proprietary technologies are rarely mentioned (Maududy and Gamal, 2019) and as we have shown above, no one has investigated the impact of IP on innovation or the success of PropTech companies.

As can be seen, most articles are related to decentralized technology (Blockchain), which is also related to the concept of Web 3.0. The articles define specific research niches, but we can conclude that there are many challenges, and that significant research will be needed in this area. However, there is, so far, not a single study detailing the impact of IP on PropTech innovation. As can be seen in the attachment, even the most significant papers only superficially consider the role of IP, although they confirm that IP has a significant role. PropTech has enormous innovation potential with the arrival of the 5th industrial revolution and 4.0 PropTech revolutions (robotization, smart intelligence, smart contracts with realization in the present time...) and understanding how innovative protected technological solutions can increase the revenue of PropTech companies is very important for both management researchers and managers. NFT has significant potential in the domain of IP of PropTech solutions and this is the area of software protection. The Office of Technology Assessment of the US Congress has reported that copyright law provides unsatisfactory protection for computer software.

The book of Rushing & Brown (2019) analyses the importance of the social rate of return on investments in new technology and deals with a discussion of some policy issues regarding IP rights. The less developed countries tend to feel that IP rights give inventors and innovators an undesirable monopoly on advanced technology that can be used to extract unjustifiably high prices, as well as unwarranted restrictions on the application of the technology. The main point is that if one considers the long-run benefits for economic growth resulting from IP protection, as well as the long-run costs in terms of economic stagnation when no protection exists, the case for strengthening IP protection in developed and developing countries is very strong. Creating new types of output in such areas as biotechnology, computer software, and information transmission, not considered in IP protection mechanisms, means that maintaining a degree of protection requires flexibility in the mechanism itself. The impact of IP protection on the firm's decision to allocate resources to research and development (R&D) is clearly at the core of any discussion regarding an optimal IP policy. From the firm's perspective, the degree of protection afforded IP has an impact on its profits and therefore on the amount of money that it invests in R&D.

PropTech is also a collective term used to define startups that offer technologically innovative products and new business models for the real estate market. Proptech startups are important drivers of change in accelerating the digitization of buildings. While many researchers analyze the economic and environmental savings from the application of digital technology, far less attention has been paid to the challenges for PropTech startups to increase profits and become sustainable businesses (Tan & Miller, 2023). Lawrence (2023) says that European Proptech startups are thriving because they are changing the way real estate is bought, sold and rented.

Those 9 articles talk about the application of innovations in technology, but specifically not in PropTech. Therefore, the interconnection between PropTech and IP presents an important research niche.

Financing is growing, and companies are expanding their markets and developing new, innovative products. There are many types of IP recognized by law, and each type provides some form of protection to a person who has made the creation. The basic idea behind various types of IP is to provide an incentive to the owners to disclose the idea to the public, so that others can further develop the technology, and therefore, it leads to an overall growth of science and technology. As logical as this may be, it has been criticized by many people who follow an opposing school of thought propose that IP rights serve as a tool to provide monopoly to large corporations, and it's difficult for smaller players to invest in R&D as much as bigger companies, eventually, strict implementations of IP laws kill the innovation and thus it defeats the sole purpose. There are two solutions for small start-up companies in the fields of Proptech, Contech or Fintech:

- to book a presentation space on some PropTech fairs and secure a presence in the central innovation area. If this business idea has the power to disrupt the real estate industry, some investor will invest in R&D and IP proteciton and a new innovation will be born.

- to improve the actual situation defined by a lack of research, I recommend that academic institutions encourage more research on PropTech and its connection with innovation and IP. This can also be accomplished by offering relevant courses, supporting doctoral-level research on the topic, and engaging industry-academy consortium research projects.

- academic institutions can further encourage ProptTech startups to cooperate with them to improve their products and services and underpin the growth of the industry as a whole.

- academic institutions can support founding of spin-out and spin-off PropTech enterprises.

The practical application of innovations on PropTech cannot yet be fully explored, until there will be more research papers in the field of IP and PropTech.

ACKNOWLEDGMENTS / ZAHVALA

I would like to thank Dr. Ana Hafner who has been instrumental in furthering my understanding of intellectual property.

Her guidance and support are invaluable to me.

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A ATTACHED DOCUMENT

A.1 Research method of articles considering, together, PropTech and intellectual property

An Information-Centric Perspective on Data

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ABSTRACT

While the focus of information theory, science, and technology is information, most of the current legal and regulatory frameworks focus on data and portability, disregarding the information aspect, and therefore fail to successfully achieve their goals. The paper presents an information-centric perspective on data. Furthermore, it argues that data ownership could enable additional regulatory aspects while being key to develop a data market and a data value chain. Moreover, some ideas are drafted on how the value of information could be attributed across different stages of the data value chain.

KEYWORDS

Data, Theory of value, Data value chain,

1 ECONOMIC ASPECTS OF DATA

1.1 Who or what generates data?

Data is defined by Bygrave [4] as "*signs, patterns, characters or symbols which potentially represent some thing (a process or object) from the 'real world' and, through this representation, may communicate information about that thing*". Nevertheless, Gellert [8] notes that the definition of data and the distinction between information and data remain a matter of discussion. Two kinds of data generation processes exist. First, we find sensors that observe certain phenomena (either physical or virtual) and quantify them. Second, we find processes that generate synthetic data based on previous knowledge about something they aim to emulate (e.g., heuristics or machine learning models for synthetic data generation).

1.2 What makes data valuable?

Data is not sought by the data itself, but for the information it contains. While information has been defined in many ways, it is generally understood as the knowledge communication [5]. That knowledge is sought at a particular time with a particular goal in mind, and the value of the information is related to that goal [1].

The increasing adoption and use of machine learning fosters an increasing demand for data suitable for satisfying the particular goals the machine learning models are trained for. In the machine learning realm, multiple paradigms exist and they conceive learning goals in different ways. Among these paradigms, we find unsupervised learning, supervised learning, and reinforcement learning [2]. Unsupervised learning aims to learn from unlabeled data for clustering, density estimation, or dimensionality reduction. Supervised learning aims to learn the association between input vectors and dependent variables (classification or regression settings). Finally, reinforcement learning aims to find suitable actions in a particular situation that maximize a reward and help achieve a certain goal. In reinforcement learning the algorithm interacts with the environment by trial and error, exploring actions and context to learn something new, and exploiting gained knowledge to attain the final goal. In every case, the relevant knowledge toward the specific goal is different. Furthermore, it can be conveyed using different modalities (tabular data, graph data, sequence data, or image data).

While commodities usually are subject to divisibility, appropriability, scarcity, and display decreasing returns to use, it has been observed that information is not easily divisible, and its value often increases with its use [9]. While data is abundant and can be replicated arbitrarily, the scarcity could arise from the finite amount of means to replicate, process and store the data.

From the abovementioned observations, multiple considerations arise, which we briefly introduce in the following sections.

1.3 How informative is the data?

Many approaches and metrics have been developed to measure the amount of information present in the data. Among common measures we find the Shannon entropy, mutual information, and directed information. The Shannon entropy measures the degree to which the data is unexpected: the higher the unexpectedness of the data, the higher the information value it holds. Conditional entropy measures the degree of unexpectedness of a variable given the value of another known variable. Mutual information assumes two random variables are given and measures how much information about one variable can be drawn by observing the second one. Finally, given a pair of sequences, the directed information measure the extent to which one sequence is relevant for causal inference on the other one.

In machine learning, there is an interest in understanding what is invariant and what is noise across datasets and contexts. The capacity to discriminate between information and noise is a key aspect of learning [16]. While in this context valuable data would be the one that provides information that displays little correlation to already known independent variables, such information could still be useful to a person for the sake of context (e.g., while economic growth is usually correlated with employment rates, and using both may be meaningless for a

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Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia

machine learning algorithm in certain cases, they may still be valuable to a person).

1.4 Do we have substitutes?

A key aspect that defines the economic behavior of consumers with respect to a given product in the market, is whether a good substitute product exists for it. The demand for substitute products shows a negative correlation: the demand for one product reduces or replaces the need for the other. Substitutes of a particular data variable would be any kind of data that displays a high enough degree of mutual information.

1.5 Data enrichment

When considering learning goals for a specific machine learning algorithm, we may find that a single data variable will unlikely be able to describe complex relations observed in the real world. Therefore, data enrichment is required to join multiple data variables describing the different aspects of the real world, and therefore providing new information to the machine learning model or the person consuming it.

1.6 Data elasticity

The demand for a certain product is considered elastic when the demanded quantity of a product changes more than proportionally when its price increases or decreases. While product elasticity is usually considered in the realm of physical products, intangible assets could also display elastic behavior. E.g., people would be more or less likely to disclose some sensitive information based on the perceived benefit. The perceived benefit could be considered the price of that piece of data, paid either in kind (e.g., access to a product feature), money (either selling or renting the data), or both. A particular example could be access to data describing typing patterns. Such data could be used for continuous authentication of a person using a particular hardware (e.g., ensuring only the owner uses a particular device) [7, 15], or for early disease diagnosis [10]. In each case, the person could grant access to the data in exchange for (a) a digital good (e.g., a typing profile), (b) some service (e.g., authentication, (continuous) identity verification, or disease diagnostics, or (c) money obtained from data leased or sold at an aggregate level (e.g., for analytic purposes, such as its use within the scope of the research of a given disease, public health policy planning, or market research). While in (b) the person would benefit from the service and eventually pay an additional fee for it, in (c) the person could perceive a fraction of the money paid to access some of the data he owns. We devote part of Section 2.3 to weight the benefits and drawbacks of granting access to data permanently, and the benefits and drawbacks of selling or leasing data.

1.7 Data amortization

Amortization refers to the accounting method used to expense the cost of intangible assets over their expected lifetime for tax or accounting purposes. Amortization is analogous to the depreciation of physical assets. The costs are expensed to reflect the asset's loss of value over time (e.g., in physical assets this could be due to the wearing out with their use over time). Without delving into the details of data amortization, it can be observed that not all data was created equal: while certain data wears out with time (e.g., fraud patterns change over time, and, therefore, past patterns do not provide insights into current fraud strategies), some other may be lightly affected by time (e.g., prices in inflationary context), or may not be affected by time at all (e.g., landscape images). When the underlying semantics change (e.g., new types of fraud emerge and old ones disappear) there is little that can be done to avoid data depreciation. Nevertheless, when the semantics remain the same but changes in the data distribution are observed, we speak about data drift. Data drift can be mitigated to a certain extent with strategies that learn how to align past and current data distributions (e.g., through Monge mapping). While not always feasible, such alignment could extend the lifecycle for certain data if required. Anyway, the existence of different data lifecycles requires different depreciation strategies to be considered in each case.

2 DATA: ITS VALUE AND PRICING

2.1 Theories of value

A key question in economic theory regards the value of goods and their price. In his work "*An Inquiry into the Nature and Causes of the Wealth of Nations*" [13], Adam Smith presented the water-diamond paradox: water, which is required for life, is far less expensive than diamonds, which have very limited use. The subjective theory of value solved the paradox by claiming that the value of the asset is determined by the consumer, based on the marginal utility. The theory explains that while water, in total, is more valuable than the diamonds, water is plentiful, and diamonds are scarce. Therefore, an additional unit of diamonds exceeds the value of an additional unit of water. Nevertheless, does the paradox hold in the realm of data? The paradox supposes four key properties are observed in most assets: appropriability, divisibility, scarcity, and the display of decreasing returns to use. Appropriability relates to the ownership of data. While data is not divisible *per se*, divisibility could be derived from ownership: access to data could be granted by extending ownership, through a lease, or as a donation. While data is abundant and can be replicated arbitrarily, the scarcity could arise from the finite amount of means to replicate, process and store the data, and from the fact that ownership should be respected. Finally, the decreasing returns in the realm of data could be associated to the degree of information that each new piece of data provides. This is likely to diminish over time. Nevertheless, a fifth factor must be considered: the malleability of the asset under consideration, defined as how a certain asset can be used. The higher the malleability, the greater the market potential and its potential demand. While physical assets have a limited range of uses, each piece of data can be used for a virtually infinite amount of applications, and therefore directly impacting its value. Nevertheless, the subjective value assigned to data in each case may not directly correlate to its pricing. Data can be used in applications that have different value regimes, centered on different value forms (e.g., economic or aesthetic), each of them subject to different internal dynamics [3].

Bolin [3] considers that the following aspects are relevant to data valuation: (a) data is transient (the value of data diminishes over time), (b) it requires human involvement to be generated and processed, (c) data will never be exhausted as long as there is human activity, (d) and it is a non-rivalrous good. We agree with the author that data requires human involvement to be generated and processed. Furthermore, we consider both properties as the foundation of data ownership. Nevertheless, we consider that while (a) is true for certain cases, many phenomena described by data remains invariant through time (e.g., images describing a landscape). Moreover, technological degradation could impact the ability to produce data. Finally, we agree that data is a non-rivalrous good (the use of data by a company does not infringe upon others' use of it). Jones [11] considers this has at least two consequences: (a) it cannot be priced if not legally restricted (ownership attributed to it), and (b) there may be potentially large gains by using it broadly. Furthermore, it considers that giving data property rights could generate nearly optimal allocations. While we agree that data should be given property rights, we consider that two dimensions of data value must be considered: the ownership of data and the information contained in the data. While the data ownership enables selling or renting a particular piece of data, the information contained in a piece of data may be shared by a wide range of data. We elaborate further on this concept in Section 2.3, linking this property to data pricing.

2.2 Owning data

Ownership is considered a key aspect of pricing. While some authors argue that data exhibits traits of a public good (public goods are non-excludable (it is costly or impossible to exclude someone from using the asset) and non-rivalrous) data is not non-excludable *per se*. Therefore, while some data could be legally turned into non-excludable (e.g., due to public interest or the owners' will), by default, it should be considered private property under the scheme of data markets. We ground this claim in the fact that all data is collected as a result of human intervention and certain investments, and therefore fulfilling the criteria that ownership is gained by doing some work. Nevertheless, data has the particular characteristic that its value relates to the information it holds, which (i) by the definition of information relates to a certain goal, and (ii) can be found in other pieces of data that may be owned by other people. Therefore, while data is owned by the person or entity producing it, the ownership over the information cannot be enforced and could be shared based on data ownership attribution.

2.3 Pricing data

Usually, consumers are willing to pay a higher price for products they consider to be of higher value. Therefore, how should data be priced? Spiekermann et al. [14] explored a user-centered value theory for personal data. Based on experimental research, the authors concluded that (a) most people are not aware that their data may have a market potential, (b) awareness that there is a market for data influences the perceived value of data, (c) the value of data correlates with engagement and psychological ownership (e.g., in a certain application or platform), and (d) lack of control over how data is used likely leads people to abandon the data market.

Data ownership and administration. To solve issues related to peoples' ignorance about data market potential, ensure their psychological ownership and grant them control on how the data is used, we propose regulation should mandate that browsers and devices must have a data management dashboard linked to a digital profile. Such a dashboard could display what data is being collected and provide a typified description on how this data can be used, the privacy implications, and the estimated price a piece of data has on the market. The dashboard should also display which websites /applications/legal entities are accessing the data or have accessed it in the past, the time span for which they stored the data, the purpose for which they use it, and their price offerings. Finally, it should provide data administration tools to operate with the data supporting e.g., the deletion of certain data to anyone who acquired it in the past, disable its further use, or grant it to some particular entity or anyone interested in it.

Such a dashboard could be a product created and marketed by any company interested in providing such oversight. The companies would not store the data: the dashboard would just issue API calls to any third parties and keep track of what data was given or not to particular websites/applications/legal entities. Furthermore, such implementation would provide a default and full GDPR-compliant interface e.g., ensuring the right to data deletion, which under existing implementations is hard to realize. We consider key to data privacy that such dashboards are associated with distributed identities [6]. Furthermore, such a distributed identity could be associated with multiple virtual wallets to preserve data owners anonymity and enable the trading of data.

Data intermediaries. To increase data marketing power and in the interest of privacy, persons could provide some of their data to data intermediaries who would market the data or aggregated data to interested parties under particular terms of use. This would help such parties to acquire a critical mass of data of interest while also increase price negotiation power on behalf of the data producers. The Data Governance Act has already established a legal framework and certain governance standards for data intermediation services [12].

Pricing data. When pricing data, we consider that for each piece of data two things must be considered: (i) the (ownership of the) data itself, and (ii) the information contained by the data. While the data is owned by someone, the information cannot be owned exclusively and is shared across many pieces of data. Therefore, data pricing should consider (i) the compensation paid to the owner for the right to exploit the piece of data with a particular goal, which accounts for the information value of the data in that particular case, and (ii) the compensation paid to anyone who has a piece of data that shares some amount of the information extracted from the piece of data mentioned above. The second compensation is rooted in the fact that given the data is a non-rivalrous good, a single piece of data could be arbitrarily selected and exploited without limit, inducing a certain loss to the rest of the owners of pieces of data that contains similar information. The compensation should alleviate that loss. This second component could be fixed, the amount established by a regulatory entity and paid to a third party, in a similar manner as public performance royalties are managed, collected and distributed by performance rights organizations in the music industry. The royalties would be distributed based on the fraction of information shared by a particular piece of data for which the royalty was paid, and the data owned by a particular person or legal entity. We consider that such an information-sharing-based compensation schema would help to solve attribution issues that arise from generative artificial intelligence models, where no direct attribution to a digital work exists. Furthermore, it would solve issues that arise from competing interests between open-sourced datasets and private datasets that could contain similar information, compensating for the loss caused to owners of private datasets due to the adoption of opensource (free) ones. This is particularly relevant given the non-rivalrous nature of data.

Renting data. While data could be sold, we consider data renting to provide a more appropriate framework. By renting data, the data producers retain the rights to the data and therefore can decide at any moment to stop sharing it, relocate it, or delete it, among other choices. Data rental could provide a solution to the data portability issue: since the company would not own the data, the data generator retains the right to move the data somewhere else. Therefore, it could be considered that companies take the cost of hosting data as part of the exchange price for data. Nevertheless, they could be mandated to offer a portability service (export some or all of the data producer data on request, for a given fee), to honor the ability to relocate the data. Furthermore, such a service should guarantee that exported data can be understood (e.g., by providing a minimal amount of metadata, with a good-enough semantic description). Specialized companies could provide hosting services for exported data if a person just wants to move the data from some company to avoid losing it when denying further use of it. Furthermore, competing companies could assume the costs of porting data between platforms as a means to lure new consumers to start using their product.

When considering the data rental model, data pricing could have two components: a fixed price paid for the ability to use the data, and a variable price based on the effective value the data provides to the product. The variable component could be measured based on how many requests impact analytic outcomes leveraging certain piece of data, or if a certain piece of information is key to a machine learning model or particular request (e.g., feature significance or other explainable artificial intelligence outcomes, and how these correlate with a particular piece of data). Furthermore, in some cases, to guarantee transparency, the insights used to assess the degree up to which a piece of data is relevant for an outcome should be the ones provided to create explanations as required by regulatory normatives for the use of AI in a product (e.g., the AI Act). The price paid in the market for the (rented) data should be related with the value it provides to a particular feature or product. Furthermore, a fraction of the fixed and variable price should be assigned to the performance rights organizations established to compensate the loss suffered by other data owners whose data contains similar information as the one that was shared.

2.4 Data value chain

We envision the data value chain should have at least three parts: (a) the value of the product (e.g., some application or synthetically generated image - their value is determined by the market price based on specific value regimes), (b) the value of the information extraction process (e.g., artificial intelligence model or analytics - it considers how much of the product value can be attributed to this component (e.g., by number of requests, shared screen time, etc.)), (c) the value of data (determined through some attribution technique, e.g., which variables were most relevant to a forecast, what data contains that information, and in what degree). The data value chain also contemplates at least five distinct actors: (i) consumers (use the application), (ii) data owners renting or selling their data, (iii) data owners compensated (given data shared by third parties contains certain degree of the information contained by their data), (iv) some regulatory entity ensuring such compensations take place, and (v) a person or company that owns and develops the product.

3 CONCLUSIONS

In this paper we have briefly described some considerations regarding the value of data. We consider data ownership is key to realizing data markets, where data rental would provide means to not only pay data owners for their data, but also provide a technical solution that enables the realization of privacy rights. Furthermore, we propose the compensation of data owners based on the information contained within their data and the data shared by third parties. Finally, we propose a data value chain

ACKNOWLEDGMENTS

This work was supported by the Slovenian Research Agency, the European Union’s Horizon Europe research and innovation program project Graph-Massivizer under grant agreement HE-101093202 and EU H2020 project STAR under grant agreement H2020-956573.

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Fostering Research & Innovation in AI through Regulatory Sandboxes

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ABSTRACT

This paper advocates for the establishment of AI regulatory sandboxes in the European Union to enable responsible testing of AI systems in real-life conditions. By aligning the sandbox modalities with the risk tiers of the AI Act, a smooth transition from research to testing of AI systems is ensured. The framework emphasizes the oversight and compliance obligations needed for the desired outcomes to be realised. This will foster AI Research & Innovation in the European Union, delivering benefits for society and ethical legally conforming AI technologies.

KEYWORDS

AI systems, knowledge transfers, EU regulation

1 INTRODUCTION

The European Union (EU) is currently deploying or getting ready to deploy several regulatory instruments to deliver a Union "fit for the digital age"[1]. The not-yet adopted Artificial Intelligence (AI) Act, is one of them. It imposes obligations on providers, makers, and facilitators of AI systems, as well as on users of AI systems or their outputs. The specifics of what constitutes an AI system, the obliged parties, and the conditions these must abide by are still being discussed. The European Commission (EC) released its Proposed AI Act in 2021 [2]. The Council [3] and the European Parliament (EP) [4], have both released their amended versions of the text. These bodies are now engaged in interinstitutional negotiations, which will deliver the Final AI Act, expected by the end of 2023.

The operational functioning of the AI Act will be set at a later stage through implementing acts. However, the content of these documents indicates that regulatory sandboxes will be the chosen environments for the development of safe AI Research & Innovation (R&I). This paper argues that AI regulatory sandboxes should be structured following the tiered approach towards risk that characterises the AI Act, as the space where certain AI systems can be tested before being placed in the market. This framework for AI regulatory sandboxes will favour the growth of AI technologies in the EU and bring about benefits to society.

Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia

2 KEY ASPECTS OF THE AI ACT

To understand the content of this paper, some concepts contained in the AI Act need to be introduced and clarified.

2.1 A Tiered Approach Towards Risk

The Proposed AI Act regulates AI systems based on a tiered approach towards risk. It differentiates between (i) unacceptable risk AI systems, to be outlawed; (ii) high risk AI systems; and (iii) low or minimal risk AI systems. Moreover, the Proposed AI Act sets two categories of high risk AI systems: those characterized by their use as safety components of specific products, and those with implications for fundamental rights. Thus, both the purpose of the AI system and the technologies it utilizes will be key factors in determining the risk category of the AI system. The Final AI Act is expected to follow this structure. However, the specific traits defining what makes the AI systems fall within each category of risk have still not been set. The Final AI Act will likely follow the Proposed AI Act in providing flexibility for the expansion or modification in the future of the traits of AI systems that define them as high risk.

Moreover, the Council and the EP agree with the Proposed AI Act that high risk AI systems will need to be assessed before being put on the market and throughout their lifecycle, while limited-risk AI systems will only need to comply with transparency requirements, enabling users to make informed decisions as to engaging with them. To ease the transition of AI systems from the inception stage to the market stage, the regulation puts forth the creation of AI regulatory sandboxes (sandboxes).

2.2 AI Regulatory Sandboxes

The Proposed AI Act envisions controlled environments for the testing and refinement of AI models, named AI regulatory sandboxes. These are intended to allow obliged parties to ensure that the AI systems comply with the AI Act obligations and to provide feedback on potential risks before such risks can be realized in society. This includes instances of substantial modifications of the AI system which motivates the need for a new conformity assessment. Sandboxes are also intended to enhance legal certainty for AI system innovators.

The concept of regulatory sandboxes is not new. They have been analysed in the literature as experimental regulatory instruments "offer[ing] the flexibility, adaptability, room for compromise, and innovation-friendliness required by novel technological developments" [5]. Regulatory sandboxes have already been implemented across jurisdictions, especially in the financial sector. They serve companies to test the potential compliance of new business models [6]; and regulators to understand the evolution of new technologies [7] and develop "evidence-based lawmaking" [8].

The Council and EP agree on the creation of AI regulatory sandboxes. Both bodies consider that the specific conditions for the establishment of these environments need to be developed through later delegated implementing acts. Thus, the actual functioning and structure of AI regulatory sandboxes will depend on the implementing acts to be developed and adopted after the Final Text of the AI Act becomes law. The current vision regarding regulatory sandboxes described in the Proposed AI Act and the amendments adopted by the Council and EP contemplates the following stages:

2.2.1 Establishing AI regulatory sandboxes. Specific competent authorities at the Member State(s) and (or) the EU will oversee the accreditation and auditing of these spaces, following given rules and principles. The competent authorities have discretionary powers to adapt their tasks to specific AI sandbox projects.

2.2.2 Conditions of operation of the AI regulatory sandbox. The operation of the AI regulatory sandbox, including the procedure to apply for its utilization, the eligibility criteria, the rights and obligations of participants, duration, and other aspects of operating the AI regulatory sandbox will be set in implementing acts. These sandboxes will be under the direct supervision, guidance, and support of the national competent authority. These are key aspects for the proper functioning and the effectiveness of regulatory sandboxes, as explained by Ranchordas [5].

2.2.3 Modalities of AI regulatory sandboxes. Possibly, different modalities of AI regulatory sandboxes should exist. All sandboxes are intended to deliver controlled environments, permitting the assessment of AI systems before facing full-scale regulatory requirements in real life. The specific requirements and scenarios of different sandboxes are likely to depend on the individual function, technology, or purpose of the given AI systems they are envisioned to assess.

2.2.4 Testing and assessment of AI systems. The sandbox is designed to identify the risks of the AI system, with the purpose of both classifying the AI system accordingly and assuring that the AI system complies with the corresponding rules and obligations. The methods utilized in the AI regulatory sandbox must be geared towards the identification of risks and their mitigation to ensure legal compliance with the AI systems. The AI regulatory sandboxes should focus on dangers to fundamental rights, democracy, the rule of law, health, and the environment. These are, especially, distinguishing traits of high risk AI systems. This way, AI sandboxes can enable truly responsible innovation.

2.2.5 Cooperation among AI Regulatory Sandboxes. The competent authorities should cooperate and coordinate their activities. When possible, cross-border cooperation should be facilitated. This is essential to prevent differences across Member States, and to assure the maintenance of the free movement of products and services in the Union's internal market.

2.2.6 Exclusion of administrative fines by using AI regulatory sandboxes. The sandbox participants that have respected the rules and procedures set within the AI regulatory sandbox framework can enjoy a presumption of legal conformity and will not be subjected to administrative fines for eventual infringements of AI systems legislation, even if they remain liable for the damages they may cause.

In terms of the appropriateness of mainlining the responsibility for potential liability damages during the duration of the sandboxes, the question remains open in the academic sphere. One side agrees with maintaining liability, as the EC and Council defend, arguing that this is necessary for consumer protection and the keeping of trust. However, others consider this approach too onerous, warning that it may disincentivise innovation, and harm smaller players in the market who could be burdened by extensive legal obligations even before fully operating in the market. [9]

2.3 Research Activities & the AI Act

The Proposed AI Act did not include a provision excluding AI research activities from its scope of application. However, both the Council and the EP have brought forth this exemption in their adopted amendments. This suggests that the Final AI Act will set a different framework for such activities.

The Council desires to amend Article 2 of the AI Act to explicitly exclude its application to AI systems "specifically developed and put into service for the sole purpose of scientific research and development", as well as "any research and development activity" [3]. Meanwhile, the EP would amend Article 2 to exclude AI systems research, testing and development activities "prior to this system being placed on the market or put into service" [4]. Neither of these suggested exclusions, however, sufficiently pre-empt potential risks.

This paper argues that for this exemption to operate, the research activity must be performed ensuring the absence of harm to people. Otherwise, research activities that require interaction with people (e.g., to gather behavioural insights, people-facing testing, etc.) could be wrongfully placed outside the scope of the regulation. This could lead to the same societal harms that the AI Act is explicitly tasked to avoid. Thus, this latter type of research activities should also be conducted within the scheme of AI regulatory sandboxes, and their appropriate controlled environment.

3 AI REGULATORY SANDBOXES THAT FOSTER SAFE AI RESEARCH AND INNOVATION

This section argues for the incorporation of three key traits into the framework of AI regulatory sandboxes, either within the AI itself or its delegated implementing acts, for the sandboxes to serve as effective environments for the development of transparent and responsible AI innovation and safe AI systems: (1) making AI regulatory sandboxes the environment for the controlled testing of AI systems in real-life scenarios, (2) creating different modalities of sandboxes following the tiered risk approach of the AI Act and (3) outlining some common requirements for all types of regulatory sandboxes. They also recognize the varying complexities and potential impacts of different AI technologies, ensuring that regulatory oversight is proportionate and targeted to foster the transfer of AI knowledge to society.

3.1 The Shaping of the AI Act Regulatory Sandboxes as the Environment for Real-Life Testing

The Council and EP agree that the 'placing in the market' of the AI system should be the moment when the AI Act is triggered, and the AI system needs to fully comply with the legal obligations within the AI Act. This circumstance is understood as the moment in time in which "[a product] is first supplied for distribution, consumption or use on the market in the course of a commercial activity, whether in return for payment or free of charge" [10]. However, research activities that interact with people in the real world should be covered by AI safeguards, and regulatory sandboxes could provide the entities with means for a progressive transition towards the full applicability of the AI Act.

Currently, the Council and the EP diverge on whether entities should be given the possibility to test AI systems in real-life settings. The Council considers that this should be enabled, under specific conditions and safeguards, within AI regulatory sandboxes. The EP, however, would not exempt the testing of the AI system in real-world conditions from the full application of the AI Act. This paper argues that enabling real-life testing in regulatory sandboxes is the safest and most significant manner in which the AI Act can foster AI R&I while preserving the trust and safety of the people. Real-life testing is necessary. This is in line with the ordinary operation of entities in the market. For example, companies incrementally test whether the changes they implement are successful and behave as expected. If so, they propagate the changes to the rest of their goods or services, while if issues are identified, they revert to the previous version and resolve them.

Carrying out this process for the real-life testing of AI systems within AI regulatory sandboxes, where approval of the AI system is needed before it can be fully released to the market, enables the avoidance of misconduct or abuse. It also ensures that risks are properly identified and mitigated and that by the end of the sandbox period, the outcomes are fully compliant with existing regulations.

3.2 Regulatory Sandboxes Based on the AI's Tiered Approach Towards Risk

This paper argues that AI regulatory sandboxes should be structured following the tiered approach towards risk that characterises the AI Act. Two modalities of regulatory sandboxes can be created according to the potential risk the tested AI systems can generate. These modalities would be foundational, but not exhaustive; others can be created based on criteria such as the sector where the AI system would be deployed.

3.2.1 Regulatory sandboxes for limited-risk AI systems. This sandbox would serve to test new limited-risk AI systems, or those which are already in the market, but are being applied to an additional or different purpose. Access to such a sandbox should be voluntary, and legal requirements less strict.

3.2.2 Regulatory sandboxes for (potentially) high risk AI systems. This sandbox would test new high risk applications, or existing high risk AI systems for a new purpose. This sandbox should also be utilised if the entity is unsure about the risk classification of the AI system. The main purposes of this modality are to enable entities to (1) test their AI system, to assess whether it is high risk, and (2) if the AI system is high risk, to determine what mitigating factors can be implemented, and if the implemented mitigated factors are sufficient. The utilisation of this type of sandbox could be voluntary or compulsory. The choice depends on the ability of certification bodies to establish sufficient high risk AI systems regulatory sandboxes, and the associated benefits the entities utilising them could enjoy. Making the utilisation of this sandbox compulsory is the most effective way of assuring that high risk AI systems conform to the law before being placed in the market. If the utilisation of this sandbox is made voluntary, its use could provide the entity with a fast-tracking process in the third-party conformity assessment procedure all high risk AI systems must undergo.

Moreover, certain entities utilising this type of sandbox could be given access to a 'nursery status', a concept developed in other jurisdictions. This status acts as a transitional phase where companies, especially startups, can continue to receive targeted support even after exiting the sandbox environment. This responds to the fact that startups often rely heavily on the guidance provided during the sandbox period, unlike established companies that are more experienced in the field of regulatory compliance. The nursery status recognizes that, mitigating the risks of no longer being exempt from regulatory consequences, and facing real-world responsibilities (including potential fines), by offering increased support. This continued assistance helps organizations meet regulatory requirements and build the necessary experience in a more controlled setting, serving as a period of growth. [11]

3.3 Common requirements for all Regulatory Sandboxes

Regulatory sandboxes must adhere to certain common requirements to ensure that AI systems and other innovative technologies go through real-life testing within controlled and legally compliant environments. These minimum terms and conditions must be explicitly defined, as part of the procedure to establish the regulatory sandbox. The requirements for limited-minimal risk AI sandboxes can be adjusted, reflecting the lower danger posed by such AI systems. This section argues that all AI regulatory sandboxes must meet the following criteria:

3.3.1 The identification of the AI system features that are being tested. This encompasses understanding not only what functionalities are being tested but also why and how they are being assessed. The supervisory authority will not have direct access to the code itself and must safeguard sensitive and(or) proprietary information, allowing innovation to flourish without undue risk of exposure.

3.3.2 The proportion, composition, and selection of users subjected to testing. Users should be made aware that they are engaging with an AI system that is being tested, and must provide their consent. For instance, if a financial institution is offering a new credit product based on an experimental algorithm, customers must be informed that this offering is not part of the financial institution's regular operation.

3.3.3 The time frame for testing, with provisions to interrupt it. The complexity of the technology and the nature of the testing environment should justify the start and end dates of the regulatory sandbox. Crucially, provisions must be made to allow for an immediate interruption of the testing if insurmountable risks arise, with an identification of the measures set to identify such a situation.

3.3.4. Documentation and timestamping. Entities benefiting from regulatory sandboxes must develop rigorous documentation. This may include timestamps indicating when specific documents, descriptions, or test plans were submitted. As a counterpart, entities could utilise this document to undergo or strengthen their claims over intellectual property rights.

4 BENEFITS OF REGULATORY SANDBOXES

Regulatory sandboxes can be constituted as the best environment to achieve legally conforming AI systems being released to the market. They entail benefits for the various stakeholders:

4.1 AI System Innovator

The AI regulatory sandbox enables the testing of new technologies that do not yet exist in the market and may therefore still not be subjected to a given classification, or which need to be modified to mitigate risks. In cases where the use of the AI regulatory sandbox has not served to prevent the materialisation of risk, the company utilizing the AI system may still be considered liable for the harms incurred, but the companies will not be fined for unexpected harms of the AI system.

The UK experience with regulatory sandboxes reveals other associated benefits. Among them, sandboxes have been found to improve access to capital, as firms operating within these controlled environments often find it easier to secure investment. These firms are also more likely to remain in operation and even secure a patent. Sandboxes also significantly reduce the time and cost of getting products to market, a factor that is particularly beneficial for first-time innovators. [12]

4.2 AI System Regulators

The regulatory sandboxes permit the establishment of feedback loops in the regulation. Regulators themselves can observe if the sandboxes are meeting their desired goals, or whether some AI systems need to transit from one category of risk to another. In cases of AI systems causing harm despite being considered legally compliant by AI regulatory sandboxes, the regulators can update the functioning of the AI regulatory sandboxes, to avoid this from happening again.

4.3 Benefits for Society at Large

The purpose of the AI Act is to foster safe innovation. Regulatory sandboxes would enable this, but also an increased degree of positive spillover effects for society. The sandbox, by improving the collaboration between the regulator and the innovator, has the potential to enhance consumer protection by fostering a more transparent and cooperative relationship that focuses on safety and compliance. Another significant benefit is the increased throughput of tested and introduced products and services to the market. Regulatory uncertainty frequently inhibits the most innovative products from reaching consumers, as they are often abandoned at early stages due to associated risks. Through the sandbox framework, these products can be guided and supported, thereby minimizing early-stage abandonment and enhancing the flow of innovative solutions into the marketplace.

5 CONCLUSION

This paper contends that AI regulatory sandboxes must be established as the natural environment for the controlled testing of AI systems within the EU. By aligning sandboxes with the tiered risk approach of the AI Act, two main modalities of AI Regulatory Sandboxes can be created, tailored to the potential limited-minimal risk, or high-level risk of the AI system. This structure not only facilitates a seamless transition from research to testing but also ensures strict, transparent oversight of AI technologies. By integrating provisions for user consent, intellectual property protection, defined time frames, and safeguards against risks, these measures will propel the growth of AI technologies in the Union, while allowing the systematic and informed integration of AI technologies into broader societal contexts and applications.

ACKNOWLEDGMENTS

This work was supported by the Slovenian Research Agency and the European Union's Horizon Europe research and innovation program project Graph-Massivizer under grant agreement HE-101093202.

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New Initiatives for Knowledge Transfer between Industry and Academia: The INDUSAC Project

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ABSTRACT / POVZETEK

At the Jožef Stefan Institute most current practices of knowledge transfer involve licensing and contract and/or collaborative research between researchers and industry, whereas student-industry relations are less explored, often do not regard geographical or gender balance, and rarely involve upskilling in entrepreneurship. In the Horizon Europe INDUSAC project, the main objective is to develop and validate a simple and user-friendly industry-academia collaboration mechanism for short-term (4-8 weeks), challenge-driven co-creation. Knowledge transfer is importantly extended from researchers to also involve students, who are in turn financially supported. Gender balance is ensured by the conditions set out in the project's calls for applications. Emphasis is put on upskilling, achieved through looking for solutions to real-life challenges faced by industry. The workflow involves registering on the INDUSAC online platform, issuing a Challenge by companies, assembly of student/researcher co-creation teams, and submitting Motivation Letters to apply to solve a Challenge. Once Motivation Letters are evaluated and approved, selected co-creation teams proceed with solving the Challenge with assistance from the company. Once completed, companies and co-creation teams submit reports and feedback on the process in terms of experience with the project, and upskilling and familiarity in regards to selected entrepreneurial areas. The workflow will be carried out three times during the project, so as to allow for dynamic Challenge solving and feedback-based improvements on the process itself. By solving companies' Challenges, students are expected to acquire international collaborative experiences as well as transversal and entrepreneurial skills, access to companies from the EU and associated countries, and references for future networking. Through supporting at least 300 transnational co-creation teams and creating a dynamic community of industry-academia stakeholders, the INDUSAC mechanism will establish the co-creation system as a catalyst for integration of academia in business practices and technical solutions in the future.

Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia

KEYWORDS / KLJUČNE BESEDE

INDUSAC project, international cooperation, student-industry cooperation, upskilling

1 INTRODUCTION

Knowledge transfer may involve different types of collaboration; in most often listed examples, it takes place between knowledge-rich entities (such as universities and research institutes) and industry. The Jožef Stefan Institute (JSI) is the largest Slovenian public research organisation and hosts working units that carry out activities connecting research and industry. While current practices at JSI involve licensing and contract and/or collaborative research between researchers and industry, student-industry relations are less explored, or they are explored indirectly, involving students in cooperation with departments that may cooperate with industry, and mostly without particular regard to geographical or gender balance. Furthermore, researcher-industry collaboration takes place mostly as licensing or contract / collaborative research but rarely as upskilling in the fields of entrepreneurial skills such as marketing, product development, or business modelling. Lastly, knowledge transfer is not inherently financially supported; therefore, funding schemes and mechanisms that encourage collaboration by, for example, cascade funding (such as the calls for third parties within running Horizon Europe projects) are constantly sought in order to boost small-scale short-term R&D projects.

Enter the INDUSAC project. The on-going Horizon Europe Quick Challenge-driven, Human-centred Co-Creation mechanism for INDUStry-Academia Collaborations (acronym INDUSAC) project (www.indusac.eu) started in September 2022 (EU project number 101070297) with the main objective to develop and validate a simple and user-friendly industry-academia collaboration mechanism for quick, challenge-driven co-creation. The process allows to develop solutions that address the needs and interests of companies, students, and researchers in the EU, with special attention to widening[1] and associated[2] countries. In the project, knowledge transfer is extended from researchers to also involve students, who are in turn financially rewarded for successfully completing the project, and gender balance is ensured by the conditions set out in the project's calls

[1] Widening countries: Bulgaria, Croatia, Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia

[2] Associated countries: Albania, Armenia, Bosnia and Herzegovina, Faroe Islands, Georgia, Iceland, Israel, Kosovo, Moldova, Montenegro, North Macedonia, Norway, Serbia, Tunisia, Turkey, Ukraine, Morocco, UK

for applications. Emphasis is put on upskilling, achieved through looking for solutions to real-life challenges faced by industry.

2 METHODOLOGY AND OUTPUTS

The INDUSAC platform. To enable the workflow of the project described below, an online platform has been set up as a user-friendly and intuitive tool for posting industrial challenges, assembling co-creation teams, applying for calls to solve the challenges, and submitting reports.

General workflow of the project. The workflow (Figure 1) starts with a company registering on the INDUSAC platform and issuing a Challenge (eg. a particular problem that needs to be solved). Students and researchers likewise register on the platform, select a Challenge to solve, assemble an international team, and submit a Motivation Letter to the company. If selected, the student/researcher teams proceed to solve the Challenge, and submit appropriate reports for evaluation, as well as responses to upskilling questionnaires.

Registering on the INDUSAC platform. Before co-creation projects can take place, companies, students, and researchers need to register on the platform. Registration allows a company to create a profile and publish a Challenge, and students/researchers to submit Motivation Letters.

Issuing of industrial Challenges. In October 2023, companies will be invited to issue a Challenge by selecting one of nine different predefined Challenge type templates, covering mainly entrepreneurial skills, and ranging from developing a product, market analysis and strategy, and developing service/product ideas, to developing a business plan and a business model. There is no limitation regarding the area of industry – Challenges may, for example, be from the area of sustainable biotechnology seeking product development, automotive industry seeking business plans, or textile industry seeking assistance with marketing. The Challenge, apart from describing the problem (excluding confidential information), will also list the companies' expectations in terms of solutions, and in terms of the co-creation team's skills. Eligible companies shall comprise companies established in the EU or associated countries, but there are no restrictions on the sector, type, or size of a company to issue a Challenge, or the number of Challenges issued per company. The company defines the maximum number of teams that may be accepted to solve the issued Challenge.

Submitting Motivation Letters. As part of an ongoing campaign, students and researchers from public universities and public research institutions are made aware of the INDUSAC project by promotion by the INDUSAC Consortium and by the academic institutions themselves, as well as by non-academic institutions such as clusters and chambers of commerce, through social media and physical leaflets. In November 2023, students and researchers will be able to apply to a Call, which entails putting together an international and gender balanced student/researcher (ie. co-creation) team and filling out a joint Motivation Letter. The Motivation Letter includes a description of the applicant's motivation and skills.

Eligibility of co-creation teams and team members. Students and researchers in each co-creation team must come from EU member states or associated countries, as indicated by their citizenship or residency. Students must attend public universities during the entire duration of the activity whereas researchers must be employed at a public research organisation during the entire duration of the activity. An individual student or researcher will be able to participate in more than one co-creation team but in no more than three different applications of a Motivation Letter. The co-creation team must have at least three and up to six members. Team members must be from at least three different EU member states or associated countries and at least 60% members of the co-creation team must be from widening countries. The co-creation team has to be gender balanced, including at least two out of the [Male], [Female], and [Would rather not say] gender options. A co-creation team must include at least one student, ie. no co-creation team may comprise exclusively researchers.

Evaluation of Motivation Letters. As noted above, a company may select more than one co-creation team to solve a Challenge. Motivation Letters are evaluated by a company representative, on a number of criteria - team's motivation and enthusiasm, excellence, market impact, team quality, resource allocation, and transversal criteria.

Signing the FSTP Declaration. If a Motivation Letter has been approved, the co-creation team signs the Declaration on Financial Support to Third Parties. FSTP, in the amount of up to 1,000 EUR gross per student and up to 3,000 EUR gross per co-creation team, is given solely to student members of the co-creation teams, after the finalisation of the project.

The co-creation process. INDUSAC will provide the co-creation teams with a list of deliverables, methods and tools for solving the Challenge. Throughout the process, the company will have an introductory meeting, and subsequent milestone meetings as needed, with the co-creation team. The co-creation process will also be monitored by the INDUSAC consortium so as to enable smooth progress. Should the co-creation process give rise to any form of intellectual property (IP; for example, a patent application), division of ownership of IP rights, the type of IP and its management will be arranged with appropriate agreements.

Reporting by co-creation teams. After completion of the co-creation project (ie. solving the Challenge), co-creation teams submit implementation reports including a summary / description of results (ie. solutions to Challenges), deliverables as defined in the Challenges, filled-in upskilling and familiarity questionnaires (one before the project and one after the project), and testimonials about the experience. Solutions to Challenges are evaluated by the Evaluation Board and companies, and include scores on deliverable quality, business performance indicators, technical performance indicators, and deadline compliance. The co-creation process ends when the Evaluation Board and the company evaluate and approve the implementation report and students receive funding.

Reporting by companies. In addition to co-creation teams, the company also provides feedback in form of a quality assessment of the solution to the Challenge, including deliverable quality, business performance, technical performance, and deadline compliance. The company also fills out the questionnaire indicating their experience during the project.

Time dynamics of the project. Industrial Challenges will be posted continuously. Motivation Letters will also be able to be

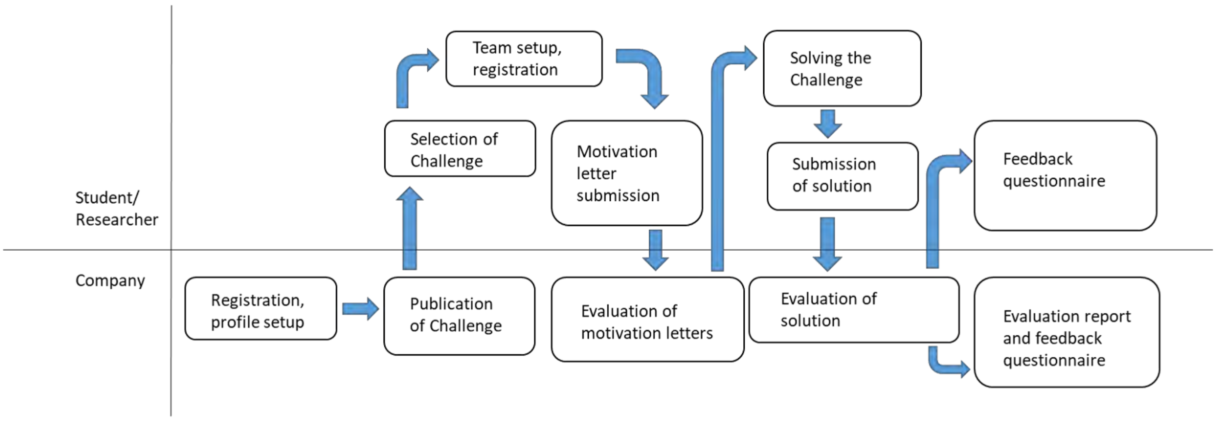

Figure 1: Simplified general workflow of the INDUSAC project.

submitted continuously, but they will be evaluated following three cut-off dates (in January 2024, May 2024, and October 2024). Four weeks after the call opening, applicants receive a decision on their applications. If approved, one week later, solving of the Challenge may begin. Individual co-creation projects will be given 4-8 weeks to complete. Three months after the first cut-off date, co-creation teams will be asked to submit final reports for revision; two weeks later, the Evaluation Board confirms the list of students from the co-creation teams to be funded; a month later, provided that administrative procedures from the students' side have been finalized, all students from the list receive funding.

3 DISCUSSION

The INDUSAC approach brings several advantages to the existing landscape of knowledge transfer practices. First of all, the calls for solving Challenges within the project are prepared with particular attention to geographical and gender balance in order to maximise inclusiveness. Including gender balance and an international dimension in a project have been shown to result in increased returns-on-assets and financial performances of companies, acquisition of new skills and knowledge, and increase in regional competitiveness (eg. [1-3]). Making sure the co-creation team members must be from at least three different countries not only increases geographical balance but also importantly provides the team members with experience in working in international teams. Thus it enables exchange in knowledge and experience between individuals from different backgrounds that come together to collaboratively create and innovate. This collaboration is further strengthened by the process that includes several checkpoints and feedback meetings between the co-creation team and the company. This encourages participants to provide constructive criticism, suggestions, and insights at various stages. Iterations and refinement of ideas based on the feedback received ensure continuous improvement and successful outcomes. The condition that at least 60% members of the co-creation team must be from widening countries further emphasises the support given to areas that do not reach 70% of the average research excellence index[3]. This is assisted by publishing a wide range of different types of Challenges, which enables diversity in content and field of work, and the possibility for individuals to participate in more than one co-creation team expands their opportunities as well.

The co-creation team also has to be gender balanced and the expected outcome is at least 50 % female representation in the co-creation projects overall, which will aid in changing the current trend of representation of women in entrepreneurship trailing behind that of men [4,5]. Finally, the project is strongly oriented towards students, as every co-creation team must include at least one student. The student status, as attested for by the registration process, is of particular importance as the INDUSAC mechanism puts emphasis on supporting the younger generations in acquiring experience in working with industry. This is further supported by the fact that only student members of co-creation teams receive financial support, which is a welcome mechanism for facilitating student-industry collaboration usually hindered by the lack of financial support [6,7]. The combination of geographical balance and the requirement for student participation also represents a unique opportunity for students to get a head start in creating international networks on their career paths.

Importantly, the major output of the project, which is the INDUSAC platform, enables most of the activities to take place conveniently and user-friendly at one place.

Rather than putting emphasis on particular technological achievements and inventions, the INDUSAC project makes upskilling the central knowledge transfer theme. Co-creation teams are given upskilling and familiarity questionnaires before the start of the co-creation project and after its end. It is the co-creation project's ambition to increase the students' and researchers' skills / experiences in working in an international team, working with companies, solving concrete tasks, assisting a group to agree on a mutually acceptable solution, working within a group to identify common goals, and listening to suggestions. Communication and negotiation skills, results oriented thinking, creativity, critical and analytical thinking, time management and effective planning, and leadership are among the skills mostly encouraged in the INDUSAC project. These types of skills have been shown to be important both in employer selection as well as for increased productivity in industry 4.0 and

[3] Widening countries, as defined by the European Commission, are countries where the Composite Index of Research Excellence is less than 70% of the average value of this indicator for all EU countries (modified after https://quantera.eu/spreading-excellence/).

digital transformation of manufacturing [8]. In particular, the project aims to improve familiarity of students and researchers with methods such as SWOT analysis, utility analysis, trend analysis, cost-benefit analyses, product portfolio analysis / BCG Matrix, creating marketing strategies, value proposition analysis, developing a business plan, preparation of business model canvas, and target group analysis. The concept, ie. the short-term nature of the co-creation projects and three separate opportunities (cut-off dates), encourage looking for quick and dynamic solutions with possibilities of advanced problem solving by extending the primary Challenge through the next cut-off date.

Specific control steps (evaluations), as defined in the INDUSAC project's methodology, ensure that the co-creation process is not only inclusive but also of high quality: the review process ensures a high-quality cooperation arrangement, and specific requirements for the reports (i.e. pre-set structure and content of the work) ensure high-quality performed tasks. Furthermore, by setting up three consecutive calls, the process is continuously refined through feedback-based improvements of the methodology itself.

In the first year of the INDUSAC project, 34 Letters of Support from universities from Cyprus, Greece, Hungary, Latvia, Lithuania, Czechia, Slovakia, Austria, Germany, Spain, Slovenia, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, and Serbia have already been collected, indicating vast interest across Europe in participating in the project, and several students, approached at various conferences and fairs, have expressed interest in being informed about the call once it opens. Through the experience of supporting at least 300 transnational co-creation teams and creating a dynamic community of industry-academia stakeholders throughout the project lifetime, the INDUSAC mechanism will establish the co-creation system as a catalyst for integration of academia in business practices and technical solutions. At least 70% of students and researchers participating are expected to report at least one core professional transversal and entrepreneurial skill having been significantly developed by participating in the INDUSAC project. An improved set of skills in students and researchers by at least 30% compared to before the beginning of the project is expected, allowing them to rapidly expand their skill set in a short period of time and to find themselves more prepared for the business environment. Provided the project is successful, it represents an encouraging inspiration for similar industry-academia knowledge transfer practices, and the lessons learned will provide a basis for policy recommendations for similar EU and national initiatives in the future.

ACKNOWLEDGEMENTS

Work described in this manuscript has received funding from the European Union's Horizon Europe Programme under grant agreement No 101070297.

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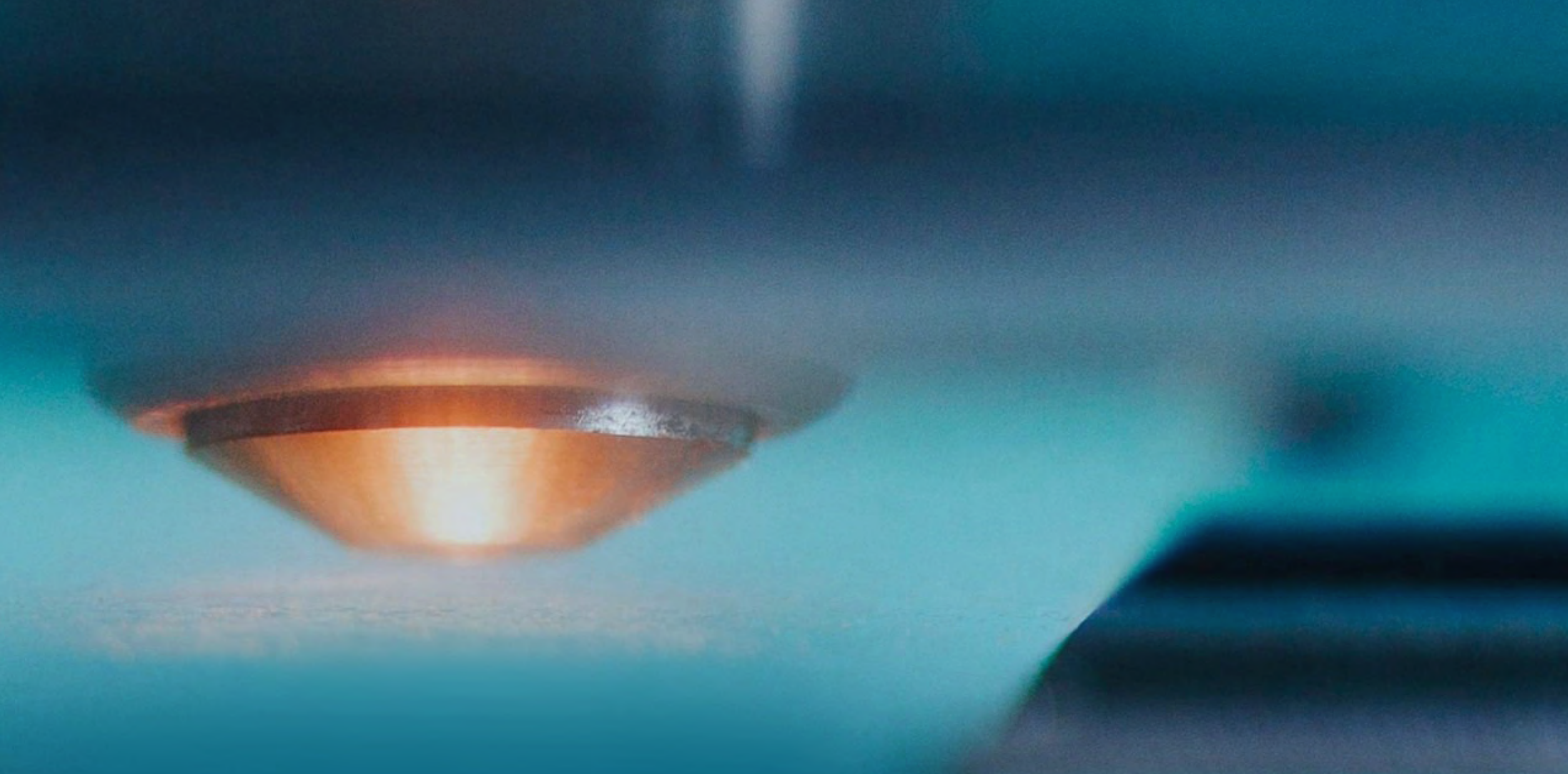

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