MY-GATEWAY Technology Transfer Methodology

2019

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OVERVIEW

Universities have two core goals: expanding the global knowledge base and teaching. These two goals are continuously promoted through research. University research is mainly conducted with public funding[1,2,3] and, thus, some of the research areas are directed for national and international purposes. In general, universities and public research institutes are the main source of innovation[4].

In recent years, it became clearer that universities and research institutes are a growth engine for the economy and, in particular, for the high-tech industry. In her book "The Entrepreneurial State," Professor Mariana Mazzucato surveys the contribution of universities and research institutes to innovative technologies. She indicates that in the last decade, 75% of brand name drugs were developed based on research conducted at universities. The Internet, GPS technology, cellular networks and even Google's search algorithm were also initially developed at universities. Over 50 other technologies such as touch screen, voice recognition and miniaturization of cameras, which are commonly used today in mobile devices, were also initially developed at universities.[5] We have prepared the following table that summarizes some of the innovations that are originated from universities:

[1] https://247wallst.com/special-report/2017/03/22/universities-getting-the-most-money-from-the-federal-government/
[2] https://www.universitiesuk.ac.uk/policy-and-analysis/reports/Documents/2016/university-funding-explained.pdf
[3] https://www.oecd.org/austria/38307929.pdf
[4] https://www.autm.net/AUTMMain/media/SurveyReportsPDF/AUTM_FY2016_US_Highlights_no_Appendix_WEB.pdf
[5] Mazzucato, M. (2015). *The entrepreneurial state: Debunking public vs. private sector myths* (Vol. 1). Anthem Press.

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Everyday Life

Fluoride toothpaste
Seat belt
Grass hybrids
The spreadsheet
e-ink
GPS
Nicotine Patch
Polaroids
Google
Wetsuit
Television

Technology

Internet
Web browser
Computers
Magnetic core memory
LCD screens
Lithium-ion batteries
Plasma screens
RSA cryptogtaphy
Touchscreens
Hypertext
WLAN
LASER
LEDs
Computer games
Androids
Yagi-Uda antenna
Adobe Flash
Radio
Nanowire

Sceintific Tools

Electron microscope
Oncomouse
Windtunnels
Richter Scale
Geiger counter
Telescopes
Periodic table
Crystallographic electron microscopy

Industry and Exploration

fRocket uel
Concertestream curing
Plexiglas
Modern oil prospecting
Solar power
Oil refining
The black box
Silica gel
Chemical battery
pH meter
Nuclear power
Graphene
Concrete with glycerin

Medicines & Treatments

Insulin
Tuberculosis
Warfrain
Adenocard
Restasis
Chemotherapy drugs
Allegra
Emtriva
Trusopt
Citracal

Vaccines

Polio vaccine
Canine Parovirus vaccine
Kennel cough vaccine
Hepatitis B vaccine
Flu Shots

Medical Practices

Penicillin
Pap smear
Blood preservation technique
CEA markers
LASER cataract surgery
Artificial blood transfusion
Apgar score
Artificial insemination
Bone marrow transplant
Open heart surgery
Stem cells for gene therapy

Medical Devices

Ultrasound
Heart-lung machine
Pacemaker
CAT scan
MRI scanner
PET/CT scanner
Artificial heart
Cochlear implant
CPAP mask
Iron lung
X-ray

Food Science

Saccharin
Vitamin D fortification
Gatorade
Probiotics

Crime and Warfare

Breathalyzer
Radar detection
Polygraph

Figure 1: Innovations that are originated from universities

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In recent years, a considerable number of successes have been recorded in Israel for university research. The brand name drug, Copaxone, developed at the Weizmann Institute of Science, was traded by Teva Pharmaceutical Industries and yielded more than EUR 3 billion in royalties to the Weizmann Institute. Three of the six largest exits in 2017 were university technologies: Mobileye, developed at the Hebrew University, was sold to Intel for more than EUR 13.25 billion, Kite Pharma, developed at the Weizmann Institute of Science, was sold to Gilead for EUR 10.51 billion, and NeuroDerm, developed at Ben Gurion University, was sold to Mitsubishi for EUR 0.97 billion. These successes encouraged the Israeli Council for Higher Education to initiate the establishment of university entrepreneurship centers. Recently, three such entrepreneurship centers have been established in Israeli universities and budgeted at a total of EUR 11 million.

However, many universities still encounter difficulties in transferring the knowledge generated from research and translating it to products for the benefit of humanity. Mainly because universities specialize in carrying out research but do not engage in development[6], a critical stage in translating knowledge to products. In fact, most of research products do not reach the development stage and face difficulties in crossing the "Death Valley" stage. The term "Death Valley" is used to describe the point in a technology's life cycle at which the research is transitioning from an academic basic research program to an applied industrial development program. The challenge usually revolves around the industry's willingness to adopt earlier stage technologies through funding and licensing[7]. The "Death Valley" is that period in the development of a product when a significant increase in investment is required, making the risk of failure much more likely to outweigh any potential future return[8]. The following diagram describes the life cycle of research.

[6] https://www.greentechmedia.com/articles/read/into-the-valley-of-death#gs.46goql

[7] Lin, J. Y., Bank Conference on Development Economics--Global., Lin, J. Y., Pleskovic, B., & World Bank. (2010). *Annual World Bank Conference on Development Economics--Global: 2009*. Washington, D.C: World Bank.

[8] Great Britain., & Great Britain. (2013). *Bridging the valley of death: Improving the commercialisation of research : eighth report of session 2012-13 : report, together with formal minutes, oral and written evidence*. London: Stationery Office.

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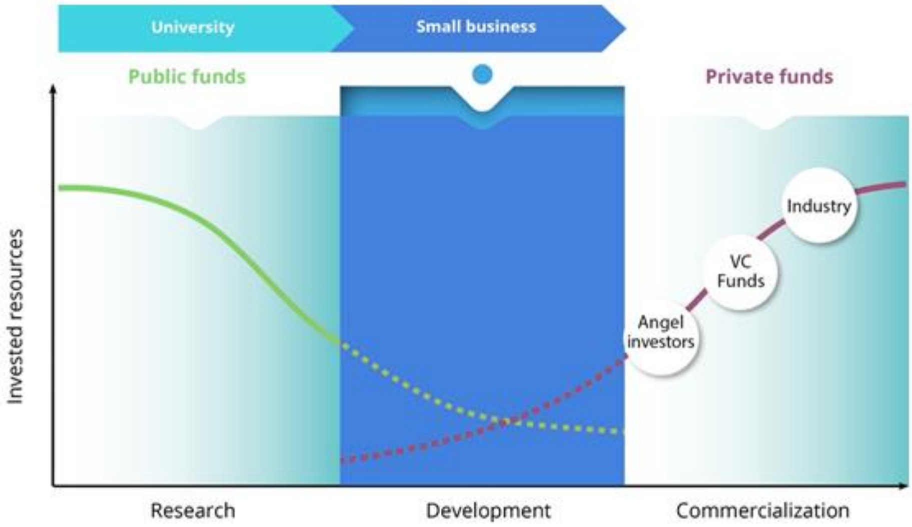

Figure 2: The life cycle of research[9]

As previously indicated, the basic **Research Stage** is carried out in universities and research institutes and is funded through public research grants. Funding sources for pure research are many and varied including funds from governments, international organizations such as the World Bank, the World Health Organization, the European Union, inter-state cooperation, philanthropic organizations, and non-profit organizations. The Research Stage is characterized by high funding but as the research progresses, the funding rate decreases until the research is completed[10].

The outputs of the Research Stage are research products which were validated in feasibility tests. At the next stage, the **Development Stage**, two major processes are taking place: the protection of the intellectual property and the commercialization of the research products. The commercialization process at this stage, the Pre-Development Stage, is a difficult and complex task, mainly due to the uncertainty in the implementation of the technology and the results of the Development Stage. Since Development Stage's investments are highly risky, only a few investors tend to invest at this stage. As a result, many inventions have difficulty crossing this stage, which has become known as the "Death Valley" Stage.

[9] https://www.greentechmedia.com/articles/read/into-the-valley-of-death#gs.46goql
[10] https://www.greentechmedia.com/articles/read/into-the-valley-of-death#gs.46goql

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In order to assist inventions to cross the **"Death Valley" Stage**, a model of cooperation between the main stakeholders (i.e. industry, investors and government) and institutions interested in the inventions' success is required. Institutions that should take part in the model are universities, investment companies, industrial companies and governments. However, only few universities, such as Harvard, Cambridge, Oxford, and KU Leuven, took initiative in such models. Their success was not long in coming. They achieved great success in the commercialization of their knowledge, increased their income, contributed to the national economy and to the accessibility of knowledge for the benefit of humanity. In the past 10 years, for example, Harvard's research innovations have formed the basis of more than 100 new startup companies in Massachusetts and around the world[11].

However, the vast majority of universities are still unable to cross the "Death Valley". In this chapter, we present a new approach to successfully transfer knowledge produced in the universities into viable business models and new businesses. This approach is based on the combination of resources that are available at universities (such as intellectual property, human capital, teaching and training capabilities), with those of main stakeholders (such as capital and industrial experience). A detailed overview of those resources and relevant stakeholders is provided in the following paragraphs.

[11] https://otd.harvard.edu/faculty-inventors/commercializing-technologies/

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1 RESOURCES

1.1 INTELLECTUAL PROPERTY

According to OECD, 20% of research and development in scientific and technical fields is carried out by universities[12]. These are pioneering studies at the forefront of science. Historically, the majority of research in universities has focused on pure research[13]. However, in the past decade, pressure has been exerted on research funding bodies (mainly the European Union, but not only), shifting research from pure research to applied research, with the aim of directing research to produce economic benefits[14]. As a result, we assume that the number of research products with commercial potential gradually increased.

Although there are research products with commercialization potential in the fields of humanities and social sciences, most of the research products with commercialization potential are originated from research in the fields of Science, Technology, Engineering and Medicine (STEM)[15]. This intellectual property, whether protected by a patent or know-how, accumulates in universities' Technology Transfer Offices (TTO) which are responsible to the commercialization of this knowledge. TTOs commonly use the classic commercialization model that grants license in return for royalties. When the potential for success is high, this model yields high income. However, since not all inventions have high potential, they remain in the "Death Valley" stage. Some innovations though have high potential, fall into the "Death Valley" stage when failing to be transformed into commercially viable products. Instead of yielding any income to the university, all those innovations become a heavy economic burden due to the high maintenance costs of patent protection.

[12] OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society. OECD Science, Technology and Industry Scoreboard. OECD. 2015. p. 156. doi:10.1787/sti_scoreboard-2015-en. ISBN 9789264239784
[13] Stephan, Paula (2012). How Economics Shapes Science. Cambridge, MA: Harvard University Press. p. 146. ISBN 978-0-674-04971-0.
[14] Jansen, D. (1995). Convergence of Basic and Applied Research? Research Orientations in German High-Temperature Superconductor Research. *Science, Technology, & Human Values*, *20*(2), 197-233. Retrieved from http://www.jstor.org/stable/689991
[15] Demiralp, B., Morrison, L. T., & Zayed, S. (2018). On the Commercialization Path: Entrepreneurship and Intellectual Property Outputs among Women in STEM. *Technology & Innovation*, *19*(4), 707-726.

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The goal of the model we are presenting is to maximize revenue from the patent portfolio found in each university. Our basic assumption is that universities with STEM faculties have intellectual property with high potential for commercialization.

1.2 HUMAN CAPITAL

There are two main types of students in the universities: non-research Bachelor and Master students, and research Master and Doctoral students. Our model focuses on the latter, research Master and Doctoral students. Our assumption is that the contribution of students engaged in research and research writing will be greater than that of other students. Only few of those students aspire to an academic position. However, the majority, at the end of their studies, are seeking employment in their field of expertise. Some of these students have entrepreneurial potential or are so-called "Natural Entrepreneurs". Natural Entrepreneurs are entrepreneurs of an entrepreneurial nature who will strive to realize the entrepreneurial potential inherent in them. The percentage of natural entrepreneurs out of the total population is estimated at 10%[16]. With Global Entrepreneurship Monitor report[17], it can be assumed with high probability that at least 5% of the population is of a natural entrepreneurial nature. Our conservative assumption is that the percentage of natural entrepreneurs among university research students is equal to the percentage of natural entrepreneurs in the general population. If we take Bar-Ilan University as a representative case, out of about 17,000 students, about 3,000 students are research students. Five percent of these students are about 150 students. Five percent of the total global research students constitute the majority of universities' entrepreneurial potential and are a significant available human capital.

[16] https://www.gemconsortium.org/report/50012
[17] https://www.gemconsortium.org/report/50012

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1.3 TEACHING AND TRAINING CAPABILITIES

Universities have the highest level of teaching and training capabilities[18]. Universities build teaching systems in various fields on a regular basis as a function of the development of science in all fields. Universities with economics or business administration faculties have a clear ability to establish courses in entrepreneurship in which students will be trained to establish and manage start-up companies. These courses will include training in performing due diligence, conducting market surveys, developing intellectual property strategy, preparing a business plan, raising capital, building investors pitch, etc. In fact, any university can establish an entrepreneurs training course either by using existing academic staff or by recruiting external experts to fill in the gaps.

[18] LTEC (Workshop), In Uden, L., In Liberona, D., & In Ristvej, J. (2018). *Learning technology for education challenges: 7th International Workshop, LTEC 2018, Žilina, Slovakia, August 6-10, 2018, Proceedings*

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2 STAKEHOLDERS

2.1 INDUSTRIES

Industries have a strong interest in continuous relationship with universities. IBM, for instance, has added nine new academic collaborations to its more than 1,000 partnerships with universities across the globe[19]. These relationships expose the industry to both high quality manpower and innovative technologies that are potential growth engines. Basic and applied research in universities is a major source of technological innovation for various industries. The pharmaceutical industry is based mainly on university research, the cyber industry is continuously fed by research products carried out at universities, and so are other industries by solutions for energy, water, environmental, medical devices, monitoring and surveillance, personalized medicine, food, machine learning and natural language processing, among others. Strengthening the relationship between the university and industry can lead to the realization of technologies found in the "Death Valley" for the benefit of the stakeholders.

2.2 INVESTORS

Venture capital funds, investment houses, angels, strategic investors, social investors, local and international investors, and other investors are interested in discovering innovative technologies for economic, strategic, or social reasons. As explained before, these entities rarely invest in research products which are considered to be investments at high uncertainty level or high risk investments. In order to increase the involvement and investment of investors in research products, the level of risk must be reduced. This can be done by, for example, establishing graduated investment mechanisms, involving public fund sources in the Development Stage, and using professional and experienced managers to lead the Development Stage.

[19] http://analytics-magazine.org/ibm-university-partnerships-focus-on-big-data-analytics-skills/

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2.3 GOVERNMENT

The government has a central interest in transferring successful knowledge from academia to industry. Its interest derives not only from its being the main investor in basic and applied research in universities, but also because of the many advantages of knowledge transfer.

Knowledge transfer contributes greatly to economic growth through the novelty resulting from this knowledge. Many industrial companies need innovative technologies and products on a regular basis. Removing barriers in the knowledge transfer process will inevitably lead to better absorption of the research products by the industry.

Another possibility in the process of knowledge transfer is the establishment of start-up companies based on university research products. Increasing the number of start-up companies established on the basis of university research products increases the total number of start-up companies in their country. An increase in the number of start-up companies also may lead to an increase in the number of exits and their total value. Exits not only benefit the stakeholders but also generate additional income for the state from taxation. For example, when Mobileye was sold to Intel for more than EUR 13.25 billion the Israeli, it brought into the state coffers a tax of EUR 1 billion.

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3 RESOURCE POOL

As we presented in detail in the previous chapter, universities have three main resources:

1. Intellectual Property - Innovative technologies and research products.
2. Potential entrepreneurs - among the research students at the universities.
3. High level teaching and training system.

The pooling of the above resources in a structured process and in cooperation with stakeholders can lead to a successful exploiting of the cumulative intellectual property, to successfully carry out the development stage and to establish start-up companies based on existing resources. This process is done in several stages:

1. Discovering the group of entrepreneurs among all the research students at the university - this process is based on two central elements:

   1.1. The process of identifying talents, as presented in Section 4.2, developed in the framework of this project, is based on a unique questionnaire and method of analysis developed by NOVA University in Portugal. This process assists in discovering potential entrepreneurs during their studies on the campus and registering them in the potential entrepreneurs' database.

   1.2. Smart Matching Process - a process in which the potential entrepreneur will be matched from the pool of entrepreneurs identified in step 1.1 to the appropriate technology from the database of technologies available for commercialization at the university. This process is based on personal interviews of the potential entrepreneurs, defining their personal preferences, examining their skills and their ability to lead an entrepreneurial project and their commitment to the process. In this framework, a smart match will be made between the entrepreneur and the project. For example, a match between a technology for artificial meat production and a vegan entrepreneur creates motivation for success for ideological reasons. Smart matching also exists in cases in which identified entrepreneurs are already involved in a research project that has commercialization potential. Today, research students go out to seek work immediately after graduation. In our model, when research

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students are identified as having entrepreneurial potential, they would also be considered smart matching as their knowledge of the field of research increases the chances of success of the project.

This process will also lead to a parallel process of "commercialize or release" in the university TTOs. Naturally, when a portfolio of technologies that are available for commercialization in TTOs is accumulated, each technology has a different marketing potential. In the matching process between the entrepreneur and the technology, a de-facto scan of potential technologies and an initial feasibility study is carried out. This feasibility study rates the potential of the technology. In other words, technologies with high commercial potential will be channeled to start-up companies, while technologies with low commercialization potential will be released and become public property. The benefit of this "commercialize or release" strategy is two-fold. Not only will the costs of patent maintenance and the efforts to commercialize them be reduced, but the public will also benefit from the knowledge that has become public domain. The following scheme that we designed presents this process:

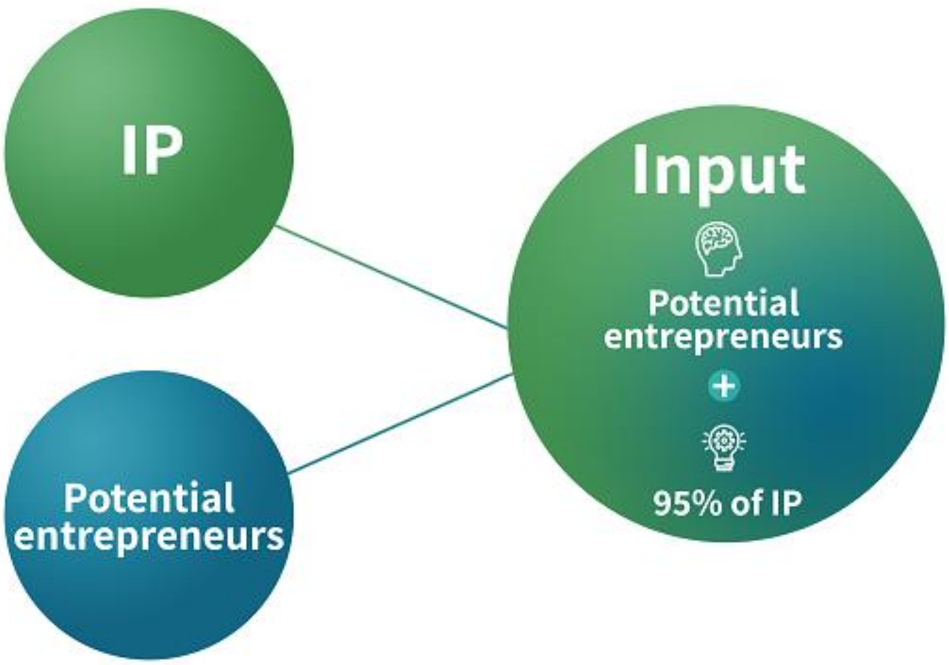

Figure 3: The smart matching process

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2. The process of training entrepreneurs - the training of entrepreneurs is carried out in an innovative model. Entrepreneurs get personal coaching services on their project from the establishment of the company to significant capital raising and, in some cases, even to commercialization. The process is carried out by appropriate instructors from the University's staff, external experts and an advisory committee composed of industry representatives and venture capitalists. The entrepreneur learns how to conduct technological due diligence, execute market surveys, write business plans, raise capital, manage lean mechanism, and manage the development plan. The coachers accompany the start-ups for a period of 18 months or for a shorter period depending on the entrepreneur's skills. A sample training program is presented hereafter.

The entrepreneurship program is carried out in cooperation with the School of Business Administration. The student is encouraged to specialize in entrepreneurship in a special program and comply with the university's academic requirements.

The essence of training in entrepreneurship is the use of the three central resources available to the university: academic study, intellectual property and human capital. The combination of these resources enables the commercialization of the university's discoveries (namely, its IPs) and turn them into companies. The university ensures its share in these companies through a number of adapted mechanisms. The assumption is that this activity will generate revenues for the university in the form of royalties and realizations.

Potential entrepreneurs will have a master's degree or higher, including post-doctoral students in a variety of fields. The program consists of three stages:

STAGE 1

Entrepreneurs complete the required theoretical studies at the School of Business Administration and through a matching process, the appropriate IP is matched to their education, skills and personal preferences.

STAGE 2

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Entrepreneurs establish the company, write a business plan and prepare the venture to fundraising.

STAGE 3

Entrepreneurs manage the technology development, raise funds and penetrate the market.

The program is presented in the following diagram:

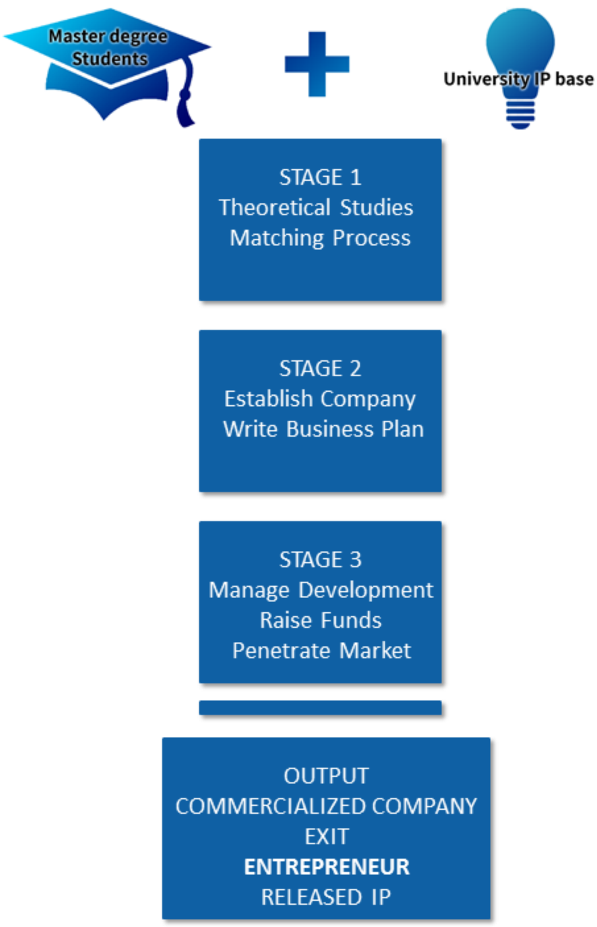

Figure 4: The entrepreneurs training program

The program also contributes to the strengthening of the academic connection with the industry and cultivates a generation of entrepreneurs with a connection to the university.

The program opens the university to an additional target audience: students who are interested in higher education on the one hand and entrepreneurship and practical experience on the other.

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The entrepreneurship program provides, among other things, a solution to the development stage and will increase the number of research projects that cross the "Death Valley".

The program allows researchers to engage only in research at the development stage if they are not interested in continuing to the stages of development and commercialization.

3. A brief sample training program

General:

- The program will take place in specific country for 10 intensive weeks of training.
- Each week will be comprised of 3 days of studies, 1 day of visiting relevant leading companies in various fields, and one day dedicated to homework and assignments.
- Each week will be focused on a main subject that teams will learn and tackle.
- Each team will have its own dedicated mentor who will accompany them throughout the program and all processes.

Weekly Program:

1. **Project Management** - Teams will learn a crash course in all the most effective methodologies for running a successful project, including "Lean", "Agile", "Scrum", Gantt management and other tools and technics that the fastest growing startups and companies use today.
2. **Business Development** - Teams will learn in depth about their specific ecosystem's needs, target market, how to create more value, the Business Model Canvas methodology, building a business plan, exploring new cooperation possibilities and how to grow and expand their business.
3. **Due Diligence** - Teams will learn how investors perceive them and what aspects are critical to them, allowing teams to better prepare for investors and VC's and improve their chances to get funded.
4. **The Art Of Presenting** - Teams will dive deep into how to tell a compelling story, how to build a strong presentation, graphics, and the art of presenting.

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5. **Finance and Legal Aspects of Startup Companies** - Teams will learn how to survive in the startup world, a deep dive into all the most important details of - Financial Aspects, Legal Aspects, and Intellectual Property Strategy (IP).
6. **Funding** - Learning all the possible ways a young company can get funding, seek cooperation activities with other companies, find all relevant local programs, working with existing European programs, Strategic Partners, University funds, Non-Monetary funding, Alternative Funding options, such as Crowd-Funding, scholarships and many more.
7. **Innovation** - The teams will be exposed to the top trends, technologies and most recent developments in the high-tech world, Cyber, Science and much more.
8. **Experts** - A zoom in into each team's industry and ecosystem. Each will get a tailor-made syllabus, handpicked experts to enrich their knowledge of their own industry.
9. **Hackathon** - All teams will take part in an intense live Hackathon contest, that will push them to be creative, resourceful and force them to solve problems, cooperate with one another and find solutions fast and excel. The judges of the event will be angel investors and VC owners.
10. **RoadShow Week** (DemoDay/Rap-up Event) - Teams will learn how to search and create relevant funding companies, contacting them and setting up a roadshow, presenting, learning, fixing and improving the presentation, the art of body language, who are you talking to and how to get the most out of every meeting (contacts, suggestions, connections, references and networking, including going to meetings with relevant investors. Teams will go out and present to local Angel investors, VC's, cooperation relevant companies and potential Partners, with a large Rap-up event that will include top local personal.

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4 FUNDING

There are several options for financing the development stage. Some of these sources are public and others are private.

As part of the Horizon 2020 program, there are several appropriate financing programs.

4.1 SME INSTRUMENT

The SME instrument supports close-to-market activities, with the aim to give a strong boost to breakthrough innovation with a market-creating potential. The SME Instrument offers small and medium-sized businesses the following[20]:

PHASE 1: Business innovation grants for feasibility assessment purposes.

PHASE 2: Business innovation grants for innovation development & demonstration purposes.

4.2 FTI (FAST TRACK TO INNOVATION)

The Fast Track to Innovation (FTI) is a fully-bottom-up innovation support programme promoting close-to-the-market innovation activities open to industry-driven consortia of 3 to 6 participants. It can help partners to co-create and test breakthrough products, services or business processes that have the potential to revolutionise existing or create entirely new markets.[21]

[20] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/sme-instrument
[21] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/fast-track-innovation-pilot

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4.3 POC ERC

The ERC Proof of Concept funding is made available only to those who already have an ERC award to establish proof of concept of an idea that was generated in the course of their ERC-funded projects. The funding will cover activities at the very early stage of turning research outputs into a commercial or socially valuable proposition, i.e. the initial steps of pre-competitive development.[22]

[22] https://erc.europa.eu/funding/proof-concept

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5 ADVISORY BOARD

The inclusion of industry representatives in the advisory committee is beneficial to all parties. The involvement of industry representatives in the development stage contributes to directing development to market needs, thereby contributing to the project's chances of success. Moreover, the industry is exposed to technological innovations in areas relevant to its operations in the early stages, and this exposure can yield a significant advantage over the competition. The representatives of the industry, as part of the development process, actually enjoy the right to a first glance to early stages' discoveries.

The following is a sample of industry representatives of advisory board:

Figure 5: Sample industry representatives of advisory board

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6 INVESTMENT FUND

Public universities have several sources of funding for their activities: government budgeting, tuition fees from students, revenues from the commercialization of knowledge, and the provision of services and philanthropy. The nature of philanthropy has changed over the years. In the past, most of the donors to the universities were adult donors who were honored by getting their names on buildings, departments, institutes, or faculties. The motives for philanthropy are many and varied and may include the desire to contribute to the common good, to finding a cure for rare diseases, or to the strengthening of the state through the universities. However, in recent years, we have witnessed a new type of donors: university graduates who have established successful ventures and made a fortune. This group of donors is characterized by its young age and their wealth. For the most part, they are not interested in the proposed exchange of classical philanthropy, that is, a structure or faculty in their name. At the same time, they have a warm place in their heart for the university which trained them to become who they are today. Gil Shwed, for example, founded Check Point Institute for Information Security at the Tel Aviv University School of Computer Science, which operates on a grant system provided by Check Point Software Technologies[23]. Such business-oriented donors are the target audience for investing in a venture capital fund affiliated to the institution. They are willing to invest at a high-risk level and even lose their investment, provided that in case of success, their investment will leverage both the university and their investment. In recent years, a number of venture capital funds belonging to a certain university institution have been established in Israeli universities (i.e. Technion, Tel Aviv University, and Hebrew University) and a large proportion of the investors are graduates of the institution. This kind of philanthropy is in addition to the classic philanthropy.

[23] https://www.wealthx.com/dossier/gil-shwed/

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OVERVIEW OF EXISTING RESOURCES IN CZECH REPUBLIC, SLOVENIA, ROMANIA, SERBIA, NORTH MACEDONIA, BOSNIA AND HERZEGOVINA

In order to offer a knowledge transfer model, we collected data on the current situation in the ecosystem of Romania, Slovenia, Czech Republic and for the Balkan countries Bulgaria, Serbia, North Macedonia. For each country we surveyed the universities, at each university we examined whether there are STEM faculties, research students (MSc.), economics studies, business administration studies, and what was the scope of intellectual property in each university. We also reviewed the presence of industries in each country.

Our data collection methodology had the following stages:

- We collected data from a variety of websites including the universities' official websites and Wikipedia.
- We distributed the data collected among the consortium's members according to members' state and ask them to verify the data and complete, when possible, the missing data.

Indeed, where it was not possible to estimate the current data due to the lack of sufficient and reliable information, we have preferred to refer to it as "not applicable" (N/A in the tables).

It follows a summary of our findings per each of the country analyzed:

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CZECH REPUBLIC

UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
Masaryk University	Brno	32,500	No	YES	N/A	N/A	6	8,779
Mendel University	Brno	8700	YES	YES	N/A	N/A	N/A	N/A
University of Veterinary & Pharmaceutical Sciences	Brno	3,000-3,999	N/A	N/A	N/A	N/A	N/A	N/A
Brno University of Technology	Brno	24,000	YES	YES	N/A	N/A	17	14,800
University of South Bohemia in České Budějovice	České Budějovice	10,000-14,999	NO	YES	N/A	N/A	1	N/A
University of Hradec Králové	Hradec Králové	8,500	YES	NO	N/A	N/A	N/A	2,400
Technical University of Liberec	Liberec	9,000	NO	YES	N/A	N/A	1	3,750
Palacký University	Olomouc	20,395	NO	NO	N/A	N/A	2	6,118
University of Ostrava	Ostrava	9,000	NO	NO	N/A	N/A	5	1,700
Technical University of Ostrava	Ostrava	22,512	NO	YES	N/A	1,740	4	N/A
University of Pardubice	Pardubice	9,200	YES	YES	N/A	N/A	2	N/A
University of West Bohemia	Pilsen	18,151	NO	YES	N/A	N/A	6	N/A
Czech Technical University in Prague	Prague	18,875	NO	NO	N/A	37	55	17,503
Czech University of Life Sciences Prague	Prague	18,000	YES	YES	N/A	N/A	1	N/A
Charles University	Prague	51,438	NO	YES	4,057	N/A	3	N/A

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UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
University of Economics	Prague	15,000	YES	YES	N/A	N/A	N/A	N/A
University of Chemistry and Technology	Prague	4,000-4,999	NO	NO	509	422	N/A	N/A
Tomas Bata University	Zlín	9,200	YES	YES	N/A	N/A	25	N/A

Table 1: Czech Republic data

SLOVENIA

UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
University of Ljubljana	Ljubljana	38,762	YES	YES	3,500	N/A	27	N/A
University of Primorska	Koper	4989	N/A	N/A	260	100	N/A	N/A
University of Maribor	Maribor	13,407	YES	YES	1,800	N/A	29	N/A

Table 2:Slovenia data

ROMANIA

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UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
1 Decembrie 1918 University	Alba Iulia	N/A	N/A	YES	N/A	N/A	N/A	N/A
Aurel Vlaicu University	Arad	7,288	N/A	YES	N/A	N/A	N/A	N/A
University of Bacau	Bacău	6,581	N/A	YES	N/A	N/A	N/A	N/A
Transilvania University of Brasov	Brasov	19,320	YES	YES	N/A	N/A	N/A	N/A
University Politehnica	Bucharest	25,469	YES	N/A	N/A	N/A	N/A	N/A
Technical University of Civil Engineering	Bucharest	8,600	YES	N/A	N/A	N/A	N/A	N/A
University of Agronomic Sciences & Veterinary Medicine	Bucharest	11,941	YES	YES	N/A	N/A	N/A	N/A
University of Bucharest	Bucharest	31,805	YES	YES	N/A	N/A	N/A	N/A
Carol Davila University of Medicine and Pharmacy	Bucharest	4,800	N/A	N/A	N/A	N/A	N/A	N/A
Bucharest Academy of Economic Studies	Bucharest	22,684	YES	N/A	N/A	N/A	N/A	N/A
Technical University of Cluj-Napoca	Cluj-Napoca	20,786	N/A	N/A	N/A	N/A	N/A	N/A
University of Agricultural Sciences & Veterinary Medicine	Cluj-Napoca	6,000	N/A	N/A	N/A	N/A	N/A	N/A
Babes-Bolyai University	Cluj-Napoca	41,136	YES	YES	N/A	N/A	N/A	N/A
Iuliu Hațieganu University of Medicine and Pharmacy	Cluj-Napoca	6,129	N/A	N/A	N/A	N/A	N/A	N/A
Ovidius University	Cluj-Napoca	15,000	N/A	YES	N/A	N/A	N/A	N/A
University of Craiova	Craiova	20,088	YES	YES	N/A	N/A	N/A	N/A
University of Medicine and	Craiova	3,404	N/A	N/A	N/A	N/A	N/A	N/A

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UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
Pharmacy of Craiova								
University of Galați	Galați	11,752	YES	YES	N/A	N/A	N/A	N/A
Gheorghe Asachi Technical University	Iași	16,382	YES	YES	N/A	N/A	N/A	N/A
Ion Ionescu de la Brad University	Iași	4,261	N/A	N/A	N/A	N/A	N/A	N/A
Alexandru Ioan Cuza University	Iași	25,724	YES	YES	N/A	N/A	N/A	N/A
Grigore T. Popa University of Medicine and Pharmacy	Iași	11,922	YES	YES	N/A	N/A	N/A	N/A
University of Oradea	Oradee	14,133	N/A	YES	N/A	N/A	N/A	N/A
University of Pitești	Pitești	9,087	N/A	YES	N/A	N/A	N/A	N/A
Lucian Blaga University	Sibiu	14,467	N/A	YES	N/A	N/A	N/A	N/A

Table 3: Romania data

SERBIA

UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
University of Belgrade	Belgrade	75,047	NO	YES	N/A	N/A	11	N/A
University of Novi Sad	Novi Sad	50,358	NO	YES	N/A	N/A	54	N/A
University of Niš	Niš	24,625	NO	YES	N/A	4,284	N/A	N/A
University of Kragujevac	Kragujevac	20,000	N/A	YES	N/A	N/A	N/A	N/A
State University of Novi Pazar	Novi Pazar	4,500	NO	YES	N/A	N/A	N/A	N/A

Table 4: Serbia data

NORTH MACEDONIA

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UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
Goce Delčev University of Štip	Štip	16,000	YES	YES	N/A	N/A	N/A	N/A
Ss. Cyril and Methodius University of Skopje	Skopje	50,000	NO	YES	N/A	N/A	N/A	N/A
St. Clement of Ohrid University of Bitola	Bitola	15,000	NO	YES	N/A	N/A	N/A	N/A
State University of Tetova	Tetova	13,000	YES	YES	N/A	N/A	N/A	N/A
University of Information Science and Technology "St. Paul the Apostle"	Ohrid	450	NO	NO	N/A	N/A	N/A	N/A

Table 5: North Macedonia data

BOSNIA AND HERZEGOVINA

UNIVERSITY NAME	CITY	NUMBER OF STUDENTS	BUSINESS FACULTY	ECONOMICS FACULTY	ACADEMIC STAFF	RESEARCH STAFF	REGISTERED PATENTS	STEM STUDENTS
University of Sarajevo	Sarajevo	30,866	YES	YES	N/A	N/A	N/A	N/A
University of Mostar	Mostar	9,758	NO	YES	N/A	N/A	N/A	N/A
University of Tuzla	Tuzla	10,683	NO	YES	N/A	N/A	N/A	N/A
University of Zenica	Zenica	6,000	NO	YES	N/A	N/A	N/A	N/A
University of Bihać	Bihać	4,881	NO	YES	N/A	N/A	N/A	N/A
University Džemal Bijedić of Mostar	Mostar	3,396	YES	NO	N/A	N/A	N/A	N/A

Table 6: Bosnia and Herzegovina data

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7 SUMMARY OF FINDINGS

The findings clearly show that in each of the countries surveyed there are the necessary resources (i.e. universities with STEM studies, universities with Business Management studies, universities with economics studies and universities that produces patents) to establish an efficient and successful knowledge transfer process. In each country there are universities with STEM and economics or business administration studies, research students and a high level of teaching and training. From the findings we also learn that in all the above countries there is a local and international industry. As previously indicated, industries have a strong interest in continuous relationship with universities. Thus, we can assume with high probability that they will be interested in innovative technologies for the benefit of their next generation products.

The main thing that can be identified as a missing element is the knowledge and experience of organizing these resources so that they will be translated into start-up companies. The "bridge" model is designed to enable almost every university to utilize its existing resources, while collaborating with other stakeholders by establishing a "local ecosystem". Its goal will be to utilize the University's resources in a way that will ensure a significant increase in the transformation of research products into producing companies for the benefit of the university, industry, government and humanity as a whole.

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8 THE BRIDGE MODEL

The following scheme presents the core elements of the Bridge Model:

Figure 6: The Bridge Model

The bridge model is intended to serve as a bridge over the Death Valley, to enable a more continuous and efficient passage of the knowledge generated in the academy to the industry. The proposed model can be applied to any university that produces valuable research products. This requires the establishment of an entrepreneurship center or an institute for innovative research that will serve as a platform for the entire process of knowledge transfer. This institute will be managed by a professional team and will be accompanied by an advisory board.

In order to promote the research and the results of the research, and as a result, to increase the University's income, this innovative Bridge Model is proposed. This model offers a solution to the continuity of research management, maximizing funding for the development stage, maximizing the utilization of sources of financing in the public and business sectors, improving the transfer of knowledge from academia to industry, training of entrepreneurs, empowering the academia and strengthening the national economy.

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The main objectives of the Institute are:

- Maximizing university revenues,
- Increasing the relationship between funding bodies and knowledge bodies,
- Maximizing the creation and commercialization of intellectual property in the short and long term,
- Significantly increasing the growth in R & D activity,
- Improving the University's reputation and image,
- Improving the quality of research and removing bureaucratic obstacles in its implementation,
- Establishment of start-up companies with external financing,
- Training entrepreneurs,
- Empowering the national economy.

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9 RECOMMENDATIONS

For further implementation of the model, we recommend to:

- Perform a pilot by implementing the model in the three Balkan countries,
- Choose one large university for the pilot in each country for the pilot,
- Review and identify the resources at their disposal,
- Quantitatively and qualitatively evaluate the resources available in each of the selected universities,
- Accompany and guide the Institute's establishing and management team,
- Provide the various tools for identifying and selecting natural entrepreneurs,
- Impart knowledge and skills to establish the study program for entrepreneurship,
- Accompany the first projects that will be established in the process until their maturity.

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