Entrepreneurial Impact: The Role of the Instituto Superior Técnico

André Jorge Dias Coelho
andre.j.d.coelho@tecnico.ulisboa.pt

Instituto Superior Técnico, Lisboa, Portugal

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Abstract

This thesis has a strong exploratory nature and is fuelled by the idea that future research could be built with these results as foundation. The question that is tried to answer in this dissertation is: "What influence had IST on its students who became entrepreneurs and how did their companies impact the economy?" To do that, it first researched the country's ecosystem and how it is evolving. Afterwards, the school's history and services were investigated to grasp the past and present entrepreneurial paradigms that students were and are living in. Furthermore, a survey was designed and disseminated to gather data to solve the question asked, by assessing and perceive both IST's impact on the alumni entrepreneurs and the 2020 Economic Impact of their companies. Several insights were inferred from the entrepreneurs and their companies working with what was obtained from the survey. Concluding, some ideas and recommendations were devised to boost the entrepreneurial mindset of the future professionals graduated by IST during their stay at the institution. A few recommendations are the reintroduction of curricular units on entrepreneurship in the Computer Science degree's curriculum, and the possibility of an incubator network associated with IST.

Keywords: Entrepreneurship, Innovation, Instituto Superior Técnico, Economic Impact, Alumni, Survey, Portugal

1. Introduction

1.1. Motivation

The topic of Entrepreneurship was both relevant and exciting to assess inside the university's context, and having the article from [7] to serve as guidance, it started to make even more sense. Ultimately, the value proposition of a university is to educate and form the future generation of professionals who will disrupt the markets and provide a better future for society. Entrepreneurship is a natural consequence of these highly-trained persons. The ambition to create their path towards an impactful life brings them to create their businesses.

However, there is not an extensive study on the entrepreneurial side of IST alumni. To better accommodate the institution's services towards forming these students with an entrepreneurial mindset, information about what was relevant in the past is crucial. The lack of a data-driven approach to this topic also led to creating a template that helps future projects assess the alumni's corporate economic impact throughout the next generations. If this study helps to achieve a slightly better picture of what path the university has to take and helps to create a generation of better entrepreneurs, it makes the time spent worth it.

1.2. State of the Art

This section's purpose is to introduce the reader to relevant concepts mentioned during this dissertation.

1.2.1 Entrepreneurship

In its essence, entrepreneurship is the term used to describe the act of creating a business. Starting a new operation entails several risks and strenuous efforts in order to be successful. Notwithstanding, the keyword is "act", as actions move entrepreneurship. Throughout the evolution of the concept, several "schools" of the concept were born. These "schools" could be grouped in six different approaches to the subject according to [2].

In its more abstract definition, an entrepreneur is a subject without whom the original idea would not be created. In this study, the simplest ramification of this approach will be chosen, i.e. the "Management" definition. A person who founded a company will be categorised as an entrepreneur. This choice derived from the fact that if one considers the more personal/intrinsic ones, those are more subjective, and that convolutes the creation of an assessment focused on entrepreneurship.

Regarding economic growth, innovation leads to

Categories	School of Entrepreneurship	Focus
Assessing Personal Qualities	"Great Person"	Innate ability
	Psychological Characteristics	Unique values
Recognising Opportunities	Classical	Creating innovation
Acting and Management	Management	Organise and Manage
	Leadership	Lead and Adapt
Reassessing and Adapting	Intrapreneurship	Inside innovation

Table 1: Summary of the schools of Entrepreneurship (Adapted from [2])

economic growth and its economical impact is proportional to the level of disruptiveness [8]. Translating the act of entrepreneurship into numbers is a difficult task, dividing the literature until today, but looking at the values obtained by [7], in a conservative estimation, if the entrepreneurs from MIT were considered as a nation, they would be positioned as the seventeenth economical power of the world.

1.2.2 Business Incubators and Acceleration Programmes

Business Incubators, or only "incubators", were one type of organisations that were born with the uptrend of the concept of entrepreneurship. These are organisations whose primary focus is helping in the process of developing a new business enterprise. They facilitate the translation of ideas into profitable ventures by providing mainly office space and consulting services. In addition, they also provide a great network of investors and logistic-focused companies. According to several studies, this last service is the most crucial aspect of a business incubator.

Recent reports have gathered some interesting insights about the effect of incubators on startups and universities (when university-based). In the case of university-based incubators, although they seem like a step towards helping the students successfully kickstart their entrepreneurial ventures, the effects on the school hinder in comparison [5].

Accelerators (short for "Business Acceleration Programmes") are also a recent business model. Their definition is still divergent amongst researchers due to their diverse areas of impact. However, in short, accelerators offer a more serious environment for the growth of companies, focus on small teams of founders (and not individually) and provide pre-seed investment in exchange for equity.

1.3. An Entrepreneurial University

Summarising this topic would be to write that an entrepreneurial university is an HEI in which entrepreneurship is encouraged, the mindset and the skills are provided throughout the education of the students. Services are available to help kick-start, and initiatives are ready to guide the entrepreneurs into a successful venture [4]. This synopsis would be a correct assessment, but it would also be a disservice to not mention the shift in mindset that occurred worldwide in which academia started to accept that entrepreneurship could be learned [6]. Over the years, the concept of entrepreneurial university mutated several times, and [10] arrived at a set of important characteristics, adapted and resumed in the scheme in (Fig. 1).

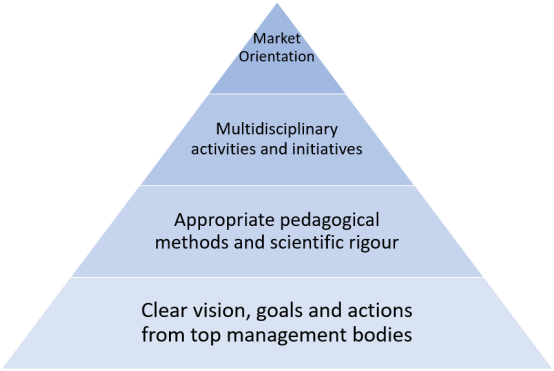

Figure 1: Characteristics of an Entrepreneurial HEI (Adapted from [3])

1.3.1 Curricular Entrepreneurship

As it was mentioned, the topic of entrepreneurship in education is In Europe, education on entrepreneurship is a very recent topic when compared with other more well-known subjects. However, when the Atlantic is crossed, it is remarkable to understand that the issue of creating and managing new businesses remounts back to 1947, when the course "Management of New Enterprises" was established in the MBA taught at Harvard Business School. After that implementation, several study programmes and books were created throughout the USA [9]. By the year 2000, more than 700 different programmes were being offered in the United States.

This development in Europe was not evident at such a large scale, as the different societies approached the topic with a cultural bias inherent in the various regions.

In the present days, entrepreneurial education is present everywhere, from business schools and engineering universities to private academies and online courses. Some studies from different countries conclude that people who had an academic background in entrepreneurship are more inclined to devise a business venture in the future, generate higher revenues, employ a more significant number of people, and extensively contribute to overall economic growth [1].

1.4. The Portuguese Landscape

Even though this project is leaning over the impact of IST on the economy through its alumni, it is important to reflect on the general state of the country. This studious exercise is relevant to comprehend the climate alumni faced when they finished their degrees.

Traditionally, Portuguese entrepreneurship has evolved from the necessity of the population to earn money to support themselves. This situation made the entrepreneurs of the past, people without higher education and limited them to markets like textiles, cork and footwear. However, recently, these Portuguese markets found a technological boom and now are at the top of their technological paradigm.

Nevertheless, Portugal has been focusing many resources on E&I policies, activities and services for many years and it grew to be considered an ecosystem still in its development phase, but already appealing.

In 2008, the great global recession occurred and profoundly affected the country (and the world). Not long after, the Portuguese economic crisis of 2011 through 2014 also brought down numerous companies. The unemployment rate increased significantly, mainly due to the overall job destruction. Moreover, the number of jobs with the minimum wage increased and the constraints in contracting credit imposed a taller barrier to reinsert people in the market.

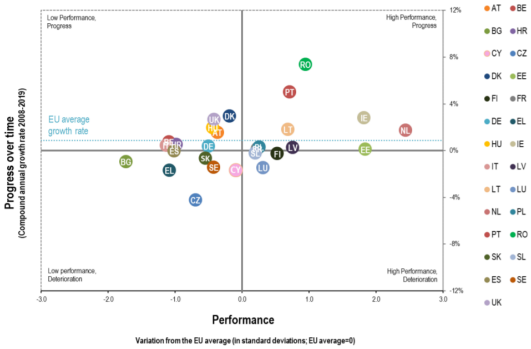

Figure 2: Positioning of each EU-28 Member State in terms of their performance and progress over time for entrepreneurship (2008-2019) (Source: European Commission)

Notwithstanding, since then, the country has seen an above-average growth (Fig. 2) in the entrepreneurial chapter compared to other EU member states. Moreover, one of Portugal's initiatives towards entrepreneurship, "Capitalise 2018", was one of the highlighted proposals by the report due to its innovation and possible positive impact.

1.4.1 Entrepreneurial Education

Nowadays, there is an immense offer of entrepreneurial education in Portugal. There is a clear mindset of providing everything an entrepreneur needs to prepare its ideas for the market. Almost every university has available curricular units on entrepreneurship, TTOs, complete degrees on the topic have emerged in business and engineering schools, and academies that provide extra-curricular training were established in the country. These core changes in society have brought enormous pressure in the education for entrepreneurship to be successful. As mentioned in section 1.3.1, it is studied that, with the correct innovation on education, a clear positive response will generate an innovative and prosperous society.

1.4.2 Incubators and Accelerators

In Portugal, the number of incubators has grown significantly in the past years. From the year 2002, when they were only 23, the number grew to 72 in 2014. In 2020, there were counted around 100 certified incubators. Regarding accelerators in Portugal, some of the incubators also provide the service of an accelerator. However, the more established accelerators are: Energia de Portugal, Lisbon Challenge, Building Global Innovators, Founder Institute, Startup Braga Accelerator, IEUA Play, UPTEC Accelerator, inRes - Entrepreneurship in Residence, Indico Capital Accelerator Programme.

1.4.3 Investment in R&D

Fig. 3 presents data collected from DGEEC's reports on the investment made in R&D.

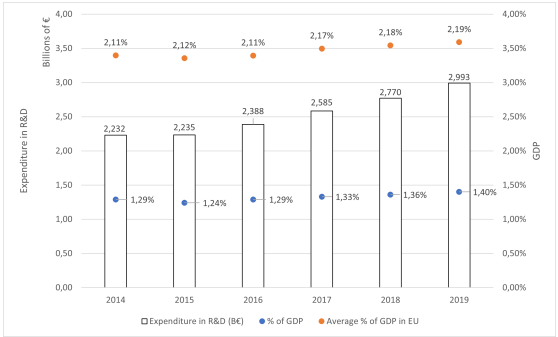

Figure 3: Expenditure in R&D vs Europe (Source: DGEEC)

In this graph, it is possible to observe a trend for a positive growth in investment that accompanies Europe's. However, the percentage of the GDP is still, on average, 0.83% below. The main precursors of this value are the Scandinavian countries accompanied by Germany and Austria. These values go in accordance with economic power these countries

possess, and how focused they are on technology-based ventures, being some of the more industrialised nations in Europe. In terms of investment in R&D, Portugal clearly isn't on the same level. The most significant chunks of these 1.4% of the GDP are almost evenly distributed across corporations and HEI (around 93%). Companies have been getting a larger percentage lately (in 2019, 52.5% in companies vs 40.5% in higher education) and it is relevant to point out that most of this investment is spent on personnel (55% on average).

2. IST and the creation of an Entrepreneurial Mindset

IST was founded 110 years ago, and since then, engineers from all fields have been educated to create and improve society's way of living and the world as we see it.

2.1. From the Foundation to an Established Institute

The historical and political environment before the foundation of IST is outside the scope of this study. Therefore, the thesis starts with its foundation. Alfredo Bensaude was appointed by Brito Camacho, a minister in the First Republic's provisional government, to be the first dean of IST. Alfredo was very keen on creating a school of excellence from the beginning by fomenting a "school spirit" and an innovation mindset. The degrees were six years long, divided into two segments of three years each. The first was focused on basic engineering concepts, while the second regarded five different fields of studies available (Civil, Electrical, Industrial Chemistry, Mechanical and Mining Engineering).

Until then, the political and economic elite of the monarchy was not centred around the industry (according to the census created in 1900, 79% of the population was illiterate, and only 1% was working in an industrial environment), placing Portugal in the very back regarding education and innovation in Europe.

This paradigm led the first graduates of IST to become instrumental in rearranging the industry and seeking innovation by establishing numerous new companies. From the first 80 graduates, 12 founded their own company, and three became factory directors immediately.

In 1927, Bensaude stepped down and Duarte Pacheco, former IST student, takes charge as director. During his mandate, with three other institutes and already 20 years of history, IST is integrated to constitute the Universidade Técnica de Lisboa. Under his mandate, the Alameda campus is also built, and notorious other feats of engineering were made.

In the 1980s, IST was already an established Institute and another profound internal restructuring occurred due to the Complexo Disciplinar and the inherent creation of autonomous research groups. The university faculty's statutes were published for the first time, and there was a push to integrate IST into society by creating partnerships with various institutions and companies.

The start of the last decade of the XX century marked the introduction of new courses and post-graduate degrees. In 1994, IST's north and south towers were inaugurated, creating the conditions to boost the number of students to 8000 in that decade. The last two significant additions to IST's installations were the Taguspark, in 2000; and Tecnológico e Nuclear campi, in 2013. Taguspark aims to connect the university and its students to the industrial polo present in the area. At the same time, the Nuclear campus objectives revolve around advanced and specialised scientific and technological research, mainly in radiological protection and nuclear safety.

Nowadays, IST counts with over 10000 students distributed by these three campi.

2.2. Introduction of Education on Entrepreneurship

In IST, the first curricular units focused on technology-based Entrepreneurship started to be taught with the profound restructuring that occurred in 2006, with the implementation of the European Higher Education Area defined by the Bologna Process. One of the key points in implementing the Bologna Process that favoured the introduction of the entrepreneurship courses was the one that mentioned acquiring broad skills. The result was the introduction of courses on TBE or EITT. Nowadays, there are six Master-level courses (outside of the MEGIE) and three PhD-level ones available. Some concerning issues could be raised from the data made available by IST. The first topic relevant to be discussed is how inconsistent the entrepreneurship courses have been. This concern could be the result of an undecided IST management body, could stem from the number of registrations in those courses or even the availability of faculty to host them. Also, it is essential to refer that some degrees lost the entirety of their registrations in this kind of curricular units, namely MEE, MEIC(-A & -T) and METI.

Disregarding these observations, there has been a steady climb in students enrolled and interested in entrepreneurship from 2011/2012 until 2017/2018. From that academic year on, the number stagnated just below 500 enrolments. The degree that contributed the most is MEEC due to the compulsory nature of their course and the overall number of students accepted per year.

In a more recent paradigm, IST introduced the MEGIE, to accomodate students that wanted to follow an entrepreneurial masters program and in 2021, it will restructure it's entire education structure.

2.3. Services to promote Entrepreneurship

2.3.1 Technology Transfer Office

The TTO was established in 2009 to fill the existent gap of connecting the school with society. The implementation of this office stems from an initiative started in 2007 called UTEN. UTEN was a programme created by the Portuguese government in partnership with the IC2 Institute of the University of Austin. Its mission was to gradually build a professional, highly competitive and sustainable network of TTOs. IST's TTO is the contact point with the entrepreneurial and corporate world and helps the Executive Board of IST by contracting, protecting, managing and exploring IST's intellectual property.

Traditionally, an office dedicated to technology transfer revolves around IP protection and IP licensing. However, it was decided that the approach to this office would be different. The office tackles a wider variety to be more thorough and to aim to address every need. The overall scope of the office includes the NPE, the NPI, TAN and the Entrepreneurship & Innovation Working Group (E&I).

3. Methodology of Data Acquisition

3.1. Target Population

The rules below will bring the total impact of the companies down and skew the data to have more recently created businesses (and create an estimation by default), but they are necessary due to the means of dissemination detailed below (section 3.2).

3.1.1 Type of Education

This study focuses only on IST alumni that started and finished a cycle of studies (either the first cycle, Bachelor's Degree; the second cycle, Master's Degree; or the third cycle, PhD).

If a person did not complete one of these educational marks, it would not be considered in the study.

3.1.2 State of the Company

The list of rules regarding the state of the company is the following:

If a company, for any reason, was closed until the end of 2020, that business did not enter the study.

The company has to be born after the founder completed a study's cycle.

If a company was acquired or merged during its lifetime, it will not be considered.

If a company was founded after October 2020, it was not considered due to its short time in the market.

If a company did not present any economical value, the rationality was that the founder did not want to disclose important information and therefore it was unconsidered.

3.1.3 State of the Founder

The rules regarding the founder itself are: The person who has founded the enterprise must be alive.

The founder, too, must still be working for the company/companies that have started.

3.2. Dissemination

Regarding the dissemination of the form, the peculiar nature of the study and its target population made it challenging to find a customary way to obtain responses. Three options were considered: Through the Alumni Network of TTO, through the OEIST, through LinkedIn.

It was understood that the third option (LinkedIn) was the more favourable to reach better results.

3.3. Survey Structure

Personal: Age, Gender, Degree, Year of the conclusion of the degree.

Entrepreneurial Profile: Have you created a company? If yes, how many?

How many of them are active?

Company Loop: Year the company was born?

Support/Funding: Did the company get any support? If yes, from whom?

Activity: Main Area of Activity?

The Service/Product's base of knowledge?

Principal Market? If it worked with foreign markets, which?

Economic Impact: Number of employees, Revenues in 2020? (EUR), Imports in 2020? (EUR), Exports in 2020? (EUR)

(Loop if there are companies unmentioned)

IST Influence: Did you register in a curricular unit of Entrepreneurship during your academic life? If yes, what was its impact?

Did you participate in any of these events or services provided by IST?

How do you measure the impact of IST in the creation of your company?

Lastly, it was asked for feedback on the survey.

3.4. Liabilities

The liabilities considered are: inaccurate educational background on LinkedIn; false professional background; incorrect input of the values in the survey and unwillingness to respond to the section related to the company's numbers.

4. Results of the Survey

This chapter will approach both the pre-processing of the data acquired via the survey and insights obtained.

Regarding the insights, the three focus points attributed in the previous chapter will be mentioned, namely: a description of the founder, the economic impact of the companies founded by IST alumni and the overall impact of IST in the establishment of said companies.

4.1. Dissemination Results

Throughout the time allocated for disseminating the inquiry, 513 persons were contacted via LinkedIn through the connection request. From those, 221 accepted the invite and 96 responses were registered. This ratio means that 43.4% of the people that accepted the invite filled the form. Moreover, a total of 19.1% of the request population that was contacted filled the form.

Therefore, with the amount of data gathered, it is believed that the following results may not truly represent the reality of the impact caused by the IST entrepreneurs.

4.1.1 Companies Considered

The number of companies considered in this study is summarised in Fig. 4.

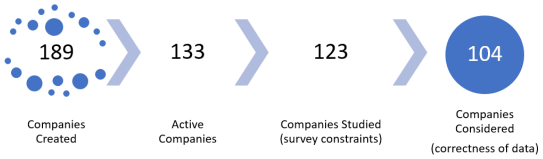

Figure 4: Pre-Processing of Companies

4.1.2 IST's Impact

Regarding the answers to the question assessing if the founder had registered himself in a curricular unit on entrepreneurship, 20% of the answers were positive. However, knowing that the average year of the degrees' conclusion is 2003 and taking out all the answers from before 2006 (adoption of the Bologna Process), the percentage only grows to 23%. The expected number would be closer to 50%. The disparity encountered indicates that people that concluded the course before the restructure of 2006 had classes on Entrepreneurship. These answers could indicate that the question was dubious (they could have had courses outside IST on Entrepreneurship), or regular project-oriented courses that touched slightly on the topic of entrepreneurship were considered); or IST provided courses on Entrepreneurship before the restructure (going against the research made).

In a quantitative perspective, the entrepreneurs that filled the form did not consider too significant both the curricular units on entrepreneurship they frequented and IST's impact on the foundation of their company. The overall impact was just below average and the entrepreneurship course had an average importance. These outcomes show that even though IST has made several integral changes to their structure, the effect on the students is not proportional. Still, on the topic of IST's impact on the entrepreneurs, regarding the services and activities

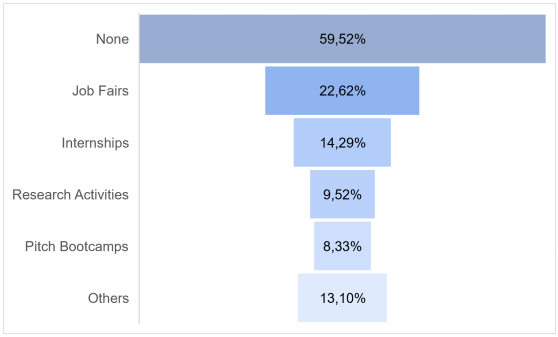

Figure 5: Participation in IST's services

provided, it is problematic for IST to understand that 60% of the founders inquired did not participate in any activity. Fig. 5 refers to the answers founders have given and it's important to reveal that the percentages of attendance for services focused on entrepreneurship are really scarce.

4.2. 2020 Economic Impact of companies founded by IST alumni

Firstly, from the data gathered, when everything is summed, it is possible to observe that the overall value of the volume of revenues is €248 million in 2020. The values for exports and imports were approximately €64 million and €5 million respectively. These results show that the companies founded by IST's alumni give a boost to the economy by bringing to Portugal money from different markets while importing significantly less. Despite that, compared to the overall state of revenues of companies mentioned in section 1.4, the relevancy of the revenue is minimal considering the national panorama. This comparison could be unjust as the population reached in this study is quite underrepresented.

4.2.1 Maturity

Separating the revenues by maturity, and knowing the average time for an alumnus/a to create a company is 12 years, it is interesting to see that revenues are not proportional to the maturity distribution (descending from the beginning of the professional careers). Companies where the founders had twelve to fifteen years in the market, are the most successful. This might come from the fact that these entrepreneurs worked in their markets for quite some time, and after analysing a necessity and having a seasoned perspective, they were able to translate their knowledge into a great product.

Maybe due to sheer numbers, the runner-ups were the younger entrepreneurs, who have started their companies in the first three years after graduating. This outcome could be result of the recent infrastructures present in IST and Portugal that facilitate the contact with entities that will help them reach more significant numbers. Concluding the analysis

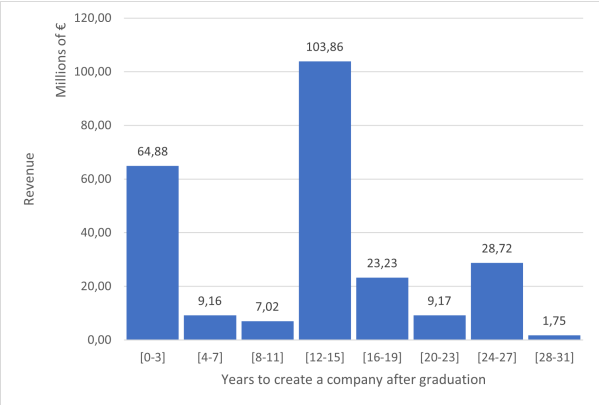

Figure 6: Revenue per Maturity of the Entrepreneur

on the figure, there does not seem to exist a trend on the other intervals. Notwithstanding, the entrepreneurs on the right side of the graph (16-31) present higher revenues (on average) than those between four and eleven years in the market.

4.2.2 Base of Knowledge

When it comes to how the company was formed, it is relevant to study what is behind the service/product of the said company and analyse it to understand what kind of revenue it brings. Observing Table 2, this table differentiates the revenue by the number of employees and the knowledge mentioned above. From this table, it is possible to infer that nearly 5% of the companies inquired made almost ten times the revenue of 66%, and have 61% of the total revenue. From the last row of the table, it is also perceptible that knowledge acquired in IST, when applied in the market, corresponds to the more significant piece of the pie with almost 48%. Non-Technological companies represent the biggest share, but one value that may put into perspective the sample size is that no company was categorised as non-technological and with 10-49 employees.

4.2.3 Markets

Three metrics were created ("Market Dominance", "Exports Dominance" and "Imports Dominance") to understand the contrast between the number of enterprises per market and the value obtained on those markets. These metrics evaluate the ratio between the value of a market and the total value of all markets.

The first and most glaring "error" in the results is the one that states that companies whose founders did not insert a foreign market ("No Foreign Market" row) have 2.37% of the "Exports Dominance". This incongruity indicates that they probably misfiled the form. Another mentionable fact is that Oceania has no Exports, which tells that the company is probably headquartered in that continent and works internally. Moreover, the monetary values of exports in the South and Central America are superior to the revenues. This issue is somehow paradoxal.

To better understand the two segments created, the following figures (Figs. 7 and 8) translate those into bar plots and illustrate the competition between markets. Concentrating first on the "Predominant markets", almost two-thirds of the companies inquired are more directed towards the Portuguese market, which is very important for the country. Despite that, when the revenues are considered, the natural consequence is that the businesses focusing on broader markets increase their revenues. The "Exports Dominance" metric of the companies whose focus is the foreign market also dominates the respective column completely. This value may be one of the causes for the almost even distribution of overall revenues.

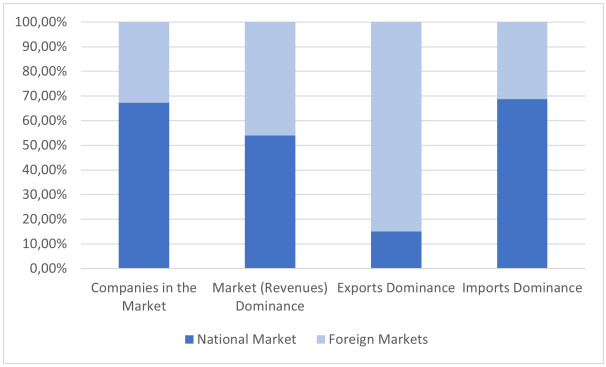

Figure 7: Predominant Market Illustration

When considering the "Imports Dominance", it seems that it is quite proportional to the number of enterprises. This figure, in general, translates what was expected from the enterprise ecosystem. However, it is essential to remember that the data acquired is a small subset of the total target population, and only active companies were considered.

Focusing now on the "Foreign Markets", it was necessary to assume that when the companies indicated that they have worked in more than two options, the values were proportionally divided by each option. Looking at the results, some are very interesting.

Disregarding the "No Foreign Market" anomaly in the exports, their numbers are proportional to the number of companies and revenues/market dominance. The European marketplace, on the contrary, shows a significant disparity in the number of businesses and revenues. Despite that, due to geographical proximity, they have the hegemony of the exports.

The Asian markets are astounding when considering the ratio of the number of companies and values obtained. With just close to 3% of the corporations,

Number of Employees	Companies (%)	No Technology (€1000s)	Outside Technological Knowledge (€1000s)	Acquired-in-IST Technology Knowledge (€1000s)	Total (€1000s)
1-9	66.35	7653.1	2862.0	5550.4	16065.4
10-49	20.19	0.0	19130.0	19880.0	39010.0
50-249	8.65	6000.0	3000.0	32800.0	41800.0
250+	4.81	71000.0	20000.0	60000.0	151000.0
Total	100.00	84653.1	44992.0	118230.4	247875.4

Table 2: Number of Employees vs Technology Base Companies (in Revenue)

this market possesses second place in revenues (one-fourth of the total revenues) and exports (41%, close to Europe's near 44%). These three market segments (fully National, European and Asian) dominated the overall assessment.

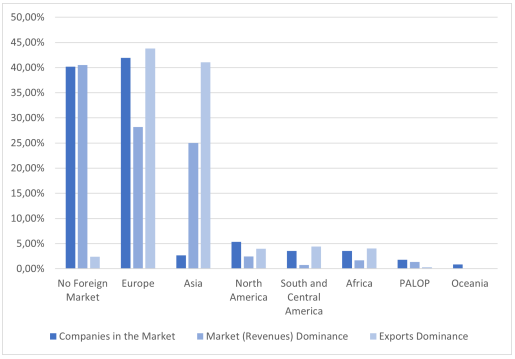

Figure 8: Foreign Markets Illustration

Now, zooming into the smaller markets, the American continent is the second more frequent choice for companies to focus and sell their products. This outcome, however, was expected to be higher and it is due to the small sample size. Companies like "Talkdesk" or "Anchorage", based in the USA, were unfortunately unreachable during the dissemination phase. Their numbers would probably be considered outliers in this study and would certainly boost the overall structure of the North American market. The South and Central American markets also show a pattern of having a considerable amount of enterprises, low revenues but great numbers in exports (disregarding the issue indicated above).

Finally, having already mentioned the Oceanic market, the African presents the same trend as the South and Central American market. Adding to African markets the values from PALOP, Africa obtains a noticeable share of the overall dominance.

4.2.4 Main Area of Activity

The information for the main area of activity of the enterprises present in this study is structured similarly to the one used in the "Markets" segment. Every sector is discriminated by their revenue, exports and imports.

When analysing this table, what comes first to mind is that, outside of the top four sectors, the rest lack dominance compared with their percentage of companies. This issue could come from their lack of time in the market. As it was seen in the previous topic, time in the market usually reflects in more revenue. Companies in the top four in revenues show an increase in number of companies before the other sector, with "IT Consulting" being the exception to the rule. So, time in the market is also important for this subject.

Analogous to what was done in the "Markets" section above, Fig. 9 illustrates the different dominance levels for each sector. Besides, it helps to visualise what are the activities that contribute the most to each metric.

Focusing now on the graph, "IT" is an activity that significantly contributes to the revenues and exports of the total dominance, above their percentage of companies, while committing less value to their imports. On the other hand, "Consulting" brings many revenues and focuses less on the foreign markets, having values below their companies percentage. "IT Consulting" could be defined as the more proportional, as the revenues and exports are somewhat similar dominance, but despite that, their share of the imports is relatively quite high.

Closing the top four of the companies' main activities is "Finance & Management", with the most substantial gap between their companies percentage and every dominance metric evaluated. This insight might indicate that IST graduates are profoundly proficient in Management and Monetary works and are very requested in this field.

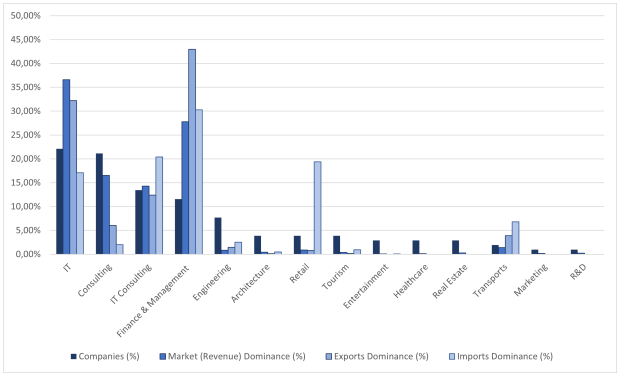

Figure 9: Main Area of Activity Illustration

When analysing the rest of the sectors, some conjectures could be created. Apart from the "Retail" field, being an outlier in the "Import Dominance" metric and the "Transports" sector, bearing some money in all of its dominance variables, the rest fall

Activities	Companies (%)	Revenue (€1000s)	Market (Revenue) Dominance (%)	Exports (€1000s)	Exports Dominance (%)	Imports (€1000s)	Imports Dominance (%)
IT	22.12	90704.5	36.59	20604.0	32.20	881.00	17.07
Consulting	21.15	40921.0	16.51	3852.0	6.02	104.00	2.02
IT Consulting	13.46	35365.4	14.27	7930.0	12.39	1053.00	20.41
Finance & Management	11.54	68800.0	27.76	27490.0	42.96	1563.00	30.29
Engineering	7.69	2040.0	0.82	920.0	1.44	130.00	2.52
Architecture	3.85	1115.0	0.45	75.0	0.12	25.00	0.48
Retail	3.85	2180.0	0.88	507.0	0.79	1000.00	19.38
Tourism	3.85	980.0	0.40	110.0	0.17	50.00	0.97
Entertainment	2.88	189.5	0.08	0.0	0.00	4.15	0.08
Healthcare	2.88	300.0	0.12	0.0	0.00	0.00	0.00
Real Estate	2.88	680.0	0.27	0.0	0.00	0.00	0.00
Transports	1.92	3500.0	1.41	2500.0	3.91	350.00	6.78
Marketing	0.96	500.0	0.20	0.0	0.00	0.00	0.00
R&D	0.96	600.0	0.24	0.0	0.00	0.00	0.00
Total	100.00	247875.4	100.00	63988.0	100.00	5160.15	100.00

Table 3: Main Area of Activity Summary

short of their company percentage and bring little to no value. These inferences could result from their more recent establishments, and it will be interesting to continue following the evolution of their impact.

5. Conclusions

When addressing the concept of entrepreneurial university (section 1.3), the story and efforts mentioned in section 2, it is factual that IST can be considered an HEI concentrated in entrepreneurship. It follows all the steps on the pyramid (Fig. 1) and has provided an apparent intention in bringing more entrepreneurship to its students with the introduction of the MEGIE and a new and more diverse curricular plan with the MEPP2122.

Regarding IST's impact on the alumni that filled the survey, the results were somewhat inconclusive and average at best. Its impact on the base knowledge of a company is important but, for the entrepreneurs, they feel like their post-graduate education was the most significant. Mostly in business administration, their post-graduate degrees fill the gap left by IST on the fundamental knowledge to constitute a company in comparison with the one obtained during their engineering, science or technology training.

6. Ideas and Recommendations

This section of the conclusions is reserved to provide some ideas that could improve the entrepreneurial mindset of IST's community. It also brings up some recommendations for external factors that may positively affect the ecosystem.

6.1. **Internal Factors**

6.1.1 University Incubator

The idea of a University-based incubator could come as a possible initiative to promote entrepreneurship to its students by luring them to an easier way to diminish the risk associated with their startup. However, as mentioned in section 1.4.2, the investment in the said incubator would take valuable resources from the TTO.

Even though IST already has partnerships that form 2 acceleration programmes, it could also benefit from the plethora of incubators available in Lisbon. So, what is proposed is for IST to study this possibility and, if plausible, reach the several incubators available near the institution. A new network of incubators could be created, similar to what already is happening with companies (TPN).

This way, IST would profit from the prestige and marketing potential of having a diversified incubator network and cut potential costs of having a fully functional one under its name. Furthermore, it would benefit from the inherent advantages of incubators by increasing the chances of successful businesses founded by its alumni network.

6.1.2 Inter-University Classes

From the feedback acquired through the survey, it was stated that one of the main difficulties in the creation of a company and its implicit growth management was the business side of every entrepreneurial venture. This issue created a need for an alumnus/a to enrol in an MBA to acquire specific management training or create a network of like-minded people with already acquired business knowledge.

The suggestion proposed next might bring some additional bureaucracy and logistic issues. IST already has a background in courses lectured in other schools. It would be interesting to explore new possibilities by having entrepreneurship courses with students from universities like ISEG or NOVA. Thus, the entrepreneurial projects developed in said classes would already have a more diversified founder base, with knowledge in business management and engineering. It could expose students to a new network of contacts (engineering students with business ones and vice versa) and prevent a lack of knowledge that usually provokes the end of a start-up.

This measure might be the most influential one in the mindset of the students in the author's perspective.

6.1.3 Focus on Entrepreneurial curricular units in Computer Science Degrees

Being Computer Science one of the degrees with more entrepreneurs, it is remarkable that the degree itself has not registered any students in entrepreneurial curricular units since 2015.

The inherent structure of the course implies the accumulation of several projects being developed over the years of the degree. Despite that, there is not (and will be in the MEPP2122) a course focused on creating a business out of those projects. With this in mind, it would be interesting to see what would be the effect of a course with that focus to enable a more business/entrepreneurial mindset in the students.

This counsel, nonetheless, does not have to stop with Computer Science Degrees. If innovation courses are disseminated among every degree, the probability of an entrepreneur being graduated may rise.

6.2. External Factors

6.2.1 Investment

Even though Portugal has been increasing its investment in R&D recently (following the growth of the ecosystem), primarily due to the increase of company-side investments, it is critical to push this trend to even higher numbers.

6.2.2 Bureaucracy

One of the more consequential concerns of the Portuguese entrepreneurs is the bureaucracy associated with creating a company. One of the branches is the taxes and how to comply with all the established rules. Croatia has created an initiative to combat the complexity of the tax reports requested of the SME. It could be interesting to discuss a possible adaptation to Portugal.

7. Future Work

For Future work, it will be important to: expand the scope to sociological or environmental impacts, include MEGIE and MEPP2122, improve dissemination and survey quality, include other universities and create a national benchmark of entrepreneurial impact oh HEI.

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