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Innovation challenges and benefits in high-tech start-ups: A quantitative analysis of university student entrepreneurs in Romania

Provocările și beneficiile inovării în afacerile noi înalt tehnologizate: analiză cantitativă în rândul studenților antreprenori din România

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Abstract

This article analyses the entrepreneurial students' attitudes towards innovations developed in high-tech industries, with the aim of identifying the benefits brought to the entrepreneurial ecosystem. It also identifies the main challenges that entrepreneurial students are faced with when developing innovations in high-tech start-ups. The empirical study used the quantitative methodology with the hypotheses tested with the independence tests for a sample of 98 students (n=98) from Romanian universities. The results confirm that students would start-up a new business in the activity fields connected to their studies whereas an association between their start-up idea and innovation in high-tech businesses was identified, with the need of proper managerial education. Hence, our findings demonstrate that there are variances between genders with regard to the challenges of implementing innovations in high-tech start-ups. They also show that the start-up ideas, according to their innovation type (application, platform or device with software), bring different benefits to entrepreneurs, within the three business fields they belong to: Earth problem-solving, business engineering and human and animal welfare. In this respect, our conclusions have significant implications for both the literature and practice of entrepreneurship.

Keywords: Business creation, innovation, high-tech industry, Romanian entrepreneurs, students.

Rezumat

Acest articol analizează atitudinile studenților antreprenori față de inovațiile dezvoltate în industriile înalt tehnologice, cu scopul de a identifica beneficiile aduse ecosistemului antreprenorial. De asemenea, lucrarea identifică principalele provocări cu care se confruntă studenții antreprenori atunci când dezvoltă inovații în afacerile noi din industriile înalt tehnologice. Studiul empiric a utilizat metodologia cantitativă, ipotezele fiind testate cu teste de independență pentru un eșantion de 98 de studenți (n=98) din universitățile din România. Rezultatele confirmă faptul că studenții ar înființa o nouă afacere în domeniile de activitate legate de studiile lor, fiind identificată o asociere între ideea de start-up și inovarea în afacerile din industriile înalt tehnologice și necesitatea unei educații manageriale adecvate. Prin urmare, rezultatele noastre demonstrează că există diferențe semnificative între genuri în ceea ce privește provocările implementării inovațiilor în start-up-urile înalt tehnologice. De asemenea, arată că ideile de afaceri noi, în funcție de tipul lor de inovație (aplicație, platformă sau dispozitiv cu software), aduc diferite beneficii antreprenorilor, în cadrul celor trei domenii de afaceri din care fac parte: soluționarea problemelor Pământului, ingineria afacerilor și bunăstarea oamenilor și animalelor. În acest sens, concluziile noastre au implicații semnificative din punct de vedere teoretic, dar și pentru dezvoltarea practicii în antreprenoriat.

Cuvinte cheie: Crearea afacerilor, inovație, industrie înalt tehnologizată, antreprenori români, studenți.

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Introduction

Business survival is linked to the process of innovation (Goffin & Mitchell, 2016). Over the years, technological innovation has attracted major interest from academia, business, industry, entrepreneurs and policy makers who have started to put their efforts with the aim of developing the entrepreneurial ecosystem at the level needed to integrate technological innovations.

Recent studies (Solaimani et al., 2019) have led researchers to reconsider the main drivers of innovation, showing that managing innovation requires a wide variety of qualities and capabilities surpassing Research and Development expenditure, while the size of R&D investment would not be the only determinant for creating value with innovation (Cooper & Edgett, 2008). For this reason, research carried on innovation do not focus anymore exclusively on the technological aspects of innovation; managerial innovation has been attracting considerable academic interest (Nieves, 2016; Omri, 2020) as well. The introduction of new management practices (like Agile frameworks for project management, LEAN manufacturing methodologies, Blue Ocean strategic approach or methods of design thinking) helps entrepreneurs both to improve performance and to develop technological innovation capabilities (Camisón & Villar-López, 2014). Such trends have led to the start-up and rapid growth in number and size of medium-high and high-tech businesses, whose definition relies on their continuous engagement in scientific research and successful commercialization of their technological innovation achievements domain (Jian & Hongxia, 2023).

Several scholars have already demonstrated the positive effects of innovation on business performance and competitiveness, underlining how important innovation is in promoting a sustainable society (Bekhet and Abdul Latif, 2018; Omri, 2020). Despite this strong attention given to innovation in meeting sustainability goals, there are some gaps in the existing literature. Lately, researching innovation outside the technological domain has become a real need (Damanpour & Aravind, 2012; Damanpour, 2014). However, new research focusing on the challenges of managing innovation from the very moment of business creation is underdeveloped. Controversely, there is a lack of data on the entrepreneurial approaches to innovation management with regard to the developing countries and emerging economies like Romania. By using innovation management as a theoretical framework, this paper examines entrepreneurial students' attitudes to implementing innovations in new high tech businesses. University students are the youth of any country and its future (Singh & Alwaqaa, 2023) and their role as subjects of research is crucial for sketching national and regional programs. It also underlines the challenges to overcome and the benefits foreseen with the help of quantitative data. The authors have formulated the following general research objectives, driven by the identified need to deal with the topic formulated in the title:

(O1) Analysing entrepreneurial students' attitudes towards innovations in high-tech industries and development within innovative start-ups;
(O2) Identifying the entrepreneurial students' approach about the challenges they might be faced with when managing innovation in high-tech start-ups;
(O3) Evaluating the main benefits of innovation within high-tech start-ups;

The significance of the results resides in the fact that students perceive differently the challenges of the new businesses in high-tech fields: men and women are alike willing to take up innovations in start-ups, but they behave differently, women being more risk-aware, when concerned with legal issues and standards, talent development and retention, and organisational culture. Hence, the entrepreneurial path of Romanian students seems to be very academic centred: they would start up a business in the fields they study, not looking for business opportunities, meeting their passions and hobbies, or finding other motivations.

In this respect, according to the herein before mentioned objectives, the paper presents the five sections rigorously connected one to another: the background of the topic is given in the introduction; the literature review, split into two sub-sections, follows and lays the bases of the study on the challenges met by student entrepreneurs in high-tech industries; next, the research method, hypotheses and the statistical analysis of results are presented in detail. The outcomes of the study are discussed in relation to the previous research. In the end, conclusions are highlighted as well as the future impact of the paper in terms of theoretical and managerial approaches within the Romanian entrepreneurial ecosystem.

Theoretical Framework

Innovation within the context of technological entrepreneurship in emerging countries

Technological entrepreneurship refers to the ability of the entrepreneur to apply and manage technological innovations so as to develop new products and services or improve processes as well as to enter new markets (Kuratko, 2005). Thus, the entrepreneurial vision is focused on economic growth based on innovation, which finds itself at the crossroads between exploiting opportunities in technology and meeting customers' needs and developing markets.

As entrepreneurs step into the realm of technology-based entrepreneurship, they realize that innovation is a way to thrive within the technological landscape, a dynamic and competitive environment. In our view, technological innovation is of two types: product/service innovation or process innovation (management and marketing). Product innovation refers to the introduction to the market of a new good or service or of an improved version of an existing good or service, differing from the firm's or the competitors' previous goods or services; process innovation means the introduction of new or significantly improved methods of production, distribution, delivery or logistics systems within the enterprise (OECD, 2005). Hence, innovating a business process implies a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been introduced into use within the firm (OECD, 2018). Product and process innovations, also encompassed and known as technological innovations (OECD, 2005), are considered to be the core element of firm competitiveness (Walker et al., 2015).

Most previous research has analysed the relationship between technological innovation and the economic performance of companies (a major benefit for developing innovation in a start-up), considering innovation as a mainly technology-based phenomenon (Armbruster et al., 2008; Battisti & Stoneman, 2010; Evangelista & Vezzani, 2010; Damanpour, 2014), emphasizing aspects such as intellectual property (Fischer et al, 2020), openness to innovation (Chen & Liu, 2018), innovation ecosystems (Bandera & Thomas, 2018) and R&D (Ferraris et al., 2019). This makes us conclude that technological innovation has always preserved its role as an essential tool for achieving sustainable development. Some authors have shown that the three pillars of sustainable development (economic, socioeconomic and environmental) rely on technological innovations, but mainly in rich countries. In middle-income countries, it negatively influences the economic and environmental dimensions to some extent whereas it has no impact in low-income countries (Omri, 2020). Hence, our research helps understand better the entrepreneurial environment to develop innovation in countries like Romania, an upper-middle-income country.

As one of the fastest-growing economies in Europe, Romania has attracted international investors and multinationals, especially in the IT sector. The growth of digitization, artificial intelligence (AI) and software development combined with the fact that the Romanian economy benefits from a relatively low cost of labor compared to Western Europe (Cristescu et al., 2024), makes Romania an attractive location for high-tech startups. The government has implemented policies to support innovation (Spitzer, 2020), such as tax incentives for research and development (R&D) activities, as well as special programs to encourage the creation of technology startups. Moreover, the innovative capability of businesses started being measured, defined as a company's ability to develop new products and/or markets by aligning strategic orientation with innovative behaviours and processes (Guan & Ma, 2003; Wang & Ahmed, 2004; Wang & Ahmed, 2007). Ramanathan et al. (2018) measured the innovativeness/innovative capability of firms by analysing the impact of newly developed products and processes on financial performance.

In Romania, this context presents vast opportunities for technology entrepreneurs. The presence of technology hubs in cities such as Bucharest and Cluj-Napoca allowed local startups to attract global investors', potential customers' and partners' attention. Romania has a strong pool of technical talent, the universities having a very large number of engineering and IT students. Romanian young entrepreneurs are often described as resourceful, adaptable, and capable of overcoming significant obstacles (Ion et al., 2023). Universities' efforts to support innovation and digitization, in parallel with the creation of business pre-acceleration programs, have made technology entrepreneurship among students increasingly promising, and within the entrepreneurial ecosystem, university-based startups are on the rise.

Student entrepreneurship amid the Romanian innovative business ecosystem

Entrepreneurial students are agents of change, able to identify opportunities where others cannot see them (Cruzata-Martínez et al., 2021). Technological entrepreneurship comes with a series of challenges which new entrants in the world of entrepreneurship, irrespective of how much risk takers they are, may face with. First, there is innovation itself driven by the entrepreneurs' desire and motivation to innovate. Technological development tries to disrupt traditional industries, helps emerge new technologies and implements advanced products and services to transform the society. Recent literature approaches technological innovation capabilities through new dimensions such as human resource management, innovation culture, organizational learning and entrepreneurship (Zhu & Cheung, 2017). In our view, these are pillars for growing start-ups in high tech industries and lay the basis of the research objectives herein before mentioned.

Secondly, there is the belonging to the business ecosystem which may facilitate or create opportunities to new entrants by providing access to resources (including capital), investors, (interdisciplinary) knowledge, cooperators, markets and by creating the proper strategies to cope with possible barriers. Some papers underline organizational innovation which refers to the elements of innovation used in administrative and managerial processes, within the advance or implementation of cutting-edge technologies, development of new products and processes, and continuous creative pursuit to meet customer needs (Soto-Acosta et al., 2016; Prange & Pinho, 2017).

Thirdly, technological entrepreneurs meet world objectives such as digitalization, globalization and sustainability which will contribute to the reduction of the processes of differentiation of the development of regional economic systems (Lukianova et al., 2022), addressing societal challenges, ethical issues and supporting the development of smart environments. Hence, there is a need to undertake research on student entrepreneurs to understand their innovative thinking and to analyse their role as technological entrepreneurs. In a dynamic technological environment, where change is continuously occurring, startups made by students play an increasingly important role in driving innovation. They are fuelling technological advances, redefining traditional business paradigms, as speciality literature stated, disrupting traditional industries and shaping the future of businesses (Ahmad et al., 2024). Amid their transformative path, there are modern innovation management methods as the Agile ones, which have become a complex but indispensable facet that distinguishes successful high-tech startups from the rest (Onwu, 2021; Crnogaj & Rus, 2023, Khuan et al., 2023). In the context of technologic start-ups, innovation is not simply about the development of innovative products or services, but it also involves the dynamic interplay of organizational culture in order to survive in a highly competitive market, and thrive amidst uncertainty (Gao & McDonald, 2022; Daymond et al., 2023, Moșteanu, 2023). In high-tech start-ups, an innovative culture influences everything from problem-solving approaches, like for example design thinking, to product/service development and to market scalability.

Moreover, in emerging countries, featuring high growth potential and willingness to solve societal issues, entrepreneurial students are the needed players for developing and implementing innovation and starting-up new businesses. Fields like fintech, agritech, healthtech, edtech and cleantech are dynamic and bring many opportunities in emerging countries, so they are appealing to new entrepreneurs, of which students make an important sub-category. Students are implied in solving community challenges and they benefit from the outcomes that technological entrepreneurship brings to societies like Romania, as the creation of jobs, the acceleration of economic growth and the absorption of tech-based innovations. On the other hand, students may face major challenges such as: lack of infrastructure and capital, reluctance to uncertain markets and technological solutions, restrictions given the unclearly defined and restrictive regulations and unpredictable tax regulations, shortage of talent and specialized skills to develop teams and deficiency of managerial skills to scale up the business. But, with government support and global investors' consideration, innovation and entrepreneurship are fostered and the business ecosystem is blossoming, making emerging countries like Romania with 33.4 as Global Innovation Index (WIPO, 2024), number 48 in the world rank, a ground for fruitful partnerships, talent pools, accelerator hubs and funding networking.

Under such circumstances, this research focuses on university students to investigate the challenges and benefits perceived when becoming an entrepreneur in the high technology fields in Romania. The topic is significant as it highlights major trends in Romanian entrepreneurship, outlining the benefits of innovation in high-tech start-ups which may be analysed for other countries too, by simply replicating the instrument of research. Furthermore, apart from the theoretical relevance herein above mentioned, the study is

important for socio-economic reasons: skill development in entrepreneurship adds value to the human resources trained by universities which, based on real data, can design better study programs, support innovation within incubators and dynamically increase the entrepreneurial talent. Innovation is generated by organisations, including universities, within organisational processes and practices with the help of product development projects (Hansen et al., 2000; Schulze & Hoegl, 2006), public hackathons (Almirall et al., 2014; Irani, 2015), or collaborative programs between industry and science (Fontana et al., 2006; Perkmann et al., 2013); sufficient diversity generates novelty while fostering communication between domains to enable implementation (Caccamo et al., 2023). To conclude, in Romania, universities are major drivers of both innovation and entrepreneurship.

Methodology

This quantitative study is a piece of empiric research focused on assessing the challenges of innovation for students matriculated with Romanian universities who intend to start up a high-tech business. Given its scope, the quantitative research methodology gives the possibility to identify the intensity of student entrepreneurship as well as its upward or downward tendencies (Bienkowska & Sikorski, 2024). According to the general objectives hereinbefore expressed, the following hypotheses were formulated:

H1. There is significant association between study programme and business fields challenging for starting up a high-tech business.
H2. There is significant association between start-up idea and innovation in high-tech businesses.
H3. There are significant differences between genders with regard to the challenges of implementing innovations in high-tech start-ups.
H4. There is a significant association between the business field and the managerial methods and instruments to be used by high tech start-ups.
H5. There is significant association between the business fields and the benefits brought to start-ups by innovation.

The researched population consists of students matriculated with Romanian universities at all the three levels of study: Bachelor, Master, and PhD and post-doc interested in becoming a tech entrepreneur. Their number is impossible to calculate or estimate, so we will include all the university students, which counted 15.51% of the total population matriculated in the Romanian educational system in 2022. Table 1 presents the descriptive statistics of the studied population in the last 5 years, which has slightly started to decrease in 2021 and continued this trend in 2022.

Table 1.
Descriptive statistics of the studied population

Total number of students matriculated in Romania	**2018**	**2019**	**2020**	**2021**	**2022**
At all levels of education	3,547,301	3,526,189	3,494,604	3,495,791	3,472,784
In universities, of which	533,749	543,299	560,490	554,007	538,720
Female	290,865	296,622	308,222	307,677	298,137
Male	242,884	246,677	252,268	246,330	240,583

Source: School Population, 2024

For collecting the primary data, we designed an online questionnaire. It comprised two parts: one collecting the demographic data of the respondents (gender, age, residence and programme of study) and one centred on entrepreneurial students' attitudes and opinions about innovation in high-tech start-ups, the challenges and the benefits. The latter consisted of 8 directed questions, 2 semi-directed questions and 1 open question.

The questionnaire was spread during the 2024 edition of one of the most important national hackathons organized for students by Romanian universities. A national tech hackathon offers the students the necessary opportunity to provide business ideas whereas implementing technology. Apart from the drive that a national hackathon gives to the entrepreneurial ecosystem, it offers researchers the possibility to identify the health of the environment created by entrepreneurial students, insight in the national and local actors' interest. Thus, we used non-probability sampling based on convenience and availability. Because the participants were included at researchers' will, our sample was a controlled one which generated a mini-

sample of the population. Although considered non-representative of the general population, recent research seems to give it more importance for various fields, as for example health (Turban et al., 2023).

Results and Discussion

The participation in the study was not mandatory for the students partaking to the hackathon. But those who agreed to answer the online questionnaire gave their written informed consent to the researchers who were present at the hackathon. We obtained 98 reliable answers (n=98) which were analysed by using IBM SPPS. We performed the chi-square goodness-of-fit test to check the sample reliability (no data entry errors were identified) as we had assumed there was no preference of entrepreneurship between genders. As $\chi 2(1)=36.735$ and $p=0.000$, the statistically significant association showed that, due to their presence at an entrepreneurship event and availability to take part in the study, student men would start up a business in high-tech businesses more than student women would.

The characteristics of our sample (n=98) are:

- In terms of gender, 19.4% of respondents were female and 80.6% were male;
- In terms of age, all of them were below 29 years old (young, according to the European Union's policies and programmes);
- In terms of residence, 16.3% of respondents live in rural areas and 83.7% in urban areas;
- In terms of field of study, 49.0% of respondents were studying computer literacy (information technology, computer science and applied computer science), 30.6% were studying engineering whereas 20.4% other fields of study (economic sciences, medicine, sociology and psychology).

Regarding the business ideas, the respondents presented within the questionnaire medium-tech and high-tech solutions responding to: business and public institutions' needs only (32.7%), population's needs only (48.0%) and physical and legal persons alike (19.3%). Due to the various number of high-tech and medium-tech fields, the business ideas belonged to the following three economic sectors: 25.5% Earth problem-solving (sustainability, smart mobility, agriculture, smart city, green tech), 36.7% business engineering (administration, manufacturing tech, IoT innovations, cybersecurity solutions, logistics, fin tech services, e-commerce, data analysis, digital marketing) and 37.8% human and animal welfare (health care tech, lifestyle and ed tech). In order to classify the business ideas of the sample according to the medium-tech and high-tech economic activities they belong to, we used the taxonomy proposed by EUROSTAT based on NACE Rev 2 and presented in Table 2 below.

Table 2.
Presentation of high-tech industries and high-tech services

Tech degree/Sector	High-tech industry	High-tech knowledge-intensive services (KIS)
High-tech economic activities	Manufacture of basic pharmaceutical products and pharmaceutical preparations	motion picture, video and television programme production, sound recording and music publish activities
		programming and broadcasting activities
		telecommunications
	Manufacture of computer, electronic and optical products	computer programming, consultancy and related activities
		information service activities
		scientific research and development

Source: Eurostat Statistics Explained, Glossary: High-tech classification of manufacturing industries.

Moreover, 14.3% of the business ideas presented during the hackathon were devices with their corresponding applications (high-tech industry), 28.6% were platforms and 57.1% were applications (high-tech knowledge-intensive services). In the total business ideas, 44.9% changed a product or service whereas 36.7% aimed at bringing out new products and services. Only 18.4% were focused on processes, particularly on innovating a new method to reach potential customers.

For testing the first two hypotheses, we used crosstabulation to analyse the frequency of responses between 2 categorical variables on nominal scale and Pearson's chi-square test for independence. For test reliability, there should be no data entry errors, at least 80% of cells should have expected count less than 5 and the significance level should be less than 5%.

H1 is supported with $\chi2(4) = 26.343$, $p=0.000$, underlining the importance that students give to the correlation of a start-up to their education. Motivation is important and having expertise in the field helps the entrepreneur to scale up the business with lower effort and less resources (time, logistical, human and financial).

H2 is supported with $\chi2(4) = 15.962$, $p=0.003$ showing that innovation plays a central role in starting up new businesses in high-tech industries. But students are focused on the product and service itself and not on the processes implied in marketing them or on the management of the business. Innovation of new managerial methods for the business was taken into account by none of the respondents. Moreover, innovation of new methods to approach future customers got 18.4% (absolute frequencies) of total responses, having been given importance only related to intangible intellectual products like applications and platforms.

For testing H3, we analysed the responses to the 3rd question of the survey with the frequency table created according to the multiple responses given by respondents. The six responses received in total 198 answers, the most important being limited financial resources (29.80%), (rapid/accelerated) changing technologies (19.70%) and regulations/standards (15.66%) expressed as relative frequencies. Figure 1 shows the differences between genders with regard to the challenges they perceived in implementing innovations. We observe that student women well-thought-out every of the six challenges; notable differences between genders are recorded when thinking about regulations/standards, talent development and retention and rigid organisational culture. Little differences between the two sub-samples are registered at aggressive/high competition, (rapid/accelerated) changing technologies and limited financial resources, highlighting that both genders considered that their innovative ideas could be put at risk by the three challenges.

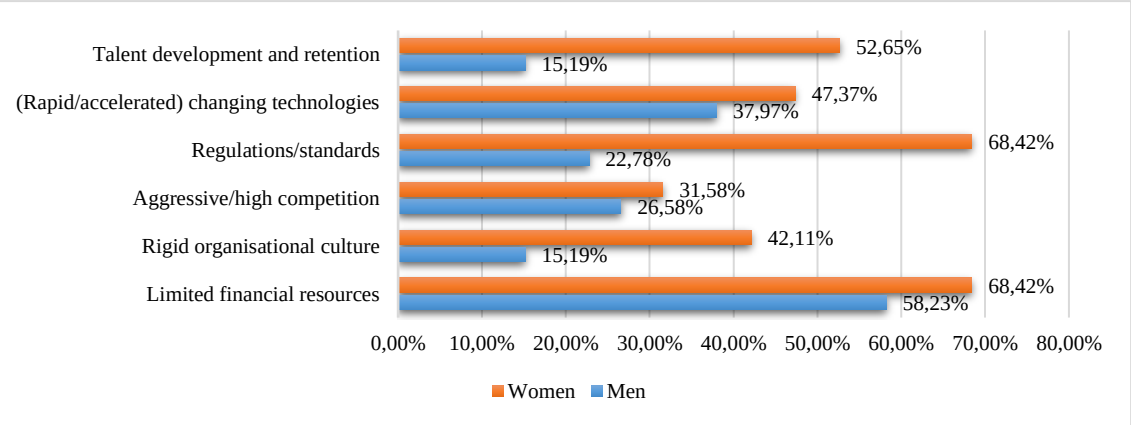

Figure 1. The challenges to innovation in high-tech start-ups.

When analysing with the test of independence the association between variables, we identified that there are differences in the distribution of:

- Regulations/standards between men and women, $\chi2(1) = 14.750$, $p<0.05$, and between respondents living in rural and urban areas, $\chi2(1) = 8.425$, $p<0.05$.
- Aggressive/high competition between respondents innovating new products/service, changed product/ service and new methods to approach potential customers, $\chi2(2) = 7.999$, $p<0.05$
- (Rapid/accelerated) changing technologies between respondents innovating applications, devices with their applications and platforms, $\chi2(2) = 6.101$, $p<0.05$
- Talent development and retention between students studying computer literacy, engineering and other fields, $\chi2(2) = 11.074$, $p<0.05$, and between the business fields students would like to innovate, variable valued as earth problem-solving, business engineering and human and animal welfare, $\chi2(2) = 6.204$, $p<0.05$.

For the deep analysis of respondents' attitudes toward the topic, we designed 6 questions to assess in more detail the six challenges to innovation: the risks of lacking financial resources, of facing competition and of meeting legal provisions as well as the need of a powerful organisational culture to develop and maintain talent and of keeping up with the latest technologies.

The first, the financial risk, was analysed by dividing the sample into 2 sub-samples: conservative and careful (50.0%) and risk-takers and courageous (50.0%). The sample mean is of 3.47 with student women more risk-reluctant (mean of 3.10) than student men (mean of 3.56). The test of independence showed there was a difference between students matriculated with different study programmes in terms of risk perception (with $\chi2(2) = 8.133$, $p=0.017$), students from computer literacy and other fields being more risk-avoiding than students in engineering. The second, the competitional risk in the market, showed that respondents made decisions to innovate by analysing and researching the market (32.7%), intuitively (20.4%%) and both ways (46.9%). We observed an association between this variable and programme of study ($\chi2(4) = 11.131$, $p<0.025$) with students at computer literacy taking into account their competition both by intuition and by analysis and research (27.6%), and students in engineering, by analysis and research only (16.3%). Last, but not least, the legal risk, the third risk analysed, presented the degree in which respondents based their investment decision to innovate on the legal provisions and standards. The sample mean was 2.85 whereas men had 2.83 and women 2.94, so there are no differences between genders. Hence, 20.25% of student men and 26.31% of student women stated that they often or always made decisions to innovate by analysing the legal environment.

Previously, the rigid organisational culture was perceived as a challenge to innovation by 15.19% men and 42.11% women. When asked what aspects of the organisational culture were the most important to stimulate innovation, respondents provided 286 answers and the four variables created were uniformly represented in relative frequences: 29.37% support for new and unconventional ideas, 27.62% promotion of open communication, 22.73% encouraging risk-taking and 20.28% rewarding (financial or otherwise) efforts. Moreover, results showed there were differences in the distribution of rewarding (financial or otherwise) efforts between men and women ($\chi2(1) = 4.184$, $p<0.05$) and between business idea as platform, application and device and application ($\chi2(1) = 7.076$, $p<0.05$). There is also significant association between innovation aims (to make a new product/service, to change a product/service or new method to approach potential customers) and support for risk-taking ($\chi2(2) = 7.435$, $p<0.05$).

Changing technologies is a variable analysed in correlation with the entrepreneurs' willingness to update their knowledge about the trends and emerging technologies which could influence the industry. The sample mean was 4.10 with 4.27 for men and 3.36 for women; moreover, 42.9% stated that they would update knowledge to a high extent (39.8% men and 3.1% women). For a deep analysis, we regrouped the variable into two categories, lowest through mean (57.1%) and mean through highest (42.9%). We observed the association between respondents' attitude to keep up with the latest trends and gender (with $\chi2(1) = 7.051$, $p=0.008$), study programme (with $\chi2(2) = 8.303$, $p=0.016$), business field (with $\chi2(2) = 8.909$, $p=0.012$) and innovation (with $\chi2(2) = 10.435$, $p=0.005$). Hence, we underline the fact that there is a high degree of consciousness of the need to keep up with new and to innovate.

Talent development and retention is analysed more into detail by asking respondents to provide their opinion on the means they would involve their teams and promote collaboration and creativity in the innovation process. There were 273 answers for the four variables distributed as follows: 27.94% would use brainstorming and idea sessions, 25.37% would encourage feedback and suggestions, 25.0% would divide tasks by all the members whereas 21.61% would facilitate interaction and cooperation (in relative frequencies). Differences between participants in rural and urban areas were recorded in association with facilitation of interaction and cooperation (with $\chi2(1) = 4.114$, $p=0.043$). We observed that 0% women and 13.33% men living in rural areas expressed this point of view showing the reluctance to using cooperation.

H4 was tested with the variables presenting the methods and instruments that respondents used to encourage and manage innovation within businesses. The results are uniformly spread, with Agile techniques receiving 29.6% of the responses, design thinking methods 26.5%, online cooperation platforms 24.5% and decision-making techniques having reached 19.4%. The null hypothesis is accepted as we found no association between the business field where to innovate and the managerial methods and instruments envisaged to be used within high tech start-ups.

The last aspect analysed in the research was the respondents' opinion about the benefits that innovation brings to high tech start-ups. The responses received showed that the most important benefit is the increase of customer satisfaction (36.7%), followed by the security of business sustainability (24.5%), the improvement of operational efficiency (21.4%) and increasing revenues (14.3%). H5 is supported (with $\chi2(6) = 13.376$, $p=0.037$) showing the association between the business fields and the benefits brought to start-ups by innovation, thus: increasing customer satisfaction for businesses aiming at earth problem-

solving (8.2%) and human and animal welfare (20.4%) whereas improving operational efficiency for start-ups aiming at business engineering (14.3%).

To sum up, this research investigated the Romanian students' views on the innovation of the entrepreneurial ecosystem, focusing on high-tech business initiatives. Aspects needed for generating proper policies and research-centred strategic approach at national and local level were considered, thus meeting the three objectives formulated:

a) We analysed Romanian students' attitudes towards innovations in high-tech industries and development within innovative start-ups;
b) We identified the challenges young entrepreneurs might be faced with when managing innovation in high-tech start-ups;
c) We assessed the benefits of innovation within high-tech start-ups.

Consequently, the results presented in this paper highlighted various relationships, of which the one between the study programme students were matriculated at and the fields of activity in which they intend to set up a high-tech business. Confirming the literature on innovation (Zhu & Cheung, 2017), the results emphasized the importance that students had given to linking a start-up with their education. Motivation is important and domain expertise helps the entrepreneur to develop the business with less effort and fewer resources (time, logistical, human and financial).

Research has shown that a higher start-up intention led to more innovative behavior (Lee et al., 2019). In Romania, there have been implemented large programs with European funding (Nicolau & Foris, 2018) to teach entrepreneurship and create incubators and technology transfer centres (Gagu & Kusio, 2024).

In addition, results also confirmed the association between start-up idea and innovation in high-tech businesses. The fact that students were focused on product and service itself more than on managerial processes would have positive consequences on their future business, but only on short term, in the first part of the implementation period of the business plan. Entrepreneurs should focus on both the technological and the non-technological component of innovation; the introduction of new management practices generates positive results on performance and contributes to the development of capabilities in technological innovation (Camisón & Villar-López, 2014) which should bring economic efficiency. According to this research, as participants did not give too much importance to the managerial processes (innovation of new methods to approach future customers got 18.4%, in absolute frequencies, whereas innovation of general managerial processes received no answer), we underline the need that public national and local policies should focus on increasing the theoretical knowledge and skills of entrepreneurs in the field of management, with a modern design of training methods and instruments. Specialty literature in the field showed this need (Li et al., 2020). Innovation management requires vision to design appropriate strategies and processes for implementing innovation, as well as conditions and an organizational culture that make it easier for ideas to emerge and for them to be implemented (Bel, 2010; Solaimani et al., 2019).

Hence, the research showed significant differences between genders with regard to the challenges of implementing innovations in high-tech start-ups. The results confirm that student women assessed as important all of the six challenges with weighty differences than men in terms of regulations/standards, talent development and retention and rigid organisational culture. In contrast, both genders had the same attitude at aggressive/high competition, (fast/accelerating) changing technologies and limited financial resources which were perceived as major challenges. The organisational culture, the pillar of innovation management processes, concentrates mutual convictions and formal and informal norms that influence how people are open to new ideas, approach problem solving, emphasize continuous learning and collaboration (Williams et al., 2022; Holbeche, 2023). The start-up culture shapes the way people think, influences how they approach challenges and manage risks. A culture that encourages employees to be creative, to think and implement new ideas and to adopt a continuous improvement mindset is a culture that promotes innovation. It is essential that this culture is underpinned by leadership that supports and fosters risk tolerance and openness to new ideas, that actively fosters an environment where failure is valued as an opportunity to learn and improve. Such an attitude encourages people to come up with new ideas, to experiment and to push the boundaries of conventional thinking. (Ren et al., 2020, Zala, 2021).

Under such circumstances, technological start-ups, in order to be able to surpass the risks they are faced with within their markets, engage in different strategic partnerships. It has been highlighted in recent

approaches that regardless of their nature, partnerships improve start-ups' ability to expand, enable them to overcome resource constraints by facilitating the exchange of know-how, allow them to get over resource constraints (especially financial), increase their competitiveness, and benefit of new opportunities (Peltonen, 2022; Mehrotra & Jaladi, 2022; Jones & Schou, 2023; Ahmad et al., 2024). This leads us to suggest that strategic partnerships create a collaborative ecosystem conducive to innovation. These elements are fundamental to the success of technology start-ups. (Mızrak, 2023).

Correspondingly, the results are partly unexpected, having identified no association between the field of innovation and the managerial methods and tools expected to be used in high-tech start-ups. This means that although students have innovative ideas and are aware of the managerial methods and tools that can help them to make their work more efficient, they do not focus on their use and do not highly appreciate their possible benefits brought to the efficiency of the business. In our view, young entrepreneurs shall train themselves seriously in business management, not focusing only on the business idea, the economic field and the consumer. Unlike large companies, the environment where start-ups operate is more uncertain, risky, full of resource constraints and features the need to adapt quickly. Therefore, alongside innovation, effective risk management becomes a key factor for survival and an important component in innovation management. A characteristic of the constantly evolving high-tech sectors is the speed of product/service development, often perceived as a risk itself. The need for responsiveness, adaptability and flexibility to the constant and rapid changes and the continual aim of eliminating errors have created new approaches to innovation management, such as Scrum and Lean Startup methodologies. They prioritise compliance, collaboration and customer-centricity, enable startups to react rapidly to changing market dynamics, test hypotheses and integrate feedback effectively (Tegegne et al., 2019; Zavazava, 2022; Olek, 2023; Ahmad et al., 2024). The common goal of the two methodologies is to speed up the product development process and ensure that final products are in line with customer needs.

In contrast to the conventional waterfall model, agile methodologies acknowledge the dynamic nature of customer requirements and the potential for customer feedback to generate new insights. By adopting a flexible and adaptable approach, these techniques allow new businesses to adapt quickly to market trends and consumer behaviours, user feedback or emerging technologies, seizing new opportunities and gaining a competitive advantage over their competitors. Hence, as agile methodologies prioritise customer requirements, they facilitate the innovative development of solutions that not only meet but also exceed user expectations, thereby enabling start-ups to gain a competitive advantage (Corvello et al., 2023; Griva, et al., 2023).

Finally, the results reveal that there is a significant association between the business areas and the benefits of innovative start-ups, with the most important benefit being increased customer satisfaction, followed by ensuring business sustainability, improved operational efficiency and increased revenues. By boosting performance and achieving better outcomes with technological innovation, start-ups are to benefit from the implementation of innovation. Innovation management is related to new practices in organization structuring and management of administrative systems, processes and techniques that may create value for the companies because of their potential to bring about strategic transformations, organizational renewal and improvements of firms' efficiency (Walker et al., 2015).

Subsequently, these findings may have important implications for student entrepreneurs, universities and the stakeholders within the Romanian entrepreneurial ecosystem. Firstly, all stakeholders should participate in the creation of entrepreneurial strategies to develop local communities. Secondly, the public institutions should establish partnerships with the universities to develop curricula to encourage entrepreneurial mindset and skills, also engaging research institutes and industry to ensure that these training programs are designed to meet entrepreneurial needs. Also, universities should provide physical spaces for the intermediary organizations (business incubators and accelerators) to advance their projects and programmes to develop the entrepreneurial ecosystem, as they are change agents for the sustainable innovation of small and middle-sized companies (Mota Veiga & Teixeira, 2022). Thirdly, investment institutions should provide entrepreneurs with fund (for start-up and development as well) whereas incentivize the establishment of venture capitals (VC) and angel investors. This can be achieved through direct financial support, such as investment commitments to VC funds for engagement in the county (to create a local equity market), or co investment in students' start-ups together with private investors (to crowd-in private sector investments).

Last but not least, the institutions in collaboration with start-ups and intermediaries should simplify the procedures for incorporating businesses and administrative procedures.

To conclude, our research provides insights into the specific context of Romanian universities, with its localization and underrepresentation of women in the sample (Zamfirache et al., 2023) be possible limitations. As for analysing the different policies and management cultures in universities in other countries, our study is may be reproducible and bring out valuable information for the future strategic development of the entrepreneurial ecosystem. However, an international comparison could provide interesting results controlling for university cultures and policy contexts. Further research might use a sample more representative of a population and also could incorporate additional variables.

Conclusions

This research has provided significant insights into the development of student entrepreneurship in high-tech industries within Romania's emerging economy context. Our findings demonstrate relationships between educational backgrounds and entrepreneurial choices in high-tech fields, while revealing important gender-specific challenges in innovation implementation. The study particularly highlights how students strongly align their entrepreneurial ventures with their academic expertise, though there remains a notable gap in their appreciation of management processes alongside technical innovation.

The implications of these findings are substantial for multiple stakeholders in the entrepreneurial ecosystem. Universities should develop curricula that more effectively encourage entrepreneurial mindset and skills, while public institutions need to establish stronger university partnerships for entrepreneurship development. Additionally, investment institutions have a crucial role in providing startup funding and incentivizing venture capital participation, particularly in supporting student-led ventures in the high-tech sector.

For the advance of the entrepreneurial ecosystem, our findings suggest the need for integrated strategies at the local community level, including the creation of physical spaces for business incubators and accelerators. The simplification of business incorporation and administrative procedures emerges as a critical factor in supporting student entrepreneurship. Public policies should focus on increasing entrepreneurs' theoretical knowledge and skills in business management, with particular attention to modern training methods and instruments.

While our study provides insights into the Romanian context, future research could benefit from international comparative studies that control for different university cultures and policy contexts. Additional investigation into management education needs within technical entrepreneurship programs and research on effective support mechanisms for student entrepreneurs would further enhance understanding in this field. These findings contribute to both theoretical understanding and practical development of student entrepreneurship in high-tech industries, particularly in emerging economies like Romania, while opening new research paths in entrepreneurial education and support systems.

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