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Student Entrepreneurship and Research Commercialization at Universities in Azerbaijan, Colombia, Egypt, India, Poland, and Portugal

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ABSTRACT:
This study examines student entrepreneurship and research commercialization practices across six countries: Azerbaijan, Colombia, Egypt, India, Poland, and Portugal. Drawing on a comprehensive literature review and original student survey data, the study investigates how entrepreneurial intention, student capabilities, and external factors—such as institutional support, funding access, and mentorship—affect the commercialization of university-based research. Structural Equation Modelling (SEM) was deployed to analyze relationships among four key latent variables: Student Capabilities (SCAP), External Circumstances Influencing Research (ECIR), Entrepreneurial Intention (EN), and Research Commercialization (RC).
The findings reveal significant cross-national variation. While entrepreneurial intention positively correlates with commercialization in some contexts, such as Portugal and Poland, this relationship is weaker or absent in others, including India and Azerbaijan. This suggests that individual motivation alone is inadequate without institutional alignment and external support structures. Moreover, student cognizance of available commercialization pathways and support services was varying, indicating a need for clearer institutional communication and engagement policies.
The study contributes to the literature by offering a multi-country comparative framework for analyzing student-driven innovation. It also underscores the importance of culturally responsive policies and targeted interventions that address both individual-level capabilities and system-level barriers. Based on the findings, the article recommends integrated strategies for universities and policymakers, including improved mentorship programs, streamlined commercialization processes, and enhanced visibility of support resources. These steps are essential for fostering inclusive and effective entrepreneurial ecosystems in higher education institutions across diverse socio-economic contexts.

Keywords: student entrepreneurship, research commercialization, student competencies, social capital, mentorship, Structural Equation Modeling

1. Introduction

University education systems are now expected to cultivate human competences that enable the initiation and execution of innovative processes through new discoveries and technological advancements. Contemporary universities are tasked with conducting

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fundamental research as the cornerstone of their activities, as well as interdisciplinary and transdisciplinary research, in collaboration with industries, research and development (R&D) institutions, and professional service providers. In today's competitive landscape, universities must compete for top scientist, grants and market acceptance of their research outcomes.

The commercialization of university research results involves two main types of technology transfer: research explicitly aimed at commercialization, and transfer of creative ideas and innovative solutions to establish new companies. The primary goal of this study is to identify variables influencing students' entrepreneurship and research commercialization. Therefore, this contribution introduces theoretical perspectives on entrepreneurship and commercialization of research. Generally, universities are increasingly interested in active participation of academicians not only in teaching and didactic processes, but also in developing solutions that address market demands and collaborating with business on joint research projects. Consequently, there is a growing need to identify principles for managing intellectual property, research outcomes, commercialization efforts, and facilitate invention and transfer process from universities to market. Authors of this paper have formulated key research questions, including: what types of educational and training programs are offered by universities to support students in developing entrepreneurial skills? What is a university's role in supporting students to participate in research commercialization activities? Do universities create an environment for enabling knowledge transfer? How aware are students of their entrepreneurship as a key concept to develop commercialization and market orientation? Answers that questions are included in this paper. The authors have gathered students' opinions on the factors that influenced their entrepreneurship competences and opportunities to commercialize their research. The questionnaire on students' perception of entrepreneurship and research commercialization was distributed simultaneously among students of six universities in six countries. The questionnaire dissemination was followed by meetings offline and online and discussions of teachers from that six universities. The authors have observed that the universities' governors have a problem how develop the entrepreneurship and research commercialization, but the proposed actions are not sufficient. Therefore, the proposed study is to fulfill the gap and support the universities actions in future.

2. Theoretical Background

Contemporary universities are increasingly focused on expanding entrepreneurship education opportunities with the dual goal of enhancing students´ professional skills and accelerating research commercialization. However, questions remain about how to effectively design entrepreneurship education (Epstein et al., 2020; Xiao et al., 2019). The concept of academic entrepreneurship encompasses both courses that teach entrepreneurial behavior and the activities of academic spin-off enterprises created by faculty to commercialize knowledge and technological advancements. At universities, the entrepreneurship education spans a wide range of actions. In general, it is defined as a process of providing individuals with the knowledge, skills and abilities for entrepreneurship to recognize opportunities that provide a competitive advantage (Passavanti et al., 2023). Entrepreneurial indicators are often grounded on psychological

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constructs, i.e., self-efficacy, confidence, attitudes, and intentions. Student entrepreneurship goes beyond competences development, but it also focuses on creating business value. Students can develop their own business or technical initiatives, create a platform for the exploration of new ideas, and generate products accepted by a market (Lukita et al., 2023).

Students are located in a certain university ecosystem including educational programs, infrastructure, university regulations, business rules, property rights, and university culture (Kapturkiewicz, 2022). Student entrepreneurs can be perceived as a distinct group of people, who have a different way of reasoning than highly experienced managers. However, students learn to use resources in a similar way as entrepreneurs, who just start up their firms. In the field of business research, Chandler and Hanks (1993) defined the concept of entrepreneurial ability as a competence to recognize opportunities. Jung (2012) claims that the entrepreneurial ability includes dimensions, i.e., motivation, personality, and risk-taking propensity. That ability covers competences of tacit knowledge usage and decision-making in circumstances of high uncertainty (Soltanifar & Smailhodzic, 2021). Kooskora (2021) has defined the entrepreneur's features as follows: intelligence, independence, high motivation, energy, initiative, innovativeness, creativity, desire for success, originality, optimism, self-confidence, dedication, ambition, perseverance, leadership qualities, and low averse to risks.

Entrepreneurship education is context dependent (Henry & Lahikainen, 2024). Its strategic goal is to learn students to become critical thinkers, to take responsibility for their decisions, as well as to develop a self-motivation system. The education should also include consideration of harmful aspects, i.e., competitiveness on a market, sustaining or sustainability (Izquierdo & Buyens, 2008). Block et al. (2023) argue that entrepreneur education effects depend on the student's experience, personal talents, and the contextual socio-economic environment. Nybye (2023) has added that the primary entrepreneurial experience of students is derived from academic curiosity, and that curiosity about whether the solution works and gives benefits is more important than making money. Block et al. (2023) emphasize that student entrepreneurship is an opportunity for self-realization, although there are some strong demotivates, i.e., fear of failure or financial loss, lack of new ideas, competences, or financial support. Although, it is known that entrepreneurship stimulates innovation, and influences sustainability of entrepreneurial efforts, there is still a scarcity of studies exploring the determinants having impact the students' entrepreneurial decision-making and activities. There is also a need of evidence on the links between the traditional commercialization of university research (i.e., patents, licensing, and spin-off) and informal knowledge exchange activities (i.e., collaborative research, consultancy, and students' projects) (Zhou & Baines, 2024). According to Medne et al. (2024), universities often see the entrepreneurial culture as a way to gather resources from different sources. Beyond that, a process of exploration of market opportunities can favor university-industry-government collaboration (Schmitz et al., 2017). A literature survey on entrepreneurial activity at universities revealed that academic entrepreneurship is associated with the commercialization of knowledge created in academic research (Abd Rahim et al., 2021).

Commercialization can be achieved in various ways, including industry-sponsored research, new enterprise creation, licensing the intellectual property to an existing entity,

or governmental institutions sponsored research and development (Hisrich & Soltanifar, 2021). The process of technology or a business solution commercialization is as follows: researcher engagement, invention disclosure, opportunity evaluation, asset development, business strategy development, deal creation, and royalty allocation and compliance (Pogue et al., 2014). The process of commercialization is combined with the transfer of knowledge or technologies, and the creation of spin-off or start-up companies, granting licenses or sale of know-how or know-why (Trzmielak, 2013). Huegel (2024) rightly notes that research achievements of scientists are defined by the number of citations and publications. Research commercialization is a different activity for academicians and challenges them to operate in a different context where research products are to be provided on a market. Distanont et al. (2019) argue that research commercialization is not an easy task, because there are some problems, i.e., possibilities of industrial production, market size, readiness level of technology, too difficult theories and principles for industrial implementation. Zastempowski et al. (2023) claim that commercialization can be a form of university functioning and as such should be included in university strategy plan. Invention transfer and cooperation between university, industry, and government should generate various benefits, providing in this way financial resources for universities.

Even if universities seem to be conscious of these benefits, they still need more arguments to change national regulations and university – business cooperation for further entrepreneurship and research commercialization support. However, in this study, the authors do not focus on political issues nor regulations modification, but they want to emphasize the students capabilities and circumstances encouraging them to entrepreneurial activities.

1. 3. Student Entrepreneurship and Research Commercialization in Selected Countries

Universities worldwide employ diverse approaches to support student entrepreneurship development and research commercialization. This study examines the characteristics of programs and regulations in six countries: Azerbaijan, Colombia, Egypt, India, Poland, and Portugal.

In Azerbaijan, the role of innovation and entrepreneurship in general, but also more especially regarding diversification of the economy and its sustainable development, was underlined in the document written by Aliyev (2021). This strategic framework has called for the development of students and lecturers in entrepreneurship skills, thus positioning higher education institutions as an active contributor to the national economic landscape. Until 2023 only a few universities such as ADA University, Azerbaijan State University of Economics-UNEC offered specialized courses and workshops on entrepreneurship in Azerbaijan. However, the Erasmus+ capacity-building project Enhancement of Entrepreneurial Ecosystem in Azerbaijan Universities, involving 11 partner universities, has integrated entrepreneurship into strategic management and curriculum design. As a result, "entrepreneurship and innovation" has been introduced as an elective course in curriculum regardless the field of study. Up to now this initiate made by the consortium the universities taught the entrepreneurship only for business related

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fields. The academic landscape in Azerbaijan is characterized by a growing recognition of the importance of research commercialization, yet significant barriers remain. For instance, the cultural and institutional frameworks within universities often do not encourage students to pursue commercialization as a viable career path. Many students are unaware of the potential avenues for monetizing their research, and there is a lack of awareness regarding the resources available to them, such as funding opportunities and mentorship programs. This situation is exacerbated by the limited engagement of industry partners with academic institutions, which further restricts students' access to real-world applications of their research.

Colombian Universities have progressively integrated entrepreneurship education as a central component of their curricula, offering both formal and informal programs aimed at fostering entrepreneurial competences (Garcia-Gonzalez, 2008). Many universities have incorporated specific courses on entrepreneurship, innovation management, business creation and business modeling within their regular academic offerings (Colciencias, 2013; Plan, 2011). Universities in Colombia are increasingly recognizing their pivotal role in facilitating research commercialization, particularly through the establishment of technology transfer offices (TTOs). Many universities are including students' entrepreneurship into their broader objectives by embedding entrepreneurial thinking in various disciplines. A growing number of institutions are also fostering collaborations between academia and industry, which enhances students market orientation by linking academic research to market needs.

In Egypt, there are several courses offered in the undergraduate program that support the students in developing their entrepreneurial skills (Monic et al., 2023). The Egyptian higher education officials are encouraging the academic involvement in Innovative field practices to respond to international trends in education to go parallel with strategy 2030. Multiple tools of interdependent methods of learning are engaging students in Egyptian universities towards innovation and learning to ensure employability skills acquisition (Younis, 2020). At the British University in Egypt (BUE) (*BUE official site, 2024*), there is a specialization in the Business Program, in the faculty of Business administration, Economics and Political Science (BAEPS), named "Entrepreneurship and Sustainability". By studying entrepreneurship as an academic specialization, education becomes a compelling endeavor to foster entrepreneurship, particularly among aspiring entrepreneurs which leads to building capacity and encourage innovation (Lima & Baudier, 2017). A big interlinkage is developed as this specialization is aligning with the university strategy towards the support of young entrepreneurs through the Science Innovation Park which was launched in 2018 and is the first in Egypt with a partnership collaboration with the university of TUS in China. The setting of the university helps start-ups and several firms to conduct and explore their business ideas in an environment that links industry to academics.

Universities in India are becoming more aware of "student entrepreneurship" as vital for commercialization and market orientation of knowledge (Kanojia et al., 2021; *SINE, 2024; Centre for Innovation, 2024*). This awareness is reflected in integrating entrepreneurship into curricula, establishing incubation centers (*Entrepreneurship Cell*, 2024), and setting up technology transfer offices (*National Institute*, 2024). Universities are

also providing funding, hosting competitions, and forming industry partnerships to support student-led startups (*IIT Madras*, 2024; *TiE*, 2024).

In Poland, the Law on Higher Education and Science (Act of 20 July 2018) imposes on HEIs the obligation to adopt regulations for the management of intellectual property and the principles of commercialization. Beyond that, there are plenty of programs to support investigators in the research and development projects, e.g., Technology Transfer Offices (TTOs), Incubator of Innovation 4.0 (IoI4.0) (https://ctt.ug.edu.pl/en/innovation-incubator-4-0/), Polish Association of Centers for Technology Transfer (PACTT) (https://pactt.pl/en/aboutpactt), Special Purposes Vehicle (SPV), and IDEAS NCBR (the National Centre for Research and Development) (https://www.gov.pl/web/ncbr/ncbr). The Law on Higher Education and Science (Act of 20 July 2018) imposes on HEIs the obligation to adopt regulations for the management of intellectual property and develop the principles of academic commercialization.

University of Economics in Katowice (UEKat), is a member of Global Entrepreneurship Research Association (GERA) London Business School, and is the creator of the Global Entrepreneurship Monitor (GEM). Beyond that, UEKat is cooperating with the United States Association for Small Business and Entrepreneurship (USASBE), which supports local communities through teaching, scholarship, and practice.

In Portugal, universities offer a variety of education and training programs to promote entrepreneurial skills. These initiatives provide students with hands-on experience and training in entrepreneurship, covering topics such as needs assessment, digital tools for problem identification and solution, and business/project idea development. Entrepreneurship is a driver of sustainable regional economic development and innovativeness, which in turn supports job creation (Dentoni et al., 2021). According to Etzkowitz et al. (1966), the entrepreneurial universities are involved in the transfer of knowledge to the local communities, through entrepreneurial activities. Universities in Portugal, including the Instituto Politecnico de Castelo Branco (IPCB), are actively working to establish an environment that fosters knowledge transfer and commercialization. Specifically, IPCB promotes collaboration with industry through co-creation projects, which provide significant opportunities for the commercialization of research and the transfer of technology.

2. 4. Modeling Entrepreneurship and Research Commercialization

The entrepreneurship can be understood by considering the Theory of Planned Behavior (TPB), which suggests that personal attitude, subjective norms, i.e., perceived social pressure to perform a behavior, and perceived behavioral control are antecedents of entrepreneurial intention (Ajzen, 1991). However, earlier, Fishbein and Ajzen (1975) explained the Theory of Reasoned Action (TRA), according to which the determining factor of human behavior is the intention formed through the attitude towards behavior and the subjective norm. According to the TRA, people have an intention or motivation to perform certain tasks if they have a positive attitude and feel that others want them to do it (Vivekananth et al., 2023). Beyond that, the Entrepreneurial Event Model (EEM) proposed by Shapero and Sokol (1982) and the Theory of Planned Behavior Entrepreneurial Model (TPBEM) developed by Krueger and Carsrud (1993) provide a

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framework for understanding the factors having impact on entrepreneurship. The Entrepreneurial Event Model (EEM) of Shapero and Sokol (1982) conceptualized the entrepreneurial initiative as an event that can be explained by the interaction between ideas, skills, management, relative autonomy and risk. According to the EEM, a personal decision to start an initiative depends on three elements, i.e., the perception of desirability, the perception of viability, and the propensity to perform.

The Model of Development of the Professional Career (MDPC) (Sonnenfeldt & Kotter, 1982) proposed the studying the entrepreneurial profile using some variables, i.e., family history, work experience, education, identified obstacles for the company creation, as well as the psychological variables such as the need for achievement, the ability to take risk, perseverance, and creativity. According to the Model of Determinants of Entrepreneurial Intentions (MDEI) (Davidsson, 1995), the intention can be influenced by the willingness to change, competitiveness, monetary orientation, achievement and autonomy, social contribution, as well as by employment status. The Model of Entrepreneurial Intention (MEI) (Elfving, 2008) has explained the reasons why individuals want to be entrepreneurs, and relations among the entrepreneurial intention and motivation, perceived desirability, observed viability, opportunity assessment, and self-efficacy. Sutrisno et al. (2024) claim that the Effectuation Theory (EF) is facilitating the acquisition of entrepreneurial competences and supports initiating the students' own business ventures. For the Happenstance Theory (HT), Mitchell et al. (1999) have formulated the concept of five planned happenstance skills, which are important for creating and recognising career opportunities, i.e., curiosity, persistence, flexibility, optimism, and risk-taking. The Theory of Entrepreneurial Thought and Action (TETA) encourages students to create, discover, and exploit opportunities. It promotes the "learning by doing" practice. In this theory, entrepreneurship characteristics are as follows: knowledge, motivation, self-image, social communication, business operation abilities, and self-efficacy (Zeng et al., 2023; Khairani & Zhang, 2025). The Social Cognitive Theory (SCT) views human behavior as dynamic and influenced by environmental, behavioural, and individual factors (Vafaeinejad et al., 2024). According to Vankov and Wang (2024), the SCT is a framework for studying human behavior in an entrepreneurial context. There are six dimensions exploring entrepreneurial requirements, i.e., vision, opportunity recognition, investor capital, innovativeness, leadership, and business resilience. This theory emphasizes the need for development of people's cognitive, social, and behavioral competences, the cultivation of people's belief in their capabilities, and the enhancement of people's motivation through goal systems (Wood & Bandura, 1989; Patricio & Ferreira, 2023).

The Social Learning Theory (SLT) defines that people learn from their interactions with others in a social context. By observing the behaviors of others, people develop their own behaviors, they imitate others and they are directed toward goals of others. Their behaviors become self-regulated. Cognition plays an important role in learning, and reinforcement and punishment have rather indirect effects on behavior (Tadayon Nabavi & Sadegh Bijandi, 2011). The Motivation-Opportunity-Ability (MOA) framework is based on the assumption that people are driven by self-interest, while performing a desirable behavior (Aloysius et al., 2025). Individual motivation, as a driving force, directly affects the final behavior, while ability and opportunity play regulatory roles.

Motivation is expressed as willingness, interest and desire. Opportunity is a collection of many external factors that affect the human behavior, while the Ability is the competence that is needed for the successful behavior (Wang et al., 2023). According to Thi Ngan and Huy Khoi (2020), the Entrepreneurial Attitude Orientation (EAO) is modelled through Self-Esteem, Personal Control, Innovation, and Achievement. People with innovative ways of thinking are able to take on an entrepreneurial opportunity and they have a high need for achievement (Vashishtha, 2021). Krueger and Brazeal (1994) have developed the Entrepreneurial Potential Model (EPM), which defines three critical constructs, i.e., perceived desirability, self-efficacy, and credibility. Perceived desirability is undertood as the degree of attraction an individual perceives towards a specific behavior, e.g., entrepreneur's behavior. Beyond that, in their model, Krueger and Brazeal (1994) have included two moderating variables, i.e., precipitating events and the propensity to act.

The Entrepreneurial Intention (EI) model explains that some constructs, i.e., Locus of Control, Propensity to take Risk, Self-Confidence, Need for Achievement, Tolerance of Ambiguity, Innovativeness, Personal Attitude, together contribute to the Entrepreneurial Intention (Ferreira et al., 2012). Taking into account all the above models, the authors have proposed their own model on the Student Entrepreneurship and Research Commercialization determined by Student Capabilities and External Circumstances.

3. 5. Conceptual Model Identification and Formulation of the Hypotheses

In this research, the authors describe the relationships between External Circumstances (ECIR), Student Capabilities (SCAP), Entrepreneurship (EN), and Research Commercialization (RC). The Student Capabilities (SCAP) construct covers some variables included in mentioned above theories. The set of variables comprises Self-Regulated Learning (SRL), Opportunity Recognition (OR), Risk Taking (RT), Self-Efficacy (SE), Leadership (LE), Planner (PL) and Innovator (INN) (Figure 1). Self-Regulated Learning is understood as a method of learning without assistance of others (Abd Rahim et al., 2021). Usually, scientists must self-regulate their behaviors. The Opportunity Recognition means the ability of an entrepreneur to detect the chances that the solution or an idea can be further developed into a product to a market. Even if people have the same knowledge, beliefs, attitudes, and personality characteristics, their capabilities can lead to different perceptions of entrepreneurial opportunity (Bergmann, 2017). A person's cognition determines how business or technical ideas are perceived as more or less attractive. The Risk Taking or Risk Averse ability is measured as the level to which individuals are willing to use risky resources, or catch an opportunity with probability of costly failures (Abd Rahim et al., 2021). People should carefully analyze the factors having an impact on their results. They are expected to intelligently take risks and adapt to the continuous changes in the socio-economic environment (Lopes da Rocha et al., 2022). Risk preference of an individual may lead to special behaviour that is entrepreneurship alertness and intention (Hosomi et al., 2024). Self-Efficacy is described as an individual's beliefs in the ability to perform and control tasks. It is related to risk-taking, innovativeness, proactiveness, and competitiveness (Ferreira et al., 2017). Self-Efficacy is a concept of the Social Learning Theory that is related with an individual self-

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perception of their own capabilities in performing specific tasks (Bandura, 1982; Gao et al., 2024; Vaiciukynaite et al., 2023). Leadership means an impact of a person who influences other people to adopt the solution or actions (Lopes da Rocha et al., 2022). Leaders are able to create a vision and clearly communicate what the team should achieve and why (Kooskora, 2021; Tweheyo et al., 2024). The Planner is a person who organizes and prepares themselves to achieve a goal. These persons are able to elaborate procedure of actions. They anticipate the facts and circumstances and have an organizational vision (Lopes da Rocha et al., 2022). The Innovator is a person who relates ideas, facts, needs and market demands in a creative way to provide inventions available for further development and application.

In this study, the External Circumstances (ECIR) that may have impact on Entrepreneurship (EN) and Research Commercialization (RC), are proposed as follows: Social Capital (SC), Funding (FU), Entrepreneurial Peers (EP), and Mentor Support (MS). Social Capital is created through social networks that involve personal, professional, and business linkages among researchers, developers and practitioners, especially to the formation of entrepreneurial intention or start-up companies (Abd Rahim et al., 2021). Social capital seems to be a potential resource, which combines people within a community, i.e, the social network, formed in the long term and provides a cohesive force to bring a group together (Xiao et al., 2019). Huegel (2024) argues that social capital facilitates researchers to commercialize their results. Through the provision of any funds from internal or external sources, the financial gap between research development and commercialization is closed. Funding or financing allows us to proceed with experiments, enter the target market, and further catch opportunities at the right time (Abd Rahim et al., 2021). Beyond that, the authors have included the Entrepreneurial Peers variable proposed also by (Abd Rahim et al., 2021). Peers, i.e., friends, colleagues, co-workers inspire people to become entrepreneurs. Activities of people, who you know and who are involved in spin-off work, contract research, patenting, licensing, or consulting may have an impact on students' propensity to engagement in innovation development and transfer activities. Mentor support and culture can encourage students and young researchers to contribute to successful development of innovation, and further research commercialization and transfer to market. The mentors are expected to persuade the young researchers that the proposed solution should be implemented as feasible and valuable to the market. According to Abd Rahim (2021), the formal mentoring program can increase mentee's self-efficacy.

The proposed conceptual model covers two endogenous variables, i.e., Entrepreneurship (EN) and Research Commercialization (RC) (Figure 1). Entrepreneurship (EN) covers activities undertaken by academicians as well as students to commercialize research results or transfer technology-based innovations from university to external institutions, which are able to utilize them as products (Abd Rahim et al., 2021; Epstein et al., 2020). According to Wang et al. (2022) academic entrepreneurship is defined as research commercialization activity involving academic scientists such as researchers and professors. Unfortunately, that definition excluded students and alumni as the main actors for academic entrepreneurship. However, students as entrepreneurs can also be innovative and able to recognize opportunity and manage various risks. Schmitz et al. (2017) claim that entrepreneurship is an expression of a talent

of human beings, skills for the discovery and exploitation of opportunities. Universities are expected to establish learning methods and courses for their students and facilitate an inclination for innovativeness and entrepreneurship, as well as ensure professional advice to business incubators and create spin-offs. According to Rueda-Armengot et al. (2017) the entrepreneurial universities integrate the traditional activities of education and research, while contributing to economics and social development. Students-entrepreneurs are driven by their attributes, i.e., solid knowledge and innovative thinking (Gao et al., 2024). However, although they have a passion for innovations, they are afraid of financial bankruptcy, loss of reputation, and falling behind peers.

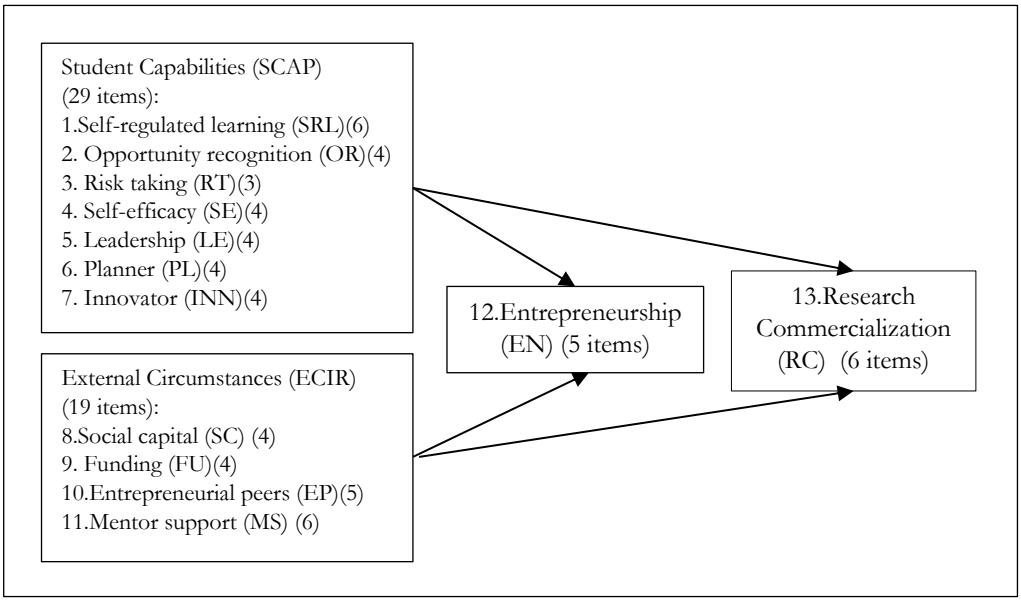

Figure 1: Conceptual model

Research commercialization refers to the ability to offer a new product to market (Belitski et al., 2019). Huegel (2024) emphasizes that commercialization of research results is fundamentally a different endeavor for academic scientists than for business people, and challenges the academicians to operate in a different context, where knowledge is to be used and capitalize. Research commercialization initiatives can generate interest in emerging areas of interest, such as Generative Artificial Intelligence (GenAI), with improvements of research funding, job creation, innovation quality management, and economic sustainability at universities (Caulfield & Ogbogu, 2015).

The identified hidden variables allowed for formulation of conceptual framework (Figure 1) and hypotheses:

H1: Positive external circumstances (ECIR) enhance entrepreneurship understood as behaviour (EN).

External circumstances such as social capital, funding, and mentorship can influence an individual's perception of the norms and expectations around

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entrepreneurship. For instance, if external circumstances are supportive, individuals may perceive entrepreneurship as a socially desirable and viable path.

H2 : Favorable external circumstances (ECIR) enhance research commercialization (RC).

External circumstances such as access to funding, networks, and institutional support increase perceived behavioral control by providing the necessary resources and reducing barriers to research commercialization.

H3: Positive attitudes towards entrepreneurship (EN) increases research commercialization (RC).

Entrepreneurial individuals with a positive attitude toward innovation and commercialization are more likely to engage in research commercialization. In the TPB, a positive attitude towards entrepreneurship translates into a higher likelihood of engaging in behaviors that lead to commercialization.

H4: Higher student capabilities (SCAP) positively influence entrepreneurship (EN).

Student capabilities, such as self-efficacy, leadership, and innovation skills, directly influence perceived behavioral control. When students feel capable and confident in their entrepreneurial abilities, they are more likely to pursue entrepreneurship activities.

H5 : Higher student capabilities (SCAP) positively influence research commercialization (RC).

Student capabilities influence both the attitude towards commercialization and the perceived ease of engaging in it. Students with strong capabilities are more likely to view commercialization as a positive and achievable outcome.

4. 6. Conceptual Model Estimation Results

The data samples were prepared in six countries separately. Numbers of recipients involved in the survey were slightly different in that countries. Sample size for Azerbaijan covers 110 responses, Colombia -110, Egypt – 97, India - 100, Poland - 117, and Portugal -114. The surveys have been distributed and the data was collected in 2024. The Appendix table covers identification of model constructs and items. That table, in the last column, includes the origins of the items. The presented instrument was initially piloted in Poland, and later the questionnaire was translated into other countries' languages. Authors of this study had opportunities to discuss that conceptual model during their teaching staff mobility meetings. Those discussions allowed to reveal the culture differences, the translation results, local regulations impact on university activities, and other socio-economic circumstances that might have an impact in the latent variables as well as on the items' interpretations.

This estimated model validity was verified through Average Variance Extracted (AVE). The value of AVE should be greater or equal to 0.5 in order to achieve this validity. Cronbach's Alpha is a reliability coefficient and an internal consistency measure. Internal reliability is achieved when the Cronbach's Alpha value is 0.6 or higher. Tables 1 and 2 include measures of reliability and validity.

Table 1: Model reliability Cronbach's Alpha

	Azerbaijan	Colombia	Egypt	India	Poland	Portugal
ECIR	0.097	0.903	0.958	0.939	0.887	0.973
EN	-0.119	0.844	0.901	0.782	0.903	0.892
RC	-0.073	0.829	0.919	0.822	0.652	0.910
SCAP	-0.002	0.901	0.965	0.922	0.885	0.975

Table 2: Model validity AVE

	Azerbaijan	Colombia	Egypt	India	Poland	Portugal
ECIR	0.068	0.371	0.569	0.481	0.324	0.678
EN	0.215	0.627	0.715	0.517	0.722	0.702
RC	0.198	0.550	0.713	0.535	0.373	0.691
SCAP	0.048	0.276	0.510	0.320	0.255	0.591

Table 3: Hypotheses' significance in various countries' models

	Azerbaijan	Colombia	Egypt	India	Poland	Portugal
ECIR -> EN	0.232	0.720	0.073	0.005	0.307	0.000
ECIR -> RC	0.219	0.000	0.001	0.004	0.033	0.001
EN -> RC	0.697	0.457	0.000	0.081	0.793	0.082
SCAP -> EN	0.327	0.000	0.004	0.030	0.000	0.000
SCAP -> RC	0.396	0.002	0.311	0.038	0.024	0.017

Unfortunately, the estimated model for Azerbaijan is not reliable. All hypotheses are rejected. The Outer Loadings are below 0.7, Cronbach's alpha is above 0.7, p values are above 0.05 (Table 3).

The calculation results for Colombia present that the Outer Loadings are above and below 0.7, Cronbach's alpha is above 0.7. Model is reliable, two hypotheses are rejected, p values are above 0.05. Three hypotheses significant, i.e., External circumstance (ECIR) impacts Entrepreneurship (EN), and Student Capabilities (SCAP) as well as External Circumstances (ECIR) influence the Research Commercialization (RC).

In the case of Egypt, the calculation results present that the Outer Loadings are above and below 0.7, Cronbach's alpha is above 0.7. Model is reliable, two hypotheses are rejected, p values are above 0.05. Three hypotheses are significant, i.e., External Circumstances (EC) and Entrepreneurship (EN) impact Research Commercialization (RC). Student Capabilities (SCAP) impacts Entrepreneurship (EN).

The calculation results for India present that the Outer Loadings are above and below 0.7, Cronbach's alpha is > 0.70, Model is reliable. Four hypotheses are significant, i.e., External circumstance (ECIR) impacts Entrepreneurship (EN), External circumstance (ECIR) impacts Research Commercialization (RC). Student Capabilities (SCAP) impacts Entrepreneurship (EN), as well as Research Commercialization (RC). However, it is found

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that Entrepreneurship (EN) does not significantly influences the Research Commercialization (RC).

The calculation results for Poland present that the Outer loadings are above and below 0.7, Cronbach's alpha is above 0.6, what could be acceptable for novel models. Hence, model is reliable, two hypotheses are rejected, p values are above 0.05. Three hypotheses are significant. The Student Capabilities (SCAP) and External Circumstances (ECIR) impact Research Commercialization (RC). Student Capabilities (SCAP) have impact on the Entrepreneurship (EN).

In the case of Portugal, the calculation results present that the Outer loadings are above and below 0.7, Cronbach's alpha is above 0.7. Hence, the model is reliable, one hypothesis is rejected, p values are above 0.05. Four hypotheses are significant, i.e., The Student Capabilities (SCAP) and External Circumstances (ECIR) impact Research Commercialization (RC). Student Capabilities (SCAP) and External Circumstances (ECIR) have an impact on the Entrepreneurship (EN).

After the estimation of the proposed model for the mentioned above six countries, the authors present the summary of key findings:

1. India stands out with significant relationships for ECIR -> EN, ECIR -> RC, SCAP -> EN, and SCAP -> RC, but no significant relationship between EN and RC, highlighting the importance of external circumstances and student capabilities in entrepreneurship and research commercialization.
2. Colombia and Portugal show strong overall significance, with external circumstances and student capabilities having a profound impact on both entrepreneurship and research commercialization.
3. Azerbaijan shows no significant relationships except SCAP -> EN, suggesting weaker links between the variables in the context of entrepreneurship and research commercialization.
4. Egypt demonstrates significant relationships, particularly in ECIR -> RC and SCAP -> EN, indicating the importance of these factors in their entrepreneurial ecosystem.
5. Poland shows mixed results, with significant relationships mainly in SCAP -> EN and SCAP -> RC, indicating the crucial role of student capabilities in the entrepreneurial process.

This comparative analysis highlights the varying impacts of external circumstances and student capabilities on entrepreneurship and research commercialization across different countries, suggesting that tailored approaches may be necessary for fostering entrepreneurial ecosystems in each context.

Also while this study combined constructs related to entrepreneurial intention and individual abilities, it did not empirically detach the psychological characters of motivation, risk tolerance, and opportunity recognition across the six countries. However, experiential differences in commercialization consequences may replicate basic psychological and cultural factors. For example, higher entrepreneurial results in Poland and Portugal may be influenced by stronger institutional inspiration and reduced ambiguity, while students in Egypt and India may show greater risk aversion due to socio-economic variability. Future research could adopt cross-cultural psychological profiling methods to deepen our

understanding of how personal qualities interact with contextual variables to impact entrepreneurial behavior and training requirements.

Beyond that, the authors formulate some other recommendations for research results' applications:

- Implications of research: The data presented in the above tables indicate that there are significant implications for both policy and practice of encouraging entrepreneurialism and the commercialization of research in a variety of countries.
- Support Systems Tailored to Your Needs: The countries of India, Colombia, and Portugal have demonstrated considerable influences of external circumstances (ECIR) on the commercialization of research and entrepreneurial endeavors alike. This indicates that these nations should continue to expand support mechanisms such as funding, social capital, and mentorship in order to further enhance entrepreneurial activities and efforts to commercialize their products. It is possible that Azerbaijan and Poland, who have a relatively minor impact on the European Center for International Relations (ECIR), may need to reevaluate their external support systems in order to guarantee that they are effectively supporting entrepreneurial and commercialization outcomes. While social capital significantly influenced commercialization results, the nature of these systems and access mechanisms differ across cultural contexts. In countries like India and Colombia, casual networks—such as peer groups, family ties, and alumni connections—play a stronger role in guiding entrepreneurial activities. On the other hand, students in Portugal and Poland are more likely to participate with formal structures, like university-based mentorship programs, incubators, and accelerator platforms. These differences propose that universities need to advance culturally responsive approaches: informal engagement strategies in network-based societies, and institutional strengthening in systems that rely on organized support. Modifying social capital development tactics to national culture can augment inclusivity and expand access to commercialization paths.
- Putting an Emphasis on the Capabilities of Students: In the countries of Colombia, Portugal, and Poland, it has been demonstrated that student capabilities (SCAP) have a significant impact on both research commercialization and entrepreneurial endeavors. In light of this, it is clear that these nations require educational reforms and initiatives that aim to cultivate essential abilities such as self-regulated learning, opportunity recognition, and leadership. As a result of their fewer substantial linkages, Azerbaijan and Egypt could potentially reap the benefits of a greater emphasis on the development of student capabilities within their educational systems in order to enhance the success of entrepreneurial endeavors and commercialization.
- Exploring the Relationship Between Entrepreneurship and Commercialization: The fact that there are no significant correlations between research commercialization (RC) and entrepreneurship (EN) in India, Azerbaijan, Poland, and Portugal indicates that this is a problem that is shared by all of these countries. Because of this gap, it appears that entrepreneurial endeavors alone might not be sufficient to ensure successful commercialization. Policymakers and educators must take into consideration the possibility of adopting tailored interventions in order to assist entrepreneurs in transforming their ideas into products that are commercially viable. In spite of institutional interest for research commercialization, students often face significant execution barriers. These include administrative procedures when engaging with technology transfer offices,

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inadequate legal understanding of intellectual property rights, and low financial knowledge regarding accounting, fundraising, or investment. Such challenges can hinder the conversion of student ideas into viable entrepreneurial projects. To address this, universities should match infrastructure expansion with tailored workshops, easy procedures, and hands-on support in legal and financial domains.

- Differences Across Regions: According to the fact that the significance varies from country to country, it is highly improbable that measures that are universally applicable can be successful. Instead, strategies and activities ought to be tailored to the particular circumstances of each nation, taking into account the one-of-a-kind influence of external factors and the skills of students.

5. 7. General Conclusions and Recommendations for Future Research

Empirical findings have confirmed some significant observations found in the literature survey. University in various countries have developed politics and initiatives to encourage students to be the entrepreneurs. However, the education system should strongly motivate students and empower them to take responsibility for their decisions. However, taking into account the literature survey, the publication did not sufficiently well highlight the pivotal role of student entrepreneurship in research commercialization.

Although there are still various entrepreneurship programs of study, there is still a need to increase the efficacy of the programs, because the universities play important role in promoting the entrepreneurship and innovation commercialization among students.

Through the survey distributed in six countries, this work investigates the influence of various entrepreneurial factors and regional entrepreneurship spirit on university students' entrepreneurial decision-making. To gain a better understanding of the relationship between variables, a qualitative method based on the Structural Equation Modeling (SEM) was used. The findings show that internal and external factors have an impact on the entrepreneurship, as well as on the research commercialization. However, the hypothesis on the Entrepreneurship variable impact on the Research Commercialization has been rejected. Although, the study provided by Akram et al. (2017) presented that there is a significant impact of entrepreneurial orientation of academic researchers on the research commercialization, which is positively mediated by trust.

Although students expressed generally positive views toward entrepreneurship, the survey revealed limited depth in their awareness and engagement with available institutional resources. Many respondents were unfamiliar with specific support mechanisms such as technology transfer offices, startup incubators, or intellectual property advisory services offered by their universities. This suggests that while entrepreneurial intent may be present, the practical understanding of how universities facilitate research commercialization is often lacking. The findings imply a gap not only in infrastructure usage but also in institutional communication. Future research could explore whether increased visibility and accessibility of these resources enhances commercialization outcomes.

However, there is a substantial difference between the research commercialization efforts of researchers and students. Researchers, by definition, are obliged to be creative

and provide new ideas, inventions, and improvements. Lately, through various programmes and university education, as it is presented in this paper, students are encouraged to entrepreneurial activities. For students, participation in workshops, seminars, contests, hackathons, and project-based learning (PBL) and challenge-based learning (CBL) courses is the unique way to develop their own inventions. However, the university as the only place for entrepreneurship and research commercialization learning environment is not enough, hence the students are expected to go outside the schools and work for business This paper focuses on presenting just the student standpoint and their readiness to actions.

This research is expected to make significant contributions to the field of entrepreneurship. It specifically addresses a critical gap by examining the role of university policies in fostering student entrepreneurship and advancing the commercialization of student research. Universities should perceive the entrepreneurial culture as a way of bringing critical needed resources, such as funds, collaborations, and access to facilities from different sources. The process of student entrepreneurship support and exploration of market opportunities by universities can strengthen university – business – government collaboration.

Beyond that, the authors have formulated some recommendations. First, conduct Research on Some Context-Specific Factors: Given that the results vary from country to country, it is important that future study investigates the characteristics that are distinctive to the setting, as these aspects may explain the different affects that external conditions and student capacities have. This could involve conducting qualitative research in order to discover the specific obstacles and opportunities that exist in certain places.

Secondly, investigate the mechanisms that link EN and RC**:** In light of the fact that numerous nations, including India, do not exhibit a significant direct association between research commercialization (RC) and entrepreneurship (EN), it is recommended that future research investigate the processes that mediate or temper this relationship. The study of the function that innovation ecosystems, technology transfer offices, or industrial alliances play could fall under this category.

Third, conduct Longitudinal Studies: To gain a better understanding of the ways in which the linkages between ECIR, SCAP, EN, and RC develop over time, it would be beneficial to conduct longitudinal research across all of these countries. With this information, it may be possible to discover long-term patterns and determine the viability of initiatives that are designed to improve commercialization and entrepreneurship.

Fourth, Cross-national comparative research: If the scope of this research were expanded to include additional countries and a comparison was made between different areas (for example, Latin America and Asia), it could be possible to gain a more comprehensive picture of the worldwide trends in entrepreneurship and commercialization. In addition, comparative studies have the potential to identify best practices that are adaptable to a variety of diverse contexts.

Fifth, concentrate on Governmental Interventions: In the future, research should be conducted to evaluate the efficacy of particular policy interventions that are targeted at enhancing both the external circumstances (such as funding initiatives and mentor programs) and the capacities of students (such as entrepreneurship education) in both

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domestic and international settings. In order to develop policies that are more targeted and successful, it is possible to evaluate the effects of such actions.

Finally, Studies that are Industry-Specific: When taking into account the fact that many industries could have their own distinct dynamics, sector-specific studies might prove to be valuable. By doing research into the ways in which ECIR and SCAP influence entrepreneurship and commercialization in industries such as technology, healthcare, and manufacturing, it is possible that useful insights will be uncovered that can be used to build targeted policy.

This study covers the structural equation modeling, which is based on selected social science theories and models. This paper covers de facto six case studies, as statistical data is collected in six countries. The presented model results from theoretical considerations presented in various publications. Anyway, the authors agree that this research work could be further developed including culture differences as well as socio-economic circumstances.

Although the choice of universities participating in this research was non-random, and the researcher jointly created the idea of studying students' entrepreneurship and research commercialization, this study revealed some similarities in approaching issues in countries from various continents. Maybe a globalization of the education system and internet communication enable sharing knowledge and practices, but also local needs can be similar, and everywhere young people are encouraged to be active and creative. This structural equation modeling reveals opportunities of the research continuation with usage of qualitative methods, i.e., case study, action research, including learning by doing approach, ethnographic research. These methods could support identification of the best practices and sharing them, instead of formulation of general recommendations. The general recommendations and their implementation could be the subject of discussion and inspiration to elaborate new regulations at universities.

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6. Appendix

Constructs and Items for the Student Entrepreneurship and Research Commercialization model

Internal Factors (Student Capabilities, SCAP)			**Reference**
Self-Regulated Learning (SRL)	SRL1	1. Attending the seminar and conferences allows to receive knowledge on other research ideas	Abd Rahim et al., 2024; Khairani & Zhang, 2025
	SRL2	2. Attending the exhibitions allows to gain knowledge on products that have been commercialized	
	SRL3	3. I'm able to discuss with people from the industry on their problems that could be resolved through research	
	SRL4	4. I'm able to gather market information about potential customer, supplier or competitor	
	SRL5	5. Student Research Club participation is valuable for commercialization of research results	
	SRL6	6. Consulting companies, such as external agencies are necessary to refine and enrich business plan of research commercialization	
Opportunity Recognition(OR)	OR1	1. I'm able to identify the research ideas that can be changed into new products and services	Abd Rahim et al., 2024; Lopes da Rocha et al., 2024
	OR2	2. I'm able to identify research ideas that can improve existing product or services	
	OR3	3. I'm able to identify research ideas that can benefit other organizations	
	OR4	4. I'm able to design product or services to remove customer problems	
Risk Taking (RT)	RT1	1. I'm capable to work effectively under pressure and stressful conditions	Abd Rahim et al., 2024;Lopes da Rocha et al., 2024; Ferreira et al., 2017; Hosomi et al., 2024
	RT2	2. I'm persistent in achieving my mission even though facing with misfortune	
	RT3	3. If I identified innovative application of my research, I would consider putting more effort to commercialize the opportunity	
Self-Efficacy (SE)	SE1	1. I trust I have a good competence to identify business opportunities in the market	Salati Marcondes de Moraes et al., 2022; Ferreira et al., 2017; Sadao Iizuka et al., 2024; Gao et al., 2024; Vivekananth et al, 2023; Lopes da Rocha et al., 2024
	SE2	2. When I see a problem, I can usually find several solutions	
	SE3	3. I consider myself as more persistent person than the others	
	SE4	4. I understand that gain requires pain, but I can achieve the demanded goals	

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Leadership (LE)	LE1	1. I'm often chosen as the leader in school or professional activity association	Salati Marcondes de Moraes et al., 2022; Habdal et al., 2024; Sadao Iizuka et al., 2024; Lopes da Rocha et al., 2024
	LE2	2. People respect my opinion	
	LE3	3. I can convince people to overcome conflicts and work as a team aiming to certain achievements	
	LE4	4. I can encourage people to do tasks for which they are demotivated	
Planner (PL)	PL1	1. I always plan very precisely everything I do	Salati Marcondes de Moraes et al., 2022; Sadao IiZuka et al., 2024; Lopes da Rocha et al., 2024
	PL2	2. I define my road map and all the steps I must take to achieve goals	
	PL3	3. I can define my short, medium and long term goals	
	PL4	4. I like to rise to the challenges	
Innovator (INN)	INN1	1. I'm creative when carrying out projects/activities	Salati Marcondes de Moraes et al., 2022; Sadao Iizuka et al., 2024; Lopes da Rocha et al., 2024
	INN2	2. I'm changing my way of working whenever possible	
	INN3	3. I like to improvise my work whenever possible	
	INN4	4. I like prototyping and continuously correcting ways of activity performance, not strictly according to rules	
External Circumstances (ECIR)			
Social capital (SC)	SC1	1. My contacts from professional forums (i.e., conferences, workshops, seminars) encourage me to commercialize my research results	Abd Rahim et al., 2024; Xiao et al., 2019; Huegel et al., 2024
	SC2	2. My contacts from personal network (i.e., friends, close family, colleagues) facilitate me to commercialize my research results	
	SC3	3. My discussions with potential customers or potential suppliers encourage me to commercialize my research results	
	SC4	4. My discussions with potential and actual competitors (i.e., other students, colleagues) encourage me to commercialize my research results	
Funding (FU)	FU1	1. I think that the donation offered for research and development activities (i.e., value analysis, concept idea, basic and applied R&D) is easily obtainable	Abd Rahim et al., 2024; Xiao et al., 2019; Belitski et al., 2019
	FU2	2. I think that grants offered for pre-commercialization activities (i.e., experimental research prototype, incubation) are easily obtainable	
	FU3	3. I think that grants offered for commercialization activities (i.e., pilot production, early growth, mature production, value realization) are easily obtainable	
	FU4	4. Various grants for R&D, pre-commercialization and commercialization that are easily obtained encourage me to pursue effort to commercialize research findings	

Entrepreneurial peers (EP)	EP1	1. A colleague, who has been engaged in knowledge development activity, inspires me to get involved in the same activity too (e.g., research, consultation)	Abd Rahim et al., 2024; Wang et al. 2022; Xiao et al., 2019; Sutrisno et al., 2024; Alkaabi & Senghore, 2024
	EP2	2. A colleague, who has been involved in technology transfer activity (e.g., licensing/patenting), inspires me to get involved in the same activity too	
	EP3	3. A colleague, who has been engaged in transfer of product activity (e.g., creation of spin-offs, start-ups), inspires me to get involved in the same activity too	
	EP4	4. A colleague, who has been involved in pre-commercialization activity (e.g., experimental research problem/incubation), inspires me to get involved in the same activity too	
	EP5	5. A colleague, who has been involved in commercialization activities, inspires me to get involved in the same activity too (e.g., pilot production/early growth, mature production/value realization)	
Mentor support (MS)	MS1	1. I need a mentor who helps me to identify ideas on how my research can be explored for commercialization	Abd Rahim et al., 2024; Khairani & Zhang, 2025
	MS2	2. I need a mentor who helps me with information and supports to undertake pre-commercialization activities	
	MS3	3. I need a mentor who helps me with information and supports to undertake commercialization activities (pilot production, early growth, mature production, value realization)	
	MS4	4. I need a mentor who helps me with information and supports me to get involved in book writing or consultation or contract research activities	
	MS5	5. I need a mentor who helps me with information and supports to get involved in licensing and patenting	
	MS6	6. I need a mentor who helps me with information and supports to get involved in creation of spin-offs	
Entrepreneurship (EN)	EN1	1. I'm ready to be a businessman	Abd Rahim et al., 2024; Xiao et al., 2019; Ferreira et al., 2017; Gao et al., 2024
	EN2	2. I want to create and maintain my own company	
	EN3	3. I intend to start my own business in the next few years	
	EN4	4. I'm able to develop my leadership skills through group work to be manager of own business	
	EN5	5. I believe I can improve my creativity and ability to innovate only through my own business	

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Research Commercialization (RC)	RC1	1. Commercializing my research to industry is an important part of my self-image	Chung & Hyun, 2019; Schmitz et al., 2017; Tweheyo et al., 2024; Zhou & Baines, 2024
	RC2	2. I have strong relations with academic scientists who are passionate about their research commercialization	
	RC3	3. Being a researchers is an important reflection of who you are	
	RC4	4. University should support commercialization of student research	
	RC5	5. Industry and universities should develop strategic alliances for research commercialization	
	RC6	6. University should encourage student to contract research and consulting with industry	

7.