Future Generation's Paths to Success in Research, Innovation, and Entrepreneurship: Framework Analysis of An International Student Workshop using Large Language Models

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Abstract: Entrepreneurial universities are expected not only to generate knowledge but also to translate it into innovation and new ventures. Students, through their research, innovation, and entrepreneurial activities, are key contributors to this model. Using a large language model (LLM)–assisted qualitative approach, this study explored Central and Eastern European students' perspectives on research, innovation, and entrepreneurship, and evaluated the performance of LLMs in framework analysis. Fifteen interactive workshops were organised with 75 students from Slovakia (n = 42), Romania (n = 23), Hungary (n = 9), and Brazil (n = 1). Guided by Social Cognitive Theory, 483 responses were coded across 36 themes, yielding 17,388 data points analysed by three LLMs (GPT-4o-mini, Claude Sonnet 3.7, and DeepSeek v3.1) and validated by two independent human raters. The LLMs achieved 85.6% agreement, but only 58.8% of LLM-identified themes were jointly accepted by human reviewers. Summaries of accepted codes were produced using ChatGPT 5.1. Students expressed strong intrinsic motivation, altruistic values, and positive attitudes toward innovation, entrepreneurship, and research. Resilience, critical thinking, communication, networking, and time management emerged as common enablers, whereas low confidence, limited experience, and anxiety were key internal barriers. Time pressure, scarce funding, institutional rigidity, and complex regulations were the most prominent external challenges. Tailored institutional support is needed to foster student-driven innovation, entrepreneurship and research.

Keywords: innovation; entrepreneurship; research; entrepreneurial university; large language model; LLM; qualitative analysis; framework analysis; teaching quality

1 Introduction

In addition to the traditional role of universities as knowledge-producing entities in national systems of innovation [1], in the Triple Helix model, universities appear as active shapers of the innovation ecosystem, and not as mere knowledge producers [2]. The emerging entrepreneurial university model emphasizes that universities need to formulate a clear strategic direction, and a firm commitment to putting the knowledge generated within the university in to use. This also requires the development of internal capabilities for technology transfer, research commercialisation and alliance management with key actors of the innovation ecosystem [3]. While Stanford University established the first university research park in 1951—helping catalyse early university–industry collaboration—the major surge in university innovation, patenting and technology transfer across the United States was reinforced by the incentives introduced in the Bayh–Dole Act of 1980 [4, 5]. Widely cited as the third mission, the contribution of universities to entrepreneurial activities and economic development has widely been recognised [6, 7], and many European universities have also adopted the entrepreneurial university model [8]. While the paths are converging, the European model is focused more on education, while the US entrepreneurial university model emerged from research activities [8].

Recent research has shown that students are active co-creators of entrepreneurial activities within the entrepreneurial university and largely contribute to the formation of new ventures and the spillover of entrepreneurial knowledge [9]. Furthermore, entrepreneurial knowledge, intentions, skills, venture formation and economic impact are positively impacted by entrepreneurial education [10]. Intrapreneurship (e.g., entrepreneurial behaviour within an larger organisation) is seen as a fundamental skill in entrepreneurial universities [11]. However, the integration of the multiple logic of education, research and intrapreneurship poses a considerable challenge for both individuals and academic institutions [12].

Following an ambitious rectoral strategy, Obuda University has established a regionally unique innovation ecosystem in Central and Eastern Europe. Thereby, featuring a University Research and Innovation Center, Science and Innovation Parks, a technology transfer firm (Initium Venture Labs) and a University Venture Capital Firm (OUVC) [13]. To nurture the culture of innovation and entrepreneurship, an international workshop was organised on May 19, 2025 involving student group discussions about various aspects of research, innovation and entrepreneurship in an academic setting [14]. This paper aims to summarize the main findings of this workshop about students' perspectives related to research, innovation and entrepreneurship. For the analysis, we applied a hybrid method of large language-model-based qualitative framework analysis, which was then validated by human reviewers. The secondary aim was to report on the acceptability of LLM-based analysis by human researchers.

2 Methods

2.1 Data collection

The workshops were organised a part of the IEEE 19th International Symposium on Applied Computational Intelligence and Informatics (SACI 2025, https://ekik.uni-obuda.hu/en/mecenatura-2025/). Altogether fifteen 45-minute-long workshops were conducted and moderated by pairs of researchers, who are the authors of this paper (Table 1). Up to 8 participants could register to each topic. During registration, all participants gave informed consent to participate in the workshops and publish results anonymously. The workshop topics are shown in Table 1. In each workshop, participants discussed the following questions: 1) introduction, 2) participants' connection to the workshop topic, 3) barriers and enablers of success in academic career, 4) critical skills and capabilities needed for success, 5) vision for the future. Moderators may have included a few extra questions.

The workshops were video recorded and transcribed by the Adobe Premier Pro software in SRT file format (text with time stamps) [15]. The moderators have

Table 1

Workshop topics

Workshop 1	**Workshop 2**	**Workshop 3**	**Workshop 4**	**Workshop 5**
Digital innovations and academic entrepreneur-ship in STEM education	Gaining traction in science: managing visibility and impact	Is knowledge sexy? What makes a PhD attractive?	The place of innovation in the university curriculum	Navigating the intellectual property maze: when to publish, what to protect?
Workshop 6	**Workshop 7**	**Workshop 8**	**Workshop 9**	**Workshop 10**
Academic entrepreneur-ship in medicine, health engineering, and life sciences	Using social media effectively: the like economy of science and innovation	New career paths in the innovation ecosystem	Nature and nurture: how shall universities recognise and support talent in innovation and entrepreneurship?	Embedding business planning and technology assessment in early phases of the innovation process
Workshop 11	**Workshop 12**	**Workshop 13**	**Workshop 14**	**Workshop 15**
Academic entrepreneur-ship in computer science and artificial intelligence	Using large language models and generative AI for science	Publish or perish in creative and art curricula	Student innovation: experiences and challenges of young startuppers	How to measure and predict innovation success?

double-checked the transcripts and corrected errors, and anonymously labelled participants as [P1], [P2], etc., and moderators as [M]. The workshop transcripts were stripped from time stamps, converted to a data spreadsheet and tabulated in four columns: 1) topic, 2) question, 3) verbatim transcription of the moderator asking the question, 4) participants responses. Moderators' interrogations and clarifications for each participant were included in column 4 with participants' responses. Each response per participant represented a separate row. To preserve the context during the framework analysis, the topic, question and moderator content was included repeatedly for each participant section. A sample of the dataset is shown in Table 2.

Table 2

Sample dataset

Topic	**Question**	**Moderator**	**Participant**
Navigating the intellectual property maze: when to publish, what to protect?	2. Connection with the workshop topic	The first question is how are connected to the topic, which is: What to publish and what to protect with IP, and how to balance between publishing as much as possible from the ideas, but on the other hand, be careful and patent the ideas. And I believe that you doing the two may not be easy. How are you connected to this topic? Why did you choose this topic, and what's interesting in it for you? What do you think about this question?	[P7] I just wanted to know what is, important, because, as I said, I'm from the first year, actually I have not yet published anything. So, I just wanted to hear out of some ideas how we should protect our ideas. [M] Why is it interesting for you. [P7] Because I don't know how to publish. And I would like to publish. So, I actually I didn't know that I really have to protect my ideas. So, it is important to protect what I made or discovered, and not just share as you ([P5]) had said that we just share those models, and we cannot benefit from them. Not just financially, but also, personally as my business. [M] So, you think that it is important that you have a personal benefit from your ideas and you are interested in how to protect them before you publish? [P7] Yes.

Navigating the intellectual property maze: when to publish, what to protect?	2. Connection with the workshop topic	The first question is how are connected to the topic, which is: What to publish and what to protect with IP, and how to balance between publishing as much as possible from the ideas, but on the other hand, be careful and patent the ideas. And I believe that you are doing the two may not be easy. How are you connected to this topic? Why did you choose this topic, and what's interesting in it for you? What do you think about this question?	[P8] I think that ideas that are open spread quicker. So, if, if you want to get something out to the world, you, you are better at publishing, and you'd like to offer to the public to use. But if you think that the idea should not spread quickly, or that this is necessary for something like someone else in the future, then I think, protecting it is a good choice. But in general, I like the concept of sharing, what you what you have, like your knowledge with the others. In a similar way that for example, to open source software for computers, et cetera. So, I think usually there's more benefits to share what you know with the world, because it creates new ideas for some other people. And I think that the overall the gain is positive, even though for you personally, it might not be, you may not get any benefit of this. But if your goal is let's say, very noble or altruistic, to improve the human society, then it is a benefit in itself that the library of knowledge grows, thanks to you.

2.2 Conceptual framework

Motivated by the seminal Social Cognitive Theory (SCT) of Albert Bandura [16] and its extension, The Social Cognitive Theory of Career and Academic Interest, Choice, and Performance (SCCT) by Lent et al. [17], we sought the occurrence of 36 themes in participants responses, revolving around research, innovation and entrepreneurship. We recorded knowledge related to 1) innovation, 2) entrepreneurship 3) and research concepts, 4) intrapreneurship, 5) interdisciplinary concepts, as well as 6) institutions for innovation and entrepreneurship, and 7) research. We also asked intentions related to 8) innovation, 9) entrepreneurship, and 10) research, 11) vision for the future, 12) the respondent's intrinsic motivation, and 13) extrinsic motivation, and 14) personal values. Furthermore, we sought attitudes related to 15) innovation, 16) entrepreneurship, and 17) research. We also coded subjective norms related to 18) innovation, 19) entrepreneurship and 20) research, and perceived behavioural control related to 21) innovation, 22) entrepreneurship and 23) research. We coded internal and external barriers and enablers related to innovation (24-27), entrepreneurship (28-31) and research (32-35). Finally, acknowledging that individuals who are energized by tensions tend to be more innovative at work [18], we added a final theme about paradoxes or conflicting factors related to innovation, entrepreneurship and research.

2.3 Qualitative framework analysis

The workshop content was analysed via the framework analysis technique adapted for LLMs [19, 20]. This technique applies qualitative coding along predefined themes in a matrix form, where participants'responses are organised in rows and themes in columns. First, we applied deductive coding by two LLMs (API interfaces of Open AI GPT-4o-mini and Anthropic Claude Sonnet 3.7) [21, 22]. We used

structured prompting specifying the persona (qualitative researcher in innovation management), context (workshop transcripts on academic innovation, entrepreneurship and research), task (code participant input into predefined categories) with refined input semantics (explanation of all 36 themes) and the output format. [23]. The LLMs were prompted to evaluate in each row if the theme was reflected in participant responses. If yes, the LLMs were asked to provide a 5-10-word-long summary to support their finding. If not, the LLMs were prompted to respond as NONE. All themes and their explanations were included in a single prompt (Table 3), and answers were requested as a single string with themes numbered and separated by a delimiter. We prompted DeepSeek-v3.1 [24] for a final LLM response, by providing it with the responses of the two initial LLMs as well as the original coding rules. The responses of the three LLMs for each row were captured in the data spreadsheet and split to columns by themes.

Table 3

The prompt template

Persona		
You are a qualitative researcher in innovation management.		
Context		
You will get a transcript from a workshop, which was organised on academic innovation, entrepreneurship and research. The topic of the workshop was: [topic], the question was: [question], the moderator ([M]) asked the following [moderator]. A participant's ([P1], [P2] etc.) response was this, including the moderator's brief interrogations: [participant].		
Task		
You will have to code the input from each participant according to categories provided below. Please evaluate the participant's input using the following coding rules.		
Input semantics		
Knowledge		
#1	Knowledge related to innovation concepts	Did this passage contain information that reflects the respondent's knowledge or understanding related to innovation concepts, such as innovation theories, processes, strategies, or innovation management practices?
#2	Knowledge related to entrepreneurship concepts	Did this passage contain information that reflects the respondent's knowledge or understanding related to entrepreneurship, such as theories, entrepreneurial behaviours or personal characteristics?
#3	Knowledge related to research concepts	Did this passage contain information that reflects the respondent's knowledge or understanding related to scientific research methodology, dissemination, and academic publishing?
#4	Knowledge related to intrapreneurship concepts	Did this passage contain information that reflects the respondent's knowledge or understanding related to intrapreneurship, such as theories, behaviours or personal characteristics? Intrapreneurship means entrepreneurial behaviour and innovation within established organizations.
#5	Interdisciplinary knowledge	Did this passage contain information that reflects the respondent's knowledge or understanding related to interdisciplinary knowledge, such as theories, behaviours or personal characteristics? Interdisciplinary knowledge is the ability to integrate concepts from multiple fields to solve complex problems.
#6	Institutional knowledge related to innovation or entrepreneurship	Did this passage contain information that reflects the respondent's knowledge or understanding related to the institutional structures or resources concerning innovation and entrepreneurship, such as incubators, tech transfer offices, funding sources, innovation ecosystems, related rules and regulations?
#7	Institutional knowledge related to research	Did this passage contain information that reflects the respondent's knowledge or understanding related to the institutional structures or resources supporting research such as grants, infrastructure, and libraries?
Intentions & Motivation		
#8	Intentions related to innovation	Did the respondent express his or her plans or intention to engage in innovation in the future?
#9	Intentions related to entrepreneurship	Did the respondent express his or her plans or willingness to start, lead or expand a venture?
#10	Intentions related to research	Did the respondent express his or her plans or willingness about future research activities or a research career?

#11	Vision for the future	Did the respondent express his or her vision for the future? A vision is an aspirational picture of a desired future state — what you ultimately want to achieve or become. It may be related to aspirations toward innovation, entrepreneurship, or societal impact, or personal development.
#12	Intrinsic motivation	Did the respondent reveal his or her intrinsic motivations? Intrinsic motivation is a drive to engage in an activity because it is inherently interesting, enjoyable, or fulfilling.
#13	Extrinsic motivation	Did the respondent reveal his or her extrinsic motivations? Extrinsic motivation is a drive to engage in an activity because of external rewards or pressures, such as money, grades, or recognition.
Values		
#14	Values	Did the respondent reveal his or her personal values? Values are the deeply held beliefs or principles that guide what people consider important, right, and worthwhile in life.
Attitudes		
#15	Attitudes related to innovation	Did the respondent reveal his or her attitude towards innovation, or innovation activities or roles? Was it positive, negative, or neutral?
#16	Attitudes related to entrepreneurship	Did the respondent reveal his or her attitude towards entrepreneurship, or entrepreneurial activities or roles? Was it positive, negative, or neutral?
#17	Attitudes related to research	Did the respondent reveal his or her attitude towards research, or researcher activities or roles? Was it positive, negative, or neutral?
Subjective Norms		
#18	Subjective norms related to innovation	Did the respondent reveal his or her subjective norms towards innovation, or innovation activities or roles? Subjective norms represent the perception of social pressure; the belief of what others expect from someone to do in a certain situation.
#19	Subjective norms related to entrepreneurship	Did the respondent reveal his or her subjective norms towards entrepreneurship, or entrepreneurial activities or roles? Subjective norms represent the perception of social pressure; the belief of what others expect from someone to do in a certain situation.
#20	Subjective norms related to research	Did the respondent reveal his or her subjective norms towards research, or researcher activities or roles? Subjective norms represent the perception of social pressure; the belief of what others expect from someone to do in a certain situation.
Perceived Behavioural Control		
#21	Perceived behavioural control related to innovation	Did the respondent reveal his or her perceived behavioural control about innovation, or innovation activities or roles? Perceived behavioural control reflects how much control or confidence someone feels they have over carrying out an action.
#22	Perceived behavioural control related to entrepreneurship	Did the respondent reveal his or her perceived behavioural control about entrepreneurship, or entrepreneurial activities or roles? Perceived behavioural control reflects how much control or confidence someone feels they have over carrying out an action.
#23	Perceived behavioural control related to research	Did the respondent reveal his or her perceived behavioural control about research, or researcher activities or roles? Perceived behavioural control reflects how much control or confidence someone feels they have over carrying out an action.
Barriers & Enablers		
#24	Internal barriers related to innovation	Did the respondent reveal his or her internal barriers about innovation, or innovation activities or roles? Internal barriers are personal limitations someone feels they have over carrying out an action.
#25	External barriers related to innovation	Did the respondent reveal his or her external barriers about innovation, or innovation activities or roles? External barriers are situational, environmental, or institutional obstacles that come from outside the individual and hinder their ability to act, achieve goals, or implement ideas.
#26	Internal enablers related to innovation	Did the respondent reveal his or her internal enablers about innovation, or innovation activities or roles? Internal enablers are the inner strengths and capacities that empower individuals to act and overcome challenges.
#27	External enablers related to innovation	Did the respondent reveal his or her external enablers about innovation, or innovation activities or roles? External enablers are environmental or contextual factors that support and facilitate action or success.
#28	Internal barriers related to entrepreneurship	Did the respondent reveal his or her internal barriers about entrepreneurship, or entrepreneurial activities or roles? Internal barriers are personal limitations someone feels they have over carrying out an action.
#29	External barriers related to entrepreneurship	Did the respondent reveal his or her external barriers about entrepreneurship, or entrepreneurial activities or roles? External barriers are situational, environmental, or institutional obstacles that come from outside the individual and hinder their ability to act, achieve goals, or implement ideas.
#30	Internal enablers related to entrepreneurship	Did the respondent reveal his or her internal enablers about entrepreneurship, or entrepreneurial activities or roles? Internal enablers are the inner strengths and capacities that empower individuals to act and overcome challenges.

#31	External enablers related to entrepreneurship	Did the respondent reveal his or her external enablers about entrepreneurship, or entrepreneurial activities or roles? External enablers are environmental or contextual factors that support and facilitate action or success.
#32	Internal barriers related to research	Did the respondent reveal his or her internal barriers about research, or researcher activities or roles? Internal barriers are personal limitations someone feels they have over carrying out an action.
#33	External barriers related to research	Did the respondent reveal his or her external barriers about research, or researcher activities or roles? External barriers are situational, environmental, or institutional obstacles that come from outside the individual and hinder their ability to act, achieve goals, or implement ideas.
#34	Internal enablers related to research	Did the respondent reveal his or her internal enablers about research, or researcher activities or roles? Internal enablers are the inner strengths and capacities that empower individuals to act and overcome challenges.
#35	External enablers related to research	Did the respondent reveal his or her external enablers about research, or researcher activities or roles? External enablers are environmental or contextual factors that support and facilitate action or success.
Paradoxes & Contradictions		
#36	Paradoxes, contradictions, conflicting factors	Did the respondent reveal paradoxes, contradictions or conflicting factors about innovation, research and entrepreneurship? Paradoxes, contradictions, and conflicting factors refer to situations where opposing or inconsistent elements coexist, creating tension or complexity in decision making or outcomes.
Output		
After each theme from [1]-[14] and [18]-[36] If yes, write after your (previous) answer [#] followed by a 5-10-word-long excerpt supporting your finding followed by a semicolon. If no, write after the (previous) answer [#] NONE followed by a semicolon. *After themes [15]-[17]* If yes, write after your previous answer [#] followed by POSITIVE-, NEGATIVE-, or NEUTRAL- and a 5-10-word-long excerpt supporting your finding followed by a semicolon. If no, write after the previous answer [#] NONE followed by a semicolon. *Final output request* Provide your answer in a single string, by connecting the answers to each section, in the following format. Do not provide answer in any other format, only the one described below. [1] answer OR NONE; [2] answer OR NONE; .... [36] answer OR NONE;		

We performed and LLM-assisted sumation as follows: for each theme, if the final LLM response was acceptable by both human raters (see below), we asked ChatGPT 5.1 through the standard web interface to provide a brief 20-30 word long summary of main emerging concepts. The LLM was prompted to summarize main concepts in the order of their frequency occurring in participants'responses. We counted the number of responses used for the summaries, which reflected both their occurrence as well as the joint acceptability of the final LLM response by two human raters in the framework analysis.

2.4 Validation of LLM responses

For each theme, the LLM responses were validated by independent pairs of workshop moderators via binary acceptable / not acceptable categories. For a response to be acceptable, the theme had to be present in the participant's response and correctly summarised by the LLM according to the judgement of reviewers, or the theme had to be missing and correctly coded as NONE.

We evaluated the inter-rater agreement pairwise and jointly between the three models based on a binary evaluation of their responses (theme reflected / not reflected in the response). We used Cohen's kappa and Fleiss kappa for comparing two and three models, respectively [25, 26]. We also computed the inter-rater agreement between the acceptability judgements of two human raters. Kappa values

were interpreted as follows: none (0-0.20), minimal (0.21-0.39), weak (0.40-0.59), moderate (0.60-0.79), strong (0.80-0.90) and almost perfect (>0.90) [27].

Furthermore, we tabulated the acceptability of the final LLM responses (acceptable by both raters, not acceptable by either raters, disagreement between raters) for the entire data matrix, and if the theme was reflected or not reflected. We used Stata 17 statistical software for the analysis [28].

3 Results

3.1 Dataset

Altogether 75 students participated in the workshops from four countries including Slovakia (n=42), Romania (n=23), Hungary (n=9) and Brazil (n=1). Due to anonymous participation, those students, who participated in more than one workshop, were recorded as separate individuals, so we recorded 483 responses from 95 individual respondents. The workshop transcript was 57 283 words long. The data file prepared for framework analysis with repeated questions was extended to 86 416 words. We captured the LLMs responses and human raters' evaluations in a framework matrix containing 483 rows and 36 columns (17 388 data points). According to the final LLM responses the predefined themes were reflected in 2483 data points (14.3%), while the theme was absent in 14 905 data points (85.7%).

3.2 Agreement between LLMs

The absolute agreement and kappa values between the binary evaluations (theme reflected / not reflected) of the LLMs is shown in Table 4.

Table 4
Agreement between LLMs about whether themes were reflected in participants'responses or not

	Absolute agreement % (n/N)	Kappa
GPT-4o-mini vs Claude Sonnet 3.7	86.8% (15103 / 17388)	0.41
GPT-4o-mini vs DeepSeek-v3.1	89.1% (15487 / 17388)	0.51
Claude Sonnet 3.7 vs DeepSeek-v3.1	95.3% (16572 / 17388)	0.81
All three LLMs	85.6% (14887 / 17388)	0.58

When only two LLMs agreed, it was between GPT-4o-mini and Claude Sonnett 3.7 in 8.6% (216 / 2501), between GPT-4o-mini and DeepSeek-v3.1 in 24.0% (600 / 2501) and between Claude Sonnet 3.7 and DeepSeek-v3.1 in 67.4% (1685 / 2501) of the disagreement cases.

3.3 Acceptability of LLM responses

The agreement between the acceptability judgements of the two human raters on the final LLM responses of DeepSeek-v3.1 is shown in Table 5. The raters agreed more when a theme was missing than when a theme was present in the participant's response.

Table 5
Acceptability of the final LLM responses (DeepSeek-v3.1) as judged by two human raters

	Acceptable to both raters % (n/N)	Acceptable to neither rater % (n/N)	Raters disagree % (n/N)	Absolute agreement between raters % (n/N)	Kappa
All responses	85.0% (14788/17388)	1.5% (255/17388)	13.5% (2355/17388)	86.5% (15033/17388)	0.10
Theme missing	89.4% (13322/14905)	0.8% (155/14905)	9.8% (1468/14905)	90.2% (13437/14905)	0.08
Theme present	58.8% (1459/2483)	5.6% (140/2483)	35.6% (884/2483)	64.4% (1459/2483)	0.01

3.4 LLM-assisted summaries

The LLM-assisted summaries were based on those participant responses, which were rated as acceptable by both human raters. The summaries by the 36 themes are shown in Table 6. The number of responses by theme ranged between 134 (attitudes about research) and 2 (subjective norms about innovation). Most responses referred to research (n=511), followed by innovation (n=478) and entrepreneurship (n=364). Further 140 responses were not directly related to these topics.

Table 6
LLM-assisted summaries by theme

	#1 Innovation	**#2 Entrepreneurship**	**#3 Research**
Knowledge	(n=25) Participants showed broad understanding of innovation, emphasizing early-stage planning, applicability of ideas, value creation, innovation ecosystems, incremental improvement, and linking research to practical use, supported by structured processes, expert input, and systemic innovation models.	(n=40) Participants showed solid entrepreneurial awareness, emphasizing the need for planning and vision, teamwork and networking, risk-taking and resilience, and building expertise to start ventures, communicate value, and translate ideas into viable businesses.	(n=76) Participants showed strong awareness of research processes, emphasizing publishing strategies, supervisor guidance, data quality, idea generation, literature search skills, platform use (ORCID/ResearchGate), presentation clarity, and challenges of review time, rejection, and computational limits.
	#5 Interdisciplinary	**#4 Intrapreneurship**	
	(n=43) Participants emphasized interdisciplinary integration, combining engineering, healthcare and biomedical AI, robotics, economics, and linguistics, valuing generalist mindsets, mixed-background teams, and translating theory,	(n=7) Participants highlighted intrapreneurial thinking through applying business planning in companies, engaging with innovators at work, seeking new approaches, emphasizing stakeholder communication, connecting actors in innovation offices, and envisioning innovation-driven roles in organizations.	

	data and innovation into practical, real-world applications.		
	#6 Institutions for innovation and entrepreneurship		**#7 Institutions for research**
	(n=34) Participants emphasized institutional funding schemes (EU, national agencies, loans, venture capital) and university innovation infrastructure (innovation offices, Tech Transfer, incubators, science parks), alongside patent regulations, mentorship, and ecosystem-level university–industry collaborations.		(n=14) Participants highlighted limited computational resources, access to grants, and funding schemes as key factors, alongside library access constraints and university-provided research infrastructure as critical enablers of effective research work.
Intentions & Motivation	**#8 Innovation**	**#9 Entrepreneurship**	**#10 Research**
	(n=22) Participants expressed clear future-oriented innovation intentions, repeatedly mentioning plans to develop startups, create new technological or AI-based solutions, introduce ideas into real life, and pursue innovation-driven careers in industry or robotics.	(n=24) Many participants plan to start or grow their own startups or small companies, often alongside academic careers, mainly in technology, engineering or creative fields, aspiring to leadership and impactful innovation.	(n=53) Participants aim to finish PhDs and stay in academia as lecturers or professors, continuing research, beginning to publish, improving research methods, and applying expertise in healthcare, technology and computer science.
	#11 Vision for the future	**#12 Intrinsic motivation**	**#13 Extrinsic motivation**
	(n=90) Participants most often envisioned academic careers—becoming lecturers, professors, or completing PhDs—while many also aspired to build companies or impact innovations, improve society, and create meaningful, fulfilling lives.	(n=98) Students are intrinsically driven by curiosity, learning new ideas, helping others, creating meaningful impact, exploring interests in technology, art, and research, and pursuing personally fulfilling, passion-aligned work.	(n=25) Participants are extrinsically driven by financial rewards and secure income; academic success through publications, citations and impact; patent-based personal benefits; and recognition via conferences, networks, social media visibility and followers, despite time pressures.
Values	**#14 Values**		
	(n=40) Students consistently valued helping others, sharing knowledge, and improving society, alongside open-mindedness, critical thinking, perseverance, balance, and collaboration—emphasizing altruism, curiosity, and personal integrity as core guiding principles.		
Attitudes	**#15 Innovation**	**#16 Entrepreneurship**	**#17 Research**
	(n=95) Participants overwhelmingly expressed positive attitudes toward innovation, highlighting enthusiasm for learning, creating value, collaborating, and applying ideas. Neutral views reflected uncertainty or difficulty in decision making. Negative attitudes appeared rarely, mainly tied to frustration with complexity or institutional conservatism.	(n=64) Students most often expressed positive entrepreneurial attitudes, emphasizing ambition to start companies, persistence, learning from failure, and enthusiasm for business creation. Neutral views reflected uncertainty about future entrepreneurial roles. Negative attitudes centred on fear of risk, difficulty starting, and weak entrepreneurial preparation.	(n=134) Participants predominantly express positive attitudes to research as meaningful, impactful, exciting careers; neutral ambivalence about workload, uncertainty and time pressures; and negative views on elitist, opaque, low-quality or impractical research.
Subjective Norms	**#18 Innovation**	**#19 Entrepreneurship**	**#20 Research**
	(n=2) Participants perceive strong social pressure to align with others' expectations—caring about peer evaluations, adapting research directions to social feedback, and navigating institutional conservatism that discourages innovative tools like generative AI.	(n=3) Participants perceive strong social pressure to prioritize degrees and stability over entrepreneurship, noting peers' reluctance to start ventures and a broader norm of limited initiative, unclear vision toward entrepreneurial roles.	(n=16) Participants emphasized social expectations to follow supervisors' guidance, publish in reputable venues, and maintain strong networks, while also noting peer pressure, institutional norms, and community standards shaping responsible, high-quality research conduct.
	#21 Innovation	**#22 Entrepreneurship**	**#23 Research**

Perceived Behavioural Control	(n=11) Participants expressed varied confidence in managing innovation, highlighting reliance on planning and strategic vision, the need to make decisive judgments and take risks, and uncertainty about measurement or implementation as limiting perceived control.	(n=21) Participants felt limited control due to fear of risk, difficulty finding partners, and weak networks, yet emphasized confidence, resilience, vision, and learning from failure as essential to acting entrepreneurially.	(n=18) Participants described limited research control due to inexperience, time-management challenges, and difficulty navigating publishing, while expressing growing confidence through networking, critical thinking, resilience, and seeking help to advance independently.
Internal barriers	**#24 Innovation**	**#28 Entrepreneurship**	**#32 Research**
	(n=27) Participants reported internal barriers like limited innovation-related knowledge, communication and networking difficulties, weak time management and self-discipline, and low confidence with fear of risk, failure and passivity reducing engagement.	(n=18) Participants highlighted fear of risk and failure, insufficient entrepreneurial knowledge, and introverted or weak communication limiting networking, alongside difficulties starting ventures and lacking clear, feasible business ideas or vision.	(n=45) Participants perceived limited time and heavy workloads, insufficient research experience or clear ideas, language and communication difficulties, complex literature, and anxiety, low confidence or introversion as major internal research barriers.
External barriers	**#25 Innovation**	**#29 Entrepreneurship**	**#33 Research**
	(n=61) Participants highlight insufficient funding, fragmented communication and weak networks, rigid institutional and cultural systems, and market, regulatory and data/AI constraints as major external obstacles to pursuing innovative projects.	(n=18) Participants highlight scarce funding and financial risk, uncertain or limited markets, weak mentorship and networks, patent-administrative hurdles, limited institutional support and opportunities, and communication gaps between academic research and business.	(n=53) Participants reported severe time pressure, limited funding and infrastructure, difficulties accessing or trusting quality literature, and weak mentoring, networks and institutional structures, including heavy teaching loads and patent–publication conflicts.
Internal enablers	**#26 Innovation**	**#30 Entrepreneurship**	**#34 Research**
	(n=37) Participants emphasised self-belief, ambition and courage to take risks and learn from failures, supported by strong communication and networking, critical learning mindsets, time management, diligence and adaptability.	(n=28) Participants highlighted courage, resilience, keep trying despite failure, strong communication and networking skills, curiosity and continuous learning, plus strategic vision, planning and technical expertise as key entrepreneurial enablers.	(n=46) Participants highlighted patience and perseverance, critical thinking, curiosity and learning, effective communication and networking, disciplined time management, solid technical knowledge, and self-confidence as key inner enablers supporting research success.
External enablers	**#27 Innovation**	**#31 Entrepreneurship**	**#35 Research**
	(n=74) Participants highlighted supportive supervisors and mentors, networking via conferences and social media, university opportunities and infrastructure, funding and incubation programs, and AI tools as key external enablers.	(n=16) Participants highlighted supportive networks and access to experts, mentors and role models, complemented by university programs, incubation ecosystems and online platforms, plus accessible funding such as loans and investors.	(n=31) Participants highlighted supervisors and teachers, expert stakeholder consultation, networking through conferences, workshops and online platforms, institutional funding, and AI or digital tools for visibility and writing support as key enablers.
Paradoxes & Contradictions	**#36 Paradoxes, contradictions, conflicting factors**		
	(n=50) Participants highlighted tensions between open sharing and patenting for personal gain, speed versus quality in publication, theory versus practical impact, AI/social media as productivity tools versus distractions, and innovation's promise versus heightened risk, failure, and inequality.		

4 Discussion

Based on the LLM-assisted framework analysis of the international student workshops, our main findings are the following. Students across innovation, entrepreneurship and research share strong intrinsic motivation (curiosity, helping others, meaningful impact) and altruistic values, and generally positive attitudes toward innovation, entrepreneurship and research. They see success as driven by similar internal enablers—resilience, critical thinking, communication, networking and time management—and constrained by comparable internal barriers such as low confidence, lack of experience/knowledge and anxiety. Externally, they rely on supervisors and mentors, peer networks, university infrastructure and funding, while facing pervasive constraints of time pressure, institutional rigidity, scarce funding and complex intellectual property management and publishing rules.

However, innovation, entrepreneurship and research education need for separate supporting structures and programmes. Innovation is framed around early-stage planning, applicability, ecosystems and balancing openness with protection; students struggle with measurement, implementation and regulatory and data constraints, so they need interdisciplinary project studios, support in open-science and intellectual property management, and access to artificial intelligence and technical infrastructure. Entrepreneurship centres on founding and growing ventures, where fear of risk, weak networks, unclear vision and limited markets or market knowledge dominate. These call for venture-creation programmes, role models, mentoring, networking platforms and tailored funding instruments. Research is anchored in mastering methods, publishing strategies and academic careers, with distinctive barriers in review time, literature access, limited infrastructure, heavy teaching loads and patent–publication conflicts: students need structured research training, writing and publishing support, lighter teaching burdens, better access to library and computational resources and guidance on responsible use of artificial intelligence tools and research metrics.

Regarding the institutional context of the results, the employment structure in Hungary, Romania, and Slovakia, is skewed for the industry versus services [29] assuming a generally low entrepreneurial mindset. In addition, the shares of high-growth enterprises of Hungary, Romania and Slovakia fall behind the leaders among the European Union Member States [29], suggesting that the local regulations and culture is not strongly supportive of entrepreneurship, which could discourage students' from taking this career path.

From a systemic point of view, university students play a particularly important role in the knowledge transfer value chain between the higher education institutions and industry players [30]. Therefore, enabling them with the appropriate infrastructure and knowledge could have positive halo effect on their stakeholders' attitude, as well. Considering the infrastructure, their adoption of and behaviour towards the latest digital tools will fundamentally shape how knowledge is absorbed, managed,

and disseminated [31-34]. It is thus essential to observe and understand their comportment, as they represent the future researchers, managers, and knowledge workers [35, 36].

Whereas previous literature has primarily applied institutional or systemic perspectives, a unique contribution of our study is that it examines the entrepreneurial university from the perspective of student motivational factors. The results suggest that student motivation plays important role in how an institution can develop into an entrepreneurial university. The motivational patterns clearly showed that a significant proportion of students envisioned themselves as long-term academic researchers, innovators, or social entrepreneurs, which could provide a strong human resource base for institutional innovation. Social utility is particularly important in students' value choices: many want to "make the world a better place" or "create something new and valuable," which is strongly consistent with the goal-oriented learning patterns of Generation Z [37, 38]. These findings fit well with the theoretical frameworks of entrepreneurial universities, according to which the basis of institutional success is the recognition and targeted development of student motivations [39]. However, in addition to motivations, obstacles are also significant: fear, uncertainty, and lack of knowledge emerged as consistent barriers, pointing to deficiencies in the support system. The majority of students emphasized the importance of mentoring support, community networks, and easy access to knowledge, which are among the most important structural elements of an entrepreneurial university according to international models [40].

The research thus demonstrates that universities need not only technological infrastructure but also a motivation-sensitive support chain. Overall, the study provides empirical evidence that the university entrepreneurial ecosystem can work effectively when its structural and digital elements are aligned with student motivations. Our results highlight that motivated students are not only participants in the development of the entrepreneurial university, but also, they shape it. Studying their attitude, norms and actions towards advanced technologies, such as LLMs and how they influence their views about innovation and entrepreneurship, warrants future research.

Large language models are increasingly used in qualitative research to assist human researchers [41-43]. With the rapid development of technology, the theoretical frameworks, the methodology of including LLMs in the research workflow, such as prompting techniques have also evolved over the past years [41-43]. Our analysis relied on the small-q approach, which is characterised by structured analysis, quantified results and assessing the validity and reliability of findings [43]. We have kept human researchers in the loop when defining research themes, defining coding instructions, evaluating the acceptability of responses, and summarizing themes. A limitation of our approach is that we used only 58.8% of the data points, in which LLM responses were rated as acceptable by two human raters. Thereby, a large amount of data was omitted from the analysis, with potential loss of useful information. While not quantified in his study, in several cases the theme was

present in a participant's response, yet LLMs captured unacceptable details, and were rated as unacceptable. This underpins the general finding that current LLMs may have limited value in "Big-Q" approaches involving nuanced interpretation [43].

Due to the qualitative nature of the research, the sampling procedure did not aim to achieve statistical representativeness, but rather to involve participants who had relevant experience and knowledge of the phenomenon under investigation and the topics of the research. Accordingly, the study used a non-representative, targeted sampling procedure. The sample size—75 people—can be considered relatively large for qualitative research and provides an adequate basis for identifying individual experiences and patterns. Although the sample cannot be considered statistically representative, the aim of the research was not to draw general conclusions, but to gain a deeper understanding of the experiences, attitudes, and connections related to the topic under investigation. In the next phase of the research, based on the results obtained from the qualitative data, we intend to extend the procedure to quantitative research in order to make the results quantifiable.

Conclusions

Our LLM-assisted qualitative framework analysis indicates that students' intrinsic motivation, altruistic values and positive attitudes towards innovation, entrepreneurship and research form a strong foundation for developing entrepreneurial universities. While resilience, critical thinking, communication, networking and time management are common internal enablers of innovation, entrepreneurship and research, institutional support systems and programmes need to be tailored to the diverse challenges and barriers of these fields.

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