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Evolutionary Examination of the University Innovation Ecosystem

PhD Dissertation - Collection of Theses

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Content

Abstract.....	3
Literature review.....	4
Summary of literatures	4
Relevance of the research topic	7
Overview of applied research methodology.....	8
Empirical research methodology	11
Data collection and analysis.....	11
Results of the research	14
Summary and practical recommendations.....	21
Sources.....	23
List of publication.....	27

Abstract

Understanding the innovation ecosystem requires a comprehensive research effort, as it is characterised by heterogeneous members, complex processes and strategic goals that support innovation. The result of the collaboration of actors can be an environment that not only enables the generation of ideas but also supports their realisation, creating an approach that makes its members open, creative and inclusive. Higher education institutions have a key role to play in the analysis of the innovation ecosystem, as they can provide the infrastructure and knowledge base to keep the system moving, bridging the gap between its members. The research objective of my dissertation was a comprehensive study of the innovation ecosystems in Hungarian universities, focusing on the role of universities in supporting innovation processes and their potential for development. In the course of the research, the factors that inhibit and support innovation processes and the topic of organisational culture were also studied, in order to provide practical recommendations for Hungarian universities.

In order to support the objectives, the literature review summarised relevant national and international publications, with the aim of providing a comprehensive overview of the role of universities in the innovation ecosystem. In addition, the empirical research involves the simultaneous use of qualitative and quantitative methods. The qualitative research presents interviews with senior managers from 9 domestic universities, while the quantitative questionnaire used Cameron and Quinn's organizational culture survey and Rao and Weintraub's innovation culture construct survey by questioning university faculty members, researchers, administrators and PhD students.

As a result of the doctoral research, the dissertation provides practical suggestions for the creation of the domestic university innovation ecosystem (UIE), which is not only an organisational process, but also a comprehensive approach, a synthesis of organisational culture and innovation, and the active engagement of the participants. In conclusion, UIE is a complex and dynamically evolving capital-intensive system in which universities play a key leadership role to foster innovation. Through their role as knowledge brokers, producers and exploiters, they act as a bridge between heterogeneous economic, governmental and social actors and the local environment in order to create sustainable economic and social value.

Keywords: university, innovation, ecosystem, organizational culture, knowledge

Literature review

The literary analysis is an important starting point for this thesis. It provides a detailed picture of the importance of the innovation ecosystem and the role of universities through a synthesis of relevant national and international research. The literature analysis presents theories of innovation, ecosystem shaping factors, the role of universities and their role in the ecosystem, and factors of organisational and innovation culture.

Summary of literatures

In conclusion, the conceptual framework of the University Innovation Ecosystem (UIE) is shaped by the definitions of innovation and ecosystems, while its dynamism is embodied by organizational culture and its university-specific characteristics. This conclusion is grounded in the insights of Schumpeter (1938), who defined innovation as a creative process driven by change and adaptation (Langroodi, 2021). It also builds upon the innovation development process presented in the literature, which extends beyond individual action. It surpasses simple system theories and highlights the significance of close ecosystem relationships (Granstrand & Holgersson, 2020).

In clarifying the concepts, it becomes evident that innovation is a process (Deák, 2020) built on heterogeneous actors who, through their experience and knowledge, collaborate toward unified strategic goals. This collaboration ultimately supports the enhancement of their own innovativeness and organizational efficiency (Pique, Berbegal-Mirabent, & Etzkowitz, 2018). The strength of the community and the role of feedback are essential in the cyclical nature of the innovation process, which is made whole by the ecosystem as the home of innovation creation. The ecosystem, through the organization of its members, forms a dynamically functioning network (Granstrand & Holgersson, 2020) that drives innovation processes, including the establishment of startups, spin-offs, incubation, and tech- and knowledge-transfer. Focusing on the specific area of the UIE, this network appears university-centric in the literature. Here, the university acts as both the creator of ideal partnerships and a catalyst for processes (Reichert, 2019). Through fostering a high level of innovation culture, the university becomes capable of achieving its goals (Rao & Weintraub, 2013).

Over the years, based on the reviewed literature, I can conclude that a significant transformation has taken place in academia, shifting from self-serving processes to activities that create substantial societal value (Pique, Berbegal-Mirabent, & Etzkowitz, 2018). The mission of education and research has been complemented by a third societal mission, aimed at generating solutions to local problems (Gaisch, Noemeyer, & Aichinger, 2019; Compagnucci & Spigarelli, 2020), an importance with which I fully agree. This evolution has positioned academia, still a hierarchical and bureaucratic organization, into a much more direct role (Etzkowitz, Dzisah, & Clouser, 2022). I find it essential to highlight the significance of organizational and innovation culture, a rising yet still underdeveloped topic. Therefore, it is worth conducting detailed, country- and university-specific studies to better understand and support innovation processes and the central role of university innovation ecosystems.

In the course of my work, I identify the expansion of missions as a current gap. However, it is evident that efforts toward change are rapidly filling this void and addressing the still-developing fourth mission. The literature only sporadically mentions the further expansion of universities' roles, yet we must acknowledge that the continuous social and economic development has already anticipated the shaping of not only a fourth but also a fifth mission. Based on the literature, I identify the missions that have emerged and are emerging over the years as the primary endeavors shaping the development of universities. These efforts are closely aligned with societal needs, which have been shaped by the opportunities of their respective

eras—such as the privilege of learning, the extent of material well-being, mobility, or digital advancement. In my dissertation, I view the local environmental responses of universities as the fourth mission, continuing the societal contribution of the third mission. I find it crucial that, following the general societal contribution of the third mission, the fourth mission adopts a more focused approach. This need arises from the urgency to mitigate environmental damages and support the local development facilitated by universities.

In examining the triple, quadruple, and quintuple helices, the dominant role of higher education institutions is evident, alongside other actors such as government, industry, civil society, media (in the quadruple helix), and the environment (in the quintuple helix). According to the literature, universities are also attributed significant importance in regionally focused innovation systems. Consistent with Piques, Berbegal-Mirabent, and Etzkowitz (2020), the role of universities extends beyond traditional tasks, holding equal importance compared to industry or government actors. It is also essential to acknowledge, as emphasized by Carayannis and Rakhmatullin (2014), that the boundaries between these actors overlap, highlighting the necessity of mutual complementarity. However, it is apparent—and somewhat unsatisfying—that generic models often shape the collaboration among innovation ecosystem members, where the strategically dominant partner typically determines the direction of development. This raises the question: how do models of unique innovation ecosystems manifest in reality?

Complementing the literature with practical insights and examining the Hungarian University Innovation Ecosystem (UIE) grant framework, a broad development trajectory becomes apparent. This aligns fully with the innovation ecosystem models described in the literature. The Hungarian UIE grant emphasizes culture, the development of a business-oriented mindset, the importance of communication, mapping opportunities within universities, and aligning these with industrial demands (NKFIH, 2019, p. 3). In my view, this is a highly significant and valuable initiative. Such directed policy interventions are a crucial part of supporting innovation in Hungary. However, their long-term success can only be achieved if the innovation and cultural elements of the UIE members are integrated both horizontally and vertically at the organizational level. This raises an exciting research question: to what extent has this process evolved thus far?

When assessing Hungary's current innovation landscape, there is an apparent lag compared to the EU-27 member states. This is reflected in its 23rd place ranking in the European Innovation Scoreboard (EIS) survey (76.309%) (European Commission, 2023, p. 11-13), the innovation capacity of SMEs, and the weak relationship between academia and industry. An important strategic goal is to increase the country's R&D expenditure as a percentage of GDP, which has fallen short of the target 1.8%, by 0.18%, and is significantly below the EU-27 average (2.32%) (KSH, 2023). I believe that the UIE grant provides a solid starting point for institutions, helping to increase the country's value creation potential. However, for the successful long-term application, a paradigm shift is necessary. This shift would enable the fulfillment of the regional catalyst role of academia within the innovation ecosystem, as Birkner, Máhr, & Berkes (2017) have articulated.

In the literature analysis of my dissertation, I concluded that, observing the general models of innovation ecosystems, the UIE grant in Hungary represents an important initiative for creating a successful new model. However, the deeper significance of the concept, rooted in organizational culture, remains unclear. I base this assumption on the fact that the UIE grant is a funding source generated by an external factor, and it did not emerge as an internal, self-initiated innovation effort. This raises the question of whether, after the grant period, there were any self-initiated efforts at the institutional level, or if the initiative withered. Based on Rao and Weintraub's (2013) research, innovation can only be viable if its impact is felt within the organizational culture, and if an organization is able to integrate the innovation process into its operations.

In examining Hungarian higher education, I find it important to emphasize that the goal is not to create a general UIE that encompasses heterogeneous universities with varying objectives, businesses, and

government involvement. Rather, I assume the goal is for universities with similar organizational structures to develop their own ecosystems. My assumption is that the creation of a UIE is not a simple cause-and-effect relationship supported by policy, but a complex, evolutionarily driven process rooted in organizational culture, where the organization's feedback system can exert an incentivizing effect. Therefore, the aim of this dissertation is to present a university-specific model, focusing on how a university can establish its own UIE and innovative organizational culture in alignment with its strategic goals. To achieve this, I consider it essential to define the concept of UIE and the success criteria, specifically for Hungary.

During my literature research, I further observed that the creation of a UIE serves both as a goal and a tool. The goal is to establish successful collaboration and fruitful partnerships that contribute to economic and social development, while the tool is in continuous evolution—a process of building an innovative organizational culture that enables higher education institutions to incorporate the idea of the UIE into their operational processes, facilitate ongoing knowledge sharing, and empower universities to generate socially beneficial processes in alignment with Hungary's R&D and Smart Specialization (S3) strategies. Beyond examining the theoretical frameworks, there is a clearly articulated goal in Hungarian and European policies, which presents a beneficial direction for university development. However, to achieve this goal, I assume that the implementation plans at the institutional level are often superficial, and the universities struggle to penetrate their true organizational culture. The superficiality lies in the shortcomings of universities, which try to meet the requirements of the funding schemes but fail to fully align with the characteristics of the UIE. Even though they recognize the significance of the concept—because their competitiveness and modern existence depend on it—they cannot completely identify with the core principles of the UIE.

Highlighting the relevant methodological approaches for the dissertation, Cameron and Quinn (2006) emphasize the importance of organizational culture, stating that it is a crucial factor in development and change. Organizational culture defines the core activities and collective characteristics of the organization, such as values, norms, and behaviors. The Competing Values Framework (CVF) serves as a model for organizational effectiveness and development. By understanding the organization's values, it can become more effective, and through the movement of these values, leaders can identify the needs of the organization and appropriately allocate human resources to tasks (Bíró & Serfözö, 2023).

The methodology is highly popular worldwide, through which individual and organisational behaviour can be measured in order to become more effective. The four parts of the model define the characteristics of organisations along the lines of flexibility - adaptation and stability and control, showing the ways of being, managing, organising and seeing that are favourable to the given circumstances. It is important to emphasise that stability is not ideal for all organisations and that there are many organisations that are able to function well in a stable environment (Cameron & Quinn n.d.). The types of culture help to represent the leadership styles, values and effectiveness characteristics that are specific to an organisation (Sousa, Raposo, & Mendonça, 2022). The four quadrants of the matrix are adhocracy, clan, hierarchical and market culture.

The research methodology also applies and examines the measurement of innovation culture. Rao and Weintraub (2013) investigated in which areas and how innovative an institution is. To do this, they decompose six building blocks (value, behaviour, environment, resource, process, success) into a total of 54 sub-elements, the assessment of which helps to determine the innovation metric. The InnoQuotient shows the development of the innovation culture of the organisation by presenting its strengths and weaknesses. It gives management a direction on which areas of intervention to focus on for further improvement. By looking at the hard factors as a resource and process, success can be achieved and for the soft factors, the ideal climate can be developed around values and behaviours.

Both methods rely on averaging, which I consider important because it is simple to do but gives valid results. The methods have been applied separately to for-profit and not-for-profit institutions, but there have been no publications on universities at the same time. In my work, however, I use the two methods simultaneously to examine the organisational and innovation culture of domestic higher education institutions.

Relevance of the research topic

Universities play a key role in promoting innovation and supporting the innovation ecosystem. UIE has become particularly important today, with the NRDI's UIE call for proposals in Hungary being an important initiative. In addition, the relevance of the topic is well illustrated by the national and international literature focusing on the role of universities in the creation and dynamic functioning of the innovation ecosystem.

The changing role of higher education institutions (Juhl, & Buch, 2019; Kivimaa, Boon, & Antikainen, 2017) has been a regular concern for researchers in recent decades, permeated by the importance of innovation at economic, social and organisational levels. In relation to universities, there has been a large body of research on their impact on the regional economy (Wang, 2021; Etzkowitz, 2019, Birkner, Máhr, & Rodek Berkes, 2017), their third missionary role (Taxt, Robinson, Schoen, & Floysand, 2022; Knudsen, Frederiksen, & Goduscheit, 2021), their role in coordinating entrepreneurial attitudes (Pique, Berbegal-Mirabent, & Etzkowitz, 2021; Guerrero, Urbano, Fayolle, Klofsten, & Mian, 2016; Nguyen, Maritz, & Millemann, 2022; Makai, & Rámháp, 2020) with industry (Hong, Zhu, Hou, & Wang 2019), their collaboration in the triple helix (Brem, & Radziwon, 2017, Vas, 2012), their significant involvement in the innovation ecosystem (Schaeffer, Fischer, & Queiroz, 2018).

Beyond these, we read about knowledge transfer (Kangas, & Aarrevaara, 2020; Fuster, Padilla-Melendez, Lockett, & Rosa del-Aguila-Obra, 2019), sustainability (Wagner, Schaltegger, Hansen, & Fichter, 2021), civil society (Hatipoglu, 2021; Cinar, & Benneworth, 2021), education (Caten, Silva, de Aguiar, Silva, & Huerta, 2019; Lv, Zhang, Georgescu, Li, & Zhang, 2022) or open innovation (Davies, Flanagan, Bolton, Roderick, & Joyce, 2021; Baron, 2021), start up (Breznitz, & Zhang, 2019), spin off (Fuster, Padilla-Melendez, Lockett, & Rosa del-Aguila-Obra, 2019), incubation (Lamine, Mian, Fayolle, Wright, Klofsten, & Etzkowitz, 2018) and markerspace (Halbinger, 2020) aspects of innovation, with a good number of publications with domestic and international relevance.

In this complex situation, it is important to stress that the dissertation does not provide the opportunity to explain all the elements in detail. However, it is clear that universities play an important role in the innovation ecosystem. In my work, considering the research objectives I have set, I consider the role of open innovation processes, which allow for collaborations across institutional frameworks, to be important (Baron, 2021). I agree with the fact that changes in the world have brought with them a radical transformation of universities (Huang-Saad, Fay, & Sheridan, 2017), who have previously been likened to an isolated ivory tower in terms of their first two missions, education and research (Knudsen, Frederiksen, & Goduscheit, 2021) (Etzkowitz, Webster, Gebhardt, & Cantisano Terra, 2000). A turnaround by the 20th century (Etzkowitz, Webster, Gebhardt, & Cantisano Terra, 2000) achieved the elimination of isolation (Knudsen, Frederiksen, & Goduscheit, 2021) and their mission was complemented by an adequate response from the university side to the challenges facing society (Secundo, Mele, Sansone, & Paolucci, 2020).

On this basis, I think it is important to highlight the three main activities of universities in the field of research. In the course of my research, I also accepted the finding that universities have an important role to play in the innovation ecosystem, i.e. modern universities that embrace and support entrepreneurial attitudes and the innovation processes that go with them (Montes-Martinez, & Ramirez-Montoya, 2021) that are able to target the young generation, influencing their attitudes and mindsets through theoretical knowledge and practical applications (Secundo, Mele, Sansone, & Paolucci, 2020).

In summary, universities have a wide range of social and economic functions. Their changing role has made them important players in the innovation ecosystem, contributing to long-term development. However, their evolution has not stopped and they are constantly adapting to the challenges of the world, broadening their focus and remit to support emerging societal needs, economic forms and natural challenges.

Overview of applied research methodology

In the research phase of my dissertation, qualitative and quantitative methods are used simultaneously to map the empirical data. While qualitative research provides the opportunity to explore deep-seated reasons and personal motivations, quantitative research allows the exploration of data in numbers and the signs of trends among them. The mixed methodology has a great importance and a long tradition in the field of scientific research and therefore the dissertation is based on individual interviews and questionnaire surveys, using the methodology of Cameron and Quinn (2006) and Rao and Weintraub (2013).

The overall objective of the research

In my doctoral dissertation, my research objective was to investigate the role and development of universities in supporting innovation processes through a comprehensive study of university innovation ecosystems in Hungary. The research aimed to identify the factors that inhibit and support innovation processes and to investigate the contribution of organizational culture to long-term organizational performance in innovation by defining a systems model.

In support of this, my aim is to present a comprehensive picture of the innovation situation in Hungarian universities based on quantitative and qualitative data. In addition to empirical research on the perspectives of senior university managers and organisational leaders experienced in building innovation ecosystems, understanding the factors that result from understanding the attitudes of researchers, faculty, administrators and PhD students will support the identification of the pathways for innovation processes and the internal and external drivers of innovation performance.

C1.	• A comprehensive exploration of the dimensions of the university innovation ecosystem through building blocks and their role, and policy initiatives.
C2.	• Rao and Weintraub's study of the domestic utility of measuring innovation organisational culture.
C3.	• Understanding the organisational and innovation culture of higher education institutions in Hungary.
C4.	• Identify the current and future role of the university in the university innovation ecosystem.

*1. table: Research objectives
Own editing*

Research questions:

The research questions were formulated on the basis of a synthesis of the university innovation ecosystem, the innovation and culture triad literature, and the policy guidelines that allowed to understand the current state and the factors that build it. The review of the literature revealed that the UIE framework is a complex system involving many factors and is characterised by continuous evolution. However, the Hungarian-specific understanding of the evolutionary characteristics of UIE revealed a gap, as it is clear that, in addition to policy guidelines, there is no well-developed plan for the creation of innovation ecosystems in Hungarian universities. In support of this, along the lines of the research objectives, four main research questions with specifying sub-questions have been set up in the dissertation, which deal with the understanding of the evolutionary processes of university innovation ecosystems in Hungary.

The questions of the thesis will include an examination of the establishment of a concrete definition of the domestic UIE, which will articulate all the concrete elements that make up the UIE and their interconnections and their influential role in innovation processes. The second research question focuses on universities in the specification of the elements. It will focus on the innovation departments, the leadership roles they play, the nature of collaboration and the way in which the innovation culture is manifested. The third research question will look beyond the current organisational culture to the long-term development of universities over a 10-year period, taking into account current policy guidelines and the interface between universities' future-oriented goals.

To summarise, the fourth research question aims to develop a systematic system model, which assumes that universities are the central actors and drivers of innovation processes for the members of the UIE. The starting assumption in the development of the system model is that this process is not based on a simple cause and effect relationship, which is UIE only positively influenced by policy support, but rather an evolutionary process rooted in a complex organisational culture, where the combination of organisational capability and the incentive effect of feedback processes enables a well-functioning university innovation ecosystem. The situation of universities in Hungary is generally determined from a synthesis of the individual objectives of universities and the indicator systems set up in policy applications to determine the state of functioning.

K1.	• Is there a comprehensive definition of UIE in Hungary?
K2.	• What are the elements that make up the UIE in Hungary and what concrete role do they play in promoting innovation?
K3.	• How can Rao and Weintraub's methodology for measuring innovation organisational culture be used in Hungarian higher education institutions?
K4.	• What is the organisational culture of universities?
K5.	• How well is the university prepared to be the engine of the UIE? • <i>How can you describe the university's openness to the UIE?</i> • <i>What are the strategic objectives of universities in the UIE?</i>

2. table: Research questions
Own editing

Hypotheses related to the research questions:

The hypotheses developed in the research are based on the research objectives and questions, and include the themes of UIE, innovation processes and culture, which were developed by reviewing the national and international literature.

The research model presents the hypotheses and the relationship between the main objectives. The operationalisation of the hypotheses is a key task of the research work. It provides an objective and measurable framework for defining the research objectives. When operationalising the hypotheses, the definition of the measurement of the variables to be observed and the way in which data will be collected are clarified, keeping in mind the research objectives and questions. This is supported by the table below, where the research questions and objectives, hypotheses are shown with precise conceptual definitions, as well as the methods to be objectively measured, data collection and analysis. The specific definition of the objectives and questions and the hypotheses, reconciled in the table, will contribute to the reliability and further development of the research.

H1.	<ul style="list-style-type: none">•The UIE in Hungary is a complex system in which universities have a clear leadership role and innovation processes are created through collaboration between industry partners, government, local communities and other higher education institutions.
H2.	<ul style="list-style-type: none">•Rao and Weintraub's method of measuring organisational culture can be adapted to domestic higher education institutions by taking into account local conditions.
H3.	<ul style="list-style-type: none">•The main components of the Hungarian UIE are value, behaviour, environment, resource, process and success, the synergy of which enables the promotion of innovation processes.
H4.	<ul style="list-style-type: none">•The current organisational culture of higher education institutions in Hungary is characterised by hierarchy, but universities are striving to develop an adhocracy culture that supports innovation.
H5.	<ul style="list-style-type: none">•The current readiness of Hungarian universities to act as drivers of the UIE is heterogeneous, but their openness to innovation is increasing, especially for those with close industrial links.

*3. table: Research hypothesis
Own editing*

Empirical research methodology

In the research phase of my dissertation, qualitative and quantitative methods are used simultaneously to map the empirical data. While qualitative research provides the opportunity to explore deep-seated reasons and personal motivations, quantitative research allows the exploration of data in numbers and the signs of trends among them. However, it is not enough to use only one qualitative and one quantitative method in the same research. A mixed methodology is based on the research question and the results, which provides an opportunity to revise the next step. A methodology involves the use of at least one qualitative and one quantitative method within the same research project, but the methods are also interpreted in the context of each other after being evaluated separately (Berman, 2017).

In my dissertation, qualitative and quantitative methods were developed simultaneously. The qualitative study involved individual interviews with senior university administrators, while the quantitative questionnaire survey was conducted with university administrative staff, lecturers, researchers and PhD students. The research was based on Cameron and Quinn's (2006) Competing Values Framework and Rao and Weintraub's (2013) study of innovation organizational culture.

Data collection and analysis

The 9 semi-structured interviews conducted during the research were transcribed using Microsoft 365 word. The documents were reread twice to correct typos. They were then uploaded to Atlas.ti 8 software, in 1 folder, but in separate RTF format, item by item, so that they could be corrected, and the system could interpret the content of the interviews both as a whole and separately for each interview. Subsequently, a glossary of all the interviews was downloaded to aid the coding process. The glossary contained the words spoken during the interviews. Using filtering, the nouns and verbs that were mentioned most often (at least 10 times) were summarised in a table (after selecting conjunctions) to aid the coding process.

Face-to-face interviews with senior university management were conducted between March and May 2024. The interviews were based on a structured set of questions to understand the processes, actors and roles that make up the university innovation ecosystem, including the motivations and opportunity frameworks of universities that influence the success of the university innovation ecosystem. The interviews supported the qualitative approach to the research objectives and questions already formulated earlier in this dissertation by providing insights into personal university stories and aspirations. The structure of the questionnaire ranged from a broad understanding of the university innovation ecosystem to an insight into the culture that builds the internal systems of universities through 4 main sets of questions.

The first set of questions enabled the definition of the university innovation ecosystem and the understanding of the internal and external factors shaping its functioning.

The second set of questions, already university-specific, looked at the specific UIE participation, the ecosystem's constituents, their roles, information flows and ideal relationships.

The third set of questions asked about indicators of success, barriers to the implementation of UIE, and processes for operational management.

In the end, the interviewees were asked about the organisational culture, organisational capabilities and the vision of the university during the hour-long discussions.

In the research of the dissertation, 3 main aspects were taken into account in the selection of the interviewees, in order to gain a comprehensive understanding of the UIE framework from the perspective of the heterogeneous Hungarian universities:

- The first criterion for the selection of interviewees was the UIE report held in 2022 at the NRDIH, which was used to categorise universities according to their innovative performance. The reports collected objective information on the innovation efforts of universities. These data included research development results, number of patents, industrial relations, publications, H2020 proposals submitted and awarded, number of PhD students and future-oriented development plans of universities such as infrastructure development and international relations.
- The second criterion for selecting universities is their location, with the aim of covering the whole of Hungary on a regional basis. The aim of a national location supported the understanding of the advantages and difficulties of different regions of economic activity.
- The third criterion for selection was to interview universities with a heterogeneous training portfolio. The aim of heterogeneity was to gather as wide a range of experiences and perspectives as possible during the interviews.

Interviews were conducted with senior staff members of eight universities in Hungary. The interviewees included rectors, vice-rectors, chancellors, presidents, directors, heads of headquarters, operations and departments. Most of the interviews were conducted in person, while in a few cases, due to the busy schedule of the interviewee, the interview was conducted online. The meetings provided a great opportunity to learn about the UIE framework through personal stories, feelings and aspirations. The interviews helped me to present a comprehensive picture of the state of the domestic university innovation ecosystem for my dissertation.

Name	University	Position	Fate of interview	Location
Prof. Dr. János Abonyi	University of Pannonia	Deputy Rector	2024. 02. 21. 15:00	Veszprém
Zsolt Csillag	University of Pannonia	Chancellor	2024. 03. 04. 9:00	Veszprém
Prof. Dr. Attila Fábián	University of Soproni	Rector	2024. 04. 26. 9:00	Budapest
Prof. Dr. Zita Horváth	University of Miskolc	Rector	2024.04. 30. 13.30	Online (MS Teams)
Prof. Dr. Gábor Szabó	University of Szeged	President	2024. 04. 30 16:00	Budapest
Dr. Bálint Filep, Gábor Dósa, Kornél Vági	Széchenyi István University	President, Center Manager, Operational Manager	2024. 05. 08. 13:00	Győr
Prof. Dr. Haidegger Tamás	University of Óbuda	Director	2024. 05. 16. 10:00	Budapest
Kottászné Dr. Orsolya Vass	University of Pécs	Head of Department	2024. 05. 16. 14:00	Online (MS Teams)
Prof. Dr. Péter Ferdinandy	Semmelweis University	Deputy Rector	2024. 05. 23. 12:00	Budapest

4. table: Participants of the interviews
Own editing

The aim of the questionnaire survey of my dissertation was to find out the views of university lecturers, researchers, administrators and PhD students on the organisational culture and the culture of innovation in their respective institutions. To achieve this, I developed a validated questionnaire on organisational culture by Cameron and Quinn and on innovation culture by Rao and Weintraub. The questionnaire was developed using LimeSurvey (<https://kerdoiv.gtk.uni-pannon.hu/index.php/923887?lang=hu>) to university staff during the months of January and July 2024. I aimed to reach a wide range of university employees during the chosen period, which in the case of universities was supported by a central rector, chancellor or president sharing. However, the unfortunate low response rate, which has implications for the overall interpretation of the results, was a challenge for the survey.

The quantitative research generated a total of 504 completions. After cleaning the questionnaire's separate sections (Cameron and Quinn and Rao and Weintraub), they were analysed comprehensively. The separate interpretability of the sub-units allowed for blocks to be assessed at different completion rates, but the length and complexity of the sub-units steadily reduced the number of valid completions. As a result, the demographic section was completed by 265, the section of Cameron and Quinn's survey measuring present organisational culture by 263, the section measuring future ideal organisational culture by 229, and Rao and Weintraub's survey measuring organisational innovation by 210. Overall, the questionnaire took 20-25 minutes to complete. The study used descriptive statistical methods and R Studio analysis, with an important role played by the analysis of demographic data, age, work experience, work area and the distribution of opinions by university, which helps to understand the variation in responses and to explore the relationships. Quantitative research provides a basis for future studies and strategic planning.

Results of the research

In my dissertation, I examined higher education institutions in Hungary from the perspective of the university innovation ecosystem, taking into account the existence and local characteristics of organisational and innovation culture. The main objective of my research was to gain a comprehensive understanding of the definition of UIE in the Hungarian context, which universities have heard so much about during the UIE call for proposals launched by the NRDIH. I wanted to learn about this both through the horizontal and vertical breadth of the literature and through my empirical research, paying close attention to its future-orientation. In support of the stated objective, I sought to answer the following research question.

K1. Is there a comprehensive definition of UIE in Hungary?

K2. What are the elements that make up the UIE in Hungary and what concrete role do they play in promoting innovation?

In a comprehensive review of the literature, I analysed the characteristics of the ecosystem, starting from the concept of innovation. Highlighted from this research is the work of Flechas, Takahashi, and de Figueiredo (2022), who identified five different ecosystems, namely knowledge, entrepreneurial, innovation, business, and start-up ecosystems. Focusing on the innovation ecosystem, Granstrand, and Holgersson (2020) define it as "continuously evolving activities, actors and asset systems that can be products, services, tangible and intangible assets. Institutions and the complementary, cooperative and competing, substitutive relationships between them, can contribute to enhancing their innovative performance". Continuing along this line, I also looked for formulations on the role of the university in the innovation ecosystem.

However, when I looked for a definition of the university innovation ecosystem, I did not find a specific definition, only an emphasis on the important role of the university. These include the increasing dominance of education and research (Etzkowitz, & Leydesdorff, 2000), its significant role as a driver of the ecosystem (Heaton, Siegel, & Teece, 2019), its emergence as a knowledge hub and driver of regional economic development (Birkner, Máhr, Rodek, Berkes, 2017) or the role of the university as a driver of the regional economy (Zmiyak, Ugnich, & Taranov, 2020).

Although there is no concrete and accepted definition of a university innovation ecosystem in the literature, I consider the formulation of a university innovation ecosystem to be valid for my dissertation and accept it. This statement was also supported by the personal interviews, where interviewees identified it as an artificially created concept, but were aware of the importance of the university's role in the innovation ecosystem. To summarise the interviews, in this framework provided by the concept of innovation ecosystem, universities have moved towards a culture of innovative behaviour and market openness. They sense and know that they have an important role to play in the heterogeneous industrial, governmental and civil sectors, as the impact of their work is of paramount importance in addressing local problems. However, they can only play the role of bridge between the problems and solutions of these sectors if they can also mobilise external financial resources. Otherwise, their resources will be consumed by self-preservation.

In the domestic context, the definition of UIE is of great importance, as the initial source of the financial input side of the framework was the UIE tender. This gave universities the opportunity to set up an innovative system in their own institution. However, the transformation process initiated by the call should now be left to universities to stand on their own feet, and can only be achieved if universities open up to the market, and this open collaboration is characterised by relevant problem identification, open communication, live partnerships and innovative colleagues who recognise new opportunities.

The findings lead me to the following conclusions. In line with the literature reviewed and the qualitative interviews from my own research, I define the university innovation ecosystem in the domestic context as a complex and dynamically evolving capital-intensive system in which universities play a key leadership role in promoting innovation. Through their role as knowledge brokers, producers and exploiters, they act as a bridge between heterogeneous economic, governmental and social actors and the local environment in order to create sustainable economic and social value.

H1. The UIE in Hungary is a complex system in which universities have a clear leadership role and innovation processes are created through collaboration between industry partners, government, local communities and other higher education institutions.

Based on the comprehensive domestic and international relevant literature review and the qualitative interviews, I accept the hypothesis.

1. thesis

I have demonstrated that the UIE in Hungary is a complex system in which universities have a clear leadership role and innovation processes are created through the collaboration of industry partners, government, local communities and other higher education institutions.

The second research objective of Rao and Weintraub was to investigate the domestic utility of measuring innovation organisational culture.

K3. How can Rao and Weintraub's methodology for measuring innovation organisational culture be used in Hungarian higher education institutions?

To answer the research question, R studio analysis was used to show the applicability of the methodology. In the domestic context, the analysis proved its usefulness, however, the analysis only separated 4 vertices instead of the original 6 separate units. On the one hand, process and success dominated the study, complemented by the resource building element. On the other hand, the behaviour and value block was visible, complemented by the environment. Some elements of value, however, were not linked to any of the groups and, therefore, formed a completely separate entity. As a suggestion, it can certainly be said that further clarification is needed as to the applicability of the methodology to universities and the precise formulation of the recommendations.

An important task of the second research question was to examine whether there are generalisable profiles among the Hungarian universities surveyed, which can cooperate to develop or even complement each other. Three universities, the University of Pannonia, the Széchenyi István University and the University of Sopron, were examined in more detail. It was found that all three universities need to improve in the area of processes, but that there are specific strengths, such as innovation-oriented behaviour or the significant influence of the management.

H2. Rao and Weintraub's method of measuring organisational culture can be adapted to domestic higher education institutions by taking into account local conditions.

Thanks to the R studio analysis and the quantitative questionnaire analysis carried out in the course of the research, I accept the findings, as the methodology can be adapted to the domestic institutions. The

methodology contributes to a comprehensive understanding of universities, through which university profiles characterise the level of organisational innovation. Based on Rao and Weintraub's methodology, the research presented the profiles of the University of Pannonia - mixed; Széchenyi István University - technical; and the University of Sopron - agricultural.

2. thesis

I conclude, that Rao and Weintraub's method of measuring organizational culture can be adapted to domestic higher education institutions by taking into account local conditions.

My third research objective was to understand the organisational and innovation culture of domestic higher education institutions. To support this aim, I asked the following research questions:

K3. How can Rao and Weintraub's methodology for measuring innovation organisational culture be used in Hungarian higher education institutions?
K5. How well is the university prepared to be the engine of the UIE?

I based my research on Rao and Weintraub's attributes of innovation organization. I assumed that all the six main building blocks of values, behaviour, environment, resources, process and success are present in the case of domestic universities. These elements, in a complex way, also include small sub-elements (54) necessary for innovation, such as ideation, reward, entrepreneurial attitude, communication, non-bureaucratic or commitment. Their importance lies in the fact that the average value of the building blocks determines innovative organisational behaviour, showing the strengths and weaknesses of the organisation and thus pointing the way to improvement.

To analyse the research question, I analysed the methodology of Rao and Weintraub based on the responses of the respondents to the questionnaire and used NDA analysis using R studio to group the 54 items. Based on the response of the universities, it can be concluded that the response to the 54 elements of the Rao and Weintraub methodology was medium. This underpins the importance of several development pathways, highlighting the importance of bureaucracy, resources and processes. In the NDA study, I also wanted to identify in a domestic context whether all building blocks are relevant or whether there are conflation. The analysis was able to identify 4 out of 6 elements, so I accept the hypothesis as modified. The four elements identified were the result of the merging of the 6 original sub-elements. Process and success were intertwined with resource, and behaviour and value with environment.

Referring to the qualitative analysis, it is noticeable that all six elements are present in the minds of the management. This is well exemplified by the values of tradition and local opportunities. In the case of behaviour, the aspiration to implement an innovative organisational culture can be seen. In examining the resources, it can be concluded that the UIE competition and the individual aspirations of the universities have had a significant impact on their development and have also contributed to their self-sustainability and the development of entrepreneurial thinking. The process element, which includes creative and pro-active colleagues and young graduates, is also important. There is a significant challenge in creating the right environment to support the development of an innovative organisational culture and success is very important to motivate employees. However, the last two areas are quite challenging and universities need to adapt them to the needs and opportunities of the present time.

H3. The main components of the Hungarian UIE are value, behaviour, environment, resource, process and success, the synergy of which enables the promotion of innovation processes.

I accept the hypothesis with modifications based on the R studio NDA analysis and the quantitative questionnaire, as I assumed six separate blocks in the hypothesis, but only four units appeared.

3. thesis

I conclude that the main components of the Hungarian UIE are value, behaviour, process and success, the synergy of which enables the promotion of innovation processes.

The fourth research objective is to investigate the current and future role of the university in the university innovation ecosystem.

K4. What is the organisational culture of universities?

K5a. How can you describe the university's openness to the UIE?

K5b. What are the strategic objectives of universities in the UIE?

I based my approach to the research question on Cameron and Quinn's analysis of organisational culture, which looked at current and ideal organisational culture in 5 years' time, using university lecturers, researchers, administrators and PhD students. Although the sample size of the research is small, university-specific findings are therefore only partial. Overall, the results show that the organisational culture of today's Hungarian universities is dominated by hierarchical organisational culture traits and clan-type organisational culture traits, with minor differences.

This finding is in line with the results of the interviews, as senior managers also said that the control and bureaucracy of universities makes life difficult. However, given the regulatory background of universities in Hungary today, reducing the administrative burden is a long-term challenge that is not the responsibility of universities, but of state regulators. The ideal organisational culture in five years' time, however, presents a positive picture, in that the interviewees do not want to increase the dominance of hierarchy, but on the contrary, by reducing it, they imagine an innovative adhocracy organisational culture alongside a clan, family atmosphere.

H4. The current organisational culture of higher education institutions in Hungary is characterised by hierarchy, but universities are striving to develop an adhocracy culture that supports innovation.

In order to answer the research question, a quantitative study provided the results. The results of Cameron and Quinn's organisational culture survey in the present and 5 years' time demonstrated that domestic universities currently have a hierarchical organisational culture but strive to innovate, as indicated by a shift towards adhocracy in their future vision. Subject to this, I accept the hypothesis.

4. thesis

I have confirmed that the current organisational culture of higher education institutions in Hungary is characterised by hierarchy, but that universities are striving to develop an adhocracy culture that supports innovation.

H5. The current readiness of Hungarian universities to act as drivers of the UIE is heterogeneous, but their openness to innovation is increasing, especially for those with close industrial links.

Both qualitative and quantitative analysis helped me to answer the research question. In the case of the personal interviews, it can be said that the universities were greatly helped by the UIE grant created by the NRDIH, which provided a path and opportunity, both financially and professionally. This grant scheme helped them to develop and to start on the path of the innovation ecosystem. However, it is clear from what has been said that once the tender is over, universities will have to stand on their own feet and run the system they have developed, through their own revenue generating capacity. This is still a challenge today, especially for universities that do not have a foothold with industry, either through tradition or through their currently established portfolio. During the interviews it quickly became clear that universities in Hungary today have 3 main challenges:

- Education
- Research
- Commercialization

These are the three main tasks to be integrated into their daily lives. This will support them to act as a bridge between the members of the Quadruple helix, to become catalysts for development and knowledge, and to propose solutions relevant to the challenges of the market and the local environment.

Unfortunately, if we look at the economic environment, the openness of industry towards universities is a challenge that can be achieved through a paradigm shift. Industry players need to be aware that universities have up-to-date knowledge and expertise to generate answers to the current difficulties faced by industry players. The study showed that universities that have traditionally had close links with industry have a greater influence in the ecosystem. Thanks to this industrial link, they have an active and real dialogue with the market and this provides an opportunity to identify and reflect on needs.

Cameron and Quinn's study of organisational culture confirmed that universities are currently hierarchical, highly controlled and have a clan, family-like atmosphere. This determines the way they operate, i.e. it imposes a constraint on innovation, as adherence to organisational rules and administrative processes is of great importance. Conversely, an idealised organisational culture reinforces the clan-type, family-like community atmosphere, but is complemented by an adhoc organisational culture aimed at creating an innovative and creative organisational culture.

The results of the questionnaire survey show that universities are aware of the importance of innovation, but that much development is still needed at organisational level to become a true flagship of the innovation ecosystem. Organisational development encompasses the environment, values, success, process, including the regulatory environment, resources, behaviour, right down to the importance of leadership by example. Rao and Weintraub's analysis of innovation culture identified precisely these elements, and revealed that today's Hungarian higher education institutions rank only in the middle of the five-point scale, which needs significant improvement.

I accept the hypothesis based on the results of the qualitative interviews and the quantitative questionnaire survey.

5. hesis

I have shown, that the current readiness of Hungarian universities to play a role as drivers of the innovation ecosystem is heterogeneous, but their openness to innovation is increasing, especially for those with close industrial links.

A summary table of the research objectives, questions and hypotheses is presented in Annex 10.4. In summary, universities in Hungary are currently in a process of transformation. In this process, there are a number of internal and external supporting and complicating factors. However, the research concludes that the creation of an organisational culture of innovation is of great importance. The manager has an important role to play here. For in the future, a real organisational transformation must take place, where universities individually define the main essence of their existence, the direction of their development, which provides motivation for all levels of their organisation. In guiding this, the leader has an important role to play, leading by example and with the ability to recognise the areas in which intervention is needed.

The integration of innovation into operational processes also plays an important role in this transformation. The current UIE tender scheme has implemented targeted improvements along the lines set for senior management. However, these need to be implemented on a university-specific, i.e. individual, basis, so that the value creation of the university can be established and it can be economically viable. This requires, however, that the culture of innovation embedded in the real organisation can penetrate deeply, not just be known on paper by employees.

Last but not least, it is important that there is concrete university involvement in the UIE. If the system only works while universities are holding hands with a grant, it is neither future-oriented nor sustainable. Universities must want change at the organisational level. They must see and feel its importance for their survival. This is a long process that requires a lot of learning, good communication and a well-developed internal strategy. Here, universities, based on their specific portfolios and capabilities, need to align the three main tasks of education, research and exploitation with their own objectives in the UIE, thus supporting their environment to become true flagships.

5. table: Summary of research objectives, questions and hypothesis
Own editing

Research objective	Research question	Hypothesis	Decision	Evidence	Results
C1. A comprehensive exploration of the dimensions of the UIE through building blocks and their role, and policy initiatives.	K1. Is there a comprehensive definition of UIE in Hungary?	H1. The UIE in Hungary is a complex system in which universities have a clear leadership role and innovation processes are created through collaboration between industry partners, government, local communities and other higher education institutions.	Accepted	Analysis of relevant national and international literature Qualitative interviews	Definition of UIE
	K2. What are the elements that make up the UIE in Hungary and what concrete role do they play in promoting innovation?				
C2. Rao and Weintraub's study of the domestic utility of measuring innovation organisational culture.	K3. How can Rao and Weintraub's methodology for measuring innovation organisational culture be used in Hungarian higher education institutions?	H2. Rao and Weintraub's method of measuring organisational culture can be adapted to domestic higher education institutions by taking into account local conditions.	Accepted	R studio analysis Quantitative questionnaire	University profiles
C3. Understanding the organisational and innovation culture of higher education institutions in Hungary.	K3. How can Rao and Weintraub's methodology for measuring innovation organisational culture be used in Hungarian higher education institutions?	H3. The main components of the Hungarian UIE are value, behaviour, environment, resource, process and success, the synergy of which enables the promotion of innovation processes.	Accepted with modification	R studio NDA analysis Quantitative research	Identifying the constituent elements of the domestic UIE: process success, behaviour, value
	K5. How well is the university prepared to be the engine of the UIE?				
C4. Identify the current and future role of the university in the UIE.	K4. What is the organisational culture of universities?	H4. The current organisational culture of higher education institutions in Hungary is characterised by hierarchy, but universities are striving to develop an adhocracy culture that supports innovation.	Accepted	Cameron and Quinn organisational culture survey Rao and Weintraub innovation culture study	Defining the organisational culture now and in 5 years' time
	K5a. How can you describe the university's openness to the UIE?				
	K5b. What are the strategic objectives of universities in the UIE?	H5. The current readiness of Hungarian universities to act as drivers of the UIE is heterogeneous, but their openness to innovation is increasing, especially for those with close industrial links.	Accepted	Qualitative interviews	

Summary and practical recommendations

The interviews and empirical research provided a rich source for expanding knowledge about universities. Based on this, it can be stated that today, Hungarian universities have embarked on the path of transformation towards innovation. However, due to their entrenched habits and the relatively low level of external pressure, they predominantly continue to follow the traditional and well-established paths. Nevertheless, the structure of UIE requires a different, creative, and market-oriented behavior from them, characterized by a shift from a hierarchical organizational culture towards a more open and adhocratic approach.

According to my empirical research, the process was initiated by the UIE program launched in 2019; however, true transformation can only occur if universities also adapt to the new, innovation-oriented organizational demands. In many cases, this has not yet happened, which is why I find it important to highlight intervention areas for universities in my dissertation, based on my research findings: Universities have three main strategic opportunities for developing UIE. The first is the development framework provided by public policy, which acts as an incentive for university-industry cooperation. It can be concluded that, beyond the universities themselves, policymakers also have a crucial role in this process. This could be encouraged through tax incentives, grants, innovation-oriented training programs, and the establishment of a dual innovation research career model.

Secondly, universities have the opportunity to change internal processes, which involve employees and internal management areas. This includes communication activities, internal education, mentoring, the reduction of administrative burdens, incentivization, and leadership by example. These processes contribute to shaping internal behavior, creating the appropriate environment and values, and encouraging attitudes towards innovation processes. It would be beneficial to organize professional innovation practices for colleagues, involve them in corporate collaborations and incubation programs. Universities should create transparent communication channels to support managerial communication, allowing colleagues to stay informed about the progress of innovation processes. This would help establish a shared innovation language and, through a newsletter-style approach, also inform internal employees with interesting updates. Mentoring would also be valuable in supporting colleagues' innovation activities, where domestic and international experts experienced in innovation processes could aid their personal development.

Finally, based on their external strategic decisions, universities can foster collaboration with industry through closer communication, better information flow, and fostering the appropriate attitude among university colleagues. Effective tools for this include continuous external communication via newsletters, a value-based website, quick response from internal staff, a supportive CRM system, or a community space designed for university-industry engagement. It would be advisable for universities to appoint dedicated industry liaison officers, establish structured partnership programs, and organize regular workshops to inform industrial partners and provide them with value propositions.

Behaviour Characterise organisational behaviour: <ul style="list-style-type: none"> • Energize • Commitment • Empowerment 	Name of university:	
	Process Identify what processes your organisation has in place to promote innovation: <ul style="list-style-type: none"> • Idea gathering • Shaping • Implementation 	
	Success Identify where successes occur in the organisation: <ul style="list-style-type: none"> • External results • Resulting from entrepreneurial morale • Individual 	
	Resources Identify the resources you can rely on to drive progress and success: <ul style="list-style-type: none"> • Human • System • Project 	
Values What internal values are available: <ul style="list-style-type: none"> • Entrepreneurial attitude • Creativity • Learning 		
Environment Identify what kind of environment characterises your university and influences its behaviour and values: <ul style="list-style-type: none"> • Collaboration • Security • Simplicity 		
Education Describe the educational activities of your university	Research Describe the research activities of your university	Commercialization Describe the commercialization activities of your university

1. figure: UIE canvas
Own editing

The university transformation can be visually represented by the UIE canvas outlined in the dissertation, which encourages university leadership to review opportunities presented by internal and external factors while gaining insights into the tasks relevant to the modern university. The canvas supports thought processes and consolidates the main innovation areas onto a single page. This aligns with the UIE definition I have created, offering leadership a view of the complex system. Through this, leaders are prompted to understand the dynamics of the UIE and sketch the input and output elements of the capital-intensive system within their own organization. Therefore, the canvas requires consideration of human resources, technological processes, and administrative elements, which characterize the institution. Furthermore, thorough reflection provides an opportunity to define the university's key role in promoting innovation in areas such as values, utilization, research, and education.

As a conclusion to my dissertation, I would like to emphasize that creating a university innovation ecosystem is not an easy process, but it can be achieved with dedication and conscious planning. The key message to take from this work is that establishing an UIE is not only an organizational process but also a comprehensive mindset and a synthesis of the innovation culture, which requires the active engagement of all participants, from the "janitor to the rector" (Zsolt Csillag). The key to success lies in collaboration, knowledge sharing, and value creation, with the ultimate goal being the sustainable operation of processes, contributing to continuous innovative projects, the development of human resources, and creating space for future generations. It is important for universities to recognize that the operation of the UIE is a long-term investment, which not only addresses the challenges of the present but also opens the door to the opportunities of the future.

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