



POLITEHNICA University of Bucharest
Doctoral School of Industrial Engineering and
Robotics

Management of innovation ecosystems

-Ph.D.Thesis-

-SUMMARY-

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INTRODUCTION

Innovation is the key word of our time. Europe and implicitly Romania are facing great challenges from a social, environmental, and economic point of view, whether we look at these challenges through the lens of the pandemic or through the lens of the ongoing war, and all parties involved need innovative solutions to cope with them. Universities offer education, research and knowledge production, transfer to the economic environment and innovation, respectively innovation ecosystems, thus offering concrete solutions.

The growth of the knowledge economy, together with globalization, the pandemic, the food crisis and not only because of the ongoing war, but also the environmental crisis, are unprecedented challenges that contribute considerably to the redesign and expansion of the missions and roles of universities. The dynamics of knowledge production are changing, as are the ways in which societies relate to expectations and values. In this context, academia is perceived as being at a crossroads.

Against the background of increasing demand for innovation, the university is in a new and challenging central position. Its role as a primary producer of knowledge comes with demands and expectations that entail new ways of developing institutional identity and profiles. Indeed, its new centrality depends on the university being highly responsive, adaptable, closely interconnected not only with its academic partners but also with external stakeholders, globally and locally.

Thus, in the present thesis I considered it a major challenge to discover, understand and capture the role and contribution of higher education institutions in Romania within the innovation ecosystems in which the actors of the quadruple helix interact.

This thesis aims to provide answers and best practice models by analyzing how the actors of the quadruple helix interact within innovation ecosystems, revealing the mechanisms that universities and their partners use to promote innovation. The work is focused on innovation ecosystems where the coordination and orchestration of knowledge creation are at the heart of a dialogue that encompasses civil society (represented in the thesis by students), company management, university governance and government management.

In the present research, it started from the premise that, in order to determine a change or transformation of an educational system (university, in our case), a key role is played by the feedback and support of those involved in its operation, namely the practitioners. However, the research does not want to focus strictly on academics (whether we are referring to managers of higher institutions or teaching staff/researchers). On the contrary, the approach is much more complex through the prism of the relationships within the innovation quadruple helix with the other key actors. Thus, we also want their opinion, as external stakeholders, on the performances of higher education institutions, in order to have a broader perspective, both internal and external.

The paper is organized into three chapters, each ending with preliminary conclusions. **The main research objective** can be formulated as follows: this research aims to investigate to what extent the collaboration between the four actors in the quadruple helix model influences innovation in higher education institutions.

Chapter I. Innovation in higher education: theoretical foundations, perspectives and practices

Higher education institutions: missions, roles and responsibilities

Education - primary mission

Higher education is in constant change thanks to both students and newly developed technologies. The evolution of technology undergoes constant change and affects teaching-learning strategies around the world. In recent years, new technologies have revolutionized didactic activity, both face-to-face and online [5]. All over the world, higher education institutions are developing new curricula and purchasing equipment, software and materials to support research and training [6]. The need for digitization at the level of societies and educational systems has been deeply supported by the changes that have occurred as a result of the pandemic. Digitization is transforming education, as it is happening in many sectors of society. Data is increasingly used to manage higher education systems and institutions, to better target policy interventions and to drive innovation. Devices and technological solutions powered by artificial intelligence are increasingly used to help teachers or learners study at home. A number of new solutions are being developed by education technology companies. Education could quickly become different in the way it is delivered and experienced. This raises new opportunities and challenges as education policy makers and stakeholders must harness technology to improve and potentially transform education.

Research and knowledge production

Innovation in higher education institutions is primarily manifested in their central functions, namely, (1) research, (2) teaching and learning [62], which represent the production of knowledge and the dissemination of knowledge, respectively [63]. Therefore, experts have recognized innovation in higher education institutions as the ability of an institution to develop and implement new ideas [64], such as new academic programs, teaching materials and methodologies, and research projects, which represent product and process innovation [65]. Previous studies identifying the antecedents of innovation in higher education institutions have largely focused on these two main dimensions of innovation [62]. Although these two aspects of innovation have been associated with superior organizational performance of higher education institutions [66], higher education institutions are also called upon to focus on speed and quality while introducing new academic programs, methods of teaching and research projects to remain dynamic in a complex educational environment [67]. Given the vital role of innovation speed and quality in improving organizational performance [68] and achieving competitive advantage [69], it is necessary to identify the organizational factors that influence these critical characteristics of innovation in higher education institutions.

The transfer to the socio-economic environment

Higher education institutions, throughout their history, have played a crucial role in the creation and dissemination of knowledge [78]. They are formed by a group of experts, who are simultaneously developers, users and carriers of knowledge [79], with a high degree of specialization in certain disciplines, which are organized in different scientific fields [80].

The experience of developed countries has highlighted the indispensable role of higher education institutions in economic and societal development [75], [83]. This evidence is primarily based on the triple helix model of innovation, which advocates the “university-industry-government” nexus, whereby universities have taken the lead role as organizers of innovation in the creation of knowledge-based economies [84]. Higher education institutions in developing economies are exposed to a variety of severe challenges, such as changing state funding structures, rapid technological advances, and new demands for higher education from both industry and society [62], [66]. These challenges have forced higher education institutions to demonstrate superior performance

through innovation, research activities and the production of quality graduate workforce to play a vibrant role in socio-economic development [62], [85].

Innovation and innovation ecosystems

"An innovation ecosystem consists of a group of local actors and dynamic processes, which together produce solutions to different challenges" [115]. Innovation takes place in a precise location, suggesting that the physical proximity of innovation players also matters a lot. Also, that there are certain specific local conditions which, individually or in combination, make such an innovation ecosystem flourish. There is also a dynamic process - often not easily recognizable from the outside - that makes such innovation ecosystems develop [117].

A systemic approach to the process that enables the emergence of a particular innovation ecosystem requires taking into account the critical need for a range of factors:

- from public institutions committed to developing the territory and attracting the necessary resources, to high-level universities and research institutions able to feed their human capital;
- from a (relatively) harmonious business sector where large companies and newly established start-ups specialize and cooperate within value chains and clusters, to local markets permeable to product innovation and connected to global networks;
- from an entrepreneurial culture that takes risks to a local society that accepts facing major challenges and is open to change and evolution.

Other enabling factors include the continuous movement of ideas and people, the fluid interaction and "cross-fertilization" between business and academia, academia and government, government and business, organizations and individuals. Dynamic companies play an essential role in the ecosystem, but services that support knowledge transfer and product commercialization and the development of innovation networks are just as necessary. The latter is precisely the role played by intermediate organizations such as technology centers, business incubators and a wide range of territorial innovation agents rooted in local society.

Innovation is considered a driver of economic growth, but the process is threatened by several pitfalls due to (i) its complexity, (ii) resource requirements, (iii) associated risks, (iv) specific connections and (v) vested interests. To counter these potential dangers, actors involved in the three spheres of the triple helix (industry, academia, government) must cooperate, regardless of context (local, regional, national), for a rapid and efficient conversion of ideas and capabilities into products, new useful processes and services for society [132]. The triple helix model of innovation focuses on university-industry-government relationships [128]. In this regard, it represents a basic model for knowledge production (research and development) and innovation applications (innovations). The Quadruple Helix and Quintuple Helix models of innovation are designed to understand and refer to extensive complexity in knowledge production (research and development) and knowledge application (innovation), thus the architecture analytical of these models is conceptualized more broadly.

The Quadruple Helix adds as a fourth helix "media and culture-based audiences", "civil society" and "art, artistic research and art-based innovation" [133], [134]. The quadruple helix model of innovation could also be highlighted as the perspective that specifically brings the "dimension of democracy" or "context of democracy" to knowledge, R&D and innovation.

Priorities and areas of action in the context of the 2030 Agenda

Higher education institutions, especially universities, have considered sustainability as a core goal for management and in recent years have included SDG2030 as a means to achieve a more sustainable world. The problem is how to measure this contribution when there is insufficient external information available. This is because it is not mandatory for universities to disclose their contribution to SGD2030, but individual initiatives are welcome in the literature and research, such as those presented by Mori Junior et al. [152] at the Royal Melbourne Institute of Technology (RMIT) University.

This also means that it is difficult to compare the contribution of universities in this area, given that each university may use different ways of measuring and analyzing the impact of the initiatives

implemented and their results. In this framework, the SDGs are becoming part of the sustainability strategies of universities and the interest in achieving them has increased. Most universities have included them in their agenda. However, efforts have not been made in measuring and reporting the contribution of universities to the achievement of SDG2030 goals. This shows that measuring the contribution of universities to SDG2030 remains a global challenge.

Metrics and indicators in university performance analysis

Governance and decision making

The European Innovation Scoreboard 2021 has in its composition a series of indices that measure governance in relation to innovation in each member state. With a performance index of 35.1%, in 2021, in terms of research and innovation, and with an increase of only four percent compared to 2014, our country is in the last category, that of "emerging innovators", along with other six member states - such as Bulgaria, Latvia or Poland [198]. Therefore, Romania needs to make intensified and sustained efforts on all indicators, regardless of the progress made so far. But these transformations must be the result of a concerted effort by all actors: the political class, the academic and private environment, researchers and innovators.

Quality culture

In many universities, quality management and accreditation are considered one and the same, and therefore efforts are made to achieve the requirements imposed by the standards; unfortunately, one of the most important aspects is ignored – continuous quality improvement .[199] The literature has discussed different quality assessment models in higher education institutions, such as SiX Sigma [208], the European Foundation for Management quality or EFQM [209] and the SERVQUAL model [210]. However, there is no consensus on a globally accepted model for quality management in higher education.

Teaching and learning

For higher education, the future challenges are great if we consider only those related to the teaching dimension in relation to professionalization and social responsibility roles: strengthening the professional dimensions of training (learning transfer), student learning experiences, the use of technologies in education, the development of European civic professionals [234]. At this point, there is a critical need to build strong evidence related to innovative pedagogies at HEI level and how they can respond to current challenges in order to develop, apply and scale best practice across study programmes. Indeed, if we look at the universities that are in the top of the most innovative (KU Leuven, TU Delft sa), we will find new ways of organizing learning, called innovative pedagogies. Along with these, for technical higher education institutions, challenge-based learning and vertically integrated projects are frequent approaches. The Open University's 2020 edition report, which explores new forms of teaching, learning and assessment for an interactive world, to guide teachers and policy makers in productive innovation, proposes, under the title "Innovative Pedagogy", a list of new concepts, terms , theories and educational practices that have the potential to cause major changes in educational practice [235]. The Open University (along with their associates) has lately been publishing such a report every year. The growing body of reports and literature on innovative pedagogies reflects (probably on a much smaller scale) the efforts of thousands of researchers and practitioners at all levels, their many successes and failures, but also their insistence on finding the best solutions for teaching. and learning.

Research

Next, we will analyze Romania's position within the EIS. This tool divides EU countries into four categories: modest, moderate, strong and leading innovators. In 2019, Romania positioned itself in the category of modest innovators, being listed as the most modest innovator in the EU, occupying the last place of the ranking. The figure below captures this position.

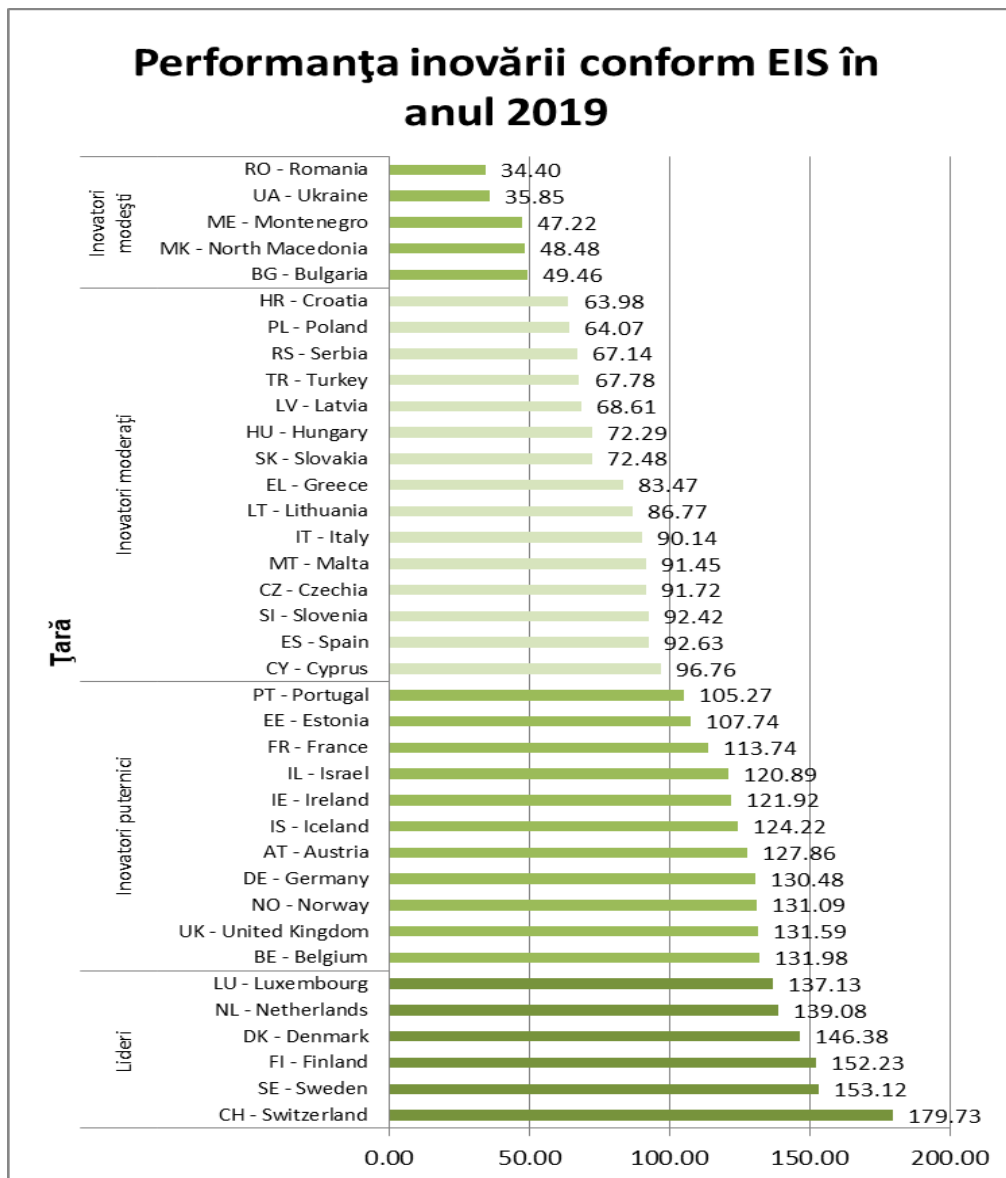


Figure 1. Innovation performance according to EIS in 2019 (European Innovation Scoreboard Edition 2020)

Thus, we observe that Romania registers negative results in the sphere of innovation and, implicitly, of CDI, the major cause being the poor financing of the system. Romania must be aware of the importance of supporting RDI activities and the increasing use of instruments to stimulate private investments in this area, whether direct or indirect.

Service to society

Universities and stakeholders within these institutions play a significant role in shaping the sustainable development agenda [245], [246] for a better society .

There is a growing demand for higher education institutions to play an active role in helping to respond to societal concerns, where sustainability is a particularly relevant issue [247].

Internationalization

Internationalization strategies take into account the prestige and status of higher education institutions on the one hand, and revenue generation and commercialization on the other. Internationalization strategies are divided according to the items in the figure below:



Figure 2. Internationalization strategies (Ana and de Dosch, 2021)

Talent management in higher education institutions

Competence, performance and professionalism in the teaching and research career

The role of educational institutions is changing from being a repository of knowledge to teaching students to select, challenge, extend their knowledge and redefine research and teaching methodologies [291]. Universities will need all their capacity to transform profoundly to serve a changing society and a profoundly changed world, and to remain relevant and meaningful for generations to come.

European Charter and Code of Researchers

The mobility of researchers is a central pillar of the European Research Area (ERA) being the main instrument formally adopted for its promotion: "The European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers" [293]. Currently, worldwide 1280 organizations have endorsed the principles of the Charter and the Code. Of these, only 14 are from Romania.

Table 1. Organizations that have approved the principles of the Charter and the Code in Romania (European Commission, 2021)

No. crt.	Organizations
1.	Alexandru Ioan Cuza University from Iasi
2.	Banat University of Agricultural Sciences and Veterinary Medicine
3.	University of Economic Studies in Bucharest
4.	National Research and Development Institute for Biological Sciences
5.	National Research and Development Institute for Mechatronics and Measurement Techniques
6.	National Research Institute - Development for Chemistry and Petrochemistry - ICECHIM Bucharest
7.	Ovidius University of Constanta
8.	Polytechnic University of Bucharest
9.	spiru Haret University
10.	Bucharest National Research and Development Institute for Textiles and Leather (INCDTP)
11.	Babeş-Bolyai University (UBB) from Cluj-Napoca
12.	University of Agronomic Sciences and Veterinary Medicine - Bucharest
13.	"Grigore T. Popa" University of Medicine and Pharmacy
14.	"Victor Babeş" University of Medicine and Pharmacy, Timisoara

Policies to ensure equal opportunities

Despite impressive achievements, significant gaps persist between the growing number of women as students and those in leadership roles [326]. There are still organizational, cultural, academic and societal barriers to career opportunities [327], [328].

From a historical perspective, the tendency towards social stratification prompts to explore if and under what conditions, some periods could be more or less favorable to unequal differentiation processes (vertical or horizontal). This requires connecting the three types of inequality of opportunity or differentiation. For example, social differentiation is not only related to resource differentiation (if the best-resourced segments of a system necessarily receive the most privileged students), but also to mission differentiation/convergence (for example, if an academic enclave of institutions non-elite might decide to exclude traditionally underrepresented social groups).

Chapter II. Scientific research methodology

In line with the innovation mode of the quadruple helix, the research follows **a quantitative perspective**. The research participants will be represented by the four categories of interested parties, in accordance with the chosen model, these being directly involved in the collaboration between the four actors.

Research design considerations

For the innovation good practice research, in terms of choosing participants for the study, the logic of Spradley [337] was applied to choose people who are currently in a position to be able to take the time to interview them, but also have a history of the situation. 8 interviews were conducted.

The abbreviations used in the research are: Univ. – University, Ind. – Industry, Govt. – Government, Soc. Civ. – Civil society.

For quantitative research, the literature supporting questionnaire design is organized around the following studies and research:

1. innovation in higher education institutions is primarily manifested in their central functions, namely, (1) research, (2) teaching and learning [62], which represent the production of knowledge and the dissemination of knowledge, respectively [63]. Therefore, experts have recognized innovation in higher education institutions as the ability of an institution to develop and implement new ideas [64], such as new academic programs, teaching materials and methodologies, and research projects, which represent product and process innovation [64].

2. the integration of project management principles (International Project Management Association) [338], [339], [340], [341], [342], [343] in the management of innovation processes [344], [345] is one among the pillars for improving results. Holistically, the IPMA OCB model provides competency development guidance for evaluating and improving project success, training and certifying practitioners. It is a project management framework that has proven to be potentially useful for university governance, as it incorporates the principles of sustained success for any project, also applicable to educational innovation projects [343], [346], [347], [348], [349], [350].

The actuality of the subject

We aim to focus on the university's role in innovation ecosystems through quantitative research and research into innovation good practice. Both analyzes focus on the changing nature and quality of interactions between universities, companies, government agencies and civil society, focusing on the orchestration of innovation by multiple actors, its new interfaces and organizational forms, changing formats and collaborative spaces, as well as on the transformation of the roles of key actors.

Research problem focus

The research problem can be formulated as follows: this research aims to investigate to what extent the collaboration between the four actors in the quadruple helix model influences innovation in higher education institutions.

The purpose and objectives of the study

The purpose of this research is to propose approaches with an ameliorative role and restructuring of innovation and governance practices in higher education institutions in order to contribute to increasing the performance of universities, by capitalizing on elements of the theory and practice of innovation and management quality.

By derivation, the following objectives can be established:

O1. Carrying out a descriptive analysis of the issue of performance and educational management and talents, focusing on the higher education segment;

O2. Investigating academics' opinion on governance and decision-making, the culture of innovation ecosystems, teaching and learning, research and social services in the context of higher education institutions;

O3. Investigating the opinion of the private environment on governance and decision-making, the culture of innovation ecosystems, teaching and learning, research and social services in the context of higher education institutions;

O4. Investigating public opinion on governance and decision-making, the culture of innovation ecosystems, teaching and learning, research and social services in the context of higher education institutions;

O5. Investigating the opinion of civil society (students) on governance and decision-making, the culture of innovation ecosystems, teaching and learning, research and social services in the context of higher education institutions;

O6. Carrying out an analysis regarding the performance and role of universities within the quadruple helix model of innovation;

O7. Carrying out an analysis regarding the role of the public environment within the quadruple helix model of innovation;

O8. Carrying out an analysis regarding the role of the private environment within the quadruple helix model of innovation;

O9. Carrying out an analysis regarding the role of civil society within the quadruple helix model of innovation;

O10. Development of a set of tools (good practices) to enhance the innovation performance of higher education institutions in Romania.

Variables and assumptions

The innovation best practice analysis focuses on the role of the university in relation to seven thematic clusters (latent variables), which will be found in the interview guide:

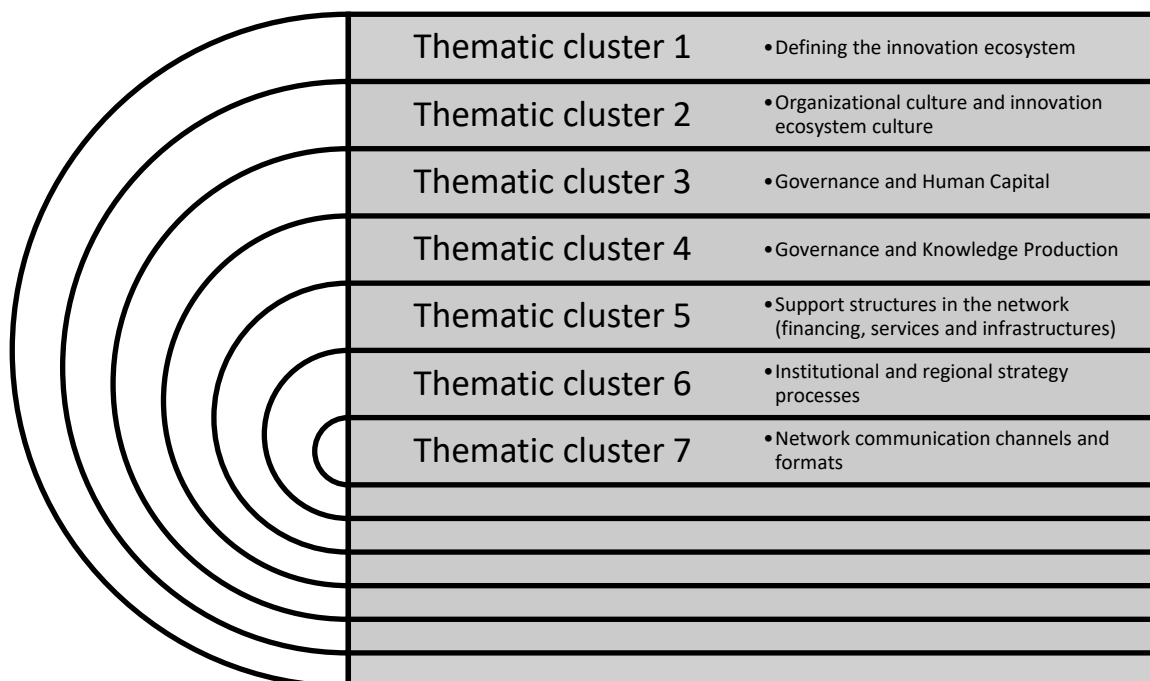


Figure 3. The thematic clusters of research on good practices in innovation (prepared by the author based on specialized literature)

Research participants. Selection methods

For the research of good practices in innovation, the sampling included the four categories of respondents, as follows: 8 respondents from the academic environment, 32 from the private environment and 7 from the public environment.

For the quantitative research, sampling is carried out for the four categories of respondents. It is non-probability sampling based on availability/convenience criteria. Based on these considerations, we opted for a survey based on a questionnaire, a quantitative study, which would allow comparisons between respondents from the academic, private sector and the social community, who are active in different fields of activity, in the context of an organizational climate that presents specificities in relation to the activity sector. This resulted in four samples: E1 – the sample of respondents from the private sector, E2 - the sample of respondents from the academic environment, E3, the sample of respondents from civil society and E4, the sample of respondents from the public environment.

Research methodology

Data collection methods, techniques and tools

In quantitative research, a Likert scale was used to rate the items [366], which is frequently used in the social sciences to measure perceptions and quantitative aspects [367]. Each item consists of five responses – (5) total agreement, (4) partial agreement, no agreement, (3) no disagreement, (2) disagreement and (1) total disagreement. A higher score is given when respondents have a more favorable perception. There are also closed questions with answers of the type: Yes, No, I don't know/ Can't appreciate. Before conducting the interviews, we pre-tested the interview guide with 7 students (ML, AR, C., D., AB, RL, RD and CP) from the Politehnica University of Bucharest, through a pilot interview to help improve the questions, the sequence in which they were asked and the way in which they were asked. Participation was voluntary and all respondents were given an Information Sheet (see Appendix 1) to read in relation to the purpose of the study.

The questionnaire addressed to managers, directors and teaching staff from higher education institutions in Romania can be found in Annex 5. At the beginning of the questionnaire, I outlined the socio-demographic profile according to gender, position held, age and level of training for academics.

The second questionnaire of the quantitative research is addressed to students (civil society), the link of the questionnaire will be sent to them. There are 2 thematic groups and 14 items, the questionnaire can be found in Annex 4. I also outlined the socio-demographic profile according to gender and age. Before application, the questionnaire will be pre-tested to identify the extent to which students understand each item regarding clarity, answer options, rating scale, etc.

The third questionnaire of quantitative research it aims at innovation and university-business environment cooperation in Romanian enterprises and is composed of 49 items (Appendix 6). Also, the questionnaire includes the socio-demographic profile according to gender, position held, age and level of training for respondents from the private sector.

The fourth questionnaire of the quantitative research aims at innovation and cooperation between the university and the public environment in Romania and is composed of 19 items (Annex 7). Also, the questionnaire includes the socio-demographic profile according to gender, position held, age and level of training for respondents from the private sector.

QUANTITATIVE COMPONENT

The investigated sample - selection and characteristics

All individuals were sent invitations to complete the questionnaire, with the request to share the link with at least three people who fit the profile of potential respondents. The completion rate of the questionnaire was approximately 25%, with a response rate of 40%.

A total of 194 students completed the questionnaire. They were joined by 8 respondents from the academic environment, 28 from the private environment and 27 from the public environment.

Data collection tools

In the first stage of the research, the resulting questionnaire was qualitatively pretested.

The answers collected were analyzed and, according to the feedback received, the questionnaire was optimized by reformulating and/or eliminating some items.

The resulting questionnaire was applied in the context of the second stage of the research. Also, the questionnaire administration technique was kept, namely the WAPI (*eng. Web Assisted Personal Interviewing*) technique, in which the questionnaire is self-administered online.

Details on data analysis

To determine the factor structure of the innovation in higher education variable from the students' perspective, principal axis factoring (PAF) analysis was performed using IBM SPSS v25.0 software. PAF was applied as an exploratory dimensionality reduction method to infer the main factors described by the study variables. Initially, the factorability of the 13 items in the student questionnaire was examined. The Kaiser-Meyer-Olkin measure of sampling adequacy indicated that the strength of relationships between variables was high: $KMO=0.837$. The dimensionality of the scale was also tested by scree plot test and Kaiser criterion - eigenvalues greater than 1. Three items had communalities (h^2) below the threshold of 0.4. However, they were kept in the analysis given their theoretical relevance. None of the factors had cross-loadings greater than 0.4. Bartlett's test of sphericity, which tests the overall significance of all correlations within the correlation matrix, was significant $X^2(78) = 636,903, p < 0,001$. Given these general indicators, factor analysis was deemed appropriate with all 13 items.

In the final solution, two factors with eigenvalues greater than one were extracted. Both Varimax and Oblimin rotations were performed. There was little difference between the two solutions provided and we decided to keep the extracted solution based on Varimax rotation with Kaiser normalization. Initially, by applying factor analysis, we reduced the number of variables and tested the dimensionality of the scale. Subsequently, structural equation modeling was applied to validate the results of the factor analysis and to test the hypotheses. The first part of the modeling was implemented using IBM Amos 26.0 and maximum likelihood estimation (ML-SEM).

Several models were tested. First, we tested a reflexive model in which all items loaded on a single latent factor (Model 1- M1 monofactorial CFA (ML-SEM)). Second, as a basis, we used a structure in which the two factors from the exploratory analysis correlated with each other (Model 2 CFA2).

As recommended by Hooper, Coughlan, and Mullen [368], the normalized/relative chi-square (X^2/df) can take values between 2 and 5. Other fit indices were calculated and analyzed: RMSEA, RFI, CFI, and TLI. MacCallum, Browne, and Sugawara [369] suggest that an RMSEA value between 0.05 and 0.10 can be considered a good fit. More recent opinions of researchers (e.g. Steiger) report values less than 0.07 [370] to consider the model fit correctly. Regarding the CFI and TLI indices, the values should be close to the threshold of 0.95 [45]. Values between 0.85 and 0.95 indicate a satisfactory fit of the model to the empirical data [368]. In this paper, we followed the acceptable criteria and thresholds suggested by Hooper et al. [368] and MacCallum et al. [369].

For the category of representatives of higher education institutions, given the small number of respondents ($n=8$), we could not perform exploratory and confirmatory factor analyses. However, descriptive statistics will be presented in the dedicated section of Chapter III.

Elements of research ethics

Each participant will receive a copy of the Information Sheet, Consent Form and Confidentiality and Anonymity Information Sheet (see Appendices 1, 2 and 3) prior to any innovation best practice interview.

Limits of research

Academic literature regarding the application of the quadruple helix model in higher education institutions is reduced, especially if we refer to quantitative invoice research. This research is innovative as little research has been conducted in this area, but this aspect is also a potential limitation as the absence of research exploring the application of the quadruple helix model is a minus in the academic literature. Due to the absence of previous quantitative or interpretive empirical research, there was a limited empirical frame of reference in which to contextualize this study, other than previous research conducted on the entrepreneurial university and the interaction of this type of university with industry, government, and the social community. This paper is an attempt to apply the quadruple helix model to a lower level of analysis – the analysis of only two higher education institutions. I would argue that this study highlights the limitations of the applied theoretical perspective. The quadruple helix model has a skewed view, favoring certain academic disciplines over others eg: science, engineering, more product focused disciplines leading to easier commercialization of research.

Chapter III. Preliminary results in research on innovation practices in higher education

Quantitative research results

Student perspective on innovation practices and services

Following the inclusion of different actors, the results are presented based on the research questions that were asked. The chapter presents progressively and in detail the analysis of the investigation starting with the questions addressed to the students, respectively the answers provided by them. The student sample consists of 194 respondents.

The factorial structure of innovation in higher education

First, the factorability of the 13 items in the questionnaire was tested. The Kaiser-Meyer-Olkin sample adequacy index indicated that the intensity of the relationships between the variables was high: $KMO=0.837$, and the Bartlett test was statistically significant: $X^2(78) = 636,903, p < 0,001$.

To reduce the number of variables included in the statistical model, PAF with Varimax rotation was performed. PAF was applied because the main objective was to identify latent factors underlying innovation in higher education from the students' perspective. The initial solution included 2 factors with eigenvalues greater than 1, which explained more than 37% of the total variance. The first factor extracted explained 20.27% of the total variance.

All 13 items included in the analysis had prime loadings above 0.4, even 0.7. The summary of the results can be found in Table 2. Summary of the matrix of rotated components, variance and eigenvalues. The table shows the two extracted factors, the explained variance and the eigenvalues. In relation to the content of the items that load on the two factors, they were called *entrepreneurship, incubation and transfer*, respectively *innovation support services*.

Table 2. Summary of the matrix of rotated components, variance and eigenvalues

Factor	Items	communality	Factor loading	%variance explained (Cumulative)	Own values
Entrepreneurship, incubation and transfer	IS10	0.609	0.772	20,272	3,920
	IS13	0.572	0.744		
	IS12	0.459	0.672		
	IS9	0.458	0.579		
	IS11	0.426	0.568		
	IS8	0.513	0.515		
Innovation support services	IS6	0.412	0.642	37,059	2,103
	IS7	0.433	0.632		
	IS5	0.586	0.527		
	IS1	0.275	0.519		
	IS4	0.401	0.509		
	IS3	0.260	0.499		
	IS2	0.213	0.450		

On the first factor, *entrepreneurship, incubation and transfer*, 6 variables are loaded. Variable loadings on this factor ranged from 0.515 to 0.772. As can be seen from the data in Table 2. Summary of the matrix of rotated components, variance and eigenvalues, item IS10 (Overall, the university supports students through specific activities to develop a business or a research project) has a primary loading of 0.772, followed by the variable *Overall, the faculty has developed competitive structures to achieve innovations (IS13)*, whose loading on factor 1 is 0.744.

The second extracted factor refers to *innovation support services*. Seven variables load on this factor, with loadings ranging from 0.450 to 0.642. IS6 (Within the university there are advisory committees for innovation in higher education) and IS7 (Within the university there are innovation services in higher education for the faculty) are the variables with the highest loading scores on this factor.

Results of structural equation modeling analysis

Model 1 – M1 one-factor CFA (ML-SEM)

In Figure 4, we present the standardized estimates of the first confirmation model (model 1) as well as the regression coefficients. All estimated coefficients were significant ($p < 0.001$) (see Table 3). Regarding the model fit statistics to empirical data obtained for the monofactorial model, the chi-square was significant, the ratio $\frac{\chi^2}{df} = 0,3,64$ (being within the assumed limits), but the RMSEA, TLI

and CFI were well outside the model acceptance limits. As suggested by both the exploratory factor analysis and the research framework, innovation in higher education could be a secondary construct underlying various primary constructs.

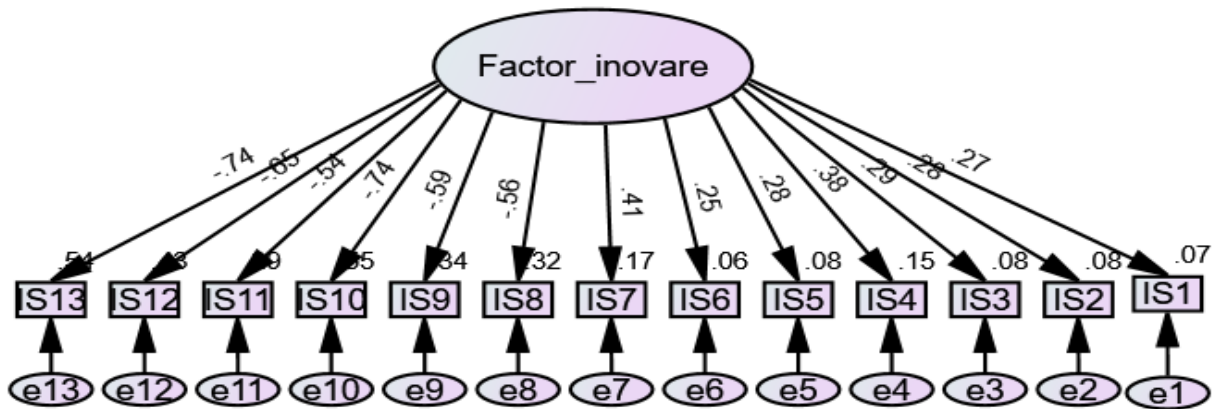


Figure 4. One-factor CFA model. Standardized regression coefficients

Table 3. M1-CFA (ML-SEM) model fit statistics

χ^2	df	p	χ^2/df	TLI	CFI	RMSEA
236.85	65	$p < 0.001$	3.64	0.642	0.702	0.11

Model 2 – M2 CFA Intercorrelated Factors (ML-SEM)

The second confirmation pattern is shown in Figure 5. The data were run through Amos with maximum likelihood estimation, and the results (Table 4) indicate a very good fit. In addition, Mardia's coefficient was 3.634 and the critical ratio (cr) was 1.28, indicating a normal multivariate distribution. So there was no need for *bootstrapping*.

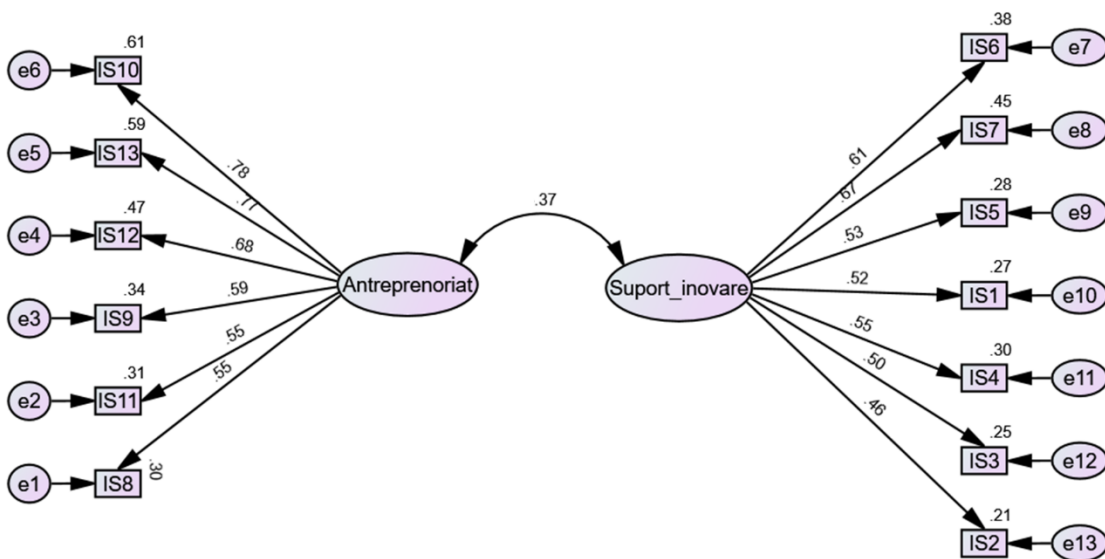


Figure 5. Model with intercorrelated factors (M2 CFA). Standardized regression coefficients

Table 4. Goodness of fit indices

χ^2	df	p	χ^2/df	TLI	CFI	$RMSEA$
71.41	64	$p = 0,245$	1.11	0.984	0.987	0.04

The path plot in Figure 5 shows the standardized estimates of the second model as well as the regression coefficients. All estimated weights were significant ($p < 0.001$). Regarding the goodness-of-fit statistics obtained for model 2, the chi-square was not and the ratio $\frac{\chi^2}{df} = 1,11$ was not within acceptable limits. But the RMSEA, CFI and TLI were within the acceptance limits of the model, with very good values. We can therefore accept the model as having explanatory value.

The perspective of managers, directors and teaching staff from higher education institutions in Romania on innovation practices and services

The chapter presents progressively and in detail the analysis of the investigation, continuing with the questions addressed to managers, directors and teaching staff from higher education institutions in Romania, respectively the answers provided by them. Their sample consists of 8 respondents.

The first variable is Support - the so-called institutional support measures, referring to actions to support innovative teaching through university governance (specific web pages, awards, training measures, conferences for the exchange of experience, advisory committees, support services for the faculty), as they are perceived by managers, directors and teaching staff from higher education institutions in Romania.

The table below (15) shows the results of this section of the questionnaire, taking into account the total number of respondents surveyed. The answers are Yes/No/Don't know-Can't rate and the results are shown as percentages.

Table 5. Evaluation of Actions to support innovation in education (%) (n=8)

Answer	Item	Yes	Not	I don't know/I can't appreciate
Innovation groups or teams in education. sup.	1	62.50%	12.50%	25.50%
Portal regarding innovation in education. sup.	2	25.00%	25.00%	50.00%
Awards regarding innovation in education. sup.	3	37.50%	50.00%	12.50%
Quality department	4	75.00%	12.50%	12.50%
Conferences for the exchange of experiences on innovation in education. sup.	5	62.50%	25.00%	12.50%
Advisory committees for innovation in education. sup.	6	37.50%	37.50%	25.00%
Services for managing innovation processes at the faculty level	7	37.50%	50.00%	12.50%
Scientific publications are created by projects based on innovation in learning. sup.	8	62.50%	37.50%	
The results of scientific publications are shared	9	75.00%	12.50%	12.50%

(Compiled by the author)

Similarly, in terms of strategies, structures and processes for supporting educational innovation, table number 16 highlights the research findings.

Table 6. Evaluation of strategies, structures and processes to support educational innovation (%) (n=8)

Answer	Item	Neither agree nor disagree	Partially agree	Totally agree
Implementation of strategic plans related to innovation in higher education	10	25.00%	37.50%	37.50%
Implementation of the structure, services or units specifically related to innovation in higher education with staff (administration and services)	11	37.50%	50.00%	12.50%

Implementation of specific requirements for the improvement of innovation projects in higher education	12	37.50%	37.50%	25.50%
Implementation of some guidelines regarding innovation in higher education	13	37.50%	25.00%	37.50%
Implementation of governance strategies to strengthen the culture and recognize achievements regarding innovation in higher education	14	25.00%	50.00%	25.00%
Implementation of specific actions and resources to improve training on innovation in higher education of the faculty	15	25.00%	50.00%	25.00%
The existence of a relationship between quality services and innovation services in higher education	16	25.00%	37.50%	37.50%

(Compiled by the author)

The third variable relates strictly to projects: the maturity of projects based on innovation in higher education works, to successfully achieve any type of change, innovation and improvement through projects. This variable includes elements such as planning and programming of innovation projects in higher education, tools and systems, indicators, criteria for measuring the quality of results and benefits of innovation projects in higher education, their monitoring and control, lessons learned and their results. The results that were obtained for this governance dimension are detailed in Table 17.

Table 7. Evaluation of work based on educational innovation projects (%) (n=8)

Answer	Item	Partially disagree	Neither agree nor disagree	Partially agree	Totally agree
The approach and implementation environment of projects based on innovation in higher education are aligned with the vision and mission of the university	17		25.00%	37.50%	37.50%
There is planning and programming of project-based projects on innovation in higher education, including opening and closing processes	18		50.00%	25.00%	25.00%
Processes and systems (indicators, criteria, tools) are available to measure the quality of results and benefits of innovation projects in higher education, as well as to monitor and audit them	19	12.50%	37.50%	37.50%	12.50%
Processes and systems are in place to manage human resources	20		37.50%	50.00%	12.50%
Budgetary planning is implemented for the financial resources and infrastructure of innovation projects in education	21		62.50%	12.50%	25.00%

(Compiled by the author)

Therefore, the fourth variable is strictly about Impact. This variable aims to evaluate the perceptions of the effects of the projects in improving quality through a series of specific dimensions that help governance to build competitive universities in international rankings. It is structured in three sub-variables: teacher impact, student impact and university impact. The results that were obtained for this governance dimension are detailed in Table 18.

Table 8. Evaluation of the impact of innovation-based work on teaching staff in higher education (%) (n=8)

Answer	Item	Partially disagree	Neither agree nor disagree	Partially agree	Totally agree
Innovation leads to the improvement of the quality of teaching activities	22		25.00%	37.50%	37.50%
Innovation leads to the positive motivation of teachers	2. 3	12.50%	12.50%	25.00%	50.00%

Innovation leads to improved collaboration within the faculty	24		50.00%	37.50%	12.50%
Innovation leads to improved teaching creativity	25		25.00%	37.50%	37.50%

(Compiled by the author)

Business perspective on innovation practices and services

The sample of the business environment consists of 28 respondents.

Final reflections of the research regarding the perspective of the business environment on innovation practices and services

The research highlighted that the most important factors to select the universities / research institutes in Romania for the purpose of a collaboration, in first place:

- Good research reputation
- Rich experience in working with the business environment
- Improving the development of products requested by customers
- Cost saving for research and development
- Accelerating the speed of research and development
- Rich network related to research and development

And in second place:

- Obtaining patent rights
- Good research facilities
- Advantages in the field of future business / products / services.

We note the importance of a good reputation in research. Scientists are motivated by the rewards of recognition and prestige and have a strong interest in gaining a good reputation. By the nature of their work, scientists constantly ask research questions and aim to show the results of their research in order to gain recognition and a good reputation. Through such academics, the reputation of the university grows.

Patenting can enhance the prestige and increase the scientific productivity of scientists by reaffirming the novelty and usefulness of their research therefore scientists may consider patenting to increase their visibility and reputation and implicitly the reputation of the university.

While we know about the monetary gains from patents, an equally interesting gain is reputation. Recognition is allocated to scientists, to the extent that they have fulfilled their academic tasks. Reputation can be achieved and demonstrated by scientific publications, honorary awards, positions at top ranked institutes and citations, but industry is not necessarily interested in these aspects. Publication of peer-reviewed scientific articles in top journals, participation in top international conferences, teaching skills and access to grants are always considered academic merits and improve the chances of promotion and growing academic reputation. Due to the intensification of university-industry relations, economic development through technology transfer has become a "third academic mission" of universities, in addition to the traditional missions of teaching and research. Therefore, in addition to the tools mentioned above, we believe that the expectations of scientists to increase their reputation (visibility / recognition) must be correlated with patenting and research.

The competition for reputation and recognition among scientists and implicitly universities leads us to the conclusion that scientists must use patents as a signal to show the industrial relevance and applicability of their research results to attract more industrial support. In this case, the research results could be patented together with the industrial financier of the project.

We note that the proactive role of universities is extremely important to respondents. The participants expressed the opinion that universities need to play a more proactive role in the commercialization of research results, which comes from a rich experience in working with the business environment.

Universities must demonstrate the applicability of research to industry in a relevant context and promote their research results, while improving the development of products demanded by customers. Before that, they need to better understand the business and user requirements around them. This will help universities align their research goals for greater impact.

Participants also suggested that universities need some entrepreneurial skills to drive faster research and development and improve the development of products demanded by customers. Thus, the participants were of the opinion that improving product development, research and development requires promotion and involvement. Researchers must try to promote their research. Universities need people with entrepreneurial characteristics whose purpose is to make things happen. Along with this, universities must work to hire and train staff who are academically qualified to understand research and its significance so that they can speak the language of business people and marketing communication. One way to achieve this is to invest in graduate and postdoctoral students, as they possess the necessary expertise and are often more open to alternative career paths rather than standard academic paths.

In this sense we believe that product / business awareness is extremely important for the academic environment. The value of awareness among researchers about a product and its life cycle, understanding the actual product and its contributing environment will lead to increased engagement between researchers and industry. It will also broaden researchers' perspective on their work. Universities must encourage such relationships.

At the same time, researchers must think beyond the narrow limits of their research results as publications, to the real application of their research. Researchers need to be aware of their research in the context of industry application to create impact.

A first step in this direction would be to improve the Alumni Association. We believe that the value, the greatest advantage of a university is its people, especially its graduates. Universities should maintain a link with alumni and share progress within the university. Good and ongoing alumni relationships can help increase industry engagement, research funding and wider societal impact. Implicitly, they can lead to new industry-university collaborations, in this case members of the private sector being represented by former graduates.

Regarding the type of activities carried out by respondents in collaboration with universities, a great emphasis is placed on:

- Informal contact with the academic environment
- Hiring recent graduates
- Access to specialized equipment
- Tests / analyzes in the university.

We note that there is an emphasis on the impact of communication (especially informal) and relationships between academia and the private environment. Good personal relationships are the basis for enabling vital links between companies and universities. In this regard, the contacts and actions should not only include at the management level, but must also be at the operational level. This includes regular interaction, continuous feedback, mutual exchange of information and updating partners on incidents or new activities. In addition, communication through a variety of channels such as e-mails, regular meetings, or face-to-face communication is advantageous, although partners must select those channels carefully, as the lack of effective communication channels is also considered a main barrier in partnerships. Mutual communication (regular, timely, appropriate, and accurate) is also beneficial in setting positive expectations about the future behavior of partners, especially when the partnership is new. Another requirement for a successful collaboration is finding an appropriate "language" for both partners, as these collaborations are often affected by the use of different (formal) styles in academic and business environments.

Regarding the barriers in the interaction between the universities / research institutes in Romania, the respondents consider that they are, in order of their importance:

- Lack of governmental support programs for the interaction between the university and the business environment
- Possible conflicts related to intellectual property rights

- Rules and regulations imposed by the government
- Difficulty finding suitable partners
- Difficulty finding the right partners

We observe that the most important barriers mentioned by the business environment relate to the framework factors. Thus, we observe that the environment can have an impact on this type of collaboration. Be it government support, legal restrictions or the market environment. Government is an influential power that can either enhance or harm collaboration. On the one hand, fiscal incentives, public funding or the government network can represent barriers in the interaction between universities / research institutes in Romania. On the other hand, legal restrictions and regulations or the lack of regional support structures can have a negative impact on collaboration. In general, government support is often needed to establish a collaboration between universities and industry work. Other negative framework factors refer, for example, to market uncertainties, which usually also relate to the rules and regulations imposed by the government.

The following factors identified as barriers refer to the legal aspects of collaborations and contracts and intellectual property rights (IPR) were mentioned in this regard, respectively possible conflicts related to these contracts or rights. Contracts detailing the arrangement, roles, and responsibilities reduce the possibility of later disputes, can help establish trust, and are necessary to verify that goals have been met by partners. Formal agreements are particularly advisable in complex collaborative projects or to ensure mutual access to expensive infrastructure. Confidentiality and non-disclosure agreements play an important role in industry-university projects, and establishing appropriate agreements is an important task for participating partners. With respect to patents or other intellectual property rights, issues and conflicts may arise regarding project ownership or royalty payments.

Added to all this are the difficulties in finding suitable, suitable partners. In this case it can be about trust - another important factor in promoting a collaboration between industry and universities. Mistrust influences the flow of information and can lead to a deviation from the initial focus of a collaborative project. Therefore, partners need to spend enough time to establish mutual trust. Previous experiences working together or undertaking smaller projects to maintain personal contacts at the start of a new partnership can facilitate trust. There is also evidence that trust can be maintained and strengthened by adopting similar operating and decision-making styles [374].

Our research on collaboration between academia and business (industry) on innovation has led us to the conclusion that SMEs are generally characterized by small size and weak networking capacity, which is why in general, they are not an attractive partner for universities. This explains why 96.4% of survey respondents are not connected to local universities/research institutes. At the same time, we found that 64.3% do not want to investigate collaboration opportunities with universities / research institutes in Romania, as a result of the key barriers to these partnerships, but also the lack of interest from the private sector (strictly small businesses and medium sized).

SMEs find it difficult to find the right candidate for industry-university collaborations due to the lack of appropriate institutional mechanisms to match industrial and academic partners. SMEs often miss out on innovation opportunities due to their relatively poor networking capability. In addition, the fear of disclosing one's intellectual property to external partners also created another major barrier to collaboration with universities in innovation projects.

I have mentioned above a series of extremely important factors in such collaborations, which is why, in the following, we will suggest a series of recommendations.

Regarding institutional factors, we recommend flexibility. This means flexibility not only in terms of your own priorities, but also in terms of your partner's priorities. We believe that formal rules should be adopted where necessary and compromises made where appropriate. Openness is equally important, not imposing one's own conventions and approaches on the partner. A beneficial industry-university collaboration requires the creation of collective goals, the sharing of the same visions and interests. At the same time, management processes must be flexible enough to deal with instability and change, as well as the diverse interests of partners.

In terms of the relationship between both partners, honesty is very important. This means treating your partner fairly, communicating openly and honestly, and promptly informing your partner of

current developments to foster trust. In addition, commitment to promises and transparency regarding objectives, IPR policies or knowledge transfer is required. Trust and reputation play an important role when partners share one of their most valuable assets - their knowledge. Therefore, trust and building trust is an important issue and honesty is a fundamental basis of it.

At the same time, clarity is needed. This means having clear objectives, planning as realistically as possible, agreeing on responsibilities, specifying the extent of each partner's contribution and defining roles right from the start. In this regard, expectations regarding policies regarding intellectual property rights, patent ownership or exploitation of project results must be clear. In this context, it is essential to allow enough time to understand the interests of the partner, to ask questions if necessary, to discuss goals and visions and possibly to negotiate them. Concrete agreements and contractual guarantees could help in this regard. In conclusion, while the different background of the two partners may lead to temptations to remain vague in the design of industry-university collaborations, in the long run a collaboration is more likely to succeed if the main points are clarified between the partners.

Regarding the framework factors, it is necessary for the partners to be aware of the economic, legal, political or social developments. These developments have a large impact on collaboration and should therefore neither be underestimated nor neglected. This involves observing and exploiting public funding opportunities or pursuing the possibility of (fiscal) incentives for industry- university collaborations. In addition, it includes monitoring changes in the market environment and awareness of political instability. It means, at a more general level, the analysis of the wealth, the intensity of innovation or the labor market of a region. In conclusion, for the establishment of a successful industry-university collaboration it is recommended to study the environment in which the collaboration is to take place, the current developments or future changes and the monitoring of environmental influences.

The perspective of the public environment on innovation practices and services

The sample of the business environment consists of 27 respondents.

Final reflections of the research regarding the perspective of the public environment on innovation practices and services

A large proportion of public sector respondents (74.1%) admitted that their institutions are not connected to local universities/research institutes. A problem related to the relations between public institutions and higher education institutions, therefore highlighted in the research, is the lack of collaboration agreements with local partners of public administrations. This may be due to the lack of demand for local research to develop new technologies. Institutions depend more on technology developed in more advanced countries because it is more reliable and commercially viable. Also, inflexible structure, strict bureaucratic procedure, lack of capacity, lack of funding and traditional values/philosophy of universities could be main challenges for developing a collaboration between universities and the public environment.

Next, the most important factors were targeted to select universities / research institutes in Romania for the purpose of a collaboration. According to the respondents, great emphasis is placed on:

- Good research facilities (85.9%)
- Advantages in the field required for future products / services (85.7%)
- Rich experience in working with the public environment (80.9%)
- Improving the development of products requested by various customers (76.2%)
- Accelerating the speed of research and development (75.2%)
- Good reputation in research (71.5%)
- Obtaining patent rights (71.5%)
- R&D cost savings (71.4%)
- Rich network related to R&D (66.6%)

– Geographical convenience (47.3%).

Starting from the answers above, we can state that the facilitators of the development of collaborative relations between the two actors can be considered the above. As highlighted, one of the reasons why the public environment and universities are motivated to develop collaborative relationships is that they have mutual interests in cooperating with each other. Whether we mean good research facilities, advantages in the field required for future products / services, rich experience in working with the public environment, or any of the above premises (improving the development of products required by various customers, accelerating the speed of research and development, good reputation in research), the advantages are definitely on both sides.

I was also able to observe how public institutions decided on partners from universities/research institutes, respectively as a result of university marketing, through internal personal connection or through a regional/national agency.

The main reasons why respondents from the public sector do not work with universities / research institutes in Romania are few resources and information (42.9%) and financial difficulties (33.3%). At the same time, regarding the plans of the public environment to investigate opportunities for collaboration with universities / research institutes in Romania, we find that 59.3% stated that they do not know yet if they want to investigate opportunities for collaboration with universities / research institutes in Romania. Only 25.9% want it, while 14.8% don't want it.

We notice that, although it is known that the public administration alone cannot respond to changes and uncertainties unless it cooperates with other stakeholders, there is still a great uncertainty: the respondents do not know what they want. Instead, when presented with concrete options regarding the activities they expect from such cooperation, we observe that their opinion crystallizes. Thus, the respondents opted for assistance organized within the university teaching program, employment of recent graduates, access to specialized equipment, university training, sponsorship of studies or research projects, as well as for tests / analyzes in the university.

At this stage, collaboration between university, industry, government and civil society to strengthen the local economy is mainly achieved through their traditional roles. Thus, universities produce and transfer more knowledge to industry and society, while obtaining additional sources of funding from industry and government to strengthen research performance. The institutional logic aligned with first-stage activities is the social belief shared by government and industry that knowledge production and technological progress are key to economic growth and success in economic competition.

Local authorities, universities and businesses must realize that technological progress and innovation are the key to economic growth.

Thus, a process of "assuming the role of the other" is required, through which the organizational actors in the four sectors realize that involvement in the fields of others is a necessary, but not sufficient, condition for achieving the desired goals. In addition, intra-organizational transformation also leads to new challenges and demands within and between stakeholders. As a solution, they need even closer cooperation and interaction with each other. Thus, it is necessary to realize that the knowledge production of a university cannot be achieved by itself, but needs industry not only as a source of research problems, but also as a strong partner in the production of knowledge. Meanwhile, university technology transfer depends on the conditions or environments created by the government. Interactions also result in the creation of hybrid organizations such as incubators, joint research centers, science parks, etc. And, in addition to all this, civil society has a major influence on other stakeholders.

ANALYSIS OF DATA COLLECTION ON INNOVATION BEST PRACTICES. ANALYZES AND CORRELATIONS FROM THE PERSPECTIVE OF MANAGERS, DIRECTORS AND TEACHING STAFF FROM HIGHER EDUCATION INSTITUTIONS IN ROMANIA ON INNOVATION PRACTICES AND SERVICES. PART I

The investigated sample - selection and characteristics

For the collection of good practices in innovation, we opted for a secondary analysis, in which the reference populations taken into account were represented by categories of actors of the academic environment: teaching staff, students and partners from the socio-economic and public environment. In this sense, we present in the following, progressively and in detail, the analysis of the investigation addressed to the academic environment. Their sample consists of 8 respondents.

Final reflections of the research on good practices. The main perspectives and implications for higher education institutions

This subchapter highlights the main research insights, explaining why and how they are important to us. Implications and conclusions for both academia and other actors are considered. The quadruple helix model is the conceptual framework used to explore and evaluate these relationships between Romanian universities and the other three components that make up this model.

Thematic cluster 1 - Defining the innovation ecosystem: the role of universities.

In general, what emerged from the respondents' answers connects development and innovation projects with training and education programs, or in other words, connects education, research (co-production of knowledge) and technology transfer or co-creation (exchange of knowledge for innovation systems).

Most respondents focused on the nature and form that innovation can take. The purpose, the social context and the different stages were mentioned less, and the means by which an innovation can take place were considered the least important. This would imply that there is no strong, reliable basis that this creation of innovation ecosystems, of networks, as advocated by the quadruple helix model, is a solid means of achieving innovation within academia. The need for higher education institutions to adapt so that internal transformation takes place together with how universities are affected by the influence exerted by other actors of the quadruple helix was seen as extremely important.

Thematic cluster 2 - Organizational culture and innovation ecosystem culture

Most of the respondents (7) believe that the organizational culture of the institution they belong to is partially favorable to a creative and innovative ecosystem, and improvements are needed to favor a creative and innovative ecosystem, but all the respondents emphasize the creative capacity that must become impregnated in the culture of higher education institutions.

Thematic cluster 3 - Governance and human capital

There is an overwhelming consensus among respondents that the university's most important contribution to innovation is educating students and preparing them for various roles in future academic and professional development and leadership. For universities and their partners, central concerns relate to the sufficient quantity and relevant quality of 'human capital'. This means finding out what conditions are necessary for individuals to realize their full potential and contribute to society, especially in a context of change.

Academics and innovators emphasized the importance of connections with the local and regional business environment. The respondents insisted on the need to integrate interdisciplinary approaches in teaching programs and methods. Interdisciplinary curriculum or specialization courses and project-based learning have served to connect scientific technological disciplines or to link the exact sciences and the humanities to incorporate technological development in the context of human action.

In this sense, the respondents agree that higher education institutions in Romania always try to innovate, both as an educational structure (school program) and as a human structure. Romanian universities are concerned with the development of human capital through education and training to ensure, maintain and motivate human resources. Therefore, universities and their partners are

concerned with the sufficient quantity and relevant quality of the "human capital" they form. However, the skills that universities develop in their students do not always seem to match the needs of current and future challenges. When asked if they think that higher education institutions in Romania produce human capital (graduates) ready to face the demands of the labor market, the respondents answered predominantly negatively. Thus, despite the efforts of the universities, they do not produce graduates who can join the labor market, the reasons being various: poor collaboration between the universities and employers, the little practice that is done in the universities, the lack of interest on the part of the students.

Given the fundamental questions that universities address in their response to innovation challenges, the universities visited in this study try to align learning and teaching reforms with their role in innovation, but do not entirely succeed. Learning and teaching reforms are on the agenda of Romanian universities, stimulated by a cultural change towards student-centered learning. When asked if they believe that curriculum development and teaching processes have changed to include the perspectives and actors of innovation ecosystems, responses are generally positive. Thus, the higher education programs are much better developed and are slowly moving towards a constant update, from year to year, restructuring the subject and updating the technologies available on the market.

For radical teaching reforms to take place, some institutional preconditions are considered crucial to ensure the desired flexibility and adaptability to innovation needs:

- Rich base of practice, respectively research that allows innovation and project-based learning;
- Encouraging mentoring;
- Close interaction with industry and other stakeholders to enable access to real-life problems for project work;
- Communication and cooperation between different disciplines, faculties and even universities.

Thematic cluster 4 - Governance and Knowledge Production

The second dimension of the university's role in fueling innovation lies in the (co-)production of relevant knowledge. In its role as a driver of innovation, be it regional or national, the university must seek a balance between international research and regional relevance. This knowledge must reflect the international research frontier in the given thematic area to ensure academic excellence and help companies or public stakeholders to face global challenges. University research helps give access to a "global pipeline" of knowledge to regional stakeholders in their innovation processes. Moreover, this knowledge must be translated into the stakeholders' own concepts and contexts so that it can be absorbed and create value. Thus,

In order to obtain and encourage competitive innovations, all universities emphasize a number of important aspects as actions/techniques and incentives. In first place are the financial incentives, mentioned by six out of eight respondents. To these, we add: involvement and open communication.

Thematic cluster 5 – Support structures in the network (financing, services and infrastructures)

From an infrastructure perspective, quadruple helix actors are well aware that a major research infrastructure is not only a facility or space that underpins a critical mass of researchers and other innovators, but also a meeting point and a way to attract more talent.

Analysis of the relationships between components (actors) in an innovation system focuses on how the actors interact and perceive each other. The first section discussed the role and nature of the relations between the actors. This was followed by an analysis of the type of relationships, their importance, with an emphasis on the dynamics of the network.

During the interviews, many respondents recognized that higher education institutions need to become thought leaders for industry and, in some circumstances, even for government and civil society, to help these two sectors achieve their goals. Industry needs, understanding the industry and meeting or serving the industry are prioritized. In terms of the role of education and higher education institutions as a means of meeting and serving the needs of industry, the university is as important as the industry. Theoretically speaking, the university is supposed to have been assigned an equal role within the quadruple helix. Taking into account the increasingly important role of higher education institutions, it seems that in practice, their role is equal to industry.

Respondents referred to the importance of academia being relevant to industry and innovation being endorsed and recognized by industry to meet their needs. The university must become a thought leader to help industry. I would argue that this consensus of opinion legitimizes academia's focus on engagement with industry and also highlights the university's awareness and acceptance of this. An interesting distinction was provided by the comment that industry provides the university with the revenue base and the university provides the accreditation base. The nature of the relationship with the university is one of co-dependence, while academia is dependent on industry and government.

Next, government actors were identified as being partially important compared to universities and industry, as well as involvement. Maintaining relationships is the main theme between university, industry, government and civil society in the future. The development of relationships, which is a more involved process, based on trust and an organizational culture that is constantly changing and adapting to requirements, characterizes the dynamics of the interaction between industry, academia and government. Respondents believe that the government could be the most important if it got more involved. For both industry and academia, the role of government has evolved as an important determinant in shaping their innovation agendas. This is primarily as a result of increased industry regulation and funding incentives in the provision of industry education. This led to closer interaction between all actors. It is desired that university and industry should jointly lobby to ensure adequate incentives, funding and fees to create interaction. At the same time, however, it is emphasized that the government should be like the parent - strictly, it must be the one that disciplines, rather than the one that builds the relationship. At the same time, the role of finance (financial instrument) and regulation (authority instrument) is recognized, which imposes an obligation on higher education institutions to understand the role of government and to function better. In this way, they can help the industry meet its obligations imposed by their interaction with the government.

Respondents evaluated the relationships from different perspectives in an attempt to consider the effect of inter-institutional networks on higher education institutions. It highlighted that most respondents considered industry, unsurprisingly, as the most important component, but some also pointed out that the dynamics of relationships are changing. For example, governments have a greater impact on industry now, so they will therefore become more important in the future.

Thematic cluster 6 – Institutional and regional strategy processes

Institutional leadership, beyond providing internal support to staff and initiatives, has a key role in aligning the university's strategy with other key stakeholders. Indeed, strategic development usually includes external stakeholders at some stage of the process and at different levels. In its strategy process, internal and external stakeholders are systematically aligned by institutional leadership to the extent that regional and institutional strategic processes merge.

All respondents agree that innovation is essential for an organization's growth strategy, as well as for regional strategy and for increasing competitiveness. Growth, if it occurs, will be the result of interaction first with industry and then with government, respondents believe.

Cluster 7.

We could observe that the actors of the quadruple helix develop networks, structures and common spaces to optimally use the geographical and cultural proximity. It brings together actors from the university, companies, government agencies or civil society, to promote mutual understanding, to develop common goals and projects and to build sustainable partnerships that help regional and implicitly national innovation. Regional innovation ecosystems are characterized by interconnected actors that promote connectivity, seeking coherence in three dimensions:

1. Organizational coherence
2. Social coherence
3. Spatial coherence

The concrete elements for achieving coherence are the interactive formats that cover all levels, from the strategic interaction between the institutional leaders of the four actors of the quadruple helix model, to co-creation research projects or student team development projects for companies. Interactive measures range from individual mobility between different institutions and sectors (such as student internships, MSc and PhD projects in industry, industry professionals as part-time teachers,

lecturers or mentors or university laboratories) to structural formats which organizes collaboration in a more sustained way.

ANALYSIS OF DATA COLLECTION ON INNOVATION BEST PRACTICES. PART II

Final reflections of the research on the collection of innovation practices. Part II -a

The main focus in this analysis is on the role of the university in the innovation process, a questionnaire being applied to obtain a multiple perspective of the regional networks of interactions and to see how the institutional processes are perceived by the actors in the higher education system. We considered six key dimensions of innovation systems and their communication processes, following a key set of questions that inform the guidelines for collecting good practices. In the following, we will detail the analysis of the results obtained as a result of the application of the tool for collecting data on best practices in innovation, which includes the previously mentioned thematic clusters from the perspective of the four actors.

1. The role of higher education institutions

There is an overwhelming consensus that the most important aspect for Romanian universities to contribute to innovation is the sufficient financial autonomy of universities to finance continuous professional development through alternative funding streams, including fees and the provision of sufficient resources. At the same time, more than half of the respondents considered it necessary to increase involvement in the field of STEM education, especially in terms of digital know-how.

The respondents in this study - academics and innovators - emphasized the importance of interdisciplinary approaches for defining and solving knowledge problems. They insisted on the need to integrate interdisciplinary approaches into curricula and teaching methods. Interdisciplinary curriculum or specialization courses and project-based learning have served to connect scientific technological disciplines or to link the exact sciences and the humanities to incorporate technological development in the context of human action.

Every respondent in the aforementioned study placed increased emphasis on project-based learning as a key ingredient of teaching methodologies and curriculum. Project-based learning is experienced as an important foundation to enable students to become future innovators.

All respondents emphasize the need for concerted efforts to promote entrepreneurial and mentoring mindsets and skills. Respondents are also concerned about the challenges of digital transformation and what this means for future graduate profiles, and are therefore considering the wider integration of digital skills into other study programmes. At the same time, retraining and improvement in response to innovation needs as well as self-organized student activities were seen as important. Ask if they believe that the university produces human capital (graduates) ready to face the demands of the labor market, all respondents (100%) answered affirmatively. At the same time, 89% of the respondents believe that the institution they belong to is favorable to a creative and innovative ecosystem.

In addition to the wide range of initiatives aimed at providing students with the right skills, abilities and mindset, respondents highlighted a widespread concern about the need to recruit enough students in areas where there are imminent labor shortages. Respondents believe that university research with international visibility attracts national and international funds and talent to the region. Respondents believe that the university is aware of current or foreseeable shortages, especially in STEM education disciplines and especially in IT branches, and invests time and resources in marketing and developing the (regional) talent pool. At the same time, respondents believe that their universities clearly contribute to ensuring a sufficient number of qualified graduates, as they attract students to the region – a growing number in most cases – and contribute to a high proportion of their graduates remaining in the region. For most of them, the proportion of graduates who stay in the region is higher than the proportion of students who originally come from the region. They are therefore net importers of talent. From the point of view of the university's role in the continuing education and professional development of partners, 56% of the respondents considered it extremely important to educate students and prepare them for various roles in future academic and professional development.

Regarding the factors with a negative impact on higher education institutions from the point of view of innovation, again the respondents brought to the fore the insufficiency of resources, the lack of extension of mentoring and the lack of retraining and improvement in response to innovation needs. All respondents are of the opinion that universities are trying to align learning and teaching reforms with their role in innovation. Asked if they believe that curriculum development and teaching processes have changed to include the perspectives and actors of innovation ecosystems, a proportion of respondents believed 89% that they have changed. Reforms of learning and teaching are therefore on the agenda of Romanian universities.

The second dimension of the university's role in fueling regional innovation lies in the co-production of relevant knowledge. In its role as a driver of innovation (regional or national), higher education institutions must seek a balance between international research and regional or national relevance. All respondents emphasize the following important developments:

1. support schemes for university-industry-government-civil society collaborations, rightly having a primary role.
2. strategic partnerships with companies, organizations, including the foresight function and sufficient organizational and academic autonomy to allow flexible and strong interdisciplinary units.
3. facilitating joint innovation between universities and companies, public organizations, civil society
4. facilitating public-private partnerships, helping to minimize regulatory hurdles and costs.

From the point of view of the research, 67% of the respondents considered as extremely important, in the short term: the lack of concrete solutions to the current innovation problems. At the same time, 44% of the respondents considered as having a negative impact: (1) The provision of insufficient basic institutional funds for investments in infrastructure, maintenance, technical personnel and (2) The lack of state-of-the-art infrastructures, strategic partnerships with companies, organizations, including the function of forecasting. From the point of view of the challenges regarding the research processes in higher education institutions, 45% of the respondents considered the challenges of a financial nature as extremely important and 33% those related to management or leadership.

Respondents did not attach great importance to strategic transformation, although the close alignment of the strategy of higher education institutions with that of the region or with the national strategy, for example, is the result of the mobilizing role of their management, as well as systematic investments and joint lobbying for major financial and infrastructural development of key thematic clusters. As we have noted, the role of universities in innovation is often linked to a far-reaching institutional transformation agenda and a deeper development strategy. In many core institutional processes, universities seek interfaces between high-potential research developments and their innovation priorities in regional or national innovation systems. Referring to the strategy of the higher education institution and the extent to which it takes into account the national strategies and regional development, 78% of the respondents believe that they consist in the orientation towards the common values of the community. Two aspects caught the interest of the respondents: (1) Expanding the international orientation, visibility and composition of the academic staff (44%) and (2) Systematic search for a key role of the university in regional, national or global innovation challenges (33%).

Regarding the key actors driving the structure of innovation, both from the point of view of institutions and individuals, 45% of respondents believed that universities lead innovation, while 44% of them believed that industry is the in charge. Thus, regarding the role of higher education institutions in shaping the innovation agenda, 56% of the respondents believe that it consists in orchestrating innovation networks with several actors, 33% believe that it consists in leading the network processes of knowledge creation and only 11% emphasize the role of mobilizing entrepreneurial commitment. Referring to the channels and formats of communication in the network, according to the respondents, the synergies between the actors involved are achieved through the following aspects:

- Support of bachelor's or master's theses, based on the interaction between engineer/external stakeholders, academic advisor and student in a proportion of 44.44%.
- The provision of internships for students in companies/ public administration/ NGOs, in proportion to 22.22% of the respondents.

2. The role of government

For the development of effective innovation systems, governments and public authorities play an important role at all levels, national, regional and local. To create framework conditions conducive to innovation, governments and public authorities act in different roles as the main regulator and financier, infrastructure developer, as well as moderator and facilitator of strategy. Asked about the effectiveness of the government's role as an intermediary (facilitating and offering incentives, strategies, etc.) to promote the interaction between the actors involved, 78% believe that it is not effective and the remaining 22% abstained.

Referring to the government's role in attracting talent to the region, 56% of respondents believe that strong/drastring government regulations affect the mobility of researchers and experts and the influx of talent. Only 33% believe that government and local government play a vital role in protecting the regional attractiveness for innovation by ensuring international accessibility (traffic connections), state-of-the-art infrastructure, digital connectivity and quality of life for internationally mobile talent

Referring to the role of the government in shaping the innovation agenda, 56% of the respondents believe that it consists in financing, 22% believe that it consists in the preparation of public policies and the function of the government as initiator and coordinator of innovation strategies, while 11% put the emphasis on the regulatory role or another role of the government.

3. The role of industry

Regarding the role of industry in attracting talent to the region, we find that 89% of respondents believe that representatives of large companies emphasize the need for excellence in research quality as a precondition for the availability of the most talented graduates and researchers. Regarding the role of the industry in shaping the innovation agenda, we find that 78% of the respondents consider the primary role of the engine of the economy, followed by the role of financing, considered as the second role of the industry in the proportion of 56% of the respondents and the role in the economic growth of the industry, stipulated by only 22% of the respondents.

4. The role of civil society

Referring to the role of civil society in shaping the innovation agenda, 50% of respondents believe that it consists in orientation towards the common values of the community, 30% believe that it consists in the production of social capital, while 20% emphasize the support of projects the community.

Final conclusions

Starting from the research carried out, we find a transition from **linear innovation to iterative innovation** in Romania.



Figure 6. Trend thematic cluster 1a

Source: the doctoral student's work

Universities and companies no longer view innovation as a linear process leading from basic research through applied research to commercialization along a continuous line of "technological readiness levels". Rather, the actors of the quadruple helix recognize and engage in innovation as a reiterative process in which basic research, applied research, and prototype development can stimulate and improve each other and multiple times in a cooperative process. Universities' ability to continually bring new perspectives from different and unpredictable angles makes them essential partners in the pursuit of sustainable innovation and trendsetting.

At the same time, we could observe in the innovation ecosystems in Romania and in higher education institutions a tendency to move from **closed innovation to open innovation** .



Figure 7. Trend thematic cluster 1b

Source: the doctoral student's work

In general, research results connect development and innovation projects with training and education programs, or in other words, they connect education, research (knowledge co-production) and technology transfer or co-creation (knowledge exchange for innovation systems), therefore open innovation.

Thematic cluster 2 (Organizational culture and innovation ecosystem culture). **The culture of the quadruple helix ecosystem**

We could observe that, in Romania, there are still universities whose organizational culture is not favorable to a creative and innovative ecosystem to a sufficient extent, improvements being necessary. Whether we refer to the evaluation of student performance (which remains primarily focused on memorization, without the request for proposals for possible/probable practical applications) or to the organizational culture at the level of teaching staff, where motivation is linked to career growth conditioned by the ability to capitalize on of innovative ideas through publication,

not of the free and daring innovative spirit, important or of the local interest, such aspects bring to the fore a series of problems that prevent Romanian higher education institutions from favoring a creative and innovative ecosystem. However, it is desired that innovation, creative capacity become impregnated in the culture of the organization so that the university becomes a leader: of thought, regarding the industry served, civil society and even the government.

Analyzing the factors with a negative/positive impact on innovation in such a culture as that of the respondents' organization, in the context in which higher education institutions must develop a creative culture that favors innovation to flourish, the following factors with a negative impact were observed on innovation:

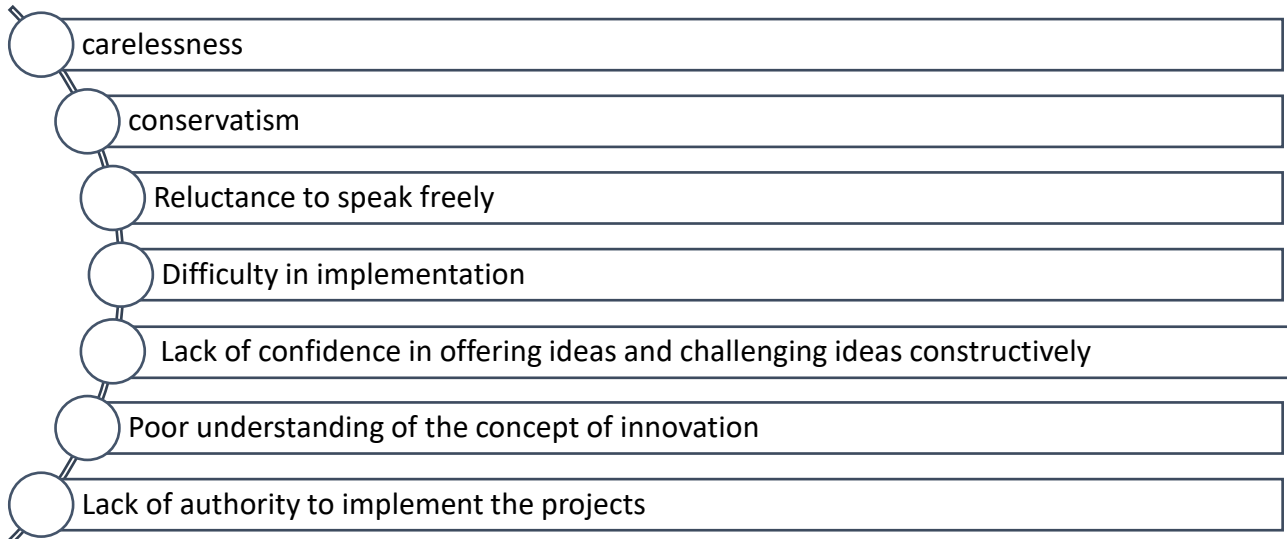


Figure 8. Factors with a negative impact on innovation

Source: the doctoral student's work

University managers and other innovation directors need to encourage creative culture by mitigating negative impact factors such as the above. They must encourage new ideas, collaboration and radical innovation. As universities choose to become the innovation ground of "game changers", they can defy all odds to innovate and succeed. Because revolutionary innovations set new trends, disrupt social habits and technological developments, open new markets or solve pressing social or environmental problems. But for this we need an organizational culture that emphasizes: quality, efficiency, involvement, encouragement, mentoring, stimulation and evaluation.

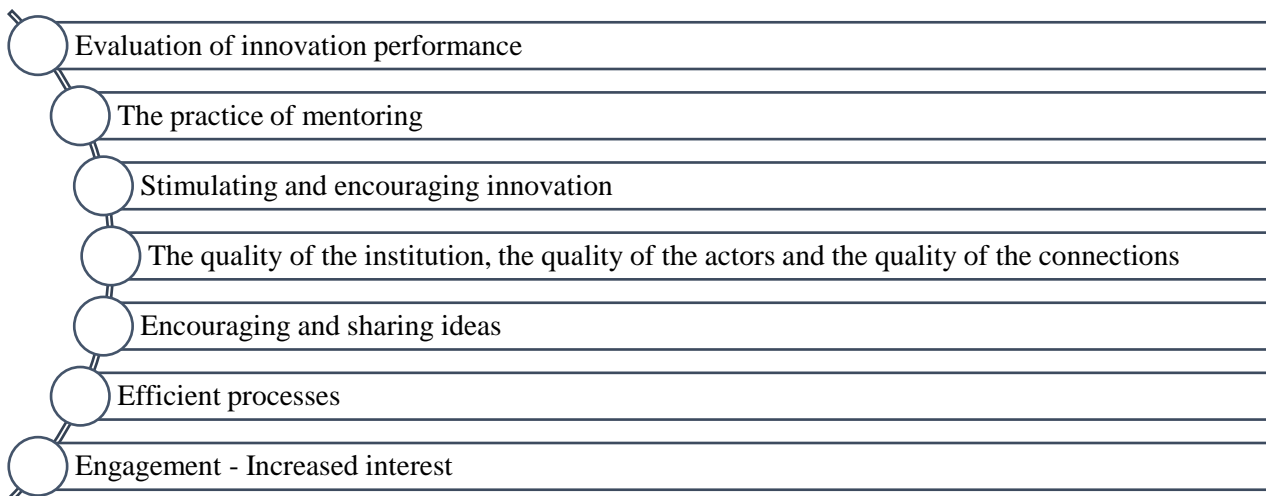


Figure 9. Factors with a positive impact on innovation

Source: the doctoral student's work

The study shows how paradigm shifts in innovation reflect a need for new forms and practices of connectivity between the partners of the quadruple helix.

Thematic cluster 3 - Governance and human capital. We could see, in this cluster, the changes that occurred within the Romanian universities that went from **technological innovation** based on challenges. Thus, if the most important contribution of the university to innovation is the education of students and their preparation for various roles in future academic and professional development and management, then the basic educational and societal role of higher education institutions, along with continuing education, emphasizing and the financial shortages they face.



Figure 10. Thematic cluster tendency 3
Source: the doctoral student's work

Romanian universities insisted on the need to integrate interdisciplinary approaches in teaching programs and methods. We therefore observe another trend within Romanian universities and innovation ecosystems: the transition from **individual innovation to collaborative and interdisciplinary innovation**.



Figure 11. Thematic cluster tendency 4
Source: the doctoral student's work

With increasing specialization, digitization and technological hybridization, interdisciplinary collaborative research and development is becoming a necessity.

For radical teaching reforms to take place, some institutional preconditions are considered crucial to ensure the desired flexibility and adaptability to innovation needs. Based on the answers provided in this research, we believe that it is necessary:

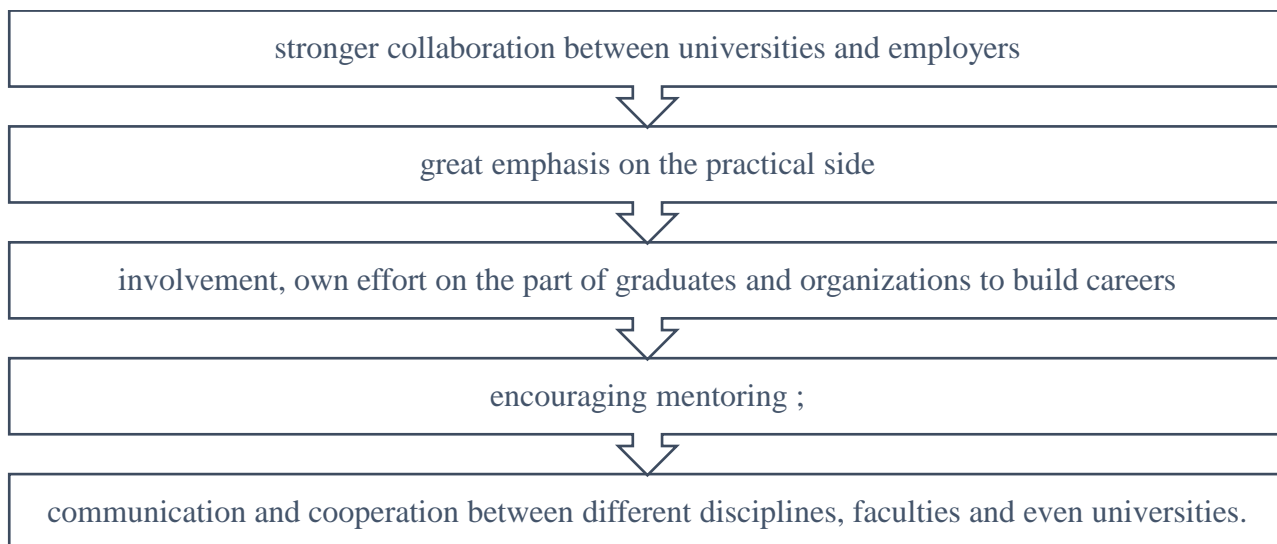


Figure 12. Institutional preconditions considered crucial to ensure the desired flexibility and adaptability to innovation needs

Source: the doctoral student's work

Thematic cluster 4 Governance and Knowledge Production . The second dimension of the university's role in fueling innovation lies in the (co-)production of relevant knowledge. In its role as a driver of innovation, be it regional or national, the university must seek a balance between international research and regional relevance. This knowledge must reflect the international research frontier in the given thematic area to ensure academic excellence and help companies or public stakeholders to face global challenges. University research helps give access to a "global pipeline" of knowledge to regional stakeholders in their innovation processes. Moreover, this knowledge must be translated into the stakeholders' own concepts and contexts so that it can be absorbed and create value.

Starting from the above, the role of universities in innovation is often linked to a far-reaching institutional transformation agenda, which is based on the organization's top management. For these reasons, the research confirmed the fact that the top management of higher education institutions in Romania encourages employee development and innovation. Extracurricular activities such as workshops, trainings, guidance, activities that facilitate innovation are mentioned as means of encouragement. As one of the most far-reaching strategic measures, academics from Romanian universities emphasize the vital role of personnel policy from the perspective of management involvement.

Thematic cluster 5 – Support structures in the network (financing, services and infrastructures)

The analysis of the components, support structures in the network is based on the actors who contribute to the generation, diffusion and use of innovations. As the quadruple helix model was the conceptual lens used in this research, institutional boundaries were predefined, that is, institutions and individuals were designated to be university, industry, government or civil society. The reality, however, is that boundaries are permeable and blurred. Respondents may exhibit traits and practices common to different spheres. Again, in this cluster, we were able to see the changes that occurred within the Romanian universities that went from **technological innovation to systemic innovation** based on challenges.



Figure 13. Thematic cluster tendency 5
Source: the doctoral student's work

In the research carried out, the actors of the quadruple helix strive to develop innovations in a systematic and strategic manner. At the governmental or regional level, although governmental institutions involve universities, businesses and civil society as well as other interested parties in structured dialogues to identify, analyze and exploit the strengths and potentials of public policies and regions, the results are extremely poor. Rarely, this is facilitated by clever specialization strategies. In Romania, at most universities, there is no close alignment between university and regional development strategies. Among the main reasons are mentioned: frequent political changes, political instability and lack of coherence in applied public policies.

Thematic cluster 6 - Institutional and regional strategy processes

The research confirmed that innovation is essential for an organization's growth strategy, as well as for regional strategy and for increasing competitiveness. Growth, if it occurs, will be as a result of interaction first with industry and then with government.

Therefore, we can observe a new trend in the Romanian innovation ecosystems: the transition from **exchange-based innovation to co-creation in innovation spaces**.



Figure 14. Thematic cluster tendency 6
Source: the doctoral student's work

With increased density, experience, and trust within long-standing cooperative frameworks, innovation can go beyond exchange between independent actors with separate agendas and institutional cultures. Now innovation becomes interdependent co-creation between actors from different sectors and institutions. Researchers, innovators and management from universities, businesses, public society or Romanian public institutions develop a common sense of regional strengths, potentials and challenges.

Thematic cluster 7 - Network communication channels and formats

We could observe that the actors of the quadruple helix develop networks, structures and common spaces to optimally use the geographical and cultural proximity. It brings together actors

from the university, companies, government institutions or civil society, to promote mutual understanding, to develop common objectives and projects and to build sustainable partnerships that help regional and implicitly national innovation. Regional innovation ecosystems are characterized by interconnected actors that promote connectivity, seeking coherence in three dimensions: organizational, social and spatial.

The concrete elements for achieving coherence are the interactive formats that cover all levels, from the strategic interaction between the institutional leaders of the four actors of the quadruple helix model, to co-creation research projects or student team development projects for companies. Interactive measures range from individual mobility between different institutions and sectors (such as student internships, MSc and PhD projects in industry, industry professionals as part-time teachers, lecturers or mentors or university laboratories) to structural formats which organizes collaboration in a more sustained way.

The current concerns of the academic environment in Romania refer to the following important developments:

1. support schemes for university - industry - government - civil society collaborations.
2. strategic partnerships with companies, public institutions and civil society.
3. facilitating joint innovation between universities and companies, public institutions, civil society.
4. facilitating public-private partnerships, helping to minimize regulatory hurdles and costs.

The purpose of the seven clusters was to determine: (1) The role of higher education institutions (2) The role of the government (3) The role of industry and (4) The role of civil society within the Romanian innovation ecosystems.

Above we noted the role of higher education institutions within the Romanian innovation ecosystems. Next, we will analyze the role of the government within the Romanian innovation ecosystems.

1. The role of government

For the development of effective innovation systems, governments and public authorities play a vital role at all levels, national, regional and local. To create framework conditions conducive to innovation, governments and public authorities act in different roles as the main (1) regulator and strategy moderator and facilitator, (2) financier, (3) infrastructure developer.

2. The role of industry

Industry representatives emphasized the need for excellence in research quality as a key condition for the strategic investment of their companies. Excellence in international research is regarded by both universities and the private sector as a precondition for the availability of the most talented graduates and researchers. Clearly, it is a decisive factor in attracting investment from the industry.

At the same time, referring to the role of the industry in shaping the innovation agenda, we find that the respondents consider the industry as having the primary role of the engine of the economy, followed by the role of financing and the role in economic growth.

Industry-university collaborations have received increased attention in recent years. However, in Romania, there is great reluctance regarding this collaboration. Business and academia are actors pursuing different goals and facing different constraints. The research highlighted that industry-university collaborations are seen as a source of complications that the business environment in Romania prefers to avoid.

There are many reasons for such collaborations to take place: companies take advantage of highly qualified human resources such as researchers or students; have access to technology and knowledge; and can use expensive research infrastructure. Universities, in turn, benefit from additional funding provided, access to industry equipment, or revenue from licensing or patenting. In fact, collaboration with industry should become an inevitable part of university funding, and funds from international organizations and business enterprises for research and development in the higher education sector should represent a "significant source" today.

Considering these effects and the financial relevance, it is important to ensure the successful management of such partnerships in order to realize advantages on both sides. The research highlighted that the most important factors to select the universities / research institutes in Romania for the purpose of a collaboration, in first place:

- Good research reputation
- Rich experience in working with the business environment
- Improving the development of products requested by customers
- Cost saving for research and development
- Accelerating the speed of research and development
- Rich network related to research and development
- Obtaining patent rights

For companies, it is often difficult to find the right skills profile because they are only accessible through personal connections. Companies need personal contacts to find the right expertise or skills. This is also why a local open innovation environment is important. At some universities in Romania, the business facilitation units within the technology transfer office try to help such intermediation. Often, thematic events may be necessary to bring together relevant companies and researchers. However, academic researchers who prove to be relevant may not be interested in devoting their time to such solutions.

At the same time, industry representatives also suggested that universities need some entrepreneurial skills to lead to accelerating the speed of research and development and improving the development of products demanded by customers. Thus, the participants were of the opinion that improving product development, research and development requires promotion and involvement. Researchers must try to promote their research. Universities need people with entrepreneurial characteristics whose purpose is to make things happen. Along with this, universities must work to hire and train staff who are academically qualified to understand research and its significance so that they can speak the language of business people and marketing communication. One way to achieve this is to invest in graduate and postdoctoral students, as they possess the necessary expertise and are often more open to alternative career paths rather than standard academic paths.

In this sense we believe that product / business awareness is extremely important for the academic environment. The value of awareness among researchers about a product and its life cycle, understanding the actual product and its environment will lead to increased engagement between researchers and industry.

At the same time, in the same context, the representatives of the business environment emphasized the fact that researchers must think beyond the narrow limits of their research results as publications, focusing more on the application of their research. Researchers need to be aware of their research in the context of industry application to create impact.

As a first step in this regard, as a recommendation, we mention the improvement of the Alumni Association for Romanian universities. We believe that the value, the greatest advantage of a university is its people, especially its graduates. Universities should maintain a link with alumni and share progress within the university. Good and ongoing alumni relationships can help increase industry engagement, research funding and wider societal impact. Implicitly, they can lead to new industry-university collaborations, in this case members of the private sector being represented by former graduates.

Regarding the type of activities carried out by respondents in collaboration with universities, a great emphasis is placed on: informal contact with the academic environment ; employment of recent graduates ; access to specialized equipment and t is / analyzes in the university.

The relationship of SMEs with Romanian universities and the interaction formats in innovation are characterized by a lower capacity of industry to interact with university researchers. We notice that the respondents from the industrial environment emphasized the impact of communication (especially informal) and the relations between the academic and the private environment. Good personal relationships are the basis for enabling vital links between companies and universities. In this sense, contacts and actions should not only be at the management level, but

also at the operational level. This includes regular interaction, continuous feedback, mutual exchange of information and updating partners on incidents or new activities. In addition, communication through a variety of channels such as e-mails, regular meetings, or face-to-face communication is advantageous, although partners must select those channels carefully, as the lack of effective communication channels is also considered a main barrier in partnerships. Mutual communication (regular, timely, appropriate, and accurate) is also beneficial in setting positive expectations about the future behavior of partners, especially when the partnership is new. Another requirement for a successful collaboration is finding an appropriate "language" for both partners, as these collaborations are often affected by the use of different (formal) styles in academic and business environments.

Regarding the barriers in the interaction between the universities / research institutes in Romania, the representatives of the business environment believe that they are, in order of their importance:

- Lack of governmental support programs for the interaction between the university and the business environment
- Possible conflicts related to intellectual property rights
- Rules and regulations imposed by the government
- Difficulty finding suitable partners

We observe that the most important barriers mentioned by the business environment relate to the framework factors. Whether it is government support, legal restrictions or the market environment, these are extremely important to the industry. Government is an influential power that can either enhance or harm collaboration. On the one hand, fiscal incentives, public funding or the government network can represent barriers in the interaction between universities / research institutes in Romania. On the other hand, legal restrictions and regulations or the lack of regional support structures can have a negative impact on collaboration. In general, government support is often needed to establish a collaboration between universities and industry. Other negative framework factors refer, for example, to market uncertainties, which usually also relate to the rules and regulations imposed by the government.

The following factors identified as barriers refer to the legal aspects of collaborations refer to possible conflicts related to intellectual property rights. Added to all this are the difficulties in finding suitable, suitable partners. In this case it can be about trust - an important factor in promoting a collaboration between industry and universities.

We believe that management in such partnerships can set an example and send positive signals for building trust. In addition, strong ties between partners, a good reputation and contractual guarantees to reduce uncertainty usually have positive effects on trust. However, the heavy use of contractual guarantees can also weaken mutual trust in cases where there are already strong ties between partners.

Our research on collaboration between academia and business (industry) on innovation has led us to the conclusion that SMEs are generally characterized by small size and weak networking capacity, which is why in general, they are not an attractive partner for universities. This explains why 96.4% of survey respondents are not connected to local universities/research institutes. At the same time, we found that 64.3% do not want to investigate collaboration opportunities with universities / research institutes in Romania, as a result of the key barriers to these partnerships, but also the lack of interest from the private sector (strictly small businesses and medium sized).

SMEs find it difficult to find the right candidate for industry-university collaborations due to the lack of appropriate institutional mechanisms to match industrial and academic partners. SMEs often miss out on innovation opportunities due to their relatively poor networking capability. In addition, the fear of disclosing one's intellectual property to external partners also created another major barrier to collaboration with universities in innovation projects.

Romanian SMEs cooperate in a shorter or medium-term perspective, often looking for concrete solutions to innovation problems for which they need applied research skills. Such needs can best be met through undergraduate or master's research projects or through consultancy provided by university researchers. Romanian SMEs also need affordable access to relevant technological

facilities and networking opportunities to explore innovation potential and maintain competitiveness. As such technical research infrastructures are very expensive, this is an area where public support or efficient sharing of basic facilities is most needed. Overall, cooperation between universities and SMEs is considered much more difficult than interaction with knowledge-intensive multinationals. It is more difficult for SMEs to find interested university partners, because most of the time they should find partners for developing solutions in interdisciplinary but short-term oriented development projects. More often than not, these challenges would provide little academic interest, as many university interviewees point out.

I have mentioned above a series of extremely important factors in such collaborations, which is why, in the following, we will suggest a series of recommendations.

Regarding institutional factors, we recommend flexibility. This means flexibility not only in terms of your own priorities, but also in terms of your partner's priorities. We believe that formal rules should be adopted where necessary and compromises made where appropriate. Openness is equally important, not imposing one's own conventions and approaches on the partner. A beneficial industry-university collaboration requires the creation of collective goals, the sharing of the same visions and interests. At the same time, management processes must be flexible enough to deal with instability and change, as well as the diverse interests of partners.

In terms of the relationship between both partners, honesty is very important. At the same time, clarity is needed. Regarding the framework factors, it is necessary for the partners to be aware of the economic, legal, political or social developments.

3. The role of civil society

The respondents did not give a major role to the civil society, they emphasized its role in orientation towards the common values of the community, in the production of social capital and in supporting community projects.

However, the collaboration between civil society and academia is extremely good. Thus, students collaborate well with professors and researchers in the university to achieve their goals through long-term collaborations with them. For a collaborative research project to exist, students and faculty must come together to pursue a specific goal or examine a specified topic or problem. Whether at a conference, an institutional research symposium, a faculty meeting, or other academically related gatherings, networking can encourage students and faculty with similar interests to gravitate toward each other, leading to the decision to collaborate to one or more projects, more or less innovative.

Regarding the relationship between higher education institutions in Romania and supporting students as representatives of civil society through specific activities to develop a business or a research project, the conclusions are positive. Indeed, many higher education institutions in Romania encourage and support entrepreneurial activities. Some higher education institutions have established "innovation labs" or "entrepreneurial societies". Others have developed incentives to support staff innovation activities and entrepreneurship, such as Transilvania University in Braşov, where the university's leadership team developed an incentive system to promote collaborations between faculty members and the business sector.

At the same time, it was noticed that there is a close collaboration between the civil society (students), the academic environment and other organizations in Romania. It is known that some higher education institutions in Romania play a key role in their communities and in the surrounding ecosystem. The Ştefan cel Mare University in Suceava, in the Northeast of Romania, plays an important role in one of the least developed regions in the country. The Western University of Timișoara is building a hub for entrepreneurship and innovation in the city. The Polytechnic University of Bucharest is active in the use of Enterprise Europe Network tools.

At the same time, the research confirms the compliance of the faculties in Romania with the requirements of the industry, which requires graduates who are better prepared and able to bring added value. Indeed, at the national level, at present, each university selects its own model for the development of entrepreneurial activities. In this sense, the Technical University of Cluj-Napoca established not only a pro-rectorate for management and entrepreneurship, but also a department for

the institutional relationship with Industry. These departments are also assisted in their mission by the university chancellor's advisory committee, which includes members from companies and other non-university organizations.

We therefore observe a close collaboration of the academic environment with civil society and industry. The students, in their capacity as future graduates, feed the companies' interest in collaborating with Romanian universities. Conversely, on the part of universities, the willingness to collaborate with companies is also strengthened by the availability of financial support. At the more technically oriented universities in Bucharest, Cluj, where such collaboration has been part of the universities' core mission since the beginning, academics show an even greater willingness to collaborate with industry, especially when the funding generated by contract research can support other independent projects.

In conclusion, all four types of actors aspire to orchestrate innovation as a common process of knowledge production. This includes processes that combine interdisciplinary perspectives of academic research and education and the exploration of new user-driven solutions with markets and business processes to identify and capitalize on innovation potential. Despite the diversity of the research actors, it was found that the expectations, values, roles and interactions of universities, companies, governments and civil society are changing, but these changes are accompanied by a common concern for new forms of connectivity to mobilize innovative potential.

Together, the four types of actors develop a new engine of innovation, with common interests, values, strategies and investments. Thus, in the process of transforming their own roles, universities, industry, government institutions and civil society actually develop the quadruple helix. In this process, integrating innovation into the ecosystem becomes crucial. To contribute to the development of common agendas in the diverse cultures of different sectors, new forms of connectivity must be based on five pillars: leadership (governance) in the form of a network, co-creative norms and narratives, common strategies, co-creative institutional structures and common spaces.

We propose in postdoctoral studies to develop these new roles for the actors of the quadruple helix, roles that actually involve increased co-creative connectivity, where the four actors will fold on the previously mentioned five pillars.

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