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TRANSITION TO ENTREPRENEURIAL UNIVERSITIES AS A MECHANISM FOR IMPROVING THE QUALITY OF HIGHER EDUCATION SERVICES: FINANCIAL, HR AND TECHNOLOGICAL MANAGEMENT

Abstract: *We studied the features of modern leading European universities' mastery of such directions of entrepreneurial activities as targeted R&D and provision of educational services to partner companies. The goal of this paper was to identify the models of transition to entrepreneurial universities as a mechanism for improving the quality of higher education services. To reach this goal, we used the coefficient and trend analysis, content analysis, analysis of strategic documents, and comparative analysis.*

We elaborated on the evolution of the phenomenon of entrepreneurial university and disclosed the specifics of higher education institutions' transition to entrepreneurship within the key scientific approaches. Systematisation of scientific approaches allowed the formulation of the authors' treatment of the essence of this notion, the scientific novelty of which is an additional emphasis on the subjective structure of the term through the introduction of students and the academic community.

We also considered the aspects of the transition to entrepreneurship by the example of the leading European universities as a precondition for improving the quality of higher education services and the level of competitiveness and innovativeness of R&D. In the course of the analysis, we established that the selected European universities are oriented towards the use of a similar model of transition (the focus on autonomous management of funding and organisation of targeted R&D and education). We distinguished the key indicators of universities' effectiveness, which can be used within methodological support in this sphere.

Keywords: *entrepreneurial universities, quality of higher education services, funding, HR management, R&D, partner companies, entrepreneurship*

1. Introduction

In the system of higher education, entrepreneurship is intended to support the

functioning of universities and contribute to the satisfaction of demand from industrial ecosystems at the regional and national levels. The effectiveness of the interaction

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between universities and the business sector in the context of R&D and personnel training and advanced training for partner companies is proof of the success of higher educational establishments in fulfilling their missions in the socioeconomic life of the region or country as a whole. Applied studies of universities, which are required by the business sector of government, contribute to the technological growth of the economy and the main sectors of life activities. Their implementation at the modern stage takes place at the level of universities' scientific centres and through the combined technological and technical potential of higher education institutions and partner subjects (technological companies, industrial companies, state-owned companies, and infrastructural objects). Interaction between universities and business customers in the sphere of education and improvement of professional skills is also an important aspect of entrepreneurship, which helps companies train personnel in line with their expectations. Unlike various organisations that do not have a good image and experience in the sphere of personnel training, universities, which possess high-tech bases, can fulfil these tasks better than other subjects in the market of vocational education and training.

The importance of the development of universities that have a high level of implementation of applied research does not diminish the need for further development of fundamental research. Universities that are aimed at entrepreneurship in the sphere of applied research, connected with innovative R&D, can interact effectively with universities or leading scholars that deal primarily with fundamental research. Such a partnership, in the form of scientific parks, contributes to the reduction of the risks of transfer of innovative technologies, especially if they are developed for the market, not for specific demands from the business sector (Zhang & Tang, 2024). The scale and results of the activities of universities that aim at applied research and

targeted training of personnel for partner companies form the image of these higher education institutions, together with such parameters as teaching. Entrepreneurial universities are flagships of progress at the regional, national, and international levels (Santos, 2022).

Modern trends of higher education's transition to entrepreneurial activities, based on applied research and training of business personnel, deserve attention, given the increasing role of universities in the technical and technological progress, which is achieved due to the effective conversion of theories to solutions, products, and technologies (Shaw, 2022). The current state of economic development, which is called the knowledge economy, involves the growth of interaction between industry and universities, ensuring stimulation of sustainable development of the country (Cabanés et al., 2025). Given the above, it is relevant to study the characteristics of the activities of entrepreneurial universities that provide scientific and technical, technological, and educational support to business.

2. Materials and methods

This paper sought to identify the models of transition to entrepreneurial universities as a mechanism for raising the quality of higher education services. The structure and order of this research are as follows.

1) Identifying the list of universities with high rankings in entrepreneurship. The focus is on the criterion of Industry, presented in Times Higher Education World University Rankings 2026 (Times Higher Education, 2026).

2) Description of the direction of higher education institutions' transition to the category of entrepreneurial universities. We find out whether there is a strategic programme connected with this transformation and describe the spheres of entrepreneurship. These spheres could be

personnel training for the business sector within individual educational and practical courses or training involving additional applied knowledge and skills; applied research in the sphere of innovative R&D at the order of business partners; creation and transfer of innovative technologies (also in cooperation with other universities). At this stage, we use comparative analysis, analysis of strategic documents, and content analysis.

3) Analysis of the components of the transition (new models of funding, HR and technological management). We identify the form of funding of the selected entrepreneurial universities and indicate whether there is a positive effect of the transition to entrepreneurship in the context of financial sustainability. Comparative analysis is employed here. HR and technological management of these subjects is studied using trend analysis.

4) Study of the effectiveness of the model of transition to entrepreneurial universities. At this stage, coefficient and comparative analyses are utilised.

We also offer an authors' approach to identifying the level of a university's transition to entrepreneurship as a mechanism of improving the quality of higher education services. This approach is based on factor analysis, which is utilised to determine the factor of entrepreneurial activity of students of higher education establishment, the factor of financial diversification, and the factor of the intensity of the university's commercialisation.

According to the authors' approach, the following indicators were calculated:

1) The factor of entrepreneurial activity of undergraduates, graduates, and postgraduates of the higher education establishment (F1):

$$F1 = N_{ss} / N_s * 100 \%,$$

Where N_{ss} is the number of students participating in the creation, launch, and implementation of start-up projects annually, and N_s is the total number of the university's students in the studied period.

2) The factor of the university's financial diversification (F2):

$$F2 = \text{Inc extn on gov} / \text{BudgG} * 100 \%,$$

Where Inc extn on gov – volume of assets received from external funds and companies; BudgG – total volume of revenues.

3) The factor of the intensity of the university's commercialisation (F3):

$$F3 = \text{Numgrst} / \text{Num R\&D},$$

Where Numgrst – number of patent and grant applications; Num R&D – number of personnel participating in R&D.

4) The level of the university's transition to entrepreneurship (TRenU):

$$\text{TRenU} = F1; F2; F3$$

The indicator TRenU provides a complex representation of the three considered factors of the university's development in the direction of transition to entrepreneurship. This parameter can be used to compare the university's development in various periods (in this case, an increase in the factors' values would be a sign of their improvement) and to compare the mentioned complex indicator at the level of various universities.

The presented authors' approach was used to compare the level of transition of the selected universities to entrepreneurship.

We also used scholarly and analytical materials, which results allowed completing the goals of this work.

A range of scholarly works deal with the analysis of approaches to the formation of criteria of university rankings. Here, we can mention the work by Santos (2022), in which the author proved the necessity for better disclosure of applied aspects of higher education establishments' activities in international rankings and indicated that describing the universities' participation in the innovative development of industry is equally important as the emphasis on citation rate and number of scientific publications of universities in international scientific databases.

An important role belongs to substantiating the importance of the transition to entrepreneurial universities, which aim at applied innovative studies that ensure innovative solutions for industry and personnel training according to their goals and directions. Shaw (2022) proved the relevance of revising the approaches to the higher education system in the context of the development of applied research to ensure socioeconomic progress and implement fundamental sciences. Zhang and Tang (2024) disclosed key aspects and the effectiveness of combining applied and fundamental studies at the level of China's leading universities and within scientific parks. The scholar analysed the activities of scientific parks in which participants are higher education establishments with a high level of fundamental science and specialising in R&D for industry. Cabanes et al. (2025) indicated the need to reconsider the strategies of university development in the context of the balance of fundamental and applied research, and an increase in their entrepreneurial potential in the development of cooperation with innovative industrial companies.

Many scholars also studied the essence of the notion of entrepreneurial universities and issues characterising the problems and specifics of the transition to entrepreneurship in the system of higher education, as a precondition for raising its quality. Etzkowitz (1983) and Clark (1998) were among the first to conceptualise the essence of the notion of entrepreneurial university. Among the modern scholars in this sphere, we can mention Andekina et al. (2024), Garomssa (2024), Klein and Mafra Pereira (2021), and Löfsten (2025).

Some papers deal with determining new forms of higher education services that are required to solve problems and meet the needs of society and the economy. Alves et al. (2026) described students' expectations from new models of higher education in the context of digitalisation and the implementation of social networks. Alves et

al. (2025) dwelt on the society and economy's expectations from the higher education institutions' activities in the regions of Portugal. The main expectations, according to the scholars, include the need to ensure a positive effect on ecology (new technologies and solutions), economy, social sphere and safety. Pedrosa et al. (2025) considered the positive influence of implementing the applied projects of the partnership between business and universities in educational programmes on the quality of higher education. In this case, businesses can expect graduates who take part in such projects to have good practical skills within their specialities.

Even though the modern scholarly community pays attention to the issues of the development of universities' applied research, there is a need to further elaborate on their transition to the entire complex of entrepreneurial activities.

3. Results

In this research, we use the terms “entrepreneurial university” and “transition to entrepreneurial universities”, so it is necessary to define their essence and the context in which they are considered.

The evolution of the term “entrepreneurial university” is as follows.

Etzkowitz (1983) defined an entrepreneurial university as a mediator between scientific inventions and industry, which ensures the generation of knowledge for concrete products and solutions. The scholar compared the transition to entrepreneurial universities to the second academic revolution, where participation in R&D for industry is the third mission of higher education institutions. According to the first academic revolution, the universities' primary mission was teaching, and the secondary mission was research (mainly fundamental sciences). Etzkowitz (1983) noted that in the course of these transformations, the entrepreneurial

university also becomes an economic subject.

Clark (1998) defined an entrepreneurial university as a subject ensuring feedback in the university-external environment interaction and meeting the interested parties' need for knowledge generation to solve socioeconomic problems. According to the scholar, entrepreneurial universities helped reduce the gap between the external environment (society and economy), the system of higher education, and science.

Introduction of the spiral concept (triple, quadruple, and quintuple spirals). The spiral subjects are as follows: triple spiral – government, industry, and entrepreneurial universities; in quadruple spiral, civil society is added; and in quintuple spiral, the surrounding environment is added.

Further theoretical approaches to this term were based on organisational, behavioural, and financial aspects of entrepreneurial universities' development.

Some scholars claim that an entrepreneurial university is a new form of a research university, which functions to search, develop, and implement solutions to practical socioeconomic problems due to effective interaction with industry and society. The process of transition to entrepreneurial universities appeared in response to the increasing demand in society and the economy. It is based on the generation of knowledge created in their environment to be used in the region or country's territory. This approach can be described as reactive entrepreneurship, which is oriented towards the economy of knowledge and applied innovations. This approach was supported by Klein and Mafra Pereira (2021).

According to Garomssa (2024), an entrepreneurial university is the key driver of entrepreneurial activities, which functions based on knowledge management, massification of higher education establishments, an increase in the diversity of the student community, and transition

from state to targeted funding (the indicator of autonomy and competitiveness). In the context of this approach, transition to entrepreneurial universities is based on their ability to meet the expectations of stakeholders to solve the problems of the social sector and industry. Löfsten (2025) indicates that entrepreneurial universities are new forms of higher education institutions that are ready to react to complex transformations in society and economy and use their own infrastructure of knowledge management and technologies. According to the scholar, transition to entrepreneurial universities allows combining the strategy in the sphere of interaction with industry and functional potential (organisational methods and availability of resources and finances), based on the focus on autonomy.

Having systematised the above scientific approaches, we can offer the following interpretation of the considered notion: entrepreneurial university is a modern form of traditional university, which functions to contribute to the resolution of socioeconomic, technical, and technological problems and requests of interested parties (industrial subjects, government, students, academic community, and civil society) and in the context of the focus on the sustainable development of environment, to support the financial, technological, and organisational autonomy.

The study of universities' rankings in the context of their influence on the knowledge economy and connection with industry allows determining the range of higher education institutions, the results of which activities are to be analysed in this paper. Connection with industry (criterion of Industry in Times Higher Education World University Rankings 2026) (Times Higher Education, 2026) is the indicator consisting of a university's participation in personnel training for business; partnership with business for R&D and creation of innovative technological solutions and products; and creation and transfer of technologies for the economy and infrastructures. We selected

universities for analysis in view of their rankings and the availability of data on the results of their activities. Among 2.191

universities from 115 countries in the ranking, only 37 universities have a 100-point score by the criterion of Industry.

Table 1. The list of the world's leading universities by the criterion of Industry in the Times Higher Education World University Rankings 2026

Position in the ranking of the Higher Education World University Rankings 2026, Rank	Universities with a high value of the Industry criterion (100 points)	Values of other criteria, points			
		International Outlook	Research Quality	Research Environment	Teaching
401-500	National Yang Ming Chiao Tung University (NYCU Taiwan) (Taiwan)	39.9	55.3	42.7	42.3
251-300	Beihang University (China)	34.7	73.8	46.5	47.8
201-250	Xi'an Jiaotong University (China)	38.2	75.9	49.4	45.1
201-250	University of Erlangen-Nuremberg (Germany)	64.2	78.6	46.5	41.7
192	Eindhoven University of Technology (Netherlands)	88.6	67	49.5	47.7
166	Karlsruhe Institute of Technology (Germany)	73.1	69.3	54.9	49.3
151	The University of Osaka (Japan)	47.9	53.3	64.9	65.9
141	Pohang University of Science and Technology (POSTECH) (South Korea)	39.9	79.2	49.5	58.3
140	National Taiwan University (NTU) (Taiwan)	59.2	68.6	54.9	59.4
131	Harbin Institute of Technology (China)	32.5	77.2	57.7	57.2
119	University of Alberta (Canada)	88.4	78.1	55.4	49.1
116	McMaster University (Canada)	84.6	93.1	49.3	42.2
103	Tohoku University (Japan)	59.2	52.8	70.8	70.9
92	RWTH Aachen University (Germany)	70.3	76.7	63	54.9
91	Charité - Universitätsmedizin Berlin (Germany)	72.4	98.2	48.7	47.2
86	Yonsei University (Seoul campus) (South Korea)	55.7	87.8	57.4	58.7
73	City University of Hong Kong (Hong Kong)	98.4	92.7	52.7	56.5
70	Korea Advanced Institute of Science and Technology (KAIST) (South Korea)	44.2	82.4	67.5	66.7
61	Kyoto University (Japan)	45.6	56.9	82.7	86.4

58	The Hong Kong University of Science and Technology (Hong Kong)	97.2	95.6	60.6	56.2
58	Seoul National University (South Korea)	43.5	77.6	74.8	74.1
57	Delft University of Technology (Netherlands)	92.1	75.5	75.1	64.1
47	University of California, San Diego (United States)	71.3	97.1	63.7	66.4
46	KU Leuven (Belgium)	79.2	91.3	73.8	61.3
40	Shanghai Jiao Tong University (China)	57.7	80.2	79.1	75.4
39	Zhejiang University (China)	55.5	84.3	78.4	75
34	LMU Munich (Germany)	78.7	92.4	75.4	68.4
31	Nanyang Technological University, Singapore (Singapore)	93.6	95.2	78.1	65.8
28	Duke University (United States)	74.2	95.4	74.2	78.7
27	Technical University of Munich (Germany)	83.4	91.3	84.8	71.9
26	The University of Tokyo (Japan)	50.8	68.2	94.2	94.7
16	Hopkins University (United States)	81.9	96.3	89.9	84.6
13	Peking University (China)	67.3	89	97.9	95.4
12	Tsinghua University (China)	53.4	93.9	98.9	95.9
7	California Institute of Technology (United States)	87.9	96.8	97.4	96.4
5	Stanford University (United States)	83.9	99.5	97.4	97.5
2	Massachusetts Institute of Technology (United States)	91.9	99.6	95.3	99.2

Source: Compiled by the authors using Times Higher Education (2026)

As shown in Table, all universities with a high level of the Industry criterion demonstrate various values of other criteria, which characterise their positions in the ranking. Let us dwell on the specifics of the transition to entrepreneurship by the example of the selected universities in the EU member states: Technical University of Munich (Germany) (27th position in the Times Higher Education World University Rankings 2026) and Delft University of Technology (Netherlands) (57th position).

An important indicator of the successful development of the Technical University of Munich (Germany) is the structure and volume of funding. The structure of funding

of the Technical University of Munich over 2020-2024 was as follows (Technical University of Munich, 2025d):

- Aggregate financial inflows in 2020 were assessed at EUR 1.89 billion, and in 2024, at EUR 2.171 billion.
- Revenue from external funds and companies equalled EUR 544 million in 2024 (25 % of the total budget). The structure of external funds included revenue for the implementation of a socially important project for Bavaria. A large share of this category's revenue accounted for payments from partner companies for R&D and educational programmes for their personnel. This indicator grew substantially

over the period of 2014-2024: EUR 281.6 million in 2014, EUR 303.8 million in 2016, EUR 356.8 million in 2018, EUR 398 million in 2020, and EUR 464.03 million in 2022.

- The amount of government subsidies equalled EUR 838 million in 2024. This substantial number is due to the university's state form of ownership (the Free State of Bavaria, Germany).

Changes in the structure of the university's funding and the growth of the budget demonstrate the effectiveness of the university's entrepreneurship. This is due to success in R&D management and the system of higher education quality (growth of revenue from personnel training for partner companies).

Entrepreneurship of the Technical University of Munich is presented by the following sectors (Technical University of Munich, 2025c):

- Activities of 22 unicorn companies, founded by university graduates.
- Creation of 110 start-ups in 2024, which conduct activities in partnership with the university and contribute to its revenues and R&D.
- R&D within seven joint research centres in cooperation with partner companies and other universities.

- Applied research to create innovative solutions in seven leading clusters that function in various sectors.

It is expedient to consider the specifics of HR management which contribute to the above financial results. HR management at the Technical University of Munich has the following characteristics (Technical University of Munich, 2025b).

- Electronic identification of employees for the effective control of their digital footprint in advanced training, creation and implementation of their own programmes, and scientific research and lecturing.
- Inclusive approach to the selection of professor candidates, which contributes to the sustainable social development of the university.

- Fair access to employment. The options include full-time and part-time employment, which allows employing people with small children, etc.

- Functioning of the family support service, which deals with monitoring of employees' families' needs and offers support in planning the work schedule.

- Support of employees in the improvement of professional communications. The university's Language Centre is responsible for this direction.

- Professional development of employees, supported by universities. There are training and advanced training offered to employees; these programmes positively influence the quality of higher education services, innovativeness of R&D, and effectiveness of technology transfer.

- Integration support of employees at the stage of hiring through a structured adaptation programme, which allows studying and adopting the university's corporate culture and mastering the main aspects of labour activities.

We should note the importance of the focus on entrepreneurship, based on knowledge generation (innovative R&D), which we revealed during the analysis of the structure of employees of the Technical University of Munich. As of year-end 2024, the structure of the university's employees was as follows (Technical University of Munich, 2025c):

- Total employees: 12,616.
- 33.8 % of lecturers and other categories of employees are not involved in research activities (4,262 employees).
- 66.2 % of personnel are involved in R&D (8,354). This allows raising students' interest in research activities and contributes to the quality of higher education. Since most of the university's employees are involved in R&D, we can clearly see the higher education establishment's course towards the development of applied research.

Technological support of the university is provided by TUM School of Computation, Information and Technology, which implements educational programmes and

scientific research and contributes to the university's technological potential. The university has a rather high level of technological support, which is due to its general specialisation. As of year-end 2024, the university has programmes of support for talented scientific employees for the creation of innovative solutions based on AI. The university also uses an AI strategy in compliance with ethical principles. This demonstrates the university's adherence to the University 5.0 concept (Technical University of Munich, 2025a). The priorities include human interests and AI-based goals of technologisation. The importance of modernising higher education services, emphasised in the works of modern scholars (Mamurova et al., 2025; Vanchukhina et al., 2022; Vodenko & Lifanov, 2026), ensures universities' moving towards the modern trends in society.

The Technical University of Munich is cooperating with various leading industrial companies. These include the following: Siemens AG – creation and improvement of additive production technologies, development of tools and systems based on the Industrial Internet of Things and digital twins); SAP – digital apps for quantum computing, software and systems for smart management of supply systems and sustainable management of business based on non-financial data; OC Oerlikon Corporation AG – joint creation of innovative materials; GE Aerospace – development of thermodynamic, hybrid, and acoustic technologies within the transition to sustainable aviation (Technical University of Munich, 2025c).

Like the Technical University of Munich, Delft University of Technology (Netherlands) is owned by the state. Transition to entrepreneurship is a precondition for raising the amount of funding from R&D for industry, educational services, personnel training for business, and technology transfer.

Dynamics of revenues of Delft University of Technology (Netherlands) in 2023-2024 were as follows (Delft University of Technology, 2025a):

- Total revenues equalled EUR 957.876 million in 2023 and EUR 1,019.121 million in 2024.

- State funding (subsidies and contributions) amounted to EUR 593.953 million in 2023 and EUR 629.263 million in 2024.

- Revenues from works performed by requests from third parties (R&D for industry and educational services for partner companies) equalled EUR 257.023 million in 2023 and EUR 280.053 million in 2024.

The Innovation & Impact Centre of Delft University of Technology is the mediator of the organisation of partnerships at the level of research organisations, government, and industry in the sphere of the creation of innovative technological solutions. The Centre organises its own technology transfer and, in cooperation with partner companies and universities that specialise in certain types of R&D. The technological development of the university is based on adherence to the value-based approach (compliance with ethical norms, rights, and interests of humans, moral and social acceptability technological solutions) and support of the system approach associated with organisation of technology transfer.

The main spheres of the entrepreneurial activities of Delft University of Technology as of year-end 2024 were as follows (Delft University of Technology, 2025b).

- Partnership in the sphere of training and advanced training of partner companies' personnel. Here, an important role belongs to partner companies' paying for post-graduates' research projects, which results are sought by customers from the business environment. These research projects are important, and an equally relevant issue is the university's support for post-graduates. Another direction in this sphere is raising the qualifications of partner companies' employees in selected specialities or interdisciplinary spheres. Delft University of

Technology also develops advanced training programmes for partner companies, which include Brunel International NV, Rabobank, Koninklijke VolkerWessels N.V., Aegon N.V., Bain & Company, Heineken and others. Partnership with Dutch companies has a very long history and is implemented within industry sectors (Delft University of Technology, 2025b)

- Cooperation with Dutch and foreign universities in joint creation and transfer of technologies.

- Innovative R&D by targeted requests from partner companies, implemented by contractual terms.

The structure of Delft University of Technology has 15 research institutes, which implement research activities in sports engineering (cooperation with the government, commercial structures, and public organisations in the sphere of creation of new materials, products, and innovative technological solutions for sports); aerospace technologies and products (partnership with government agencies and subjects of aerospace industry); security; robotics, computational science, biotechnologies, agrarian technologies, etc.

The structure of the university's commercial partners is rather diverse. The university works on various innovative digital technological solutions for large corporations and small and medium-sized businesses. Small and medium companies can purchase final innovative technological solutions and products and order individual packages. A strategic programme of support for the digitalisation of small and medium businesses is implemented in the Netherlands. The programme involves financial help and organisational and technological support (International Trade Administration, U.S. Department of Commerce, 2026). Due to this programme, subjects of the science and technologies sector (including Delft University of Technology) have serious perspectives on further development, with the expanding circle of business partnerships.

HR management in Delft University of Technology (Netherlands) relies on supporting and stimulating employees to adapt to constant changes in the external environment (digitalisation, sustainable development, and challenges connected with transformations in the labour market). The structure and dynamics of employees of Delft University of Technology were as follows:

- Employees: 4,410 in 2012, 4,821 in 2015, 5,483 in 2018, 6,263 in 2021, and 7,592 in 2024. An increase in the number of employees over the period of 2012-2024 demonstrates the university's development, including the acceleration of entrepreneurial activities and the growth of higher education services.

- From 2012 to 2024, the number of PhD candidates involved with innovative R&D increased. They accounted for 21 % of personnel in 2012, and 29 % in 2024. Thus, we can see that the university develops entrepreneurship that is based on knowledge generation.

- The teaching staff grew from 882 to 1,378 from 2012 to 2024. This is a sign of an increase in demand for higher education services and the growth of their quality in the university.

- The number of scientific employees involved in R&D accounted for 15 % of the total employees from 2012 to 2024. In the quantitative measuring, their number increased from 661 in 2012 to 1,138 in 2024. This is a sign of the university's adherence to the development of entrepreneurial activities in the R&D sector.

- The share of supporting personnel reduced from 44 % to 38 % over 2012-2024, which was due to automation of certain positions (Delft University of Technology, 2025c).

We analysed the level of the selected universities' transition to entrepreneurship (Table 2).

Table 2. The universities' transition to entrepreneurship

	Indicator	Value	
		Delft University of Technology	Technical University of Munich
1	Factor of entrepreneurial activity of undergraduates, graduates, and postgraduates of the higher education establishment (F1)	$F1 = Nss / Ns * 100 \% = 800 / 21,410 = 3,74 \%$ Where Nss = 800; Ns – 21,410	$F1 = Nss / Ns * 100 \% = 17,000 / 35,755 = 47.5 \%$ Where Nss = 17,000; Ns – 35,755
2	Factor of university's financial diversification (F2)	$F2 = \text{Inc extnon gov} / \text{BudgG} * 100 \% = \text{EUR } 0.425 \text{ billion} / \text{EUR } 1.019 \text{ billion} * 100 \% = 41.7 \%$ Where Inc extnon gov – EUR 0.425 billion; BudgG – EUR 1.019 billion	$F2 = \text{Inc extnon gov} / \text{BudgG} * 100 \% = \text{EUR } 0.544 \text{ billion} / \text{EUR } 2.171 \text{ billion} * 100 \% = 25 \%$ Where Inc extnon gov – EUR 0.544 billion; BudgG – EUR 2.171 billion
3	Factor of the intensity of the university's commercialisation (F3)	$F3 = \text{Numgrst} / \text{Num R\&D} = 287 \text{ patent and grant applications} / 1,138 \text{ personnel} = 0.252 \text{ patent and grant applications} / \text{one employee participating in R\&D}$	$F3 = \text{Numgrst} / \text{Num R\&D} = 378 \text{ patent and grant applications} / 8,354 \text{ personnel} = 0.045 \text{ patent and grant applications} / \text{one employee participating in R\&D}$
4	Level of university's transition to entrepreneurship (TRenU)	$\text{TRenU} = F1; F2; F3 = 3.74 \%; 41.7 \%; 0.252 \text{ patent and grant applications} / \text{one employee participating in R\&D}$	$\text{TRenU} = F1; F2; F3 = 47.5 \%; 25 \%; 0.045 \text{ patent and grant applications} / \text{one employee participating in R\&D}$

Source: Calculated by the author based on Delft Centre for Entrepreneurship (2026), Delft University of Technology (2025c), Technical University of Munich (2025c), Technical University of Munich (2025d), Times Higher Education (2026), and UnternehmerTUM (2026)

Analysis of the results obtained (Table 2) shows that each of the selected universities has its advantages in the sphere of transition to entrepreneurship and its growth centres that have to be developed to improve the quality of higher education.

The two selected European universities, which we studied, demonstrate an effective transition to entrepreneurship, supporting the high quality of higher education services through the involvement of students in R&D and the inclusion of scientific employees in the structure of teaching staff. Successful organisation of employee support allowed the universities to contribute to the integration of scientific employees into academic staff. The selection of effective tools of interaction with the regional industry also contributes to the sustainable development of universities and partner companies.

4. Discussion

In this research, we studied the specific features of higher education institutions' transition to the category of entrepreneurial universities as a mechanism of improving the quality of higher education services. We were able to identify models of this transition by the example of two selected European universities.

These two universities aim at raising autonomy from government funding, despite the state form of ownership. This approach demonstrates a high potential for development and readiness to bear entrepreneurial risks. On the one hand, the focus on financial autonomy can become a threat in the conditions of the growth of financial and economic challenges of an external character; on the other hand, striving towards independence positively

influences decisions in R&D and technology transfer.

The universities retain the high quality of higher education, attracting students and post-graduates, whose tuition is often covered by employers. This contributes to the applied aspect of the educational process and raises the quality of knowledge mastery and generation.

Creation of high-quality technological bases and software for digital intellectualisation is the foundation for developing, implementing, and promoting innovative technological solutions, given the standards, ethical norms, and requirements for highly competitive positions in the high-tech market.

In view of the similarity of approaches to organisation of approaches to R&D organisation and management of higher education services' quality, the two selected universities use the model of transition to autonomous management of funding and organisation of targeted R&D and education.

Further transition to entrepreneurial universities is predetermined by the creation of new models of entrepreneurship and the provision of higher education services. These transformations are important due to the necessity for reaction from the academic community to the needs, problems, and requests from interested parties from the economic, public, and institutional environments. One of the relevant directions of transformations could be the consideration of talented students' expectations from educational and practical programmes (including in the context of focus on modern ICT) (Alves et al., 2026).

Formation of models and their diversity depend on higher education institutions' readiness for the transformation of the organisational process and the ability to raise the quality and competitiveness of services in R&D and higher education.

5. Conclusion

At the current state of development of higher education services, there are educational establishments that are ready to become the subjects of sustainable development of the economy and society – entrepreneurial universities. They are mediators in the sphere of the generation of knowledge, created in the academic community and required for further development of economic entities, infrastructures, and institutional structures. Emergence of the new formation of higher education institutions is connected with the need to raise the responsibility of the higher education and science system before society and the economy for the results of its activities. Entrepreneurial universities also contribute to financial independence from government support and an increase in research freedom.

The presented analysis of the specifics of entrepreneurial universities in the EU demonstrated that these higher educational establishments have a similar approach, on the whole, to the organisation of entrepreneurship, support of HR management, and funding and technologisation of R&D and higher education services. The indicators of the effectiveness of transition to the entrepreneurial model of universities' activities organisation are their positions in international rankings and financial results. Apart from this, an important role in the transition to entrepreneurship in the conditions of the University 5.0 paradigm belongs to the focus on environment and civil society, which are milestones for the sustainable development of responsible universities.

It is possible to conclude that there is a need to compile recommendations for the transition to an entrepreneurial university, to form standards in this sphere. These recommendations can be prepared by representatives of the academic community,

institutional structures, civil society and the economy. Further implementation of entrepreneurship in the sphere of higher education must be accompanied by a simultaneous increase in the quality of educational programmes, which will become an indicator of the transition's effectiveness.

Author Contributions

1st author formulated the goal and stages of the research on the types and characteristics of the models of the transition to entrepreneurial universities as a mechanism for improving the quality of higher education services and selected scientific and analytical materials.

2nd author conducted a review of literature sources on theoretical and practical aspects

of the transition to entrepreneurial universities and worked on the definition of an entrepreneurial university.

3rd author studied the rankings of universities in the context of their influence on the knowledge economy and connection with industry.

4th author analysed the features of the transition to entrepreneurship by the example of the selected universities.

5th author prepared the discussion and conclusion section and reviewed the final paper.

All authors approved the paper's contents and its final version.

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