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**UNIVERSITY 4.0: THE EXPERIENCE OF
DIGITALIZATION IN PRACTICE – THE CASE OF
HUNGARIAN TOP UNIVERSITIES**

Doctoral Theses

Szeged, 2023

University of Szeged

Faculty of Economics and Business Administration

Doctoral School in Economics

**UNIVERSITY 4.0: THE EXPERIENCE OF
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1. Introduction, Relevance and Research Questions

With the emergence of a knowledge-based society and economy, human resources are necessarily becoming more valuable, as the quantitative and qualitative characteristics of this resource greatly contribute to maintaining and enhancing the competitiveness of regions. In addition, at global level, we experience the accelerating changes of societies and economies in recent decades, hence a higher level of flexibility and adaptability from both a human resources and a sectoral perspective is required. Today, universities – which are key actors in the training of human resource and are significant contributors to the potential emergence of innovations – are facing increasing challenges, while they also need to respond to global trends, social and economic demands, because of their increased role in societies and economies. To respond effectively to these challenges, it has become increasingly important for universities to play an active role in shaping social and economic processes, enhancing knowledge transfer activities, generating value through innovation, facilitating networking processes, and mitigating barriers of competitiveness (Goldstein 2010).

For centuries, universities have played a key role in the creation and dissemination of knowledge. As an addition, their embedment in social and economic networks is a crucial component of universities today. This is a result of a process of adaptation, as the social and economic expectations towards universities have become higher, and the nature of these expectations has constantly changed in line with the needs of the given era. Hence, universities are typically not isolated entities, but are typically an integral part of networks, professional communities and under certain conditions, can play a key role in local economic development, thus contributing to the enhancement of the region's competitiveness (Lukovics – Zuti 2014).

One of the main and most fundamental purposes of higher education is to generate competitive workforce, but in the current, changed economic and social structure, the maintenance of competitiveness is only possible by applying different methods and approaches. We can observe 2 main megatrends that are crucial in terms of the future of higher education.

One of these megatrends is the continuous change and expansion of higher education's main missions. Wissema (2009) provides a comprehensive summary on the main milestones of universities' evolution and the main differences between university generations. He identifies education as the main goal of the first generation of universities and their main output as the emergence of skilled professionals within the labor market. Second-generation universities, by comparison, have a broader objective: the training of professionals and scientists through

education and research. In the case of third-generation universities, the connections and strategic embeddedness within the economic and social environment becomes more important. Universities are increasingly recognizing the importance of being non-isolated actors of the local economy, and rather of be a prominent actor on the global map of higher education. In addition to teaching and research, universities are therefore also prioritizing the usage of practical knowledge at a local or regional level. Beyond the third generation of universities, a thought experiment has already been published in 2009: this theoretical approach explores the possible characteristics of a fourth-generation university model. The initial idea is that a university is the most dominant regional actor in its own socio-economic environment, acting as a strategic actor (Lukovics – Zuti 2014, Pawlowski 2009).

The second major megatrend is digitalization, which can be seen as the next step in globalization. As a result, new business models and technologies are reshaping all aspects of economy and society. Digital tools and solutions are emerging in those aspects of life where they were previously absent. It is also noteworthy that as a result of networking processes the emergence of highly complex connections between actors of the industry-government-academia-society sphere, and that interactions between these actors are becoming more frequent. Universities have played a key role in the formulation and dissemination of knowledge for centuries; the question presents itself: how can today's universities remain competitive in an increasingly digital world? How can they successfully adapt to this new environment, which is increasingly seen as the "new normal"?

Although the pressure towards digitalization is high in all industries, higher education had a relatively weak digitalization footprint a few years ago, both at national and international levels (Gandhi - Khanna - Ramaswamy 2016). In practice, the prospects for digitalization in higher education are now increasingly positive, with more and more good practices, but there is still a lot of untapped potential in the digitalization of higher education when examining the big picture. Besides the opportunities, we need to be aware of the new challenges that are emerging as a direct result of digitalization, namely the huge differences in how different demographic generations use technology. Today's youth are using a wide range of smart devices with ease, while previous generations have very different consumption habits and user skills.

In the light of the above, **the aim of my PhD thesis is to identify the "building blocks" of fourth generation universities that will enable them to utilize digitalization in terms of education, research, the third mission, institutional operations while being at the service of the local economy and society.**

To this end, I will map the key elements of the digitalization progress of the leading universities of Hungary, the main challenges they face, their strategic responses to these challenges, further I analyze relevant literature related to the history of the development, generations, and main missions of universities. In my PhD thesis I aim to test the following hypotheses:

- Hypothesis 1:** The natural process of digitalization in the leading Hungarian universities has been significantly accelerated by COVID-19: a pivotal digitalization leap occurred in the universities during the epidemic period.
- Hypothesis 2:** We can find practical examples of digitalization within the leading Hungarian universities in all three aspects of digitalization distinguished in the scientific literature (digitization, digitalization, digital transformation).
- Hypothesis 3:** The digitalization of the three basic missions of universities (education, research, third mission) is taking place with approximately the same dynamics in the practice of the leading Hungarian universities.
- Hypothesis 4:** In the practices of the leading Hungarian universities, the catalysts of digitalization dominate over the challenges of digitalization.
- Hypothesis 5:** The validity of the fourth mission in our "fourth generation university" theoretical demonstration model from ten years ago can be validated through the practice of today's leading Hungarian universities.
- Hypothesis 6:** Aspects that contribute to the competitiveness of a university in a highly digitalization-driven global environment can be identified and therefore an updated demonstration model for the fourth-generation universities can be defined.

2. Structure of the Dissertation

The purpose of the thesis is achieved through four main structural units. Following the introduction, the second main chapter provides an overview of the historical background of universities, examining the institutional structure of early higher education and how the university structure has evolved over the centuries from an initially closed institution to an increasingly open community. In addition, I will systematize the key concepts that emerge in relation with universities and analyze the definitional frameworks that are important from a professional perspective. In addition to enhancing the competitiveness of the given region, today's universities must also face the challenge of maintaining or even increasing their own local and global competitiveness. In this chapter, I review the most common and prominent trends and challenges to which they must provide response. I also focus on the main milestones in the development of universities, how universities in the 21st century have evolved from their early days, and how they have become increasingly locally embedded and globally engaged. Over the past decades, several research has concluded on the positive impact of universities, showing that they can add value in social and economic contexts, at local, regional, and global levels. These benefits can be partly quantified but can also be systematized according to qualitative aspects. Following the logic of Wissema (2009), I will examine the main steps from first generation, to third generation universities. In the history of university development, the term fourth-generation university also arises, which is primarily attributed to Pawlowski (2009).

In the third main chapter I examine the next stage of globalization: digitalization and the fourth industrial revolution. I review the key processes that characterize today's societies and economies. I outline the achievements and new opportunities that are brought by digitalization, and examine the habits, attitudes, and differences in the use of technology across generations. Further, I explore the key links between digitalization and universities. By analyzing the literature, it will be possible to identify the role of higher education in the fourth industrial revolution and how universities can fit to these expectations. In addition to the Fourth Industrial Revolution, the already mentioned role of universities in local embeddedness and potential positive economic development will be examined. Typically, developed societies have strategies that are aimed towards the digitalization of higher education.

The fourth main chapter is devoted to present the methodological framework of empirical research. I describe the development of the final logical arc of the primary research, the logical steps and principles used, the framework and the description of the methodology. I present

in detail how the institutions and interviewees were selected, how I structured the interviews, and the coding process closely linked to my qualitative research.

In the fifth main chapter, I analyze the results of the qualitative research. I also present the main experiences on digitalization along the institutional core missions as reported by the interviewees. I will describe what attitudes my interviewees have experienced in case of digitalization in their university communities, whether benefits were realized, or challenges were identified. In addition, I will define a set of recommendations based on national and international good practices and the results of empirical research, which will include all the knowledge, basic assumptions and conclusions that can be considered by Hungarian universities. In the seventh main chapter I outline the limitations of the research and identify potential future research directions.

3. Theoretical Background

Universities represent the highest level of professional and academic education within the higher education system. However, it is important to point out that universities are not only training and research institutions, but also provides community functions, as they are a collection of teachers, researchers, and students (Alemu 2018, Scott 2006). The ancestors of modern universities can be traced back to medieval European universities, but there are also institutions from much earlier periods that provided a higher level of education. The ancestors of university institutions were characterized by a strong presence of educational activity, academic freedom and unity within the institution. They considered education and the defense of truth as their main mission. The importance of the transmission of higher-level knowledge gradually increased in parallel with the development of the economy and society, which inevitably led to the spread and popularization of the university system (Alemu 2018, Perkin 2007, Scott 2006).

Worldwide, the need for institutions of higher education has risen, initially in elite circles. Firstly, in Europe the ancestors of today's modern universities were established, then only providing educational activities. They recognized institutional autonomy and the purpose of serving the current social and economic order by training people (Alemu 2018, Perkin 2007).

During the massification phase of the 20th century, higher education becomes available to wider social groups at a global level and then becomes an integral part of the broader education system. This change also brings along the transformation of the university-student relationship. As the number of students increases, so does their importance. Teaching and research remain relatively important, but there is a shift towards a market, consumer, managerial and

entrepreneurial approach. With the intensifying of student mobility and internationalization, the composition of the student and research base is becoming more heterogeneous compared to the past, and there is a social diversification, which poses new challenges for universities. They need to review their infrastructural and administrative foundations, rethink their financial sustainability, meet economic requirements and, therefore, necessarily transform themselves into a service provider institution with a market approach, where the student becomes part of the system as a consumer of knowledge and university services (Alemu 2018, Veroszta 2010).

Around the world, in any institution, there are pressures faced both by organizations and their leaders. On the one hand, there is an external incentive that digitalization has the potential to deliver huge competitive advantage and socio-economic actors have made digital transformation one of their top priorities. Hence, digital knowledge mapping, expanding digital competences and assessing investment opportunities are all important factors (Gurumurthy - Schatsky 2019). Digitalization is a dynamic process that can be optimized step by step with a focused strategy (Gurumurthy - Schatsky 2019).

Based on the argument of Schuster et al. (2015a, 2015b) the digitalization of higher education does not only mean that new teaching methods and platforms are made available to students, but also making education more collaborative, encouraging further collaboration, exchange of information, ideas and communication. Toffler (1990) suggests that students need to be able to learn and relearn knowledge flexibly, while getting rid of knowledge that has become redundant or obsolete. The teacher was the source of knowledge in the past, today knowledge, academic articles and books are easily available on the Internet. Furthermore, not only are teachers the main and only generators of knowledge and ideas, but students themselves play an active role in the process of knowledge dissemination and creation. Knowledge is not generated by one person, but by a community of people. In specially designed forums, students can exchange ideas, collect ideas, generate content (Schuster et al. 2015a, 2015b). In the Hungarian language, the former role is very well reflected: the student is literally called "listener". Today, however, this passive attitude is increasingly receding, and the student is becoming an active actor in education. There is a demand for this not only from the students themselves, but also from the teachers. Active participation, the creation and maintenance of a dialogue between teacher and student, is a key element in terms of the future of education (Gros – López 2016, Conole et al 2007). This approach implies a shift from individual, isolated learning processes to community-oriented learning, which reinforces Vygotsky's (1978) vision that successful learning and development depend on the quality of interactions between people and the quality of the tools that support this learning

process. There is no longer only teacher-generated knowledge, but also knowledge generated jointly by the student and the teacher in a dynamic zone through dialogue. Furthermore, the student's task will not only be the acquisition of knowledge, but also the ability to apply that knowledge in practice and the ability to produce knowledge. This means that we need to reassess not only the role of the participants in education, but also the role of the educational institutions itself (Schuster et al 2015a, 2015b). The importance of digitalization in higher education must also be recognized for higher education institutions to remain competitive both in social and economic terms. In the dissertation, I relied on the digitalization definitions of Verhoef et al. (2021), Brooks and McCormack (2020) and Mergel et al. (2019), which encompass and differentiate digitization, digitalization, and digital transformation.

4. Methodology

The aim of my qualitative research is to identify the characteristics of a competitive university that is able to use digitalization as a basis for education, research third mission and general operations. I will examine the experiences, attitudes, concrete actions and strategic approaches of 6 top higher education institutions of Hungary in terms of digitalization. To answer my research questions, I conducted qualitative research within the framework of my doctoral thesis. The final methodology, the selection of the logical arc that was considered the most appropriate, went through several cycles of reinterpretation. This was necessary because, in some cases, I encountered logical or methodological problems that would have significantly hindered the success and integrity of my qualitative research. To establish the framework for the primary research, I carried out three main steps: a study of the definitional framework of digitalization, a literature review on digitalization in higher education, and a review of relevant digital maturity models and their dimensions. To measure digital maturity, I have examined several models available in the literature (Gurumurthy - Schatsky 2019, Martínez et al 2019, Đurek et al 2019, Hummel - Schenk 2022, Barzman et al 2021, McCormack 2017, Nguyen et al 2021, Kampylis et al 2015, Berghaus - Back 2016). In this way, I could define a comprehensive framework that covers the main themes related to digital maturity. I have broken down the interview of the primary research into two major logical parts. The first major logical part was a qualitative explanatory segment. In this qualitative logical part, I framed the questioned areas with the questions "What?", "How?" and "To what end?" dimensions instead of separately defined topics. This allows me to focus on 3 main questions instead of the

many questions I had collected earlier, together with the interviewee. The structure of the new logical framework was inspired by the article of Mergel et al. (2019).

In the "What?" dimension, I was looking for answers to the question of how to define a 'screenshot' of digital maturity at a given institution. Here, the question was by default directed at all three university missions, but the interviewee was given the option to focus on one mission, based on their area of expertise or available information. I considered it important that I did not include digital maturity or digitalization in a pre-defined framework, so that my interviewees could outline the state of digitalization in their institution in their own words based on their individual interpretations. Based on my preliminary expectations, this question gives me a picture of best practices and external and internal processes that influence digitalization processes. Related to the "How?" dimension, I focus on the challenges and catalysts for digitalization. In this part, I expect to focus on how the background of digitalization processes can be described empirically, how student and university employee attitudes have emerged, what difficulties they have encountered during digitalization and how they have been able to overcome these challenges, or what are the difficulties that still persist? The question "To what end?" dimension, I focused on future outlooks. My aim was to gain insights into the institutional vision of digitalization and how to define the purpose of digitalization for a university. What are the intentions driving digitalization measures from a competitiveness point of view, how strong emphasis does digitalization has in institutional strategies. The 3 main questions are therefore the backbone of the in-depth interview, and they will help the interviewee to thematize their thoughts. In addition, I also prepared supporting questions for the 3 main questions, which further helped the interviewee to prepare. I translated the 3 dimensions outlined into 3 main questions (Table 1).

Table 1. The main questions of the in-depth interview and their interpretations

Dimension	Question	Interpretation
„What?“	How do you see the digital landscape of your university along the main university missions?	How can you describe the current state of digitalization in your institution? How can it be described in terms of solutions, tools and infrastructure?
„How?“	What are the main experiences of the digitalization process at your university?	How to define the most prominent attitudes, challenges and milestones related to digitalization in your institution?
„To what end?“	What are the characteristics of a digitally mature university in your opinion?	How can the interviewee summarize the purpose of digitalization? What are the rational arguments towards the commitment to digitalization? What objectives, strategies and guiding principles determine digitalization-related goals in the future?

Source: own construction

In all cases, the main questions were asked in an obligatory manner during the interviews and the facilitating questions were optional, so I had a great deal of flexibility to control the interview process given the time constraints. In terms of the selection of the institutions for my primary research, I considered it appropriate and obvious to use the most recent results published by the most prestigious and respected international rankings. In the literature I have reviewed and related to the topic (Fauzi et al 2020, Khan et al 2020, Selten et al 2020, Johnes 2018, Robinson-Garcia - Jiménez-Contreras 2017, Bekhradnia 2016, Pavel 2015, Hazelnorn 2011), I have observed that the basis for methodological comparisons and the common base of the most honored rankings is usually reduced to the triad of the ARWU, THE and QS rankings. As such, I have taken the most recently published list of these 3 rankings as a baseline. The top 5 Hungarian universities for each mentioned rankings are summarized in Table 2.

Table 2. Presence of Hungarian universities in ARWU, THE and QS rankings (TOP5)

	ARWU (2021)	THE (2022)	QS (2022)
1	ELTE	SE	SZTE
2	SZTE	ELTE	DE
3	SE	DE	ELTE
4	BME	PTE	PTE
5	-	SZTE	BME

Source: own construction

If we combine the universities in Table 2 into a single list, we get the 6 institutions that were selected as the subjects of my primary research: University of Szeged, Budapest University of Technology and Economics, University of Debrecen, Eötvös Loránd University, University of Pécs and Semmelweis University. In total, I contacted 31 higher education experts from top universities in Hungary to participate in the research for my doctoral thesis. 15 of them agreed to participate in the in-depth interview. In my empirical research, I explored the attitudes, experiences, concrete measures, long-term strategic perspectives, and future orientations of 6 Hungarian universities in relation to digitalization via semi-structured in-depth interviews. I chose the semi-structured interview framework because it gives me the opportunity to give my interviewees the opportunity to convey their individual experiences in their own words (Given 2008). Semi-structured in-depth interviews offer opportunities to ask spontaneous, not necessarily pre-defined questions or topics in addition to the main questions I aimed to discuss. The possibility is also opened to ask the interviewee clarifying questions if the situation requires so. In addition to the main questions, I also formulated sub-questions as guidelines to help the in-depth interview unfold (Corbetta 2003).

During the coding process, the researcher looks for patterns in the textual analysis of interview transcripts and, in this way, is able to standardize the originally raw data, similar text contexts, according to a certain predefined framework (Creswell 2013, Babbie 2016). In qualitative research, a code is an attribute whose function is to briefly summarize content, be it any linguistic or visual content (Saldaña 2013). In coding the text transcripts of the in-depth interviews, I assigned codes with the purpose of summarizing content, so that I could view the content provided during the in-depth interviews in a standardized framework. The purpose of the coding process is to help understand the data accumulated during the data collection (Saldaña 2013). The in-depth interviews were conducted online between November 2021 and April 2022 via the Zoom app. The preparation of the in-depth interviews can be divided into 2 phases. Firstly, I contacted potential interviewees via email, assessed their willingness to participate in the research, and then the next step was to arrange an appointment and send the interview questions 2 working days before the interview. Sending the set of questions in advance was a key step for the research, as it was in our mutual interest to conduct the in-depth interview with maximum professional and informational preparation.

The coding process was conducted electronically using MAXQDA Analytics Pro (2022) software. The use of MAXQDA software significantly contributes to the researcher's ability to thematically analyze and organize the open-ended interview questions and also allows for statistical analysis of the codes (Rädiker - Kuckartz 2020a). The coding was done manually (Rädiker - Kuckartz 2020a), the coding system was set up by myself, hence I used a solo coding method (Saldaña 2013).

5. Main Findings

Based on the results of the empirical research and the six hypotheses outlined in the introduction, I formulate the following findings:

Thesis 1: COVID-19 significantly accelerated the natural process of digitalization of the leading universities in Hungary: the universities observed experienced a significant digitalization leap during the epidemic period.

The acceleration of digitalization processes and the spread of digitalization solutions in universities has been positively influenced by the pandemic situation. The COVID-19

pandemic, with the exclusion of one interview, appeared as a recurring element in the context of digitalization and, on the one hand, it typically appeared early on, predominantly in the first third of the interviews, as a motif, and on the other hand, it recurred at different stages of the interview, hence this could not be excluded from the analysis. The common point of the reflections on the pandemic was its beneficial impact on institutional digitalization, meaning that my interviewees' reflections on the pandemic - exclusively from the perspective of promoting institutional digitalization - were perceived positively. Critical to the emergence of these experiences was the fact that the primary research was conducted in a time period when the institutions observed already had relevant experience in the field. COVID had its most pronounced impact on educational activities, digital culture and competency enhancement, infrastructure improvements and workflow optimization activities. This is due to the fact that in the pandemic period, the acquisition of skills and methodological competences in supporting applications in education has become indispensable and the demand for digitalization awareness and training activities and efficiency gains has increased markedly. COVID has therefore accelerated the digitalization process and the associated learning needs of students, teachers, researchers and university staff. For research, the third mission, COVID is reported to be less relevant. In the phrasing of the first thesis, the significant aspect is the enhancement of digitalization by COVID-19: we can only determine only how the flow of digitalization occurred due to this external distortion. There is no possibility to identify how the alternative course of digitalization would have progressed without taking COVID-19 into account. **Based on this, I accept the first hypothesis.**

Thesis 2: In the leading Hungarian universities, all three digitalization-categories of academic literature (digitization, digitalization, digital transformation) can be distinguished in university best practices.

As a broad umbrella definition of digitalization, three distinct phases of digitalization are identified in the literature: digitization, digitalization, and digital transformation. In my dissertation I considered it important to examine which phases emerge in the context of institutional digitalization through in-depth interviews. This area of my analysis is both important and necessary, as it provides a more clearly defined picture

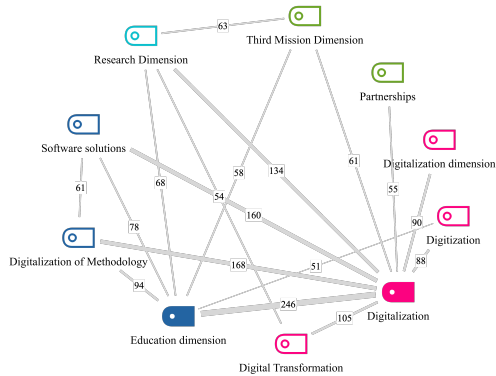
of how immature or mature the digitalization processes are in the universities under observation. It is useful to emphasize that the stages describing the maturity of digitisation are not mutually exclusive. It cannot be said that only the digitization stage can be experienced in practice in a given institution. The three stages of maturity I have just mentioned can be present simultaneously, since universities have numerous workflows in addition to the classic core missions of education, research and the third mission. It is natural that there are areas or processes where the level of digitalization is more advanced than others. While digitization and digitalization are necessary for digital transformation to take place, the realization of the latter is neither self-evident nor a quick process. In other words, the stages of digitization and digitalization are necessary but not sufficient conditions for the realization of an institution-wide digital transformation that permeates the workplace culture. The frequency of codes related to digitization for the in-depth interviews analyzed is as follows: digitization 54, digitalization 298 and digital transformation 70 code labels. This can definitely be considered an encouraging sign, as we can say that digital transformation is also present at the level of cultural embeddedness in the leading universities in Hungary, during the interval of the conduction of the interviews, hence digital solutions and services can become part of everyday life in the future, and they can become more and more accepted methods of working supported by these digital technologies. During the in-depth interviews, I deliberately did not touch upon or push this triadi of classification used in the literature. Ultimately, I do not consider this to be a serious problem, as the aim of the research was not to provide theoretical justification for the appropriate use of the literature definitions by digitalization experts and leaders in leading universities in Hungary. Furthermore, the flow experience of the in-depth interview was accelerated by the fact that digitalization was used as an umbrella term. In the contextual and software-based content analysis of the texts, I was able to categorize through a literature-focused lens, which forms of digitalization were actually discussed in the context. The leaders and experts at the leading universities in the country are well informed about digitalization, and their relatively recent and extensive experience and sectoral knowledge makes them competent and up to date in this field. The triad structuring was useful for me from a scientific point of view: it served me well to take an evolutionary perspective on the digitalization situation of the leading universities in Hungary. From an external perspective, all the concepts in the literature describing the

evolution of digitalization, from the most basic to the most value added, are present in the institutions observed. **Based on this, I accept the second hypothesis.**

Thesis 3: Regarding the three key functions of universities (education, research, third mission), the digitalization of education is measurably relatively more important than the other main activities when examining digitalization processes.

Digitalization is clearly present in all three core university missions; however, the digitalization of education (including digitization, digitalization and digital transformation) is relatively over-represented compared to the other two core activities based on the data obtained within the primary research. This finding should be treated with caution, as each of these areas is markedly affected by digitalization, however, precisely because the most prominent and recent event at the time of the in-depth interviews was the COVID-19 epidemic, which had the most significant impact on education, the education dimension necessarily gained a relatively stronger focus and higher priority during the in-depth interviews. The proximity of the epidemic period may therefore be a potentially biasing factor. In testing this hypothesis, I only looked at codes that can be linked to digitalization (i.e. the digitalization dimension, digitization, digitalization and digital transformation) and codes that can be directly linked to university missions (i.e. the education dimension, methodological digitalization, satisfaction surveys, software solutions, the research dimension, the physical research infrastructure, academic access, the third mission dimension, partnerships and knowledge dissemination) and thus form the basis of the analysis. In the 3 aspects just mentioned, which were used to analyze the relationships, the strongest relationship is usually between the digitalization code and the codes related to the educational mission. Based on this, it can be concluded that the most significant theme for the interviewees in the field of digitalization in universities is its impact on the education mission (Figure 1).

Figure 1. Connections between digitalization-related codes and university missions
(max. distance: 1)



Source: Own construction

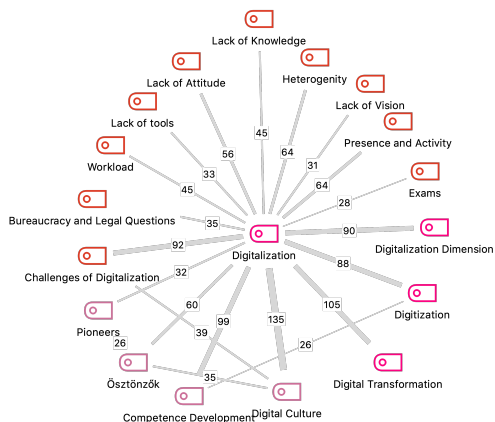
Based on this, I reject the third hypothesis.

Thesis 4: In leading Hungarian universities, the catalysts for digitalization play a stronger role than the barriers to digitalization.

The most relevant factors clearly emerge between digitalization and competence development and digital culture. There is also a relatively high frequency between the digitalization and digitalization challenges codes, but this is a code where the interviewee provides very general challenges at sectoral level rather than specific practical and experiential examples related to their institution. If we focus on the empirical examples, it is clear that university managers and digitalization experts overestimate the benefits of digitalization as compared to the challenges or the negative aspects of the phenomenon. It is important to underline that this does not mean that the difficulties of digitalization or the institutional-level dilemmas and problems associated with the phenomenon are insignificant, but rather that the primary research data suggest that the benefits of digitalization are more prominently communicated than the challenges associated with digitalization. The benefits of digitalization were more strongly linked by the university managers and experts interviewed. Although the range of challenges to digitalization is much broader compared to the number of catalysts,

the positive contribution of catalysts to digitalization is stronger than the negative contribution of catalysts to digitalization. Although the interviewees go into more detail about the content of the factors that hinder digitalization, there is a stronger link between digitalization processes and digital literacy development and digital culture. If we break down the catalysts mentioned by the interviewees in relation to digitalization into elements, the positive aspects of digitalization are more often mentioned in relation to the challenges, but it should be noted that the challenges related to digitalization are broader than the catalysts (Figure 2).

Figure 2. Challenges and catalysts of digitalization



Source: Own construction

Based on this, I accept the fourth hypothesis.

Thesis 5: The practical validity of the fourth mission in our fourth-generation university demonstration model from ten years ago cannot be uniformly verified in today's leading Hungarian universities.

By this it is meant that, although local economic development is present as an objective in the strategies of the universities observed, the university aims to play the role of an economic catalyst, but at the same time it is not a completely separate university mission but is embedded within the third mission. The original demonstration model consists of teaching-research and third- and fourth-mission pillars, with the ultimate

goal of being a successful, internationally recognized operation and embeddedness in the local economy. In 2023, digitalization as a megatrend is very much present in today's societies and economies, and it is therefore worth rethinking and updating how to redefine the "fourth-generation university" as an institutional approach. The fourth generation needs to be embraced in a different way, with an appropriate representation of digitalization. In our demonstration model from 10 years ago, digitalization was a missing factor, the crucial differentiating aspect was focused on the fourth mission, the proactive, managerial approach to local economic development. The name fourth generation university and the validity of the fourth mission in our demonstration model was not considered as a scientifically supported fact, but it was important to start a discourse on the topic, along the ideas of Pawlowski (2009). The view at the time was that the logic of the 'fourth-generation university' went beyond the structure and activities of third generation universities in that the former had a greater role in catalyzing the local economy and society, in the economic engine function, as part of a distinctly new university mission.

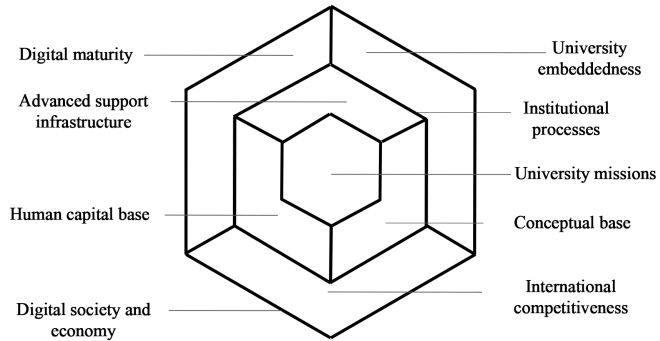
Based on the results of preliminary own and international research, and taking into account the digitalization megatrend, the views on the fourth mission are mixed, not clearly defined, and the operational strategy of the leading universities does not include a fourth mission initiative aligned with the literature. When discussing the Fourth Mission, I encountered mixed views, with the result that the subject of the Fourth Mission is a divisive one among the interviewees. Three main groups emerge from the responses: the first group sees the validity of introducing a separate fourth mission, the second group rejects or has reservations about the need for one. The third group defines this activity differently from the literature. In relation to the fourth mission, seven of the interviewees see the relevance of the fourth mission as a new mission that is well understood and can be properly integrated into the university's operations. Two interviewees consider healing as the fourth mission due to the specific situation of their university, so they do not define the topic along the lines of the literature, but for them it means something else. Four of them rejected the existence of a fourth mission, as for them this field is much closer to the third mission, and they do not feel that the fourth mission is a separate university activity. The arguments hence focus on the question if the fourth mission described in the article of Lukovics and Zuti (2014) is the extension of the third mission or it is a novel function. This question also

formulated in the article of Rinaldi et al. (2018). In the case of two interviewees, I did not discuss the validity of the fourth mission. The legitimacy of the fourth mission as a separate activity was therefore only partially supported, with almost equal numbers of supporters and opposers of the argument. In the case of the top Hungarian universities surveyed, it can therefore be concluded that there is no uniform position on the fourth mission, and there is not necessarily an established and widespread tradition the fourfold strategic activity planning based on the literature. There is no established practical application of the fourth mission as a flagship of local economic proactive participation in the universities studied. The strengthening of the impact of regional/local economic development is not a separate mission but is usually included as a sub-mission of the third mission in the current Institutional Development Plans for 2021-2024 for the universities under study in my thesis. **Based on this, I reject the fifth thesis.**

Thesis 6: Aspects that contribute to the competitiveness of a university in a highly digitalization-driven global environment can be identified, and an updated demonstration model for fourth generation universities can be provided.

In defining the building blocks of a digitally mature, competitive university model that catalyzes local economies and societies, I identify three main sources of input: interviewees' experiences, the elements of digital maturity models, and successful university models found in the literature. There was a strict consensus during the in-depth interviews that digitalization is the future. The need for institutional level of digitalization in universities is essential for maintaining and developing long-term competitiveness, without this a modern and efficient university model is unsustainable. The position of a university on the higher education map depends on the right or wrong use of digitalization. Based on three main inputs, it can be concluded that we can define the model of competitive and digitally mature university, which catalyses the local economy and society (Figure 3).

Figure 3. The demonstrational model of a digitally mature, competitive university which catalyzes local economy and society



Source: own construction

The core elements of the model are of course the university missions, which include education, research, third and fourth missions. The inclusion of the first three missions is without question. The educational aspect is a critical element of university rankings and digital maturity models, it is embedded in the basic principles of innovation systems, and it is essential to the typology of university generations. It is present from the beginning, serving as a core activity from which all other university functions have evolved. Research activity has been more and more prominent, first generating results with low utilizability, to reaching the heights of solving local economic issues. Besides, it can be a source of additional income. In terms of third mission, we can also talk about generating additional income and serving as a basis of innovation. In the age of globalization and digitalization, the participation not only local networks, but in international consortiums, research projects are essential and can boost universities. The digitally mature university is also at the forefront of internationalization, with the practical significance of removing the constraints of physical presence and geographical proximity towards university participation, while giving relevant weight

to knowledge dissemination activities in virtual space. Parallel, the function of the fourth mission is getting more mature based on analyzing academic literature and its core elements are less alien to institutions and is necessary: environmental and financial sustainability can provide a stable operational framework, and by building on the strength of the local community projects the creation of a resilient network, which can mitigate the risks to university operations, especially in situations of crisis. The fourth mission is basically the integration of the fourth and fifth helix into the university operations and strategy. The *conceptual base* consists of all contemporary definitions, ideas, concepts, which cannot be avoided by a university with national and international aspirations. These partly relate to digitalization and the fourth generation of universities, e. g. smart campus, e-university, university 4.0, sustainability, community value creation. These can provide significant added value when successfully adapted to university operations. Obviously, it is not necessary to implement all popular concepts, as this would lead to a loss of focus, furthermore, not all the concepts mentioned can be applied in all university structures and regional circumstances. The *human capital base* is essential for success in the age of digitalization. The in-depth interviews provide clear evidence that by building a solid digital culture and effectively communicating in terms of digitalization's value creation can be a major factor in the willingness to adapt such solutions. It's crucial to have individuals or dedicated teams (e. g. helpdesk) to foster digitalization readiness and to train academics, researchers, staff and students. Many universities have sought to collaborate with digitalization pioneers and innovators, relying heavily on them in times of quick decisions. Theoretical and methodological preparedness is also a fundamental principle of a digitally mature university, as the knowledge of the benefits of digital solutions and confidence in them are essential to realizing real efficiency gains within the institution. All this must be backed up by an *advanced support infrastructure*, which acts as a spine of the whole service system. This should ensure appropriate IT structures, proper integration and communication between systems, fast wireless internet access and flexible, fast procurement processes for IT solutions. Ideally, the infrastructure can provide uninterrupted digital services, wifi, 5G network, with the right storage space, servers, system integration and IT tools. *Institutional processes* are marked on the edges of the model, hence has connections with all other building blocks. Within this element, organization of data security, funding and management tasks are also defined.

From the primer analysis, we can see that the universal accessibility of digitalized institutional processes and solutions was most often identified by my interviewees as an important characteristic of the digitally mature university, which is relatively self-evident. The related processes support transparency, traceability of workflows, more efficient use of resources, enhancement of interactions between students and the institution, and accessibility of academically relevant content for education and research. Data management is also an important element. In this respect, the ethical use of data and compliance with data protection principles are essential. Data-driven decision making, the collection of appropriate data and the consistent and conscious use of the university's data assets can also provide added value. These can all contribute to optimizing the functioning of the institution along the core university activities. Adaptivity also contributes to this. A modern university should be able to be an adaptive entity on the higher education map by constantly analyzing the available data and the environmental needs and trends. This requires a proactive approach and the capacity to innovate. Many of the building blocks mentioned above support the optimization of operational efficiency, hence it is inevitable that a digitally mature university will build on these benefits and adapt a results-oriented, performance-driven operating model. The *university embeddedness*, *international competitiveness* and *digital maturity* are desirable goals to achieve in regards of universities. Depending on the university's opportunities in its regional context, their relevance may vary. The final block of the model is the *digital society and economy*, which runs also on an edge of the model, as these affect almost every aspect of our lives (as seen in the concepts of Industry 4.0/5.0 and Society 5.0), especially in knowledge-based economies and developed regions.

Based on this, I accept the sixth hypothesis.

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