CORVINUS UNIVERSITY of BUDAPEST

Doctoral School of Business and Management

SUMMARY OF THESIS

Dóra Horváth

Digital transformation and business model innovation: in the manufacturing industry, energy- and financial sectors

Supervisors:

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Department of Management and Strategy

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I. Background of the research[1]

Digital transformation is affecting all industries nowadays, resulting in the transformation of business models as the boundaries of different industries blur. In my doctoral research, I aimed to explore the changes that can be expected in three strategically important industries, as well as the impact of digital transformation on the business model of companies operating in the studied industries. The examined areas are the following: manufacturing industry (Industry 4.0), energy sector and the financial sector.

I compiled my dissertation from my published publications. Details of the publications are shown below:

- **Dóra Horváth** – Zsolt Roland Szabó (2019): Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? TECHNOLOGICAL FORECASTING & SOCIAL CHANGE 146 pp. 119-132. (Ranking of the journal based on the Scimago database: Q1-A+)
- **Dóra Horváth** – Zsolt Roland Szabó (2018): Evolution of photovoltaic business models: overcoming the main barriers of distributed energy deployment. RENEWABLE & SUSTAINABLE ENERGY REVIEWS 90 pp. 623-635. (Ranking of the journal based on the Scimago database: Q1-A+)
- **Dóra Horváth** (2020): Examination of the effect of the fintech phenomenon on traditional commercial banks. BUDAPEST MANAGEMENT REVIEW 51:9 pp. 16-29. (Ranking of the journal based on the ranking system of the Hungarian Academy of Sciences, Section of Economics and Law: B)

The relevance of the choice of the research topic can be described along several dimensions. On the one hand, it is essential to emphasize the multitude of affected companies and their role in the national economy. The number of companies operating in the industries that are the subject of my research is on the order of thousands at the domestic level, and a significant part of GDP is provided by these actors. It is also important that the examined industries are expected to be completely transformed in the future in connection with digital transformation, and by

[1] „PREPARED WITH THE PROFESSIONAL SUPPORT OF THE DOCTORAL STUDENT SCHOLARSHIP PROGRAM OF THE CO-OPERATIVE DOCTORAL PROGRAM OF THE MINISTRY OF INNOVATION AND TECHNOLOGY FINANCED FROM THE NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION FUND”

properly addressing the emerging challenges, the stage of industry maturity can be extended or even fully renewed.

The areas that I focus on are based on my personal interest and my work in university research projects. The examined areas are the following:

- **Manufacturing industry – Industry 4.0:** The Fourth Industrial Revolution, which is currently taking place, sets a number of challenges for manufacturing companies from the technological, organizational and management points of view (Szabó, Horváth and Hortoványi, 2019). The emergence of innovative technologies is transforming traditional value chains and enabling the emergence of completely new business models that increasingly involve customers (Spath et al., 2013). Industry 4.0 can also lead to significant changes in existing business models, leaving room for new forms of value creation (Kagermann, Wahlster and Helbig, 2013; Ustundag and Cevikcan, 2017).
- **Energy sector (renewable energy sources):** Thanks to climate change programs, growing demand, and the emergence of new markets and technologies, the renewable energy industry has started to grow significantly globally in recent years (REN21, 2016). In terms of technologies, solar systems play a key role, and there are various business models on the market. Thanks to the innovative constructions, several barriers to the use of renewable energy sources can be mitigated. In addition to customers, the new concepts can also bring significant benefits to companies (e.g. traditional energy utilities) that can build on innovative business models to develop their market position and achieve a sustainable strategic advantage (Richter, 2012).
- **Financial sector:** The financial sector is undergoing significant changes nowadays. The effects of the global economic crisis, ever-changing customer needs, and the intensifying digital transformation are all inducing the transformation of the financial services market (Gelis, 2016; Toit and Burns, 2016). In the examined field, several new business models and market players have emerged in recent years, encouraging traditional commercial banks to renew their business models (Eisenegger and Künstle, 2011). It is therefore questionable how digital technologies will transform the business model of incumbents, what types of services will be dominant in the future, what obstacles commercial banks will face, and to what extent they will be threatened by large technology companies that are increasingly active in financial services (e.g. Google, Apple).

Overall, digital transformation and, in parallel with the emergence of new technologies, business model innovation play a key role in all three areas examined. Successful implementation of business model innovation can result in a number of long-term benefits for companies, such as improving financial performance, targeting new customers, markets, and increasing the model's sustainability.

II. Research questions

II.1. Manufacturing industry – Industry 4.0

The goal of the Industry 4.0 research was to get a comprehensive picture of how manufacturing companies are affected by Industry 4.0. The main research questions were the following:

- How do corporate executives interpret the concept of Industry 4.0?
- What factors can motivate companies to implement Industry 4.0 technologies?
- What barriers can be identified related to the introduction of Industry 4.0 technologies?
- How are Industry 4.0 technologies implemented?
- What changes are expected within the organizations? (e.g. processes, organizational structure etc.) How does Industry 4.0 affect the business models of companies?

II.2. Energy sector

Research in the energy sector - focusing on renewable energy sources and mainly on photovoltaic solutions - aimed to identify factors that may hinder the spread of renewable energy sources. In addition, globally identifiable solar business models have been examined in order to determine how each business model can help to reduce and eliminate emerging obstacles.

II.3. Financial sector

In the financial sector, several factors can be identified that encourage traditional commercial banks to renew their business model. These factors include changing customer needs, digital transformation, and the emergence of new types of players in the market. Nowadays, only a few scientific works are available in the field I have researched, so my goal was to contribute to the expansion of the Hungarian literature. During the research, I examined the following questions through 13 in-depth interviews:

- How do players in the financial sector interpret the concept of FinTech?
- What impact do new types of players have on traditional commercial banks?

- What changes are expected in the business model of traditional commercial banks?
- What regulatory and other challenges can be identified in relation to the digital transformation of players in the Hungarian financial sector?

III. Research methodologies

III.1. Manufacturing industry

To investigate the topic of Industry 4.0, the grounded theory methodology was applied. At the time of data collection, publications dealing mainly with technological features were available from the examined area, and management aspects were only explored to a limited extent. Consequently, in our research we did not want to test hypotheses, but in accordance with the methodological recommendations suggested in similar cases (e.g. Suddaby, 2006; Mitev, 2012) we sought to explore participants' interpretations of reality - in our case, the Industry 4.0 phenomenon - in order to gain a deeper understanding of the field and to map previously unidentified topics.

The purpose of grounded theory is to provide a comprehensive explanation of a given phenomenon. The methodology is usually applied to construct theories based on systematically collected and analysed data (Glaser and Strauss, 1967). According to Strauss and Corbin (1990), *"the procedures of grounded theory are designed to develop a well-integrated set of concepts that provide a thorough theoretical explanation of social phenomena under study".*

We conducted semi-structured interviews with top executives including CDOs and CEOs. We aimed to select companies that varied across five aspects: (1) role in Industry 4.0, (2) company size, (3) commitment, (4) industry sector, and (5) domestic or multinational enterprise. The interviews were conducted in two phases between July and October 2017 and between February and May 2018. The interviews lasted between 60 and 240 minutes and were all recorded and transcribed. The 26 interviews provided more than 360 pages of interview data. After the interviews, we wrote memos to record the most important learning points, experiences and ideas. The memos helped us to look at the data from a different perspective (Charmaz, 2003).

The data were analysed using grounded theory. After transcribing the interviews, the texts were coded using QSR NVivo software. The coding process is crucial, and its success defines the conclusiveness of the research (Gelencsér, 2003). We analysed the data using Strauss and Corbin's (1994) recommendations, building on three coding phases: open, axial and selective coding. Firstly, we applied open coding and examined the transcripts line-by-line to understand

the data and identify key terms. During the axial coding, we evaluated the categories identified to create links between them and their dimensions. This phase included organizing similar concepts into groups and then creating higher-level categories (Mitev, 2012). During the selective coding phase, we defined key categories and sub-categories after a systematic analysis. We ignored any categories that were not sufficiently related to the key categories and therefore could not be used in theory development. During each phase, we made notes to help us to determine the direction of the analysis and highlight the relationships.

The coding process provided nine main factors defining Industry 4.0, plus five main driving forces and five barriers to the application of new digital technologies in manufacturing processes. These were compared to previous studies to highlight items and results that had not previously been identified.

III.2. Energy sector

A systematic review of the literature is used to identify, evaluate, and interpret relevant research available on a particular research question, area, or phenomenon. Studies contributing to the systematic review can be considered as primary studies, while the systematic review itself is considered as a secondary study/source (Kitchenham, 2004). The systematic literature review differs from the traditional narrative review in that it provides a scientific, replicable, transparent process that aims to minimize bias through a comprehensive literature search of published and unpublished studies, and provides an audit trail of the entire process, the decisions, and conclusions of the researchers (Cook, Mulrow and Haynes, 1997).

In line with Webster and Watson (2002) and Brocke *et al.* (2009), we used five successive steps: (1) scope definition, (2) conceptualisation of topic, (3) literature search, (4) literature analysis and synthesis and (5) research agenda.

1. The scope of the study is to identify the main barriers of distributed energy deployment and to synthesize possible business model solutions that may help in overcoming the emerging obstacles.
2. In the topic conceptualisation phase, we found that scholars discussing different business models generally used the Business Model Canvas. The main framework of our research is therefore the BMC in the business model presentation section. Barrier and business model discussion parts of papers are usually characterized by geographical breakdown such as developing and industrialized countries, so regional structuring

became an essential unit in our research. This phase also helped to determine the main keywords for the literature search.

3. The literature review used the EBSCO database, as this includes the most important journals in the fields of business, management, and energy. In the first step, the search covered titles, abstracts and keywords of papers and contained combinations of the following keywords: “business model”, “energy”, “renewable”, “alternative”, “distributed”, “solar”, “photovoltaic”, “barrier”, “host-owned”, “third-party”, “community”. In the second step, citations were examined, to broaden the existing base and get a wider overview.
4. In the fourth phase, the collected articles were divided into different groups by topic. After closer examination, papers that were not closely related to our scope were excluded (e.g. papers about energy production modelling). Based on Palvia et al. (2004) and Cardenas et al. (2014), we then defined the following categories among the remaining papers: survey, interview, field study, case study, literature analysis, frameworks and conceptual model. Studies on barriers were also grouped by area: awareness and behavioural, financial and profitability, regulatory and institutional, technological and company resource barriers. Papers on existing business models were divided into three categories: host-owned, third-party-owned, and community-shared. There were possible overlaps between the categories as studies could cover two or more business models and/or barriers.
5. In the final step, the study classification was completed and the papers were categorized along with the specified criteria. We used the Business Model and Lean Canvases to visualize the benefits of the CS model compared to the alternatives and to help in the further development of the possible solutions.

III.3. Financial sector

To answer my research questions, I conducted 13 semi-structured interviews with top executives of FinTech companies (startup / scaleup), commercial banks, the founder of a FinTech accelerator, and a FinTech legal expert.

Prior to my research, I reviewed the types of interviews and considered the pros and cons of each technique. According to Brinkmann (2014), compared to structured interviews, semi-structured interviews are better able to exploit the knowledge-generating potential of dialogues because they provide much more room for maneuver for both the interviewee and the researcher. In my research, I decided to conduct semi-structured interviews in order to have the

opportunity to formulate new questions in addition to the topics I had defined in advance, as well as to develop a more informal dialogue.

Prior to the interviews, an interview guideline was prepared, which included the main topics of the interview. Based on Solt (1998) and Rubin and Rubin (2011) the interview plan does not define a mandatory order of questions - as it is in fact continuous and iterative - but contains the questions to which we would like to get answers. In each case, the interviews began with an exploration of the interviewee's previous experience and his or her current role in the company and the company's main activities. Following the interpretation of FinTech's definition and key elements, the major changes and challenges in the banking sector in recent years, banks 'strategic responses to FinTech innovations, the impact of the FinTech phenomenon on banks' operations and business models, and related regulatory issues were discussed.

The interviews usually lasted 60 minutes and interviewees were assured of anonymity to increase reliability. After literal typing, the interviews were coded using QSR NVivo software. 112-page excerpts and 815 NVivo references were generated from the interviews. As recommended by Patton (2002), data were triangulated by checking companies' websites and other available materials (e.g. annual reports, presentations, previous available interviews).

IV. Research results

I consider the following to be the most important results of my research:

- A detailed presentation of the theoretical background of business model innovation and digital transformation based on the processing of the related literature, and the connection of the two areas.
- Formulating recommendations for companies operating in strategically important sectors that can help them achieve their digital strategy goals, successfully implement business model innovation, and maintain and increase their overall competitiveness.
- Identification of problematic areas and challenges during digital transformation in each sector that can serve as a guide both for companies and regulators.

In the following chapters, I present the main results of my research in each area and the recommendations formulated to companies and regulators.

IV.1. Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities?

The research examined how companies interpret the concept of Industry 4.0, and the driving forces and main obstacles to introducing new, digital technologies under Industry 4.0. It also assessed the different level of effect of each of these factors on SMEs and MNEs.

1.1. In interpreting the Industry 4.0 concept, it was apparent that suppliers mostly highlighted the technology side, but users mainly focused on the management aspects of Industry 4.0. Companies with a dual role emphasized both factors equally. In line with our preliminary determination, interviewees also defined digitalization as the overarching issue, with Industry 4.0 as a sub-category. However, to drive successful adoption of Industry 4.0 technologies, companies need to create a common understanding of the change and develop innovative forms of training that help to develop employee competences in a rapidly changing environment.

1.2. The research identified six main driving forces and five barriers to the application of new digital technologies in manufacturing processes. Management expectations emerged as an important driving force behind Industry 4.0 adoption, but this is not usually discussed in the literature. Management aspiration to increase control and enable real-time performance measurement may be a significant driving force behind the introduction of Industry 4.0 technologies.

1.3. However, it was found that profitability concerns, human resource related barriers, organizational resistance, and a lack of willingness to cooperate among supply chain actors could significantly hinder the implementation of Industry 4.0 solutions.

1.4. MNEs and SMEs do not have equal opportunities in the area of Industry 4.0. MNEs have higher driving forces and lower barriers than SMEs across nearly every aspect. However, SMEs have advantage over MNEs, including their lower profitability expectations.

1.5. Besides technological and organizational changes, management functions will also be significantly transformed. *Objective setting and strategy creation* will require more steps and much more iteration in the future. To ensure *organizational function*, the proper design of structures and processes will become even more important in a rapidly changing environment. The third feature is *personal leadership*, which will also significantly change. Social support will be even more important for employees remaining in the company and organizations must take care of the social security of their staff. To support *control* as a management function, traceability will be improved, and it will be possible to track employee performance in real time.

IV.2. Evolution of photovoltaic business models: overcoming the main barriers of distributed energy deployment

Nowadays, as customer awareness grows, there is an increasing pressure on companies to incorporate environmental factors into their value propositions. In line with this, there is a growing demand from residential customers for the use of renewable energy sources, but there are several barriers that can hinder investment in these technologies. We applied the systematic literature review methodology to explore the barriers to the spread of renewable resources, the major globally identifiable photovoltaic business models, and how each model can help address the emerging barriers.

2.1. Regarding barriers, five main obstacles have been identified: financial and profitability, awareness and behavioural, regulatory and institutional, technological and company resource barriers.

2.2. In the case of photovoltaic business models, three main models (host-owned, third-party-owned, community-shared) have been identified globally, whose building blocks have been presented in detail along the Business Model Canvas.

2.3. Using Osterwalder and Pigneur's (2010) business model definition, we summarized each business model's most important value propositions, value creation, delivery and capture mechanisms. Reduced energy bills are common to all three models, but the degree of savings may be different for each.

2.4. Overall, it can be seen that the greatest benefits can be identified for the community-owned model. The biggest advantage of the CS model is the possible economies of scale. It also allows companies to use the latest technology solutions and take into account the territorial conditions to designate the most optimal solar installation areas with the highest potential efficiency and energy output (exploiting location benefits).

2.5. We also outlined how and to what extent the different business models can help eliminate the identified barriers. The literature review showed that the spread of renewables can be significantly restricted by regulatory and institutional issues, and the identified business models provide only a limited response to these problems. Policymakers therefore need to develop comprehensive regulatory and incentive schemes that provide multiple options to foster the spread of renewable energy sources.

2.6. Despite this, the community-owned model is a good opportunity for utilities to innovate their business model and increase their competitiveness. Successful implementation will require utilities to review their strategic assets and key competences (Wüstenhagen and Wuebker, 2011). They will have to invest in high productivity and high absorptive capacity to gain sustainable competitive advantage (Hortoványi, 2016).

2.7. Overall, based on the analyzed papers, it can be said that compared to the other two models, the community-shared model can generate benefits for both customers and investors and companies in many more areas. However, the successful operation of the concept requires the preparation of a complex technological infrastructure, as well as prepared corporate management that can handle the complexity of the model.

IV.3. Examination of the effect of the fintech phenomenon on traditional commercial banks

The intensifying digital transformation in the financial sector is leading to profound changes in customer relationships and the nature of products and services provided to customers. New entrants (Fintech and BigTech companies) are putting significant pressure on traditional financial institutions through innovative business models and the use of advanced technologies. As a result of these factors, the question arises as to how the role and business model of traditional commercial banks will evolve in the future and what strategies they will use to maintain their competitiveness.

In my research, I examined (1) the interpretation of the FinTech concept, (2) the impact of Fintech solutions and new types of players on traditional commercial banks and examined (3) regulatory challenges that may be barriers to innovation both for banks and FinTech companies.

3.1 Two approaches to the interpretation of the FinTech concept have been explored. In one sense, it is necessary to examine the content elements of FinTech, while in the other approach, the main question is what type of actors are behind the phenomenon. Based on the interviews, my own FinTech definition was also defined, which combines the two points of view: *By the term FinTech we mean, on the one hand, personalized, innovative technological solutions and business models that make financial services more efficient and widely available, and, on the other hand, those actors who create an innovative service or product in the financial sector or implement an operational innovation.*

3.2 It was also identified that the growing presence of BigTech companies in financial services is a major challenge for banks. However, the presence of BigTechs for traditional commercial banks can be assessed as positive in that in this way incumbent banks are also increasingly striving to develop innovative financial services.

3.3 In recent years, several domestic commercial banks have embarked on digitalization developments, but their resources are currently significantly tied up in regulatory compliance projects (e.g. PSD2). Regarding the services of traditional commercial banks, the focus is expected to shift towards higher value-added services in the future.

3.4 The use of innovative financial technologies provides an opportunity to target new customer segments, develop faster and more personalized banking services, or even improve internal banking processes. However, the integration of new solutions can be significantly

hampered by challenges related to IT systems. In addition, despite the digitalization initiatives of the top management of banks, it is expected that it will be a long time before the drive for innovation appears throughout the organization. Typically protracted, bureaucratic processes (e.g., sales, decision-making, administration) and organizational resistance, as with any change, are significant barriers to innovation.

3.5 It can thus be seen that banks need to develop their resilience and agility in order to keep up with new players in the financial sector. It is also an important direction that incumbent banks will have to build more and more on the opportunities offered by artificial intelligence in the future.

3.6 Regarding the relevant regulations, it was revealed that both banks and FinTech companies face several challenges. In the case of services provided by banks and FinTech companies, the principle of the same service and the same regulation does not currently apply. Banks are subject to several regulations that FinTech companies do not have to comply with, making banks' financial services more expensive.

3.7 In addition, the financial education of customers, which focuses on the development of financial awareness, data security knowledge and financial culture, should be given priority, thus supporting the development and promotion of the use of new technologies.

V. Conclusions and recommendations

Overall, business model innovation can have several positive consequences for all companies. However, it should be emphasized, that business model innovation alone is no longer sufficient, and digital transformation is emerging as a mandatory element. As far as possible, it is important that individual actors, and in particular incumbent companies, accomplish digital transformation as soon as possible by removing barriers, thereby renewing their value proposition and the overall business model. In the case, if these companies recognize the need for change too late or are unable to successfully address emerging challenges, their competitiveness is expected to decline, and they are likely to disappear over time and their place can be easily taken by other actors who are still growing but have greater flexibility and entrepreneurial willingness.

Based on the three areas examined in my dissertation, it has become clear that partnerships along the entire supply chain are becoming increasingly essential for the successful implementation of business model innovation enabled by digital technologies, where the parties can work together to create a mutually beneficial situation and thereby realize the benefits of business model innovation more quickly. In my research, I have identified that in business model innovation endeavors, it becomes increasingly important for incumbent actors to strive to create an innovative ecosystem where developments are implemented jointly with other companies. In this type of cooperation, vertical relationships (supplier-buyer) are the most typical, but nowadays there are more and more examples of diagonal alliances. In the case of diagonal alliances, companies start cooperating with each other, which are neither in a supplier-buyer relationship nor competing but operate in different industries. These types of cooperations provide an opportunity for incumbents (e.g. traditional utilities, commercial banks) to enter new markets to adapt to changing competitive conditions, thereby seeking to increase their customer base and create new revenue channels. However, despite the positive examples, the different types of partnerships at the domestic level are still significantly hindered by the lack of willingness to cooperate, which based on my research, can be linked mainly to the lack of trust.

In my dissertation, it was also identified that the spread of new technologies, and thus business model innovation, can in many cases be hindered by regulatory challenges. To overcome this, regulators should strive to create a regulatory environment for all sectors that creates similar conditions for the different actors and at the same time enables the faster spread of new types of technologies and services, which can be beneficial both for the economy and customers.

VI. Own publications in the topic

Journal articles

Dóra Horváth – Kerényi Ádám – Szabó Zsolt Roland (2021): The intended benefits and challenges of cooperation between FinTechs and commercial banks: managing structural and contextual ambidexterity. Acta Oeconomica (In Press)

Ranking of the journal based on the Scimago database: Q2

Dóra Horváth (2020): Examination of the effect of the fintech phenomenon on traditional commercial banks. *Budapest Management Review*. 51(9) 16-29 pp.

Ranking of the journal based on the ranking system of the Hungarian Academy of Sciences, Section of Economics and Law: B

Dóra Horváth (2019): Bank - FinTech cooperation - The key to renewal in the financial services market? *Budapest Management Review.* 50(3) 2-10 pp.

Ranking of the journal based on the ranking system of the Hungarian Academy of Sciences, Section of Economics and Law: B

Roland Zsolt Szabó – Dóra Horváth – Lilla Hortoványi (2019): Network learning in the era of Industry 4.0. *Economic Review*. 66(1) 72-94 pp.

Ranking of the journal based on the ranking system of the Hungarian Academy of Sciences, Section of Economics and Law: A

Dóra Horváth – Roland Zsolt Szabó (2019): Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting & Social Change.* 146 pp. 119-132.

Ranking of the journal based on the Scimago database: Q1-A+

Dóra Horváth - Szabó Zsolt Roland (2018): Evolution of photovoltaic business models: overcoming the main barriers of distributed energy deployment. *Renewable and Sustainable Energy Reviews.* 90: pp. 623-635.

Ranking of the journal based on the Scimago database: Q1-A+

Dóra Horváth – Péter Móricz - Szabó Zsolt Roland (2018): Business model innovation. *Budapest Management Review*. 49(6) pp. 2-12.

Ranking of the journal based on the ranking system of the Hungarian Academy of Sciences, Section of Economics and Law: B

Dóra Horváth - Szabó Zsolt Roland (2018): Evolution of photovoltaic business models. *Budapest Management Review*. 49(8-9). 2-16.

Ranking of the journal based on the ranking system of the Hungarian Academy of Sciences, Section of Economics and Law: B

Conference presentations and/or publications in conference proceedings

Dóra Horváth (2021): FinTech and blockchain based solutions in green finance. VII. Winter Conference Of Economics PhD Students And Researchers. Doktoranduszok Országos Szövetsége. Hungary 26 February 2021.

Dóra Horváth (2020): Examination of digitalization aspirations and future role of traditional commercial banks. VI. Winter Conference Of Economics PhD Students And Researchers. Doktoranduszok Országos Szövetsége. Gödöllő, Hungary 28 February 2020.

Dóra Horváth – Szabó Zsolt Roland (2019): FinTech Start-ups and Retail Banks: how to successfully integrate structural and contextual ambidexterity. EURAM Conference. Portugal, Lisbon. Paper ID: 1241

Dóra Horváth (2019): Examination of the cooperation between banks and FinTech startups. V. Winter Conference Of Economics PhD Students And Researchers. Gödöllő, Magyarország. 22 February 2019.

Dóra Horváth – Szabó Zsolt Roland (2018): The role of network learning in addressing the barriers of Industry 4.0. Intelligent Specialization to Promote Innovation and Competitiveness Conference. Corvinus University of Budapest, Székesfehérvár Campus, 27 November 2018.

Dóra Horváth – Roland Zsolt Szabó (2018): Management aspects of Industry 4.0. John von Neumann University- III. Business and Management Scientific Conference. Kecskemét, Hungary 27-September 2018.

Dóra Horváth – Réka Sára Csontos – Roland Zsolt Szabó (2018): Management aspects of smart manufacturing In: Proceedings of the 22nd World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI Orlando, Florida pp.168-172**.**

Dóra Horváth - Réka Sára Csontos – Roland Zsolt Szabó (2018): Management aspects of Industry 4.0: Empirical results. Innovation, Integration and Mobility: The perspectives of sustainable employment in Europe Conference, Corvinus University of Budapest, Székesfehérvár Campus, 28-29 March 2018.

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