

SCIENTIFIC REPORT (Jan-Dec 2021)

Project PN-III-P1-1.1-TE-2019-1773

Title: „The fourth industrial revolution: overcoming the challenges of implementing Industry 4.0 technologies at manufacturing companies in Central-Eastern Europe”

Project director: Szász Levente

Project members: Rácz Béla-Gergely, Benedek Botond, Nagy Bálint Zsolt, Csiki Ottó

1. Stage summary

For the period of January – December 2021, within the project entitled “The fourth industrial revolution: overcoming the challenges of implementing Industry 4.0 technologies at manufacturing companies in Central-Eastern Europe” an empiric study has been conducted based on case studies, in accordance with the research plan for the calendar year 2021. In this stage we have contacted the manufacturing units of certain companies in the automobile industry and based on their acceptance we conducted the case studies based on the following main data collection methods: (1) interviews with managers responsible for Industry 4.0 projects, and other employees involved in these projects, (2) working visits in these companies (direct observation), (3) processing of secondary data about these companies and projects.

The interview protocol has been built on the analysis of academic literature elaborated in the first stage of the project. Therefore, the interview focused on the following aspects, each aspect comprising multiple open-ended questions:




	Before implementation (B)	Pressure triggering the introduction of the I4.0 project (internal and/or external)
		Role of I4.0 in the strategy
		Financial budget for 4.0 projects
		Support for I4.0 projects (internal and/or external)
		Involvement of the employees in the planning
		Previous experience in digitalization and robotics
	During implementation (D)	Steps of the I4.0 projects
		Responsible for the I4.0 project
		Involvement of employees in the implementation phase
		Knowledge used during implementation (internal and/or external)
	After implementation (A)	Result of the I4.0 project (success / failure)
		Unexpected positive and/or negative effects
		Methods of feedback collection
		Lessons learned
		The lasting effect of the I4.0 project on human resources

Figure 1.: Main investigated domains during the case studies

Due to the pandemic until now we managed to include six Industry 4.0 projects in the case studies, obtained from three companies in the Romanian and Hungarian automotive industry. To cover the whole value chain, these three companies include: (1) a OEM (original manufacturer) from Hungary (12 000 employees), (2) a “tier 1” supplier (direct supplier) from Romania (3200 employees), and (3) a “tier 2” supplier (indirect supplier) from Romania (200 employees). During these case studies we conducted a total number of 8 interviews with a mean duration of 1 hour and 20 minutes each, and 3 working visits at the facilities of the investigated manufacturing units. The analyzed six projects during the case studies can be found in the table below.

Place in the supply chain / unit	I4.0 project studied
OEM	(1) Preventive maintenance system
OEM	(2) Warehouse automation
Tier 1 supplier	(3) Replacing paperwork with digital technology
Tier 1 supplier	(4) Procurement automation
Tier 2 supplier	(5) Maintenance system
Tier 2 supplier	(6) Procurement automation

Figure 2. Description of the 6 case studies conducted within the automotive industry companies

In these case studies, besides the domains described in Figure 1, we also identified the success factors and the implementational barriers of Industry 4.0 projects. The results of these analyses are summarized in the table below.

Place in the supply chain / unit	I4.0 project	Result	Proper identification of needs	Support of the top management	Commitment of the project team	Dedicated responsible	Process is adapted to the new technology	Employee involvement	Overcoming cultural differences	Overcoming technical barriers	Employee resistance	Length of the implementation in time
OEM	(1) Preventive maintenance system	Successful	X	X	X	X	X	X				
OEM	(2) Warehouse automation	Unsuccessful	X		X	X	X	X				
Tier 1 supplier	(1) Replacing paperwork with digital technology	Successful	X						X			
Tier 1 supplier	(2) Procurement automation	Successful						X		X		
Tier 2 supplier	(1) Maintenance system	Successful		X	X	X		X			X	X
Tier 2 supplier	(2) Procurement automation	Successful		X	X	X		X			X	X

Figure 3. Success factors and implementational barriers of Industry 4.0 projects

2. Scientific description of the stage's results and the dissemination method

For the second stage of the initial project we proposed 5 case studies, an article indexed by the Web of Science (WoS) submitted for publication, and 4 conference participations. All these indicators were fulfilled or even exceeded, as follows. Even in the difficult context created by the coronavirus pandemic, until the end of this year we conducted 6 case studies, each of them focusing

on a certain Industry 4.0 technology and their implementation within a company from Central and Eastern Europe (Romania, Hungary). At the same time we managed to identify and analyze quantitative data based on an international research through the means of a questionnaire. The processing of this data was supplemental regarding the planned activities for the second stage. In addition, the results were already published in a red zone journal (Q1 according to AIS in the domain of Operations Research and Management Science). The article focuses on the automotive industry but has a broader subject, addressing the sustainable management of the technologies within these companies:

- **Szász, L., Csíki, O., & Rácz, B. G.** (2021). Sustainability management in the global automotive industry: a theoretical model and survey study. *International Journal of Production Economics*, Vol. 235, 108085 (attached to the report).

We mention that in the same time another article was finished and sent to a journal indexed by WoS in the Q1 quartile. The article is currently in the first round of review, being sent to specialists by the editor of the *International Journal of Production Economics*.

Furthermore, the intermediate results of the project were presented at international scientific conferences and the feedback received at these conferences was included in the research process with the purpose of enhancing the qualitative level of the research:

- Krisztina Demeter, **Levente Szász, Béla-Gergely Rácz** (2021), *Manufacturing technologies in the Industry 4.0 era: technology bundles and performance implications*, 28th EurOMA Conference “Managing the “new normal”: The future of Operations and Supply Chain Management in unprecedented times”, July 5-7, 2021, online, University of Sussex.
- **Csíki, O., Szász, L.** (2021). *The impact of industry 4.0 technologies on the human resources of multinational companies in the automotive sector*, 5th International Conference on Economics and Business Management, Nov 12, 2021, Babeş-Bolyai University, Cluj-Napoca, Romania.

The individuals marked with bold have participated at those particular conferences, amounting a total of 4 conference participations, in compliance with this stage’s plan.

Based on the aforementioned information all the activities proposed for Stage 2 of the research have been fulfilled, as follows: (1) Activity 2.1: Selecting and contacting companies, (b) Activity 2.2: Collecting data and interviews, (c) Activity 2.3: Creating the database containing the data collected during the case studies, (d) Activity 2.4: Analyzing data of the studies

Project director,

Levente SZÁSZ, PhD, full professor