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International Scientific Conference on the Occasion of the Hungarian Science Festival

Sopron, 2021. november 4.
4 November 2021, Sopron

PANDÉMIA – FENNTARTHATÓ GAZDÁLKODÁS – KÖRNYEZETTUDATOSSÁG / PANDEMIC – SUSTAINABLE MANAGEMENT – ENVIRONMENTAL AWARENESS

KONFERENCIAKÖTET / Conference Proceedings

Szerkesztette / Edited by: OBÁDOVICS Csilla, RESPERGER Richárd, SZÉLES Zsuzsanna

Nemzetközi tudományos konferencia a Magyar Tudomány Ünnepe alkalmából /
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Conference Proceedings

(LEKTORÁLT TANULMÁNYOK / PEER-REVIEWED STUDIES)

Szerkesztette / Edited by**:**
OBÁDOVICS Csilla, RESPERGER Richárd, SZÉLES Zsuzsanna

SOPRONI EGYETEM KIADÓ /

UNIVERSITY OF SOPRON PRESS

SOPRON, 2022

Nemzetközi tudományos konferencia a Magyar Tudomány Ünnepe alkalmából /
International Scientific Conference on the Occasion of the Hungarian Science Festival

Sopron, 2021. november 4. / 4 November 2021, Sopron

Mottó / *Motto:* **„Tudomány: iránytű az élhető jövőhöz”** / „Science: a Compass For a Livable Future”

Szervező / *Organizer:* **A Soproni Felsőoktatásért Alapítvány** / For the Higher Education at Sopron Foundation

A konferencia védnöke / Patron of the Conference:
Innovációs és Technológiai Minisztérium / Ministry for Innovation and Technology

Felelős kiadó / Executive Publisher**: Prof. Dr. FÁBIÁN Attila**
a Soproni Egyetem rektora / Rector of the University of Sopron

Szerkesztette / Edited by:
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Tördelőszerkesztő / Layout Editor: TAKÁCS Eszter

Borítóterv / Cover Plan: ZSIDY Emese

ISBN 978-963-334-411-8 (pdf)

DOI: 10.35511/978-963-334-411-8

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Sopron, 2022 – Minden jog fenntartva.

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TARTALOMJEGYZÉK / CONTENTS

Plenáris előadások
Plenary Lectures

Sustainability and Higher Education from a Three-dimensional Perspective
Dr. Rita LUKÁCS *10*

A jövő vezetőinek társadalmi felelősségvállalási attitűd vizsgálata
Examination of Future Leaders' Social Responsibility Attitude
Dr. NÉMETH Patrícia – KASZA Lajos *20*

1. szekció: Versenyképesség és fenntartható gazdálkodás
Session 1: Competitiveness and Sustainable Management

Challenges and Chances for the Social and Economic Development of a Russian Border Region (the Case of the Samara Region)
Prof. Dr. Galina KHMELEVA – Dr. Marina KURNIKOVA *33*

Soy Supply and Organic Requirements for more Authenticity
Dr. Caspar VON DER CRONE – Prof. Dr. Nicole MAU *41*

The Impact of Artificial Intelligence on Leadership in the Corona Crisis
Thomas SOLDERITS *51*

Environmental Sustainability as a Strategic Reason for the Investment in Industry 4.0: The Difference between SMEs and Large Companies
Mohamed EL MERROUN *63*

Supply Chain Resilience: Lessons Learned during the COVID-19 Outbreak and its Implications for the Future
Johannes LITZENBURGER – Prof. Dr. Nicole MAU – Prof. Dr. Markus MAU *68*

2. szekció: Turizmus, marketing
Session 2: Tourism, Marketing

Felelős márkakommunikáció a koronavírus idején
Responsible Brand Communication during the Coronavirus Pandemic Situation
Dr. habil. PAPP-VÁRY Árpád – Dr. LUKÁCS Rita *74*

A digitális transzformáció megjelenése a divatipari értékesítési gyakorlatokban
The Appearance of the Digital Transformation in Sales Practices of the Fashion Industry
VIZI Noémi *84*

A turizmus fenntarthatósága a pandémia után
Sustainability of Tourism after the Pandemic
Dr. JANDALA Csilla – GÁL Pál Zoltán – Dr. BÖRÖCZ Lajos – DARÁZS Fanni *96*

Az „Alföld Slow térség" versenyképességének vizsgálata
Analysis of the Competitiveness of the „Alföld Slow Region"
SZŐKE Tünde Mónika *107*

Aktív lovasturizmus Magyarországon és a Fertő-tájon
Active Equestrian Tourism in Hungary and at Fertő Landscape
Prof. Dr. OBÁDOVICS Csilla *119*

3. szekció: Fenntarthatóság, környezettudatosság
Session 3: Sustainability, Environmental Awareness

A vállalkozói attitűd vizsgálata bibliometriai módszer segítségével
Examining the Entrepreneurial Attitude Composite Word using Bibliometrics
Dr. FEHÉR Helga – Dr. KOZMA Dorottya Edina *132*

A fenntarthatóság környezeti elemeinek megjelenése a hazai nagyvállalatok gyakorlatában
The Emergence of Environmental Elements of Sustainability in the Practice of Large Hungarian Companies
Dr. KOZMA Dorottya Edina – BOSNYÁK-SIMON Nikolett *149*

Járvány, környezettudatosság, fenntarthatóság – mémelméleti áttekintéssel
Pandemic, Environmental Awareness, Sustainability – with a Meme Theory Overview
Dr. DŐRY István *165*

A home office és a szervezeti kultúra egymásra gyakorolt hatásai a magyarországi munltinacionális vállalatoknál – Kutatási tervezet
Interactions between Home Office and Organizational Culture at Hungarian Multinational Companies – Research Project
IONESCU Astrid *168*

A könyvvizsgálók személyisége
The Personality of a Good Auditor
Dr. NEDELKA Erzsébet – Dr. HEGEDŰS Mihály *177*

A pandémia hatásainak kommunikációja a Budapesti Értéktőzsdén jegyzett vállalatoknál
Communication of the Effects of the Pandemic by Companies Listed on the Budapest Stock Exchange
Dr. BARTÓK István János *185*

4. szekció: Vállalati döntések a koronavírus-járvány idején
Session 4: Corporate Decisions During the Coronavirus Pandemic

Corporate Strategy in a Disruptive Economic Environment – Foremost A Strategic Alignment Topic?
Thorsten SCHMUDE *193*

Sustainability and EU Law. Latest Tendencies in the Field of Public Participation in Environmental Matters
Dr. Ágnes VÁRADI *207*

How to Recover the Labor Force of the Tourism Industry after the Global Health Crisis? – A Study in Vietnam
Thị Phương Thảo HOÀNG *215*

The Impact of the Corona Pandemic on the Project Management Process in Jordan
Noor Ahmad Mahmood ALKHUDIERAT *228*

5. szekció: Versenyképesség és fenntartható gazdálkodás
Session 5: Competitiveness and Sustainable Management

Is Urban Farming the Green Economy of the Future?! Investigation of the Sustainable Management of a Hungarian Startup Enterprise
Zsuzsanna VARGA – Dr. habil. Etelka KATITS – Katinka MAGYARI – Dr. Ildikó PALÁNYI – Dr. Éva SZALKA *237*

Szakirodalmi áttekintés az amazóniai indián chagrák – őshonos agrárerdészeti rendszerek – ökológiai, társadalmi és gazdasági jelentőségéről
The Role of Indigenous Agroforestry Systems in the Conservation of the Amazon
LENTI Attila 252

Smart Development with Digital Intelligent Cities in Cross-Border Regions
Tamás GYULAI – Prof. univ. Dr. Mariana NAGY – Raluca CIBU-BUZAC 264

Explaining Correlations of Digital Transformation and Adaptiveness in B2B Sales in Relation to Resilience
Günther MAIER 278

Investor Strategy Decisions in Case of Project Implementation
Attila LEGOZA 289

Lean Thinking Strategy
Peter IMRICSKO 296

The Impact of Working Capital Management on Firm Profitability: Evidence from Pakistan
Ali Akbar SOHAIL – Abdul QUDDUS 303

6. szekció: Fenntarthatóság, környezettudatosság – marketing
Session 6: Sustainability, Environmental Awareness – Marketing

Társadalmi hatások és MI!
Social Impacts and AI!
Dr. KŐKUTI Tamás 312

A koronavírus járvány hatása a globális klímaváltozásra
Impact of the Coronavirus Epidemic on Global Climate Change
NEUMANNÉ VIRÁG Ildikó – Dr. KOZMA Dorottya Edina –
Dr. MOLNÁRNÉ dr. BARNA Katalin 325

A márkaélmény és a tartalommarketing kapcsolata
The Relationship between Brand Experience and Content Marketing
HAJDU Gergő 341

7. szekció: Fenntartható pénzügyek
Session 7: Sustainable Finances

A hazai biztosítási piac a számok tükrében: díjbevétel, szerződésszám és foglalkoztatottak
The Domestic Insurance Market in the Light of the Figures: Premium Income, Contract Number and Employees
EKE Zsolt 359

A pandémia hatásainak módszertani kérdései a nyugdíjbiztonságra
The Methodological Issues of the Effects of the Pandemic on Pension Security
SZABÓ Zsolt Mihály 366

A sikeres fordulatkezelés záloga – a pénzügyi turnaround controlling rendszer alkalmzása a magyar cégvilágban
Connecting the Turnaround to Success – the Application of Financial Turnarond Controlling in the Hungarian Business World
Dr. habil. KATITS Etelka – MAGYARI Katinka – VARGA Zsuzsanna 379

Gördülékeny tervezésű fenntartható vagyonkezelés hosszú- és rövid távú empirikus ütköztető analízise, a legfrissebb kutatási eredmények függvényében
Rolling Planned Sustainable Asset Management, Long-term and Short-term Empirical Collision Analysis Depending on the Latest Research Results
Dr. CZIRÁKI Gábor.....395

8. szekció: Versenyképesség – munkaerőpiac
Session 8: Competitiveness – Labour Market

Agrár vállalkozások jövedelmezőségét befolyásoló tényezők és az innováció további kutatási lehetőségei
Factors Affecting the Profitability of Agricultural Enterprises and Further Research Opportunities for Onnovation
ANGYAL Viktória – VAJAI Balázs *407*

A hatékony ellátási lánc megvalósulásához szükséges kompetenciák hallgatói és munkaerőpiaci szemszögből
Competencies Required for the Implementation of an Efficient Supply Chain from the Perspectives of Students and the Labour Market
MUNKÁCSI Adrienn *420*

Versenyképesség madártávlatból: globális kihívások és EU-válaszok a XXI. században
Competitiveness from a Bird's Eye View: Global Challenges and EU Responses in the 21st Century
Dr. SZEMLÉR Tamás *442*

Hajlékonyfalú csomagolóanyagok struktúrájának elemzése flexográfiai matt lakkozási technológia esetén
Analysis of the Matt Lacquering Structure of Flexible-walled Packaging Materials in the Case of Flexographic Printing Technology
VÁRZA Ferenc – Dr. habil. HORVÁTH Csaba – JOÓBNÉ dr. PREKLET Edina *448*

9. szekció: Poszter-előadások
Session 9: Poster Presentations

Egészségügyi innovációk Magyarországon – startup aspektus
Healthcare Innovations in Hungary – from the Point of View of Startups
VITÉZ-DURGULA Judit *455*

Modeling the Customs and Logistics Framework of International Integration Processes
Prof. Dr. Roman FEDORENKO *471*

A faiparban foglalkoztatottak motivációjának fenntartása a pandémia árnyékában
How to Keep Maintaining the Motivation of People Working in Wood Industry during Coronavirus
NÉMETH Miklós – Dr. TAKÁTS Alexandra *476*

DOI: 10.35511/978-963-334-411-8_s1_El_Merroun

Environmental Sustainability as a Strategic Reason for the Investment in Industry 4.0: The Difference between SMEs and Large Companies

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Abstract
The decline of environmental sustainability is undoubtedly one of the biggest problems, if not the most severe one that threatens our planet. In the past decade, to overcome this global issue, industries were regulated, events and conferences were organized, objectives have been made, but the high cost of green practices and the massive increase rate of production made all these efforts insufficient, in the other hand, the fourth industrial revolution could potentially provide suitable solutions to achieve high environmental sustainability. The question that could be raised herein is; are the firms planning to align Industry 4.0 with environmental sustainability? The present research contributes to the environmental sustainability literature by studying the vision that companies in Europe have on Industry 4.0 and the main objectives that they want to achieve from this transformation. Furthermore, relying on a statistical study, the research identifies the differences between large companies and SMEs in Europe, when it comes to the incorporation of environmental sustainability objectives within their Industry 4.0 strategy.

Keywords: Environmental sustainability, Industry 4.0, Large companies, SMEs
JEL Codes: Q56, O14

1. Introduction

The Industry 4.0 remarking the new era of industrial production, the roots of Industry 4.0 are driven from the time when the manufacturing process was depend totally on human and animal physical force, the transition from this situation into machinery, new chemical factories and iron manufacturing processes, development of waterpower, maximizing the use of steam power, and finally the development of machine tools is considered as the first industrial revolution. The iron and textile sectors presented crucial roles in the first industrial revolution as well (Mohajan, 2019). The second revolution was shaped due to the invention of many new technologies, such as the internal combustion engines, electricity, the chemical industries, alloys, petroleum, and other electrical communication and chemicals technologies (the telegraph, radio, and telephone), and running water with indoor plumbing (Gordon, n.d.). Followed by the third revolution which is best seen as the combination of digital manufacturing and personal manufacturing: the industrialization of the Maker Movement, the concept "third industrial revolution" refers to a comprehensive upheaval, which was already referred to by other authors as an "efficiency revolution", "green capitalism" and a fundamental transformation towards "green industrial revolution" (McKinsey, 2011). The most important question that could be raised here is why even if the third industrial revolution was a promising movement to help the organizations to adopt green practices and reduce the fingerprints on the environment; the results seem to be the exact opposite? In the last couple of decades, industrial activities have harmed the environment like never before, according to Donovan Alexander in 2020, human activities are the main cause of hundreds of extinctions in the last two centuries, versus the millions of years that natural extinction occurred. As we progress through the 21st century, human activities have changed the world in unprecedented ways. Industry 4.0 can play a major

role to balance the cost/reward of the engagement in environmental sustainability if it is presented in the "right way". Transforming the traditional factories into a smart production chain and business processes and deploying smarter devices and machines may present numerous advantages such as manufacturing productivity, resource efficiency, and waste reduction (Tortorella–Fettermann, 2018). On the other hand, the development of smart factories and automation will potentially results a high increase rate of production that would be associated with a high level of energy consumption and resource as well as elevated gas emission and pollution (Beier et al., 2017; Liu–Bae, 2018). What can be concluded is that Industry 4.0 is a powerful tool that might support organizations to meet global environmental restrictions without missing the internal financial objectives, to achieve that, several papers and studies have to be made to highlight the potentials of industry 4.0 in this context. Therefore, this article provides quantitative research to examine the current perspectives and aspirations of companies In Europe that they expect from Industry 4.0, also the paper examines the correlation between the size of companies and the expected outcome of the investment in Industry 4.0.

2. Methodology

Is it clear that the Industry 4.0 can potentially provide high technological facilities that can contribute to achieve environmental sustainability, the study aims to assess the differences between SMEs and large enterprises regarding the underlying reasons when investing in industry 4.0 in Europe. The main objective is to find if there is more tendency to invest in industry 4.0 to achieve environmental sustainability depending on the size of companies. In order to achieve the research objective, the following methodology has been adopted:

Step 1: Questionnaire preparation

At the beginning of the questionnaire, the participants were asked if they are users of industry 4.0, the next question is always according to the previous answer, for example, if they answer NO, the next question is, do you think of investing in industry 4.0 in the future? If the answer is still no, the survey ends, if it is yes, then they will be asked about the challenges and the reasons why they want to invest in it (the part that we are interested in). to study the objectives that they would achieve from this investment, the underlying reasons questions were operationalized using 6-point Likert scales, from 0 (not interested in this objective) to 5 (one of the main reasons of the investment).

The participants were not asked personal questions or questions about their company, since all the relevant information are available in the database that will be explained in detail in the next step, the only mandatory question is to provide their email to correspond it with the related person in the database. The link to the questionnaire can be found at the end of the article.

Step 2: Emails and raw data collection

The data collection process was made with the help of freelancers through the website Fiverr, the method used to collect the emails and the requested information is called lead generation, in which the data is collected from LinkedIn or the official website of the companies. The criteria that have been followed for the collection of emails are that the Location of the companies should be UK – Germany – France, and Netherlands. These countries have been chosen for the fact that they are considered leaders in Europe and first investors in industry 4.0. The Email owner should occupy one of the following positions: Production manager – Plant manager – Supply chain manager – Logistics manager – IT agent – CEO (only for SMEs). The data contained the following information: The company name – Location – Industry – Name of the email owner – Position – Email – LinkedIn – Employees number. The sheet contained more than 1000 emails.

Step 3: Mails sending

Since there is a huge amount of data, the mails sending was automated relying on a website called Integromat, in which you can enter an algorithm (scenario) that will be executed by the website. The variables that were changing in each mail are the name of the contact and his position. The mails were sent between the 1st and 25 of July 2021.

Step 4: Data collection and analysis

The data were collected via google form in which we received 206 answers with a response rate of 18%, which can be seen as low, but taking into consideration that none of the participants were contacted prior to the survey, the response rate is acceptable. The data analysis and interpretation were made through SPSS.

3. Results

From the 206 answers, 117 considered as large companies 57% and 89 are SMEs 43%. The responders' positions are 47% Supply chain managers, 16% IT managers, 12% Logistics managers, 11% CEO, 10% plant managers and 4% others. For the company's location: 38% Netherlands, 29% Germany, 14% UK and 19% France.

The results show a high interest in investing in the industry 4.0 for large companies compared to SMEs as the pie charts below show larger.

In our research, we are studying the differences between SMEs and large companies when it comes to the objectives of investment in the Industry 4.0. If the responsible of a company answer with yes to the question "Do you consider your company as a user of Industry 4.0? "Or the question "Does your company have any plan to invest in Industry 4.0 in the future?" (If the answer of the first question is no), then the participant will get a set of choices that represent the potential reasons to invest in the I4.0, the participant should rate each answer from 0 to 5. The list contains 13 choices, only 5 answers are related to environmental sustainability, these answers were distributed randomly with the other choices, for example: Improve reverse logistics (reproduction of used goods, return of packaging…). Then the mean of the 5 questions was calculated to get one ordinal variable (dependent variable) that we will base our study on.
According to Bruce Weaver and Karl L. Wuensch, correlation won't answer the researcher's question when they want to examine the differences between two groups in a given situation, in our case, we want to examine if the size of the company affects the underlying purposes to invest in the industry 4.0. The mean comparison is the most suitable method in this situation; we have chosen the T test to analyze our results.

Group Statistics

	Size	N	Mean	Std. Deviation	Std. Error Mean
Sustainability	**SMEs**	63	2,4032	0,60614	0,07637
	Large companies	82	3,3232	0,87819	0,09698

We can see that the valid answers for SMEs are 63 and 82 for large companies, these are the companies that consider themselves as users of Industry 4.0 or they are planning to invest in it in the future. We can already notice that the "mean" of the large companies is larger than the SMEs with 0.92 which is significant, and there is a high difference in the standard deviation, which means that the variations of our two groups might be different. Let's look at our T test:

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Sustainability	Equal variances assumed	11,380	,001	-7,112	143	,000	-,92000	,12935	-1,17569	-,66430
	Equal variances not assumed			-7,453	141,512	,000	-,92000	,12344	-1,16402	-,67597

First, we must verify our null hypothesis which is the variances of the two groups are approximately equal, we can verify that with Leven's test equality of variances, we set our level of significance to 0.05. As we can see in the table, the significance level is lower than 0.05, which means that we will reject the null hypothesis and assume that the variances are not equal. Relying on these results, the second line of the table "Equal variance not assumed" will be taken into consideration.

According to our tables, we can see that there is a significant difference (t (141.512) = -7.453, p ≤0.05) in the score with the mean score for large companies (M = 3.3232 / SD= 0.87819) was higher than SMEs (M = 2.4032 / SD = 0.60614).

The magnitude of the difference in the means (Mean difference = 0.92, 95% CI: -1.16402 to -0.67597) was significant. Hence, we can accept our hypothesis that the large companies include environmental sustainability goals within their strategy when it comes to investing in Industry 4.0.

4. Conclusion

Our study reveals several results regarding the investment in Industry 4.0 in Europe, the first thing is that, unlike the theory and the advertisements, companies are still facing multiple challenges to include new technologies in their strategy, especially for SMEs with a rate of 36%. Furthermore, most of the SMEs who are investing or interested to invest in Industry 4.0 have no interest to achieve any environmental sustainability, the main questions that could be raised; are this technological revolution will create a bigger gap between the large companies and SMEs? Can the SMEs keep up with the new EU regulations regarding their fingerprints toward the environment?

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Appendix

Questionnaire link: https://forms.gle/qTgbtQwxBuomSwzGA