INDUSTRIAL REVOLUTION 4.0 AND ITS IMPACT ON THE PREPARATION OF THE WORKFORCE BY UNIVERSITIES IN INDONESIA

Muhammad Amin[1], Jihan[2], Lilik Sulistyo[3], Najamuddin Petta Solong[4], Herman Elfridus Seran[5]
[1]Universitas Jambi
[2]UIN Datokarama Palu
[3]Universitas Islam Nahdlatul Ulama Jepara
[4]IAIN Sultan Amai Gorontalo
[5]Universitas Nusa Cendana
Email: muhammadaminunja@gmail.com

Abstract

Technological developments cause very significant changes in how goods and services are produced. This then causes changes in the ability needs of the community in the world of work. Higher education, as one of the educational institutions before plunging into the world of work, has an essential role in preparing this workforce. This study aims to see how the industrial revolution 4.0 affects the preparation of the workforce in Indonesia by universities. This research will be carried out using a qualitative approach. The data used in this research comes from the results of previous research and studies which still have relevance to the content of this research. This research finds that there is a debate some experts think that the total number of workers in the world will decrease, while others believe the number will remain the same. However, there is agreement that this will affect the education system, where the type of learning must change according to the needs of skills and knowledge that exist in the future so that people in the future can work according to the needs of the industry at that time.

Keywords: *Industrial Revolution 4.0, Education, Technology.*

A. INTRODUCTION

The historical development of the industrial revolution starts from industry 1.0, 2.0, 3.0 to the industrial revolution 4.0. These changes are environmental changes faced by the real industry. The first developments in industrial revolution 1.0 were marked by the industrial revolution, which made the production process mechanized to create efficiency and effectiveness in human activities (Vinitha et al., 2020). The subsequent development of the industrial revolution 2.0, which encouraged mass production and standardization of quality, the next industrial revolution 3.0 was marked by mass adjustments and production flexibility based on automation and robots. And now, the industrial world is facing the industrial revolution 4.0, which departs from a German government project to promote manufacturing computerization by utilizing cyber, physical, and manufacturing collaboration (Wibowo & Munadi, 2020).

The impact of significant changes in industry 4.0 has been researched and studied by the Mckinsey Global Institute with the conclusion: Industry 4.0 will have a broad effect on the industrial world due to the use of robotics and machines, which have an overall impact on the labor sector in particular. However, on the contrary, positive benefits will be obtained in this industrial revolution process because the digitalization and robotics processes will increase work efficiency and effectiveness (Bittencourt et al., 2021). By Mcckensey, it is predicted that the industrial revolution 4.0 will eliminate 800 million jobs currently in the world. With robots taking over jobs and fully utilizing the digitalization process until 2030, the industrial

revolution process could become a threat in Indonesia. Indonesia currently has a large workforce but also has a high unemployment rate. The importance of understanding the technological environment has turned into a demand to prepare for it, and almost all existing professions are directly or indirectly affected (Szabó-Szentgróti et al., 2021).

This fourth industrial revolution (RI-4) corresponds to the use of robots –programmable machines– and artificial intelligence (AI) –machines that learn– in production, which affects the existence of human, repetitive or creative work. This, in turn, affects the organization of businesses, they are directly or indirectly related to this revolution since new forms of organization of work, distribution, and exchange are required (Kineber et al., 2022).

The RI-4 has an unavoidable impact on business schools in different contents that will be analyzed in this document: personnel management, employability, and pedagogy. Others barely mentioned –they constitute a broad field of research–, such as the organization of companies and businesses, logistics and similar topics, and their curricular effect (Matthews et al., 2021). To address these issues, first, an outline of the road traveled to reach the RI-4 is presented, then the effects on employment and then on education, closing with conclusions.

B. METHOD

This research will be carried out using a descriptive qualitative approach. The data used in this study were obtained from various previous studies and studies that still have relevance to the content of this study. After the research data has been collected, the next step is the data will be processed by the researcher so that the results of this research can be found.

C. RESULT AND DISCUSSION

1. Higher Production With Less Employment: Historical Trend

The relationship can be traced back to the first Industrial Revolution (RI-1) in the mid-18th century. The pin factory that astonished Smith and allowed him to outline the study of productivity entailed a result that he did not address: what would happen to those displaced by the machine. Two reasons can be adduced to explain the omission of it. First, in the economic theory of that time, the only possible unemployment was voluntary. The second that the increase in the mass of merchandise produced with the machine found its outlet in foreign trade, towards a planet that was beginning to move away from artisanal production, making it possible to continue creating companies and employment without the imbalance appearing (Siddique et al., 2022).

In his book dedicated to machinery, Ricardo gives some arguments about this issue. He explains that he “had given my support to doctrines that I now classify as erroneous”; and he points out, “I am now convinced that the substitution of machinery for human labor is often very detrimental to the interests of the working class” and that it can “make the population redundant and deteriorate the worker’s condition.”

Marx established in the Grundrisse (Manuscripts) of 1848 that human work would gradually be replaced by machines since, socially, the manufacture of a machine should involve less work than what it would replace, or else it would simply not be useful for capitalism. “The increase in the productive power of labor and the maximum negation of necessary labor is the necessary tendencies of capital.” This dynamic in which, he predicted, a stage would be reached in which machines make machines, added to his theory of surplus value, led him to conclude that automation would imply a continuous fall in the rate of profit, a subject that he analyzes in the third volume of Capital (Huettinger & Boyd, 2019).

These effects of the first Industrial Revolution soon spilled over, as seen with the great migrations of the second half of the 19th century that had two concomitant causes. One is the expansion of the agricultural frontier and, in general, the productive apparatus in America and Oceania, marking the demand for workers. But the other was the massive expulsion of workers

from the artisan workshops and peasants of industrialized Europe. When the effects of the RI-1 had not yet ceased, the second industrial revolution (RI-2) occurred around 1870.

Later, Keynes also addressed the problem during the worst economic crisis hitherto known and concluded: "The increase in technical efficiency has occurred faster than we can cope with the problem of labor absorption" and foresaw the decline in employment, concluding that by 2030 the working day would be three hours a day (Zhou et al., 2021).

In agriculture, the expulsion of labor has occurred at a slower rate because the increase in productivity is slower and even more so in backward countries. According to Amin: The productivity ratio of the most advanced capitalist countries to the poorest, around 10 to 1 before 1940, is now approaching 2000 to 1! One can suppose that the food sent to the market today by 3,000 million peasants, discounting their subsistence, can be produced by 20 million new producers.

Something similar was experienced by Europe in the 19th century, which produced enough population to occupy almost three times as much land as its own in America and Oceania. Later, the Crisis of 1929 transformed the American farm, and the surplus population was welcomed by the plans promoted by the New Deal, and finally, World War II served as a Malthusian solution to population pressure (Dzenovska, 2020).

Thus, thanks to the cushioning role of expanding the borders, unemployment did not appear as an insurmountable problem in the first and second revolutions. However, the third revolution (RI-3) –around 1970– and fourth –around 2000–, would put the issue at the forefront of discussion.

The nineteenth-century migrations were transmuted into the current geographical displacements of production, affecting employment. Acemoglu, Autor, Dorn, Hanson & Price argue that since the beginning of the 21st century in the United States, there has been a notorious loss of manufacturing jobs due to the impact of trade with China, meaning the disappearance of a good part of those created during the 1990 boom.

Ebenstein, Harrison, & McMillan present evidence that globalization has become the force that has driven the relocation of world production seeking lower wages, particularly for the United States-China relationship, which occurs at a higher rate than the growth of trade between those countries. They also show how the reduction in unemployment in the United States is more associated with the effects of robotization than the shift to China (Witt et al., 2023).

In this dynamic, it is once again considered whether each position lost in one country is replaced by one in another. Assuming different productivities, it can be inferred in the first instance that more jobs will appear in the new one, but their salary sum must necessarily be less than the amount paid in the first country. However, it must be taken into account that due to considerations of productivity and the fight for markets, there will be convergence regarding the use of technologies so that the net increase, due to displacement, will be very little.

The synthesis of the problem is elementary: productivity increases to the extent that there is more use of capital (expressed in its most primary form, money, but essentially in its practical form, machinery and technology) and less use of labor. In other words, a task for administrators and engineers is to show producers and investors how to make a good cheaper. This implies optimizing many things, such as the time per unit, the quantity and type of materials, and the versatility of the production chain in the company (Howcroft & Taylor, 2022).

Each adjustment to improve productivity affects employment absorbed and potentially created. The question is whether there is global equilibrium in employment in the long term, assuming a planetary NAIRU rate. As noted, Ricardo, Marx, and Keynes did not conclude that the balance was positive or even zero-sum.

Rodrik identifies several aspects of the problem: In developed countries, de-industrialization and the creation of highly-skilled service jobs occur in fewer numbers and with lower wages than those displaced. He adds that in Asia, there is growth in manufacturing jobs, but in a smaller proportion than those destroyed in developed countries, and, again, with lower wages (López González et al., 2019).

On the contrary, neoclassical analyses such as that of the McKinsey Global Institute – MGI point to a positive outcome. "Even if technologies replace some jobs, they are creating new jobs in industries most of us can't even imagine, as well as new ways to generate income and match talent to jobs." Arntz, Gregory, and Zierahn suggest that the labor replacement rate will not be as fast as it is usually shown, which will give workers more time to adjust to the new labor demands, and, in addition, new technologies will create an increasing demand for new jobs.

A counter-tendency that mitigates the negative labor effects stands out: The opportunity cost can postpone a certain impact of robotization, as occurred with the steam engine, whose invention was in the first century AD but whose massification occurred in the RI-1. Arrighi highlights recent examples in China around 1990, where he identified how, due to the high cost of robots, there was more use of labor than automation since he exemplifies there are assembly lines with no conveyor belts but freight men. Similarly, MGI weighs opportunity costs to conclude that they slow displacement.

Autor underlines the current difficulties for substitution due to programming problems. With this, he discusses whether robots are capable of self-programming and whether they can learn from their actions, that is, to perform non-routine tasks.

For Sachs, Benzell, & LaGarda, the problems are limited by the imperfect substitution that robots make of the goods produced by workers. Once this hypothesis is accepted, they deduce that what comes in employment is a virtuous circle of more and better job options.

This article hypothesizes that almost total displacement is possible since, in the long term, there is no insurmountable technical barrier in light of advances in science and Turing's postulates. Stephen Hawking and other scientists warn that AI will outperform human thinking in every way.

Turing believed that one day there would be a program that would teach itself: a "machine-child," a "seed AI" that would create new versions of itself. It is speculated that such a recursive self-enhancement process could lead to an intelligence explosion resulting in superintelligence."

Wadhwa and Salkever analyze the Internet of Things and show how it autonomously resolves the operation of devices and even identifies the moment when it is about to break.

The learning machine or artificial intelligence would be a way of overcoming Polanyi's paradox, according to which man cannot teach what he does not understand, that is, a computer cannot be programmed to do something that human intelligence does not understand, but if it is a machine capable of learning from his activity, that limit would have been exceeded.

From an epistemological perspective, there are barriers to total production automation. Chollet maintains that intelligence results from experience, interaction with reality, and a cognitive process that no learning machine can do beyond the field of action for which it was conceived.

However, the idea prevails that AI does not replace man, it replaces some human activities. The more repetitive the task, the more robotized it will be. Weaver mentions the composer David Cope who, in 1980, designed the Emily program to create music that composed some 5,000 chorales with all the coloratura of Bach's in one hour.

To analyze the potentiality of the replacement, Leontiev introduced the simile between the displacement of the horse by the engine to evaluate the situation in the RI-2. Using that

seminal idea, and analyzing the fields in which there may be displacement today, Benzell, Kotlikoff, LaGarda, & Sachs, conclude: "the central message is disturbing."

However, in the result visible today, evaluating the development of current technology to produce robots, there are still not good enough for activities that involve creativity, empathy, persuasion, or complex decision-making, as well as for some tasks that require a certain level of sensorimotor ability, such as caring for the sick.

2. Labor Trends

The RI-4 is inducing Industry 4.0 to designate smart factories or internet factories, in which there are new processes (related to global value chains), new ways of organizing work, and new skills. It is worth highlighting the main ones, insisting on the role of administration and business schools in promoting research in these fields and incorporating the results into curricula (Mahdiraji et al., 2022).

a. It has been said that the substitution rate of a job is inversely proportional to the degree of emotional intelligence needed for its exercise, such as teaching or psychology, and to the greater unpredictability of the task, such as fixing a room, taking care of a sick person or doing a new design (Chigeda et al., 2022).
   For MGI, what can be replaced today with known technology would imply 1,200 million jobs, 700 of them between China and India.
   73% of the activities carried out by workers in the food and accommodation service have the potential for automation, based on technical considerations. The importance of human interaction is evident in two sectors that, so far, have a relatively low-potential technique for automation: healthcare and education.
   Frey and Osborne analyze 702 occupations organized by high, medium, and low skill levels and their susceptibility to being replaced by robots. Their results generally show an increased risk of replacement and underline that not even jobs associated with the same robotic services are exempt from risk, being the least prone to those that involve skills and social intelligence, such as the ability to negotiate, persuade and care for people.
b. Due to the effects of RI-3 and RI-4, the expression "I'm going to work" is being increasingly replaced by "I'm starting to work". It can be identified as the "gig" economy, or sharing economy, defined as "the labor market characterized by the prevalence of short-term contracts or freelance work, as opposed to permanent work".
   Among the many effects of this new economy is the one it brings to the old hierarchical organization and company promotions (Carracedo et al., 2021). If you are freelance, what job design will prevail? What about organizational memory? Leighton & Brown shows the panorama of these workers, whom it calls iPros (independent professionals), and identify various problems and transformations in organizations and education.
c. It is noted that each productive revolution causes the disappearance of certain occupations and the emergence of new ones. In a survey at the Davos Forum in 2016, 371 employers were asked about labor trends and stressed the need to increase the number and capacity of human resources and public sector relations specialists to meet the growing demand for jobs in business, finance, computing, math, and management. It notes that "by 2020, more than a third of workers will need skills they do not have today."
   Taddy recalls that while the initial use of AI was for video games, it quickly jumped into the business, citing Microsoft and Amazon as examples, mixing engineers with semi-autonomous systems to solve business problems. In the same sense, MGI highlights digital platforms for transactions or to evaluate credits for businesses (Patrickson, 2021).

d. In Latin America, a paradox appears. Specific policies and production models framed in the first two industrial revolutions, both in developed and backward countries, allowed the transfer of production from those to here, a trend reinforced by global value chains. But RI-4 is inducing a corporate "homecoming." IFR mentions Whirlpool, Caterpillar, Ford Motor Company, and Adidas as examples and that, in a Citi study of its clients, 70% reported the possibility of concentrating the dispersed production chains in the country of origin (Luz Tortorella et al., 2022).
e. Sumell, Stephan, & Adams discuss how the knowledge obtained by PhDs at universities is transferred to companies, particularly what they call "tacit knowledge", which could well be understood as soft skills:

   Much of graduate student training is implicit in nature. These new techniques, which cannot be codified, can be passed on to industrial R&D labs by recruiting newly trained scientists and engineers.

   These authors cite a Carnegie Mellon study to establish the ten main ways in which this transfer is achieved, and publications and research reports stand out in the first two positions, and 30% of the answers emphasize the importance they have recent graduates bring industry in touch with that tacit knowledge and their role as brokers in knowledge networks.

   Sumell emphasizes that for companies that have clearly defined their course, it is not essential to be close to the university because when they need something, they look for it, while those that do not have it defined require more help from universities.

3. Its Effect On The Educational System

These trends offer a rosy outlook for business schools in Latin America because, as has been seen, they imply a radical change in the way companies and businesses have worked. However, there are barriers such as low credibility in our schools, which is reflected in the search for degrees in universities in other latitudes, even if they have less recognition in university rankings, according to Mollis, who also highlights that foreign investment usually comes with its management team. He adds that the region has economic difficulties in launching postgraduate programs, particularly doctoral programs that offer real alternatives to entrepreneurs and investors (Gereffi et al., 2021).

Each revolution in production induces an educational system that guarantees research and teaching of new types of organizations and work. This account is beyond the scope of this document, but it would show, for example, the emergence of engineering faculties as a result of RI-1 and administration as a result of RI-2. Also, the role of the educational system as a generator of ideas was shallow compared to that of the academies.

For reasons whose argumentation is beyond this document, RI-3 and RI-4 owe a deep debt to the educational system in its origin and its dissemination and application. Muzzacato explains, for example, how twelve essential smartphone components arose in university laboratories, primarily financed by public agencies.

The effects of the RI-3 on education are analyzed in the OECD, where they discuss, among others, the role of education in the knowledge economy and the creation of its corresponding learning system, the effect on sectors such as health, business and administration, and in research in general, just like McShane. For his part, Sawyer parallels education characteristics before and after the RI-3 (Adroniceanu et al., 2020).

Wooldridge's parallel between today and the Lutheran Reformation indicates that it is necessary to reconsider the conceptual bases of the administration. He points out that business schools are "the cathedrals of capitalism" with their officiants, books, and rites and highlights several misconceptions that continue to be taught, despite what the facts show otherwise (Sirris, 2019). For example, excellent business competition is assumed when oligopolistic

consolidation undermines the handy "natural" laws of the market. The same thing to the assumption that the "world is flat," as defined by the journalist Friedman, indicates a highly globalized world, which is not the case for another group of theorists such as Ghemawat and other similar counterfactual facts (Bohas et al., 2021).

Various authors repeat these discussions about paradigms that need to be reconsidered. The concentration of production in superstar firms is analyzed by Autor, Dorn, Katz, Patterson, & Van Reenen, concluding that there is a total loss of jobs and labor income in the set of countries they analyze, in addition to restraining the investigation.

Ghemawat shows that the globalization process has not been as deep and extensive as claimed and that there is a process of "deglobalization". Speaking of globalization in business, he points out that by many different measures (size, employees, investment, markets), truly global companies are a tiny and concentrated exception (Steger & James, 2020).

Before the 2008 crisis reinforced anti-globalization trends, Ghemawat showed that in many aspects, the world is more local than global, making it necessary to think more about the real, local consumer than the prototype of the worldwide consumer. The internet of things, as opposed to mass production, would appear as a solution to this dilemma.

The concern for education and technological diffusion is notorious. For example, the World Economic Forum outlines the basic skills in the 21st century, the gap to achieving them, and how technology can help to achieve them. MGI indicates the need to "improve basic science, technology, engineering, and math skills and place a new emphasis on creativity and critical thinking." To identify the effects of RI-4 on the economy, society, and education, a working group in Canada concluded that it was necessary to insist on the principle set forth by Alvin Toffler in 1970: "learn how to learn, unlearn and relearn".

The educational system and, in particular, post-secondary education in the broad field of business must reflect these trends in its contents:

a. Incorporating competencies into the curricula so that the graduate can function in an increasingly automated world: blockchain, fintech, and big data are some examples of tools for managing companies and businesses.
b. Ferguson examines ten pedagogical trends framed by current technology. They highlight, for example, the use of open texts (as opposed to the single and "pasted" text), management and thinking in terms of big data, the analysis of learning for its individualization by learning rhythms and student interests (Saçak et al., 2022).
c. Managing human talent in the new varieties of businesses requires reconsidering the related subjects.

   Among the priorities identified at the 2016 World Economic Forum are reinventing the HR function to "become more strategic," using "new kinds of analytics tools to identify talent, trends, and occupational gaps," and "helping align business's innovation and talent.
d. Macroeconomic risks derived from these new forms of economy, but with an impact on the organizational, business, and business world, such as the sustainability of health and pension systems, risk management in businesses related to the "dark web" or "deep web" and the blockchain as an antidote to risk.
e. Artificial intelligence opens the doors to a wide field of research in pedagogy. Keeping in mind what is behind the use of customer information from social networks (big data), it is feasible to investigate issues such as the learning process or desertion trends.
f. The epistemological advance implicit in interdisciplinarity or transdisciplinarity requires rebuilding the study plans.
g. The teaching-learning process is increasingly debated in an antinomy: greater knowledge and greater speed of obsolescence of these. The diffusion (convergence) of technologies in most countries is increasing. Thus, for example, steam as a source of

energy, and steamships in particular, became generalized to 90% of the countries a little over a hundred years after their first use; while the internet and cell phones did not even take a decade. The impact of this acceleration on income is highlighted by Gordon, who notes:

It took five centuries between 1300 and 1800 to double the standard of living. The doubling accelerated to one century between 1800 and 1900. The doubling peaked in just 28 years between 1929 and 1957 and 31 years between 1957 and 1988.

But the doubling is predicted to slow to a century again between 2007 and 2100.

Hence the insistence that pedagogies and curricula be introduced that transmit not only knowledge but also soft skills and their concretion in policies such as the Tuning Project in Europe and Latin America.

Deming models the study of social competencies to verify that those who have them have greater employment possibilities and draws attention to the need for the academy to find the means to increase them among students from the first educational levels.

This dilemma becomes more relevant when business schools undergo accreditation processes since there is a question: the programs must aim at specialization from the beginning, or rather they must be generic, at the price of the student having specific subjects left pending. Malamud proposes that in the medium term, there is a salary equalization between both professionals, but leaves the door open for the analysis of the significant externalities that arise from general education rather than the specific one because it is very focused on labor competencies.

h. Use of the latest technologies in pedagogy. Escueta, Nickow, & Oreopoulos identify and evaluate four categories of tools: technology access, computer-assisted learning, technology-enabled behavioral interventions in education, and online learning. Heras Castillo recounts the pedagogical problems faced in Ecuador in the challenge of new technologies (Escueta et al., 2020).

   Bettinger, Fox, Loeb, & Taylor conducted a comparative study between face-to-face students and those who take online courses and found lower academic performance and a higher propensity to drop out among the latter.

i. The role of the teacher. Sawyer says that it must be a knowledge worker who understands the principles of learning and is familiar with the activity of scientists, historians, mathematicians, and literary critics, guaranteeing them autonomy and adding that “they must receive salaries comparable to other knowledge workers”.

D. CONCLUSIONS

The RI-4 is radically changing the way of producing, marketing, and linking workers to organizations. The theory is debated between those who say that step by step, the total number of workers in the world will decrease versus those who maintain that it will increase. The point under discussion that most directly affects the educational system is the type of learning that should circulate in the classroom. Although there are varying degrees of optimism about the actual number of future human jobs and employees, the truth is that education must be routed by knowledge and skills more than planning and design that face the rapid obsolescence of knowledge and technology and make new businesses and companies viable.

REFERENCES

Androniceanu, A. M., Georgescu, I., Tvaronavičienė, M., & Androniceanu, A. (2020). Canonical Correlation Analysis and a New Composite Index on Digitalization and Labor Force in the Context of the Industrial Revolution 4.0. *Sustainability*, *12*(17), 6812.

Bittencourt, V. L., Alves, A. C., & Leão, C. P. (2021). Industry 4.0 Triggered by Lean Thinking: Insights from a Systematic Literature Review. *International Journal of Production Research*, *59*(5), 1496-1510.

Bohas, A., Morley, M. J., & Kinra, A. (2021). Perlmutter Revisited: Revealing the Anomic Mindset. *Journal of International Business Studies*, *52*(9), 1695-1723.

Carracedo, P., Puertas, R., & Marti, L. (2021). Research Lines on the Impact of the COVID-19 Pandemic on Business. A Text Mining Analysis. *Journal of Business Research*, *132*, 586-593.

Chigeda, F., Ndofirepi, T. M., & Steyn, R. (2022). Continuance in Organizational Commitment: The Role of Emotional Intelligence, Work-Life Balance Support, and Work-Related Stress. *Global Business and Organizational Excellence*, *42*(1), 22-38.

Dzenovska, D. (2020). Emptiness: Capitalism without People in the Latvian Countryside. *American Ethnologist*, *47*(1), 10-26.

Escueta, M., Nickow, A. J., Oreopoulos, P., & Quan, V. (2020). Upgrading Education with Technology: Insights from Experimental Research. *Journal of Economic Literature*, *58*(4), 897-996.

Gereffi, G., Posthuma, A. C., & Rossi, A. (2021). Introduction: Disruptions in Global Value Chains–Continuity or Change for Labour Governance?. *International Labour Review*, *160*(4), 501-517.

Howcroft, D., & Taylor, P. (2022). Automation and the Future of Work: A Social Shaping of Technology Approach. *New Technology, Work and Employment*.

Huettinger, M., & Boyd, J. A. (2019). Taxation of Robots–What Would Have Been the View of Smith and Marx on It?. *International Journal of Social Economics*.

Kineber, A. F., Oke, A. E., Hamed, M. M., Rached, E. F., Elmansoury, A., & Alyanbaawi, A. (2022). A Partial Least Squares Structural Equation Modeling of Robotics Implementation for Sustainable Building Projects: A Case in Nigeria. *Sustainability*, *15*(1), 604.

López González, J., Meliciani, V., & Savona, M. (2019). When Linder Meets Hirschman: Inter-Industry Linkages and Global Value Chains in Business Services. *Industrial and Corporate Change*, *28*(6), 1555-1586.

Luz Tortorella, G., Cauchick-Miguel, P. A., Li, W., Staines, J., & McFarlane, D. (2022). What Does Operational Excellence Mean in the Fourth Industrial Revolution Era?. *International Journal of Production Research*, *60*(9), 2901-2917.

Mahdiraji, H. A., Yaftiyan, F., Abbasi-Kamardi, A., & Garza-Reyes, J. A. (2022). Investigating Potential Interventions on Disruptive Impacts of Industry 4.0 Technologies in Circular Supply Chains: Evidence from SMEs of an Emerging Economy. *Computers & Industrial Engineering*, *174*, 108753.

Matthews, A., McLinden, M., & Greenway, C. (2021). Rising to the Pedagogical Challenges of the Fourth Industrial Age in the University of the Future: An Integrated Model of Scholarship. *Higher Education Pedagogies*, *6*(1), 1-21.

Patrickson, B. (2021). What do blockchain technologies imply for digital creative industries?. *Creativity and Innovation Management*, *30*(3), 585-595.

Saçak, B., Bozkurt, A., & Wagner, E. (2022). Learning Design versus Instructional Design: A Bibliometric Study through Data Visualization Approaches. *Education Sciences*, *12*(11), 752.

Siddique, S., Roy, B. B., Zaman, S., Khan, A., Al Alam, M. A., Chowdhury, R. B., ... & Sujauddin, M. (2022). Discerning the Circularity of the Plastic Industry in Bangladesh through the Lens of Material Flow Analysis. *Sustainable Production and Consumption*, *33*, 700-715.

Sirris, S. (2019). "The Pastors' Dilemma" Revisited. Religious Leaders Connecting the Spiritual and Organizational Realms through Conceptual Work. *Journal of Management, Spirituality & Religion*, *16*(3), 290-313.

Steger, M., & James, P. (2020). Disjunctive Globalization in the Era of the Great Unsettling. *Theory, culture & society*, *37*(7-8), 187-203.

Szabó-Szentgróti, G., Végvári, B., & Varga, J. (2021). Impact of Industry 4.0 and Digitization on Labor Market for 2030-Verification of Keynes' Prediction. *Sustainability*, *13*(14), 7703.

Vinitha, K., Prabhu, R. A., Bhaskar, R., & Hariharan, R. (2020). Review on Industrial Mathematics and Materials at Industry 1.0 to Industry 4.0. *Materials Today: Proceedings*, *33*, 3956-3960.

Wibowo, M. A. A., & Munadi, S. (2020). Critical Thinking Skills through Industrial Revolution 4.0 for Vocational Education. *VANOS Journal of Mechanical Engineering Education*, *5*(2).

Witt, M. A., Lewin, A. Y., Li, P. P., & Gaur, A. (2023). Decoupling in International Business: Evidence, Drivers, Impact, and Implications for IB research. *Journal of World Business*, *58*(1), 101399.

Zhou, X., Jia, Z., Zhang, X., Wang, B., Wu, W., Liu, X., & Wu, G. (2021). Controllable Synthesis of Ni/NiO@ Porous Carbon Hybrid Composites towards Remarkable Electromagnetic Wave Absorption and Wide Absorption Bandwidth. *Journal of Materials Science & Technology*, *87*, 120-132.