Industry 4.0 and Sustainable development

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The text provides a methodologically coherent analysis of technological development in the context of the fourth industrial revolution or Industry 4.0 and its impact on changes in sustainable development policy. The focus is on topics that are directly relevant to current sustainable business development and the promotion of research and development of clean and smart technologies and processes

Keywords: sustainability ; industry 4.0 ; digitalization ; corporate social responsibility ; sustainable reporting ; smart manufacturing ; renewable energy ; cleaner production

1. Introduction

In the second decade of the 21st century, humanity is confronted with the emergence of the Fourth Industrial Revolution or Industry 4.0 (IR 4.0) and the demand to implement the 17 Sustainable Development Goals (SDGs) set out in Agenda 2030 for Sustainable Development. The Agenda balances and links the three dimensions of sustainable development—economic, social, and environmental—and stipulates that the SDGs must be adopted in all countries of the world by 2030[1].

2. Scientific Literature Review

Most of the scientific literature described I4.0 primarily from a technical point of view[2], but there are less researched topics like organizational management[3][4][5], as well as the ecological and social aspects within I4.0. Researchers such as Birkel et al.[6] point out that there are still rare integrative researches of economic, ecological, and social aspects. It is tough to simultaneously maintain economic profitability whilst improving the environmental, as well as the social aspects of industrial value creation. Thus, the challenges and potential of I4.0 appear in stark contradiction to the three-dimensions mentioned in the Triple Bottom Line. The I4.0 concept raises fears of job losses and growing inequality. Therefore, an interdisciplinary, integrative study of I4.0 is required, which does more than merely balance the ecological and social potential, but also connects them to market success[7][8].

The comparative research delves into the opportunities offered by I4.0, including, but not limited to, improvement of various production processes, which includes robotization, as well as how I4.0 has stimulated research on the possibilities and effects outside the smart factories themselves[9][10]. There are 10 major global trends in I4.0, most of which already exist but have been improved, in terms of the features introduced: Demographic shifts, urbanization, knowledge growth, deindustrialization, market globalization compared to protectionism, advanced business models, technology convergence, increase robotics, cybersecurity, climate changes, and global sustainability[11][12]. The immediate sustainability result of I4.0 is manufacturing-economic sustainability. The digitalization of the manufacturing industry influences manufacturing efficiency, supply chain mergers, energy efficiency, the emergence of business model innovation, cost-saving, financial sustainability, human resource skills development, and corporate profitability. It is vital to replace fossil fuels with renewable energy, which also aids in the decarbonization of the society. I4.0 is eventually crucial for promoting and enabling environmental protection and emission reduction[13].

3. Industry 4.0 and Sustainable development challenges

The digital transformation in both manufacturing and the products themselves (e.g., electric cars) and the requirements to adapt the business to and operation of products following the United Nations Sustainability Goals lead to a reorganization of their supply chains, what has positive and negative consequences for society itself. The positive consequences are particularly important for developing countries, where strict environmental protection criteria are not enforced, and companies' sustainability standards are not met, leading to non-compliance with both occupational safety and child labor. The negative consequences are visible or will be visible in the reduction of jobs because the digital transformation will result in the middleman becoming redundant. Here, both scientists and governments are facing a solution to the

consequences of the digitalization of companies, for which it will be necessary to find a social consensus, which will have to be supported by concrete research both among companies and the public[14] . This research should focus on finding solutions to mitigate the effects of both digitization and the requirements of the United Nations Sustainability Goals, which include new sustainable policy programs that will offer various new forms of employment in the Universal Basic Income (UBI). Thus, in Germany in August 2020, they started a test phase under which 120 citizens will receive €1200 a month for three years[15]. It can be concluded that future researches should be focused on monitoring of the CSR and sustainable development impact on the economy. It will also be necessary to take into account the issues related to COVID-19, which has a significant impact on changes in the field of work organization, economics, and the operation of the company itself and citizen wellbeing, especially in cities that have to be transformed not only in smarter and more sustainable ways[16], but also safe from crime, natural disasters, pandemic, and other catastrophes[17][18]. The virus pandemic is leading to a faster digital transformation, and various digital platforms are increasingly being developed to enable work and education from home[19]. In the health industry, service digitalization becomes important for the monitoring of the patient from home, and it also enabled control and transparency of medical-epidemiological research and mental health service, which is especially important in pandemic time [20][21]. In the field of public administration, communication with the city administration is established, and their concerns are reported. Online citizens' participation in discussion about cities policies and budgeting is enabled. More and more administrative procedures can be done online, such as business registration, dog registration, information about historical certificates or registration, citizens id cards have been expanded, and e-voting is enabled [22][23]. We think that more research will be needed on adapting people to new conditions, such as working from home, as well as research on trust and security in digital business and the implementation of administrative procedures and e-democracy.

The next important question is how we will gain energy in the future? As we can see, opinions are very divided across countries, and practice shows that countries that have opted for predominantly green energy are having increasing problems with electricity shortages because they are no longer producing enough to shut down nuclear and fossil fuel power plants to meet the needs of both industry and households[24]. Research also shows that Germany's renewable energy project failed because the German CO2 Emissions is 10 times higher than nuclear-powered in France[25].

In September 2020, we witnessed the electricity crisis in Germany, which was forced to import energy from countries such as Poland, Bosnia and Herzegovina, the Czech Republic, and Slovenia [137]. The paradox is that such an "energy green country" cannot produce sufficient quantities of electricity with green technology and must import[26] it from countries where it is produced in nuclear and thermal power plants. The insecure energy supply, which depends on domestic green electricity, is threatened for the national economy[24][27][28]. In the field of energy, research is emerging on the applicability of new modular nuclear power plants and the very meaning of dependence on only the so-called green energy produced by solar power plants, windmills, etc.

Finally, let us mention a relatively new concept: Sustainable business finance. Within companies, sustainable reporting is becoming more critical. Companies must therefore add information on the environment, society, and governance (ESG) to their business reports. ESG information shows a picture of the company and is therefore becoming increasingly important for financial markets. Investors have become aware of the importance of sustainable development, which is increasingly gaining its place in the laws of individual countries, and among end customers, who are increasingly in demand for sustainable products and services [140,141]. In this field, it will be necessary to research sustainable reporting and, based on the analysis of company reports, to determine how this reporting changes over time and what information it contains. On the other hand, it will be necessary to analyze the responses of financial markets to insufficient sustainable reporting and the consequences for these companies.[29][30]

4. Conclusions

The relevant and current theme nowadays is oriented towards COVID-19 and its impact on the economy and society. The newspapers and some latest research journals include articles of the COVID-19 outbreak and its effect on the economy and the environment. Indeed, the outbreak of the virus brings new thinking about the reorganization of the complex relationships between consumers, businesses, and the state [31]. The question is whether, in rescuing the economy, we will unreasonably seek to return to the old patterns as quickly as possible, or whether we will use the moment to reshape and restructure the national economy. It offers a unique opportunity to solve two crises at once, with prudent behavior and wise action[32]. The response to the health and economic crisis can be enhanced by tackling the environmental crisis, which can also disrupt the food chain[33] . The latter, however, first requires an ambitious restructuring plan that transitions from a linear to a circular economy. The ideas of green transformation are not entirely new at such times[34]. During the previous crisis, state aid for the car giants was made conditional on their moving to stricter emission standards. However, the current situation allows the implementation of much more ambitious plans compared to then, as the social climate is

much more favorable today than it was in 2008[35]. Companies will have to thoroughly rethink their existing business models, organizational structure, and the way they work during and after the crisis. Intertwined global supply chains, marketing approaches that respond to pre-crisis consumer habits, and mandatory physical presence in the workplace are just some of the critical factors already under discussion and the reason for the forthcoming transformation of the business environment. The coming year or two will bring many new insights into labor productivity as one of the critical factors in production. Management discussions will revolve around the possibilities and opportunities of the digital transformation of companies. Internal policies will adapt to the new situation in the areas of business travel, contractual relations, and security. The wait for state aid will not solve several challenges, so companies must use this time to make a radical transformation. The latter requires a thorough reflection on the strategy of the company and its role in society as a whole, the business and profit model, and, last but not least, the role of employees in this process[36][37].

Finally, the role of the states themselves is, and remains, extremely important. They will bear a considerable part of the financial burden of the crisis, so timely planning and smart conditioning of measures are crucial. Rescuing companies cannot and should not be aimed at returning to a pre-crisis state. The latter is not only impossible because the world has changed considerably in a few months, but also pointless because we could miss one of the few opportunities for an extensive, green, circular transformation of the economy. State-sponsored financial instruments should, therefore, be based on the principles of green financing, grants should include a commitment to meet ambitious environmental standards, and measuring the success of a national rescue package should be based not only on traditional macroeconomic indicators, but also on broader social and environmental impacts [38]. Sustainable development and recycling must become more than just theoretical concepts, which means that they must be operationalized through sector-specific and fact-based measures. Countries can build on existing commitments and solutions; within the EU these include, for example, the efforts of European climate and energy policy or reporting and taxonomy standards for sustainable activities in the EU[14].

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