International Journal of Data and Network Science 6 (2022). 1437–1446

Contents lists available at GrowingScience

International Journal of Data and Network Science

homepage: www.GrowingScience.com/ijds

The effect of industry 4.0 on sustainability of industrial organizations in Jordan

Alaa Tawfiq AL-Zyadat[a], Jameel Mohammad Alsaraireh[a], Doa'a Ahmad Odeh Al-Husban[b], Hussam Mohd Al-Shorman[c], Anber Abraheem Shlash Mohammad[d], Farah faisal Alathamneh[e] and Sulieman Ibraheem Shelash Al-Hawary[f*]

[a]Management Information System Department, Amman College, Al-Balqa Applied University, Jordan
[b]Department of Human Fundamental Sciences, Faculty of Alia College, Al-Balqa Applied University. Amman, Jordan
[c]Department of Management information system, Faculty of Amman College, AL-Balqa Applied University, Jordan
[d]Marketing Department, Faculty of Administrative and Financial Sciences, Petra University, Jordan, B.O.Box: 961343, Amman 11196, Jordan
[e]Researcher ,Department of Business Administration, School of Business, Al al-Bayt University, P.O.BOX 130040, Mafraq 25113, Jordan
[f]Professor of Business Management, Department of Business Administration, Business School, Al al-Bayt University, P.O.BOX 130040, Mafraq 25113, Jordan

C H R O N I C L E

Article history:
Received: February 14, 2022
Received in revised format: March 22, 2022
Accepted: May 9, 2022
Available online: May 9 2022

Keywords:
Industry 4.0
Sustainability
Industrial Organizations
Jordan

A B S T R A C T

The study aim is to examine the impact of industry 4.0 on sustainability of industrial organizations in Jordan. The population of the study consists of employees at various administrative levels of industrial organizations in Jordan. Due to the large population and the spatial and temporal limitations of the research, it was difficult to collect data using the comprehensive method. Therefore, the random sampling method was applied to collect data from the research population. The structural equation modeling (SEM) technique was used to test the impact of industry 4.0 dimensions on sustainability. The study results confirmed that all dimensions of industry 4.0 had an impact on sustainability. The greatest effect was for cyber-physical systems. Based on this result, researchers recommend the management of industrial organizations to invest in information technology to provide a large variety of data in a very short time and providing appropriate programs for analyzing big data and producing accurate and reliable information that can be used by employees.

1. Introduction

Information technology has brought about tremendous developments in all aspects of life, in addition to the developments that accompanied it in social media, which was reflected in the benefit of business partners, customers and suppliers (Al-Qudah et al., 2012; Altarifi et al., 2015; Al-Hawary & Alhajri, 2020; Eldahamsheh et al., 2021). This reflected on the companies with many benefits such as improving performance, achieving sustainability and retaining customers (Alhalalmeh et al., 2020; Al-Shormana et al., 2021; Al-Hawary & Obiadat, 2021 Tariq et al., 2022; AlHamad et al., 2022). Industry 4.0 represents the Fourth Industrial Revolution, and it is an extension of the sequence of industrial revolutions that were preceded by three industrial revolutions. The Fourth Industrial Revolution aims to automate human life in all its fields. Industry 4.0 was first announced by the Germans at the Hannover Fair in April 2013 (Lin, Wu & Song, 2019). Industry 4.0 refers to the current trend in automation and data exchange in organizations. It is completely changing the way an organization works (Alwan et al., 2022; Sony & Naik, 2019). Adoption of Industry 4.0 technologies creates a superior competitive advantage for companies that adopt them as drivers of efficiency and differentiation, as well as supports innovation. (Bettiol, Capestro, Di Maria, & Furlan, 2019) investigate the relationship between digital technology investments and corporate performance by examining

* Corresponding author. Tel.: +96-2795368974
E-mail address: dr_sliman73@aabu.edu.jo (S. I. S. Al-Hawary)

doi: 10.5267/j.ijdns.2022.5.007

the technologies most likely to be associated with superior performance and, ultimately, the cumulative effect of technologies on performance, and demonstrate the positive effects on adopter performance as well as the role of robotics and laser cutting in this relationship.

Companies are eager to deliver high levels of performance. Therefore, it focuses on managing employee performance in order to ensure that they deliver to the best of their ability while also working to improve the company's overall success. The company's high performance is indicated by improved productivity and sales growth while decreasing costs in the organization, which may boost the company's profitability, resulting in growth and continuity, and therefore the company's sustainability. It may also improve the customer experience, provide them with a unique and positive experience, and raise their satisfaction, earning the company loyalty from its customers and allowing it to gain new customers through its high performance reputation. At the corporate level, performance is measured in a variety of ways. Accounting profitability measurements, the Lerner index, sales per input, and total factor productivity are examples of these methodologies (AlTaweel & Al-Hawary, 2021; Al- Quran et al., 2020; Al-Hawary et al., 2020). Distinct metrics record different aspects of a company's success, even though they are connected (Alwan et al., 2022; Al-Hawary & Al-Rasheedy, 2021; De Loecker & Goldberg, 2014). Today's businesses require the development and implementation of a solid business strategy. Business Performance Management (BPM) is an IT-enabled approach to formulating, adjusting, and implementing strategy in businesses (Frolick & Ariyachandra, 2006; León Garca & Baez Landeros, 2020; Al-Hawary & Al-Syasneh, 2020).

IT and Industry 4.0 technology resources provide tools for organizations to enhance foreign markets and positively stimulate business performance (León García& Baez Landeros, 2020). Business services firms must build information systems to monitor consumers and successful products, as well as a company culture that prioritizes stakeholder requirements, to increase business success. As well as creating regulations to promote ethical behavior (Gray, Matear, & Matheson, 2002). Modern businesses are also taking initiatives to improve their performance through increasing efficiency through enhanced openness. (Berggren & Bernshteyn, 2007). Industry 4.0 is rapidly being touted as a means of raising productivity, stimulating economic growth, and assuring manufacturing enterprises' long-term viability. (Rosin, Forget, Lamouri & Pellerin, 2019). This study provides a link to the concept of Industry 4.0 and company performance and aims to contribute to the literature and the business sector by presenting the relationship between the use of Industry 4.0 technologies and business performance. Through the researchers' review of the studies related to the subject, it was found (within the researcher's knowledge) that there is no study that dealt with Industry 4.0 and its implications for performance in the Arab region. Therefore, this study could be the first that we can add to the Arab library, and this study can add good value to the results that I reached it in addition to the recommendations it provides to companies to improve their performance through Industry 4.0 technologies. Therefore, this study came to examine the impact of Industry 4.0 on sustainability of industrial organizations in Jordan.

2. Theoretical framework and hypotheses development

2.1 concept of Industry 4.0

As market globalization, global competitiveness, and product complexity increase, technological advances, methods, and work processes are implemented (Gubán & Kovács, 2017). In today's industry, digitalization and internalization of the production process are required. Rapid advancements in manufacturing methods and industrial applications are assisting in increasing productivity. Industry 4.0 emphasizes people's rigorous integration into the industrial process for continuous development, as well as an emphasis on value-adding tasks and waste minimization (Vaidya, Ambad & Bhosle, 2018). Although Industry 4.0 has become a popular word in both academia and industry, its meaning is still under development and updating. The German Federal Government first proposed the concept of "Industry 4.0" as a strategic plan for the development of German industry, based on the integration of manufacturing machinery and information systems into a specific information space, allowing them to interact with one another and with the outside world without human intervention. (Tarasov, 2018). Industry 4.0 is becoming increasingly tailored to the needs of specific customers (Vaidya et al., 2018). The shift of organizations to digital is also known as Industry 4.0 (Sony & Naik, 2019). Industry 4.0 is powered by Big Data, Smart Factory, Cyber-Physical Systems (CPS), and the Internet of Things (IoT) (Rahman, Kamal, Aydin, & Ul Haque, 2020). Physical cyber systems (CPS) are the merging of mathematical and physical processes in which computers and embedded networks monitor and regulate physical processes, typically through feedback loops in which physical activities influence computational processes and vice versa (Lee, 2008). The Internet of Things could be defined as the operation of a network of physical devices, vehicles, buildings, as well as other items embedded with electronics, applications, detectors, actuators, and network access that allow these objects to collect and exchange data. (Schwertner, 2017), and can also be controlled remotely. One of the major architectures of Industry 4.0 is the Smart Factory, which consists of a fully connected manufacturing system operating essentially without manpower by generating, transmitting, receiving, and processing the data needed to perform all the tasks required to produce all kinds of goods (Osterrieder, Budde, & Friedli, 2020). Through advanced systems and programs that operate accurately. These systems accomplish their tasks based on information received from the physical and virtual worlds. Physical world information is, for example, the location or state of a tool, as opposed to virtual world information such as electronic documents, graphics, and simulation models (Lucke, Constantinescu & Westkämper, 2008). Big Data is described as a procedure and technology for retrieving, collecting, managing, and analyzing a vast volume of unstructured and structured data that really is difficult to process using typical databases and that requires new technologies and analysis methodologies (Zulkarnain & Anshari, 2016).

2.2 Sustainability

The rise of the concept of sustainability indicates a significant shift in global thought, prompting businesses to rethink how they manage their operations. Companies must re-establish their company strategy by developing and executing more integrated sustainable practices in order to foster economic development (Hami et al., 2015). With the growing interest in integrating sustainability standards into corporate activities, the responsibilities of the corporate board of directors, which include drawing up the general strategy and detailed action plans for the company, began to take into account the integration of environmental, societal, and government standards into the company's general strategy (Al- Quran et al., 2020). The main responsibility of the board of directors is to supervise the preparation of a disclosure report on sustainability performance in its various stages (Alhalalmeh et al., 2020). Hueting and Reijnders (1998) argue that sustainability is defined as the use of vital functions (potential uses) of our biophysical environment in such a way that they become available indefinitely. Rastislav and Petra (2016) have developed a definition of sustainable development as a broad social goal for all stakeholders and reinforced the areas where it is necessary to focus (environmental, social, and economic performance). According to Stankeviciute and Savaneviciene (2013), business sustainability demands a "triple bottom line" approach that includes principles of environmental, economic, and social equality. Based on the above definitions of sustainability, researchers defined sustainability as an attempt to preserve the quality of life that we live in the long term by meeting the needs of current generations while ensuring the rights of future generations to the available resources. Various metrics that can be used to assess sustainable development were stated in the studies, and many researchers addressed them according to the objective and nature of their research as well as the field of application. This is supported by the research (Pislaru et al., 2019), which intended to propose a technique for improving corporate sustainability management. The study evaluates the impact of a company's environmental sustainability and financial performance on its long-term success. A study (Hussain, 2015) aimed to provide a clear understanding of the relationship between disclosure of sustainability performance (SP) and financial performance (FP) by applying to global wealth companies (N100), with the dimensions of the company's sustainability performance (SP) represented by economic performance, environmental performance, and social performance. The study (Garg, 2015), which aimed to investigate the relationship between sustainability reports and the financial performance of companies in India, relied on measuring sustainability reports on economic, environmental, and social indicators (related to society, employment, and product). Sustainability was measured in a study (Jiang et al., 2018), which aimed to propose a three-dimensional sustainability assessment model to analyze the sustainable performance of companies based on the analysis of the main component, with the economic, environmental, and social dimensions. The study of (Ait Sidhoum & Serra, 2017), which aims to answer whether profitable businesses are compatible with balanced sustainability by investigating the relationship between the dimensions of sustainability and the dimensions represented by the economic, social, environmental, and governance performance of a sample of international companies. The dimensions of sustainability were represented in the study (Shahzad et al., 2020), which aims to study the role of the knowledge management process for the sustainable performance of companies with the integration of green innovation and organizational agility by following the theory of resource-based supply with the following three dimensions of the sustainable performance of CSPs: environmental sustainability, economic sustainability, and social sustainability. Based on the above, the researchers adopted the dimensions of corporate sustainable development (CSD) with environmental sustainability (ENVS), economic sustainability (ECOS), and social sustainability (SOCS).

2.3 Industry 4.0 and sustainability

Many studies have combined the Industry 4.0 variable with its impact on the sustainability variable. The study (Stock & Seliger, 2016) found different opportunities to achieve sustainable manufacturing in Industry 4.0. These potentials bring together existing research methodologies in the area of sustainable manufacturing with Industry 4.0's future requirements. Determine the use case for industrial equipment modification as a unique opportunity for Industry 4.0 sustainable manufacturing. While the findings of Soltani Delgosha et al. (2020) indicate the importance of digitization to achieving sustainable development goals, they add to the literature by developing a model that represents the pillars of digital transformation as interrelated conditions to explore how the combination of these factors achieves the sustainable development goals. Feroz et al. (2021) proposed a framework for digital transformations in four areas: pollution control, waste treatment, sustainable materials, and urban sustainability. The results of the study (Esses et al., 2021) show the extent of digital performance in each country and the relationship between performance and sustainability indicators. "Digital revolution influences every area of the company and generates a new model for fashion shops which will pay more attention to the notion of sustainability in their future development," they concluded (Bulovi & ovi, 2020). (Krmela, 2019) indicated that digital transformation supports the implementation and spread of business models. In addition, (Yalina & Rozas, 2020) were able to come to the conclusion that the use of the digital workplace can be an option within the context of global environmental sustainability. Based on the foregoing from the theoretical literature, the hypothesis of the study can be formulated on the following:

There is a statistically significant effect of Industry 4.0 on sustainability in industrial organizations in Jordan.

3. Study model

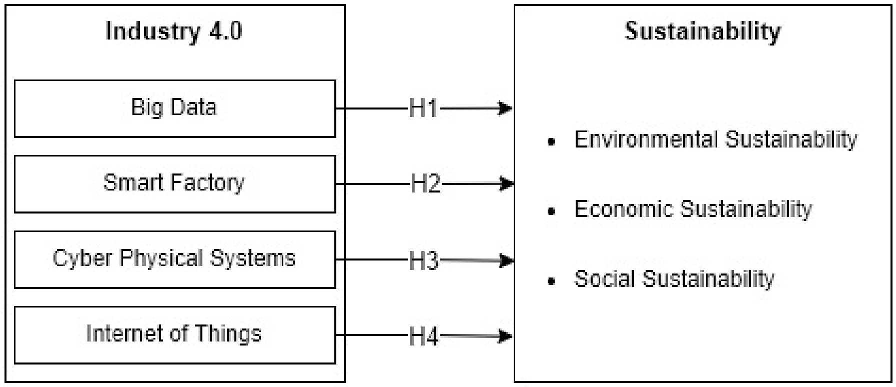

Fig. 1. Conceptual Framework

4. Research methodology

4.1 Respondents

The primary data related to the current research was collected by distributing the research instrument to the study population consisting of employees at various administrative levels of industrial organizations in Jordan. Due to the large population and the spatial and temporal limitations of the research, it was difficult to collect data using the comprehensive method. Therefore, the random sampling method was applied to collect data from the research population.

The appropriate sample size was determined according to what was indicated by Sekaran and Bougie (2016) in the unlimited population which is 383 respondents. To ensure effective sampling, the research instrument was distributed to 500 employees of industrial companies listed on the Amman Stock Exchange via e-mail. The responses were 416, while it included 26 responses whose answers did not fit with the statistical analysis procedures because the respondents were not careful in their answer. Therefore, 390 responses were used when conducting the statistical analysis of this research, as what was analyzed constitutes a response rate 0.78% of the total distributed to employees in industrial organizations in Jordan.

4.2. Measures

The instrument used in this research was a self-report questionnaire that was prepared electronically based on Google Forms. This questionnaire consisted of three main sections, where the first section was devoted to a question about the demographic information of the respondents (gender, age, work experience, educational level).

The second section included 16 items related to the independent variable represented by Industry 4.0**,** which was developed based on (Imran et al., 2018). This variable was considered a second-order construct that subdivides into four first-order constructs. Cyber-physical systems were measured by four items. Smart factory was measured using four items. The Internet of Things was measured through four items. Finally, big data was measured using four items. The items' answers were determined using a five-point Likert scale for responses alternatives.

The third section of the questionnaire consisted of 15 items devoted to measuring the dependent variable represented by sustainability, as its items were developed based on (Eslami et al., 2019). Sustainability was considered a second-order construct that was divided into three first-order constructs. Environmental sustainability was measured by five items. Economic sustainability was measured through five items. Social sustainability was measured using five items. The items' answers were determined using a five-point Likert scale for responses alternatives.

5. Research results

5.1. Measurement Model Evaluation

Confirmatory factor analysis (CFA) was applied to extract the values used to determine the validity and reliability of the measurement model. Table.1 shows the results of these tests based on determining convergent validity using the values of factor loadings and the average variance extracted (AVE). In addition to the discriminant validity test by comparing the value of AVE with the value of maximum shared variance (MSV) for each construct, as well as comparing the square root of the average variance extracted (√AVE) with the values of the correlation coefficients between the research constructs. As for the reliability, it was determined by the composite reliability (CR) of the measurement model using McDonald's Omega coefficients.

Table 1
Results of validity and reliability tests

Constructs	Items	Loadings	AVE	MSV	√AVE	CR
Big Data (BD)	BD1	0.801	0.637	0.245	0.798	0.875
	BD2	0.806				
	BD3	0.733				
	BD4	0.848				
Smart Factory (SF)	SF1	0.752	0.616	0.246	0.785	0.865
	SF2	0.769				
	SF3	0.784				
	SF4	0.832				
Cyber Physical Systems (CPS)	CPS1	0.751	0.593	0.334	0.770	0.853
	CPS2	0.726				
	CPS3	0.791				
	CPS4	0.810				
Internet of Things (IoT)	IoT1	0.815	0.634	0.210	0.796	0.874
	IoT2	0.786				
	IoT3	0.771				
	IoT4	0.812				
Environmental Sustainability (ENS)	ENS1	0.703	0.513	0.341	0.716	0.840
	ENS2	0.682				
	ENS3	0.748				
	ENS4	0.711				
	ENS5	0.735				
Economic Sustainability (ECS)	ECS1	0.782	0.573	0.216	0.757	0.870
	ECS2	0.726				
	ECS3	0.753				
	ECS4	0.813				
	ECS5	0.707				
Social Sustainability (SOS)	SOS1	0.794	0.614	0.316	0.784	0.888
	SOS2	0.856				
	SOS3	0.825				
	SOS4	0.731				
	SOS5	0.702				

The results in Table1 show that the factor loading values exceeded the minimum 0.50 to keep the factors (Ro & Ha, 2019), where the values ranged within the range (0.682-0.856). The values of AVE exceed 0.50, which is the minimum threshold for this measure (Howard, 2018). Moreover, the results indicated that the values of AVE exceed the values of MSV calculated for each construct and that the values of √AVE were higher than the correlation values for all research constructs, which are the discriminant validity conditions (Franke & Sarstedt, 2019). Therefore, the measurement model for examining the impact of Industry 4.0on sustainability was considered to have appropriate convergent and discriminant validity. Regarding reliability, the values of the McDonald's Omega coefficients used to determine the complex reliability were within the range (0.840-0.888). Padilla and Divers (2016) argued that the measurement model fulfills the condition of complex reliability if the test value exceeds the minimum threshold of 0.70. Accordingly, the model used in this paper possesses suitable composite reliability.

5.2. Descriptive Statistics

The respondents' attitudes about Industry 4.0and sustainability of industrial organizations listed in the Amman stock exchange were determined by extracting the values of means and standard deviations. Besides, the multicollinearity between the dimensions of the Industry 4.0 was tested based on the Pearson correlation matrix. Table 2 reports the results achieved from the descriptive analysis.

Table 2
Means, standard deviation, and correlation coefficients

Constructs	M	SD	1	2	3	4	5	6	7
1. BD	3.66	0.702	1						
2. SF	3.58	0.925	0.233	1					
3. CPS	3.52	0.771	0.248	0.246	1				
4. IoT	3.78	0.628	0.292	0.251	0.186	1			
5. ENS	3.70	0.819	0.401	0.264	0.305	0.371	1		
6. ECS	3.69	0.652	0.377	0.452	0.337	0.386	0.297	1	
7. SOS	3.77	0.698	0.452	0.384	0.485	0.347	0.305	0.254	1

Note: All correlation coefficients are significant at level less than 0.05.

The results indicated in Table 2 determine that the dimensions of Industry 4.0 were mostly at a moderate level, except for the internet of things (M= 3.78, SD= 0.628) which ranked first with a high level. The rest of the dimensions were at a moderate level, where big data (M= 3.66, SD= 0.702) ranked second, then smart factory (M= 3.58, SD= 0.925) ranked third, and cyber-physical systems (M= 3.52, SD= 0.771) ranked fourth. However, the dimensions of sustainability were at a high level, as social sustainability (M= 3.77, SD= 0.722) was first, followed by environmental sustainability (M= 3.70, SD= 0.819) ranked second, and finally economic sustainability (M= 3.69, SD= 0.652) in third place.

Regarding multicollinearity, the results indicated that the values of the correlation coefficients between the dimensions of the Industry 4.0 were within the range (0.186-0.292). Senaviratna and Cooray (2019) deemed that correlation values that do not exceed 0.80 are considered appropriate and indicate that the data is free from the multicollinearity problem. Accordingly, the study data does not suffer from the multicollinearity problem between the dimensions of Industry 4.0and each dimension was autonomous.

5.3 Structural Model

The structural equation modeling (SEM) technique was used to test the impact of Industry 4.0dimensions on sustainability. Fig. 2 demonstrates the model used in this test in conjunction with the results of goodness of fit indicators.

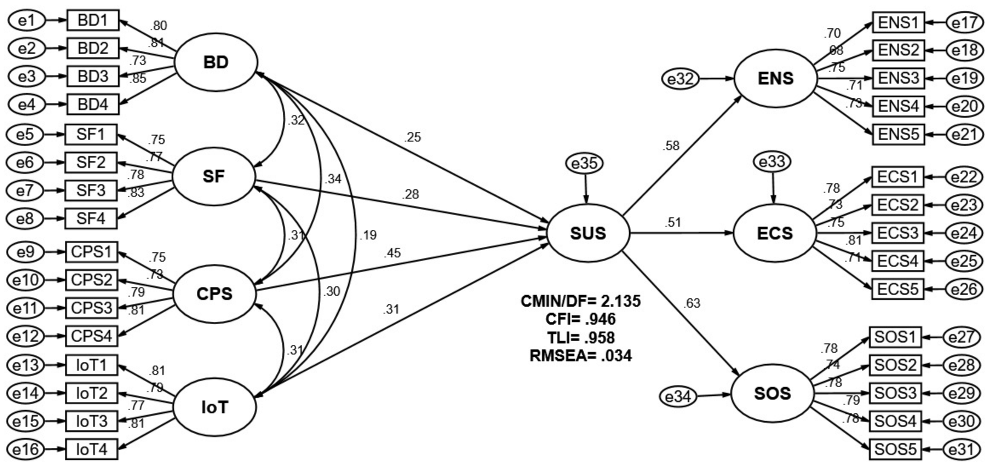

Fig. 2. SEM for testing the impact of Industry 4.0 on Sustainability

The results reported in Fig. 2 indicate that the chi-squared ratio (CMIN/DF) was 2.135, which is less than 3 the upper limit adopted for this indicator (Jorgensen, 2020). The value of the comparative fit index (CFI) and the Tucker-Lewis index (TLI) exceeded the lower limit of 0.90 (Xia & Yang, 2019). Moreover, the value of the root mean square error of approximation (RMSEA) was less than 0.08 which is the upper threshold for this indicator (Niemand & Mai, 2018). Therefore, the model used to assess the impact of Industry 4.0on sustainability was appropriate and characterized by constructional validity. Table 3 lists the values of standardized and unstandardized coefficients to examine the impact of Industry 4.0 on sustainability.

Table 3
Summary of effect coefficients

Path	B	S.E	β	t-value	p-value
BD→ SUS	0.225	0.024	0.255	9.375***	0.000
SF→ SUS	0.241	0.025	0.284	9.640***	0.000
CPS→ SUS	0.385	0.031	0.451	12.419***	0.000
IoT→SUS	0.301	0.026	0.312	11.577***	0.000

Note: * p ≤ 0.05, ** p < 0.01, *** p < 0.001.

The results presented in Table 3 confirmed that all dimensions of Industry 4.0had an impact on sustainability. The greatest effect was for cyber-physical systems (β= 0.451, t= 12.419, p= 0.000), followed by the internet of things (β= 0.312, t= 11.577, p=0.000) in the second place, then smart factory (β= 0.284, t= 9.640, p=0.000) in the third place, and finally big data (β= 0.255, t= 9.375, p= 0.000) in the fourth place.

6. Discussion

The results of the study concluded that there is an impact of Industry 4.0 on sustainability in the industrial organizations in Jordan. This result is consistent with the study (Soltani Delgosha et al., 2020), which indicates the importance of digitization to achieving sustainable development goals and the results of the study (Esses, Csete, & Nemeth, 2021), which shows the relationship between digital performance and sustainability indicators. According to Bulovi and Ovi (2020), the digital revolution influences every part of the company and generates a new paradigm for fashion merchants that will prioritize sustainability in their future development. Massah and Mohieldin (2020) found in their study that the localization of the Sustainable

Development Goals (SDGs) allows governments to effectively design sustainable development strategies at the local level, which can be enhanced through digital transformation, as indicated by Papyshev (2017) in his study that Industry 4.0 can have a potentially significant impact on several SDGs. A study (Nara, da Costa, Baierle, Schaefer, Benitez, do Santos & Benitez, 2021) demonstrated that digital transformation technologies are catalysts for long-term development. Furthermore, the study discovered that robots has a negative influence on job creation and that cloud computing and systems integration technologies have modest implications on sustainable growth. Krmela (2019) indicated in his study that digital transformation supports the implementation and spread of business models for sustainability. The study (Chandola, 2015) also determined that digital transformation has a significant impact on the company's sustainability and that it should be considered as part of the overall strategy, and that digital technologies not only change markets but also create new business models but provide solutions for enterprises to address sustainability challenges. The results of the study (Bieser & Hilty, 2018) show that digital revolution has both direct and indirect implications on greenhouse gas emissions. The creation, usage, and waste of communication and information technology (ICT) devices have direct effects, while shifts in consumption and production patterns have indirect repercussions. The study's findings also show that ICT has the potential to reduce greenhouse gas emissions in Switzerland, particularly in the construction, transportation, and energy sectors. Also (Yalina & Rozas, 2020), in their study, they were able to conclude that the application of the digital workplace can be an alternative within the framework of global environmental sustainability.

7. Recommendations

The study concluded that there is an impact of Industry 4.0 with its dimensions represented in cyber-physical systems (CPS), smart factories, the Internet of Things (IoT), and Big Data on sustainability. Based on this result, researchers recommend the management of industrial organizations invest in information technology to provide a large variety of data in a very short time, and providing appropriate programs for analyzing big data and producing accurate and reliable information that can be used by employees; and hiring experts and specialists to use the results of data analysis by developing strategies to support sustainable development in factories. In addition to linking the factory devices with identification, sensing, networking, and processing capabilities that allow the devices to communicate with each other and with other devices and services via the Internet, providing portable devices equipped with programs connected to the Internet of Things systems located in the factory, providing high-quality Internet coverage, and training employees to gain the knowledge necessary to deal with Internet of Things systems .

8. Limitations and direction for future research

The study dealt with the impact of Industry 4.0 on sustainability, and it is possible for another study to address the impact of Industry 4.0 on inventory management, supply chain management, quality management, customer service, organizational productivity, or the performance of the organization, and the study measured Industry 4.0 in its dimensions as represented in big data, smart factories, the Internet of things, and cyber-physical systems. Another study could address Industry 4.0 in other dimensions represented by cloud computing, mobile devices, cloud manufacturing, and other technologies. 4.0, the study measured sustainability as represented by the economic, social, and environmental dimensions, and another study could add to them the governance dimension. The study also dealt with the industrial organizations as a community for study, and therefore, another study can deal with the tourism sector, service organizations, the educational sector, the public sector (the state sector), or the telecommunications sector. Since the study dealt with industrial organizations, it is possible for another study to conduct a comparative study with a second country, or a comparative study in the same country with service organizations.

References

Ait Sidhoum, A., & Serra, T. (2017). Corporate sustainable development. Revisiting the relationship between corporate social responsibility dimensions. *Sustainable Development*, *26*(4), 365-378.https://doi.org/10.1002/sd.1711

Al-Quran, A. Z., Alhalalmeh, M. I., Eldahamsheh, M. M., Mohammad, A. A., Hijjawi, G. S., Almomani, H. M., & Al-Hawary, S. I. (2020). Determinants of the Green Purchase Intention in Jordan: The Moderating Effect of Environmental Concern. *International Journal of Supply Chain Management, 9*(5), 366-371.

Alhalalmeh, M. I., Almomani, H. M., Altarifi, S., Al- Quran, A. Z., Mohammad, A. A., & Al-Hawary, S. I.. (2020). The nexus between Corporate Social Responsibilty and Organizational Performance in Jordan: the mediating role of Organizational Commitment and Organizational Citizenship Behavior. *Test Engineering and Management*, *83*(July), 6391 - 6410.

AlHamad, A., Alshurideh, M., Alomari, K., Kurdi, B., Alzoubi, H., Hamouche, S., & Al-Hawary, S. (2022). The effect of electronic human resources management on organizational health of telecommunications companies in Jordan. *International Journal of Data and Network Science*, *6*(2), 429-438.

Al-Hawary, S. I. S., & Alhajri, T. M. S. (2020). Effect of Electronic Customer Relationship Management on Customers' Electronic Satisfaction of Communication Companies in Kuwait. *Calitatea*, *21*(175), 97-102.

Al-Hawary, S. I. S., & Al-Rasheedy, H. H. (2021). The effect of strategic learning for human resources on dynamic capabilities of airlines companies in Kuwait. *International Journal of Business Information Systems*, *37*(4), 421-441.

Al-Hawary, S. I. S., & Obiadat, A. A. (2021). Does mobile marketing affect customer loyalty in Jordan?. *International Journal of Business Excellence*, *23*(2), 226-250.

Al-Hawary, S. I. S., Mohammad, A. S., Al-Syasneh, M. S., Qandah, M. S. F., & Alhajri, T. M. S. (2020). Organisational learning capabilities of the commercial banks in Jordan: do electronic human resources management practices matter?. *International Journal of Learning and Intellectual Capital*, *17*(3), 242-266.

Al-Hawary, S. I., & Al-Syasneh, M. S. (2020). Impact of dynamic strategic capabilities on strategic entrepreneurship in presence of outsourcing of five stars hotels in Jordan. *Business: Theory and Practice*, *21*(2), 578-587.

Al-Qudah, K. A., Al-Hawary, S. I., & Al-Mehsen, M. A. (2012). Electronic Credit Cards Usage and Their Impact on Bank's Profitability: The Rate of Return on Owners Equity Model: An Empirical Study. *Interdisciplinary Journal of Contemporary Research in Business*, *4*(7), 828–841.

Al-Shormana, H., Alshawabkeh, R., Aldaihani, F., Aityassine, F., Mohammad, A., & Al-Hawary, S. (2021). Drivers of E-training Intention to Use in the private universities in Jordan. *International Journal of Data and Network Science, 5*(4), 831–836.

Altarifi, S., Al-Hawary, S. I. S., & Al Sakkal, M. E. E. (2015). Determinants of E-Shopping and its Effect on Consumer Purchasing Decision in Jordan. *International Journal of Business and Social Science, 6*(1), 81–92.

AlTaweel, I. R., & Al-Hawary, S. I. (2021). The Mediating Role of Innovation Capability on the Relationship between Strategic Agility and Organizational Performance. *Sustainability*, *13*(14), 7564.

Al-Alwan, M., Al-Nawafah, S., Al-Shorman, H., Khrisat, F., Alathamneh, F., & Al-Hawary, S. (2022). The effect of big data on decision quality: Evidence from telecommunication industry. *International Journal of Data and Network Science*, *6*(3), 693-702.

Al-Alwan, M., Bader, D., Al-Qatawneh, M., Alneimat, S., & Al-Hawary, S. (2022). E-HRM and employee flexibility in Islamic banks in Jordan. *International Journal of Data and Network Science*, *6*(3), 703-710.

Bettiol, M., Capestro, M., Di Maria, E., & Furlan, A. (2019). Impacts of industry 4.0 investments on firm performance: Evidence from Italy (No. 0233). Dipartimento di ScienzeEconomiche" Marco Fanno".

Bulović, V., & Čović, Z. (2020, September). The impact of digital transformation on sustainability in fashion retail. In Proceedings of the 2020 IEEE 18th International Symposium on Intelligent Systems and Informatics (SISY), (pp. 000149-000154). Subotica, Serbia: IEEE.https://doi.org/10.1109/SISY50555.2020.9217087

Chandola, V. (2015). Digital transformation and sustainability: Study and analysis. Havard University, Cambridge.https://www.researchgate.net/profile/Vikas-Chandola/publication/292983072_Digital_Transformation_and_Sustainability/links/56b3a54808ae1f8aa453513b/Digital-Transformation-and-Sustainability.pdf

De Loecker, J., & Goldberg, P. K. (2014). Firm Performance in a Global Market. *Annual Review of Economics, 6*(1), 201-227.https://doi.org/10.1146/annurev-economics-080113-104741

Eldahamsheh, M.M., Almomani, H.M., Bani-Khaled, A.K.,Al-Quran, A.Z., Al-Hawary, S.I.S& Mohammad, A.A (2021). Factors Affecting Digital Marketing Success in Jordan. *International Journal of Entrepreneurship, 25*(S5), 1-12.

Eslami, Y., Dassisti, M., Lezoche, M., & Panetto, H. (2019). A survey on sustainability in manufacturing organisations: dimensions and future insights. *International Journal of Production Research, 57*(15-16), 5194-5214.

Esses, D., Csete, M. S., & Németh, B. (2021). Sustainability and Digital Transformation in the Visegrad Group of Central European Countries. *Sustainability, 13*(11), 5833.https://doi.org/10.3390/su13115833

Feroz, A. K., Zo, H., & Chiravuri, A. (2021). Digital transformation and environmental sustainability: A review and research agenda. *Sustainability, 13*(3), 1530.https://doi.org/10.3390/su13031530

Franke, G., & Sarstedt, M. (2019). Heuristics versus statistics in discriminant validity testing: a comparison of four procedures. *Internet Research, 29*(3), 430-447.

Frolick, M. N., &Ariyachandra, T. R. (2006). Business Performance Management: One Truth. *Information Systems Management, 23*(1), 41-48. https://doi.org/10.1201/1078.10580530/45769.23.1.20061201/91771.5

Garg, P. (2015). Impact of sustainability reporting on firm performance of companies in India. *International Journal of Marketing and Business Communication, 4*(3), 38-45. Available at: https://cutt.us/TtLrM

Gray, B. J., Matear, S., & Matheson, P. K. (2002). Improving service firm performance. *Journal of Services Marketing, 16*(3), 186-200. https://doi.org/10.1108/08876040210427191

Gubán, M., &Kovács, G. (2017). INDUSTRY 4.0 CONCEPTION. *ActaTechnicaCorviniensis-Bulletin of Engineering, 10*(1), 111-114.

Hami, N., Muhamad, M. R., & Ebrahim, Z. (2015). The impact of sustainable manufacturing practices and innovation performance on economic sustainability. *Procedia Cirp*, *26*, 190-195.https://doi.org/10.1016/j.procir.2014.07.167

Hrustek, L. (2020). Sustainability driven by agriculture through digital transformation. *Sustainability, 12*(20), 8596.https://doi.org/10.3390/su12208596

Hueting, R., & Reijnders, L. (1998). Sustainability is an objective concept. *Ecological economics, 27*(2), 139-148. Available at:https://cutt.us/0D43x

Hussain, N. (2015). Impact of sustainability performance on financial performance: an empirical study of global fortune (N100) firms. Department of Management, Università Ca' Foscari Venezia Working Paper, 2015/01. Available at: https://ssrn.com/abstract=2616835

Imran, M., ul Hameed, W., & ul Haque, A. (2018). Influence of industry 4.0 on the production and service sectors in Pakistan: Evidence from textile and logistics industries. *Social Sciences, 7*(12), 246.https://doi.org/10.3390/socsci7120246

Jiang, Q., Liu, Z., Liu, W., Li, T., Cong, W., Zhang, H., & Shi, J. (2018). A principal component analysis based three-dimensional sustainability assessment model to evaluate corporate sustainable performance. *Journal of Cleaner Production*, *187*, 625-637.https://doi.org/10.1016/j.jclepro.2018.03.255

Krmela, A. (2019). Towards Sustainability through Business Model Dynamics in the Era of Digital Transformation. In Proceedings of the International Conference at Brno University of Technology, Faculty of Business and Management, (pp. 35). Brno, Czech Republic: Brno University of Technology. Available at: https://www.konference.fbm.vutbr.cz/ic/index.php/ic/article/view/113/78

Lee, E. A. (2008, May). Cyber physical systems: Design challenges. In Proceedings of the 2008 11th IEEE International Symposium on Object and Component-Oriented Real-Time Distributed Computing (ISORC), (pp. 363-369). Orlando, FL, USA: IEEE. https://doi.org/10.1109/ISORC.2008.25

León García, O. A., & Baez Landeros, E. R. (2020). Analysis of the Relationship Between IT and Industry 4.0 Technologies with Internationalization and Business Performance. Ingeniería e Investigación, 40(3), 89-99.https://doi.org/10.15446/ing.investig.v40n3.81696

Lin, B., Wu, W., & Song, M. (2019). Industry 4.0: Driving factors and impacts on firm's performance: An empirical study on China's manufacturing industry. Annals of Operations Research, 1-21.https://doi.org/10.1007/s10479-019-03433-6

Lucke, D., Constantinescu, C., Westkämper, E. (2008). Smart Factory - A Step towards the Next Generation of Manufacturing. In M. Mitsuishi, K. Ueda, F. Kimura (Eds.), Proceedings of the Manufacturing Systems and Technologies Conference for the New Frontier. London, UK: Springer. https://doi.org/10.1007/978-1-84800-267-8_23

Niemand, T., Mai, R. (2018). Flexible cutoff values for fit indices in the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 46*(6), 1148-1172.

Osterrieder, P., Budde, L., & Friedli, T. (2020). The smart factory as a key construct of industry 4.0: A systematic literature review. *International Journal of Production Economics, 221*, 107476.https://doi.org/10.1016/j.ijpe.2019.08.011

Padilla, M.A., & Divers, J. (2016). A Comparison of Composite Reliability Estimators: Coefficient Omega Confidence Intervals in the Current Literature. *Educational and Psychological Measurement, 76*(3), 436-453.

Pislaru, M., Herghiligiu, I. V., & Robu, I. B. (2019). Corporate sustainable performance assessment based on fuzzy logic. *Journal of cleaner production*, 223, 998-1013.https://doi.org/10.1016/j.jclepro.2019.03.130

Rahman, M., Kamal, M. M., Aydin, E., & Ul Haque, A. (2020). Impact of Industry 4.0 drivers on the performance of the service sector: comparative study of cargo logistic firms in developed and developing regions. *Production Planning & Control, 33*(2-3), 228-243.https://doi.org/10.1080/09537287.2020.1810758

Rastislav, R., & Petra, L. (2016). Strategic performance management system and corporate sustainability concept-specific parametres in Slovak Enterprises. *Journal of Competitiveness*, *8*(3), 107-124. https://doi.org/10.7441/joc.2016.03.07

Ro, Y., & Ha, Y. (2019). A Factor Analysis of Consumer Expectations for Autonomous Cars. *Journal of Computer Information Systems, 59*(1), 52-60.

Rosin, F., Forget, P., Lamouri, S., &Pellerin, R. (2019). Impacts of Industry 4.0 technologies on Lean principles. *International Journal of Production Research, 58*(6), 1644-1661. https://doi.org/10.1080/00207543.2019.1672902

Schwertner, K. (2017). Digital transformation of business. *Trakia Journal of Sciences, 15*(1), 388-393.https://doi.org/10.15547/tjs.2017.s.01.065

Sekaran, U., & Bougie, R. (2016). *Research methods for business: a skill-building approach* (Seventh edition). Wiley.

Senaviratna, N.A.M.R., &Cooray, T.M.J.A. (2019). Diagnosing Multicollinearity of Logistic Regression Model. *Asian Journal of Probability and Statistics, 5*(2), 1-9.

Shahzad, M., Qu, Y., Zafar, A. U., Rehman, S. U., & Islam, T. (2020). Exploring the influence of knowledge management process on corporate sustainable performance through green innovation. *Journal of Knowledge Management*, 24(9), 2079-2106. https://doi.org/10.1108/JKM-11-2019-0624

Soltani Delgosha, M., Haji Heydari, N. & Saheb, T. (2020). The configurational impact of digital transformation on sustainability: a country-level perspective. In F. Rowe, R. El Amrani, M. Limayem (Eds.), Proceedings of the 28th European Conference on Information Systems (ECIS2020) (Virtual conference), (pp. 15-17). Marrakech, Morocco: The University of Sheffield. Available at:https://aisel.aisnet.org/ecis2020_rp/33/

Sony, M., &Naik, S. (2019). Key ingredients for evaluating Industry 4.0 readiness for organizations: a literature review. *Benchmarking: An International Journal*. 1-20. https://doi.org/10.1108/BIJ-09-2018-0284

Stankeviciute, Z., & Savaneviciene, A. (2013). Sustainability as a concept for human resource management. *Economics and Management*, *18*(4), 837-846.https://doi.org/10.5755/j01.em.18.4.5631

Stock, T., & Seliger, G. (2016). Opportunities of sustainable manufacturing in industry 4.0. *Procedia CIRP, 40*, 536-541.https://doi.org/10.1016/j.procir.2016.01.129

Tarasov, I. V. (2018). Industry 4.0: concept & development. *Business strategies, 5*(49), 1-7.

Tariq, E., Alshurideh, M., Akour, I., & Al-Hawary, S. (2022). The effect of digital marketing capabilities on organizational ambidexterity of the information technology sector. *International Journal of Data and Network Science*, *6*(2), 401-408.

Vaidya, S., Ambad, P., &Bhosle, S. (2018). Industry 4.0–a glimpse. *Procedia manufacturing, 20*, 233-238. https://doi.org/10.1016/j.promfg.2018.02.034

Xia, Y., &Yang, Y. (2019). RMSEA, CFI, and TLI in structural equation modeling with ordered categorical data: The story they tell depends on the estimation methods. *Behavior Research Methods, 51*(1), 409-428.

Yalina, N., & Rozas, I. S. (2020, February). Digital workplace: digital transformation for environmental sustainability. In Proceedings of the IOP Conference Series: Earth and Environmental Science, (Vol. 456, No. 1, pp. 012022). IOP Publishing.https://doi.org/10.1088/1755-1315/456/1/012022

Zulkarnain, N., &Anshari, M. (2016, November). Big Data: Concept, Applications, & Challenges. In Proceedings of the 2016 International Conference on Information Management and Technology (ICIMTech), (pp. 307-310). Aston Tropicana Hotel, Bandung, Indonesia: IEEE. https://doi.org/10.1109/ICIMTech.2016.7930350