

Article

An Investigation upon Industry 4.0 and Society 5.0 within the Context of Sustainable Development Goals

Yunus Zengin ¹ , Serkan Naktiyok ^{2,*} , Erdoğan Kaygın ¹ , Onur Kavak ¹  and Ethem Topçuoğlu ³ 

¹ Faculty of Economics and Administrative Sciences, Kafkas University, Kars 36000, Turkey; yunuszenin23@gmail.com (Y.Z.); erdogankaygin@hotmail.com (E.K.); onurkavak@kafkas.edu.tr (O.K.)

² Faculty of Economics and Administrative Sciences, Atatürk University, Erzurum 25000, Turkey

³ Social Sciences Institute, Kafkas University, Kars 36000, Turkey; ethemtopcuoglu@kafkas.edu.tr

* Correspondence: snaktiyok@atauni.edu.tr

Abstract: In the literature, quite limited research exists on the subject of Society 5.0. The present study examined the existence of Society 5.0 and the effectiveness of Industry 4.0 and evaluated the efficiency of United Nations Development Goals (SDGs) in this process, especially in Turkey. The research was carried out based on data obtained through a survey form with 30 questions which was conducted with 335 academicians working at Kafkas University. The data were analyzed by means of exploratory factor analysis with the SPSS program, confirmatory factor analysis with AMOS, and structural equation modeling with Smart PLS. The analysis results indicated that SDG9, SDG10, SDG11, SDG12, SDG13, and SDG14 had a low influence (i.e., R^2 : 0.172) on the application of Industry 4.0 and Society 5.0. Moreover, it was observed that the participants were heavily affected by order of the day and gave responses to the questions with that impact. The study also revealed that Turkey did not have a leading philosophy in the field of Society 5.0 and Industry 4.0 and made progress by concentrating on out-dated processes.

Keywords: Society 5.0; super smart society; SDGs; Industry 4.0; digitalized society



Citation: Zengin, Y.; Naktiyok, S.; Kaygın, E.; Kavak, O.; Topçuoğlu, E. An Investigation upon Industry 4.0 and Society 5.0 within the Context of Sustainable Development Goals.

Sustainability **2021**, *13*, 2682.

<https://doi.org/10.3390/su13052682>

Academic Editor: Radosław Wolniak

Received: 8 February 2021

Accepted: 24 February 2021

Published: 2 March 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The “Industry 4.0” program was initiated in 2011 at Hannover Trade Exhibition by the government of Germany [1]. Industry 4.0 involves technical integration of new technologies such as artificial intelligence, the cloud, cyber physical system, and internet of things for industrial production [2]. With the change formed, it is aimed to enable an interaction and connection between human and machine and among machines. As a result, the production systems will be faster by 30% and more efficient by 25% [3]. Industry 4.0 is a technological attempt planned to be used only in the field of manufacturing industry in which all the processes from production to logistics are followed through the internet of things [4]. The countries to be influenced by Industry 4.0 have given new and different meanings to Industry 4.0 with new plans and projects in accordance with their own dynamics [5]. Germany’s Industry 4.0 strategy added new interpretations by putting the programs, such as “Advanced Manufacturing Partnership” by the USA, “UK Industry 2050” by the UK, “Made in China 2025” by China, “New Industrial France” by France, “Manufacturing Innovation 3.0” by South Korea, “Society 5.0” by Japan, into use [6].

The structure, concentrating only on industrial production with Industry 4.0, is attempting to be spread into every area of the society by being expanded through Society 5.0 [7]. It is aimed to increase the growth rate of Japanese society and eliminate the negative effects such as an old age population in the social structure with the help of technology [8]. The literature has unfortunately limited research on Society 5.0. According to data from the Web of Science, only 52 studies dealing merely with the topic of Society 5.0 are available in the literature [9]. For this reason, through examination of those limited studies, it was found that the United Nations Sustainable Development Goals (SDGs) formed one of the

basics of Society 5.0 [7,8,10]. The present study investigated whether the aims determined in SDGs created a sense of orientation and influence towards Industry 4.0 and Society 5.0 in Turkey as a country accepting SDGs. The study was conducted with the academic staff at Kafkas University.

2. Literature Review

2.1. Industry 4.0

The logic behind the creation of Industry 4.0 in Germany involves cooperation between private companies and universities to develop those systems and procurement of a budget for research and development by the government [11]. Recently, many efficient and effective systems using technologies, such as artificial intelligence, Internet of Things (IoT) and cyber physical systems, have been introduced [12]. However, those systems could be established and put into service in countries which do not have such developed technology on condition that their cost was afforded by some firms. The services, such as “Industrial Internet” by General Electric [13], “Industry 4.0” by IBM [14], “Internet of Everything” by Cisco [15], and Lumada by Hitachi [16], are brought into use for infrastructures of the country and companies. In Turkey, the fourth Industrial Revolution Center was founded in collaboration with the World Economic Forum (WEF) in 9 December 2020 and Turkey set a course for this issue [17]. Not only Turkey but also many countries themselves perform works such as planning, budgeting and organization so as to possess new production technology along with Industry 4.0 [18].

Artificial intelligence, the cloud, big data, cyber physical systems, and IoT form the main technologies of Industry 4.0 [19]. As a result of fast development of technology, large amounts of data are gathered in the field of both production and daily life and all those data are called big data. The big data are gathered from various sources like the internet and social media networks such as production systems, Facebook, Instagram, Twitter, and Weibo [20]. The gathered big data are raw data and their accurate manipulation through artificial intelligence makes great contribution to the business, which involve the increase in efficiency, applicable designs, more accurate demand estimates, an increase in customer loyalty as customers’ expectations are considered and creating more effective strategic plans for the business [21]. The cloud system is required in order to store big data and to conduct immediate analysis. The use of the cloud systems is possible by renting them from various firms and by having access to them through the internet [22]. In order for the cloud system to work efficiently, internet of things (IoT) is required, which refers to an internet connection which provides things to perceive the real world, communicate with each other and work in collaboration with each other [23]. On the other hand, cyber physical systems (CPS) are defined as transformative technologies which transform physical entities detected through sensors into knowledge that could be comprehended by the robots and transmit how that knowledge can be used by the robots to other robots and humans [24]. Connecting physical systems and cyber systems to each other, CPS provides connection between humans and machine and among machines through wireless sensors, IoT connections, smart phones, and tablets [25]. Artificial intelligence (AI) is a technical system that can calculate automatically how the whole system should be planned so as to reach targets and which strategies should be determined and that can develop new tactics by following instant changes occurring as a result of automatized planning [26].

2.2. Industry 4.0 and Society 5.0 Relationship

Many advantages, such as reducing the costs, zero error with machines dependent on artificial intelligence and supplying individualized products on time to the customers, have come into the business life due to Industry 4.0 [27]. However, if humans do not work and earn money, a big concern arises; by whom and how those products produced by smart factories will be bought [28,29]. This problem is planned to be solved through Society 5.0 which is accepted by Japan and plans its priority in accordance with science, technology, innovation, and the United Nations Sustainable Development Goals. Society 5.0 suggests

that many problems, including unemployment, poverty, and air pollution, will be solved under the leadership of artificial intelligence [30].

As a result of the Industrial Revolution in 1784, the technological developments experienced in the field of industry are realized to have caused significant changes in the structure of the society [31]. The term Society 5.0 confronts us first with the 5th Science and Technology Basic Plan dated 18 December 2015. In the 5th Science and Technology Basic Plan, it was planned that Society 5.0 (super smart society) would be popularized under the leadership of science, technology, and innovation [32]. When Industry 4.0 is compared with Society 5.0, it is realized that similar technologies, such as artificial intelligence, cyber physical systems, big data, the internet of things, robots, augmented reality, and the cloud, are utilized as well [33]. In management of a similar system, take place private business, universities, and a modeling and planning under the guidance and leadership of the government. While Industry 4.0 is effective in a limited area as its practice area involves the industry, Society 5.0 chooses the whole society, including the industry as practice area for itself [34]. Moreover, many social events, such as health, poverty, prosperity, easy access to water and food, smart agriculture practices, and gender equality, are handled in Society 5.0 whereas Industry 4.0 focuses mainly upon reducing the costs and more effective production techniques in industry [35]. Due to reasons such as sustainable energy policy, economic growth, development of new working models, high and effective production, safe and smart waste management, and use of infrastructure systems reasonably and sustainably, there is a direct relationship between Industry 4.0 and SDG7, SDG-8, SDG-9, SDG-11, SDG-12, and SDG-13 [36]. However, the Society 5.0 embodies all the SDGs.

The reason why Japan, a modern country with advanced technology and high income, felt it necessary to prepare a development plan like Society 5.0, creates a significant paradox. So, as to be able to understand that paradox:

Many countries ranging from the USA to France, China, South Korea, and Italy prepared their own application plans similar to Industry 4.0 in order to buy cheap and market by using smart technologies [37]. The prepared plans are factors that reduce the competitive power of Japanese companies at international markets and make it difficult for them to compete with their rivals. Society 5.0 confronts us as an obligatory practice so as to close the gap and for sustainable economic stability. For this reason, the companies such as Panasonic, NEC, Toyota, Fujitsu, and Hitachi began to integrate Society 5.0 into their institutional strategies [16].

The rate of people at the age of 65 and over in Japan constitutes 26.7% of the total population and this rate is expected to reach 40% in 2050 [38]. Along with the old age population, many problems have existed in Japan. According to the Ministry of Economy, Trade, and Industry (METI), many fatal traffic accidents occur due to accidents caused by old drivers [39]. Although a social insurance expenditure costing 120 trillion yen was made for the old age population in 2015, that number is expected to reach 150 trillion yen in 2025 [10]. Due to an increasing old age population in Japan, the fact that the economic balance is not disturbed and social insurance services are carried out sustainably, forms one of the expectations of Japan from the Society 5.0.

The population of Japan is estimated to decrease from 127 million to 117 million in 2030 and to 97 million in 2050 [40]. Since 1980, considerable decline has been experienced in the number of people living in urban areas in Japan as a decrease has been experienced in the population of 503 cities out of 790 cities in Japan [41]. A great majority of big infrastructure systems in Japan such as bridges, highways, and water lines were constructed between 1950 and 1970. In the course of times, those constructions started to wear off, hence, the new ones are needed to be constructed [10]. Through the Society 5.0, an effective solution is aimed to plan the infrastructure systems in an appropriate way

According to data in 2016, Japan is the sixth country which releases the most greenhouse gases [42]. In accordance with the Paris Treaty, Japan aims at decreasing greenhouse gas emission by 26% in 2030 when compared to the level in 2013 [43]. So, as to ensure this decrease, the activities of using energy-saving smart lighting systems at homes and

extending the use of solar energy systems are performed [44]. When the data in 2016 are considered, it is realized that 18% of greenhouse gases in Japan is formed by the sector of transport [45]. In order to reduce greenhouse gases emitted by the vehicles, electrically propelled vehicles (BEVs), natural gas operated vehicles (NGVs), and hydrogen vehicles (FCVs) are concentrated on [46]. It is declared that the vehicles produced by Toyota will work totally or partially with the electric system till 2050 [47]. It is planned that the most effective address description will be performed in accordance with instant location for the drivers thanks to the foundation of smart cities and construction of more effective infrastructure (i.e., road, bridge, and tunnel) will reduce greenhouse gas emission as a result of measuring locations used [48].

Japan faces many natural disasters such as tsunamis, storms, and earthquakes due to its location and being an island country. For instance, the Fukushima-Daichii nuclear plant disaster occurring after the large-scale East Japan Earthquake and Tsunami in 2011 showed that the natural disaster earthquake triggered a tsunami and the tsunami caused a nuclear disaster [49]. Japan, therefore, tries to diminish the effects of natural disasters by establishing effective controlling systems. Moreover, thanks to Society 5.0, it is aimed to integrate women into the business life much more and perform smart agriculture and smart food applications for a sustainable society structure [10,50,51].

Society 5.0 is a system trying to find solutions to the problems experienced in Japan by utilizing many different infrastructure and systems simultaneously. The system in question is presented in Figure 1.



Figure 1. Society 5.0 for Sustainable Development Goals (SDGs) [52].

The sustainable infrastructure systems correlate with SDG 9, SDG11 and SDG12, SDG1, SDG2, SDG12, SDG14, and SDG15 in terms of smart agriculture and food, SDG4, SDG5, SDG8, SDG10, SDG16, and SDG17 in terms of e-learning system, SDG3, SDG9, SDG11, SDG13, SDG14, SDG15, SDG16, and SDG17 in terms of early warning systems, SDG4, SDG5, SDG8, and SDG10 in terms of empowering women, SDG7, SDG11, SDG12, and SDG13 in terms of sustainable energy, SDG6, SDG7, SDG13, SDG14, and SDG15 in terms of remote sensing and oceanographic data.

3. Materials and Methods

Turkey became a member of the United Nations as a founding member in 26 June 1945 [53]. Turkey takes part within the scope of the United Nations as a respected member which acts in accordance with many treaties and laws. During the meeting held in September, 2015 by the United Nations, the Sustainable Development Goals (SDGs) involving all the member countries were accepted [54]. SDGs consist of 17 items, 169 goals, and 232 charts involving economic elements, environmental elements such as climate change,

water sources, and sea and land life, as well as social elements such as human rights, equality, and gender equality [55]. Until 2030, those goals are planned to be achieved gradually. The 17 goals stated are as follows:

- No Poverty (SDG1): Removing extreme poverty, providing humans an easy access to basic sources and services and protecting people against economic and environmental events are the aim [54].
- Zero Hunger (SDG2): It is aimed that all the people have access to safe, nutrient, and enough food throughout the year and the poverty on earth is eliminated [56].
- Good Health and Well-Being (SDG3): It is aimed to supply people with basic health needs such as treatment, diagnosis, medical care, and economic medicine [57].
- Quality Education (SDG4): An equal, life-long, and accessible education, which involves everybody from each age group, is aimed to be encouraged [58].
- Gender Equality (SDG5): It is aimed to provide gender equality in communities and strengthen the circumstances of women and girls in the society by the United Nations [59].
- Clean Water and Sanitation (SDG6): Water is one the most significant substances in the world so as to maintain life and for all living things. Therefore, it is aimed to take new measures so as to supply people with fresh and drinkable water and to use technology effectively [60].
- Affordable and Clean Energy (SDG7): It is aimed to support energy production from resources such as geothermal, hydro solar, wind, and sea waves which do not cause an increase in CO₂ emissions [61].
- Decent Work and Economic Growth (SDG8): The main aim is to ensure economic development and employing people in decent work and a work and development model which is consistent, provides gender equality, involves low or no risk, and involves relevant payments in return for human efforts is intended [62].
- Industry, Innovation, and Infrastructure (SDG9): It aims to increase human welfare by creating innovations, produce eligible products in accordance with human needs by using those innovations in the field of industry, and to construct bridges, roads, airports, water, and sewage infrastructure which are much safer, of high quality, and stronger [63].
- Reduced Inequalities (SDG10): It is aimed to reduce inequalities among countries and within countries and to prevent people from being exposed to discrimination due to age, gender, ethnicity, religion, political beliefs, and disabilities [64].
- Sustainable Cities and Communities (SDG 11): More than half of the world population lives in cities. It is aimed to reduce the life in slums, increase transportation facilities, arrange sewage and other infrastructure affecting human health, and to actualize and plan programs and practices oriented towards forming decent sustainable cities [65].
- Responsible Consumption and Production (SDG12): It is aimed to use food, water, houseware, electronic devices, energy, and all the fossil fuels economically and cyclically and to respect the future as the environmental effects of the products that we use today create greater threats for the future [66].
- Climate Action (SDG13): It aims to reduce the use of fossil fuels and the consumption of fossil-fuel dependent energy, to create carbon-free cities so as to be able to reduce climate changes, to take measures against natural disasters resulting from climate change and develop counter measures [67].
- Life under Water (SDG14): It is aimed to ensure effective use of oceans, seas, and those resources, to compensate for the destructions, to create a healthy structure, and to make use of resources sustainably [68].
- Life on Land (SDG15): It focuses on protection of ecosystems and species on earth and their sustainable use [69].
- Peace, Justice, and Strong Institutions (SDG16): Every year, many people die as a result of gunfights among countries or caused by splinter groups. Those conflicts

prevent taking service to the people and forming a more judicious and peaceful environment [70].

- Partnerships for The Goals (SDG17): It is aimed to help development of the whole world by enabling effective cooperation and communication among countries [71].

Turkey prepares various plans and programs so as to actualize 17 goals in question. The efficiency, follow-up, and control of the plans made by Turkey are performed and the final reports prepared in Turkish and English are published on the official website [72]. Furthermore, Turkey has taken many responsibilities within this context. For example, Turkey has promised that it will decrease CO₂ emission by 21% by 2030 in comparison to the level in 2013 [54]. In this respect, the questions were prepared by the authors so as to examine whether the SDGs had an influence on Turkey's efforts regarding Industry 4.0 and Society 5.0 practices. For the prepared questions, three professors at Kafkas University were consulted and the questions were revised in accordance with the recommendations given by them.

The questions consist of three sections. In the first section, there are 6 demographical questions asking for personal information of the participants. In the second section, takes place Feasibility in which the feasibility of Industry 4.0 and Society 5.0. In the third section, there are two sub-dimensions and 17 questions created out of SDGs. There are several studies that separate the SDGs into dimensions [54,55,60,61,65,68,69,73]. Even, it is realized that different results are obtained within the same country [74,75]. As a result of the analysis made through SPSS, the SDG questions were separated into sub-dimensions as social and infrastructural. Ten questions (i.e., SDG 1–8, SDG 15–16) separated by the program and seen as close to social elements formed the section of social impacts while the others (i.e., SDG 9–14, SDG 17) believed to exist as dependent on infrastructural problems formed the section of infrastructure. The questions and their distribution are presented in Table 1.

Table 1. Constructs and items.

Item	Question
Feasibility	
INDUSTRY1	The Industry 4.0 existing in Germany can be practiced in Turkey.
INDUSTRY2	I have knowledge about technologies forming the Industry 4.0 such as the internet of things, the cloud, artificial intelligence, the big data, 3D printers etc.
INDUSTRY3	Turkey has the technology that could actualize Industry 4.0.
INDUSTRY4	It is possible to found factories which are compatible with Industry 4.0 in Turkey.
INDUSTRY5	The costs of production will decrease in Turkey thanks to Industry 4.0 *.
INDUSTRY6	A more effective production potential will exist in Turkey thanks to Industry 4.0 *.
INDUSTRY7	The philosophy of Society 5.0 developed by Japan is viable in Turkey.
SDGs of Social Effect	
SDG1	Poverty decreases if the philosophy of Society 5.0 is practiced in Turkey *.
SDG2	Famine decreases if the philosophy of Society 5.0 is practiced in Turkey *.
SDG3	The health system become more effective if the philosophy of Society 5.0 is practiced in Turkey.
SDG4	The education system becomes high quality if the philosophy of Society 5.0 is practiced in Turkey.
SDG5	Gender equality is ensured if the philosophy of Society 5.0 is practiced in Turkey.
SDG6	The opportunity to have access to clean potable water sources if the philosophy of Society 5.0 is practiced in Turkey.
SDG7	The costs of energy decrease with renewable energy if the philosophy of Society 5.0 is practiced in Turkey.
SDG8	The problem of unemployment is solved if the philosophy of Society 5.0 is practiced in Turkey.
SDG15	A more respectful society to animal rights exist if the philosophy of Society 5.0 is practiced in Turkey *.
SDG16	A stronger and more effective judicial system is established if the philosophy of Society 5.0 is practiced in Turkey.
SDGs of Infrastructure	
SDG9	Inventions and innovations are made and the internet infrastructure improves if the philosophy of Society 5.0 is practiced in Turkey.
SDG10	The obstacles, favoritism, and reference system are eliminated if the philosophy of Society 5.0 is practiced in Turkey.
SDG11	A sustainable society structure is formed if the philosophy of Society 5.0 is practiced in Turkey.
SDG12	A decrease is experienced in the amount of wastes if the philosophy of Society 5.0 is practiced in Turkey.
SDG13	CO ₂ emission decreases and a cleaner environment is formed if the philosophy of Society 5.0 is practiced in Turkey.
SDG14	The death of fish in rivers decreases and the seas are cleared as they were in the past if the philosophy of Society 5.0 is practiced in Turkey.
SDG17	Turkey reaches at a stronger position and can establish international cooperation in various fields if the philosophy of Society 5.0 is practiced in Turkey *.

Note: * Items deleted after confirmatory factor analysis.

In accordance with literature review, two hypotheses were determined [7,8,10,11,16,19,25,27,31,35,41]. The model related to the hypotheses is presented in Figure 2.

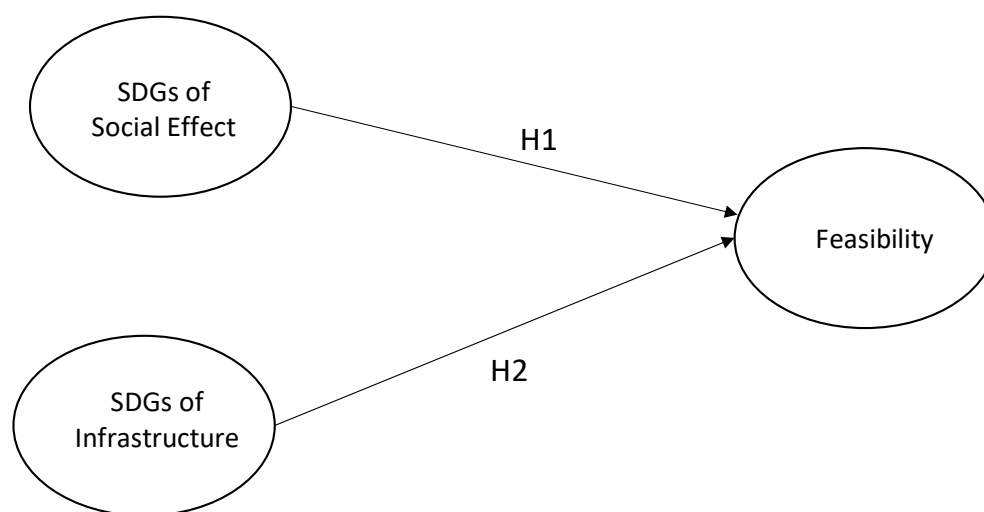


Figure 2. The hypothesized model.

Hypothesis 1 (H1). *SDGs of Social Effect influence the perception that Turkey should practice Society 5.0 and Industry 4.0.*

Hypothesis 2 (H2). *SDGs of Infrastructure influence the perception that Turkey should practice Society 5.0 and Industry 4.0.*

Sample and Data Collection

The selection of the sample is of great significance in terms often presenting and studying a subject matter or topic scientifically. Due to fact that it involves private and technical information, it seems impossible to ask questions about every kind of subject to the general public. To give an example, limited and superficial information can be obtained when the general public is asked for their opinions regarding devices with artificial intelligence and their use in the field of production. Bearing this in mind, the academicians working at the university were selected as the sample for the present study so as to get detailed information about and obtain accurate interpretations of Society 5.0 and Industry 4.0, being a strategic approach and involving high technology in its content. Despite the fact that Society 5.0 will influence the whole society, it is expected that only a limited number of politicians, academicians, and business will play an effective role in this issue. For this reason, the present study was carried out with academicians in accordance with the natural course of life. Within Kafkas University, the Faculty of Economics and Administrative Sciences, the Faculty of Engineering and related Vocational High Schools, which were thought to have a higher level of knowledge about the issue, were given priority.

The study was conducted with the academicians at Kafkas University. At Kafkas University, there are 81 professors, 101 associate professors, 277 assistant professors, 191 lecturers, and 237 research assistants [76]. In total, 887 people work at Kafkas University and the population was thought to be represented with a sample group consisting of at least 269 people with a 5% tolerable margin of error [77]. The survey was conducted with 335 people through the simple random sampling method during 14–18 December 2020. The demographical data obtained are presented in Table 2.

Table 2. Demographical information.

Gender	N	%	Income	N	%
Female	120	35.8	640–855 EUR *	156	46.6
Male	215	64.2	856–1.070 EUR	71	21.2
Age			1.071–1.280 EUR	59	17.6
20–25 age	23	6.9	1.281–1.500 EUR	17	5.1
26–30 age	43	12.8	Over 1.501 EUR	32	9.6
31–35 age	105	31.3	Experience		
36–40 age	79	23.6	Up to 5 years	103	30.7
41–45 age	56	16.7	Between 6–10 years	88	26.3
46–55 age	29	8.7	Between 11–15 years	77	23.0
Rank			Between 16–20 years	39	11.6
Assistant	86	25.7	Over 21 years	28	8.4
Lecturer	103	30.7	Education		
Assist.Prof.Dr.	88	26.3	Bachelor's degree	110	32.8
Assoc.Prof.Dr.	27	8.1	Master's degree	76	22.7
Prof.Dr.	31	9.3	Doctor's degree	149	44.5

Note: * Euro rate is taken as 9.35 TL.

In order to measure whether the data obtained had normal distribution, skewness and kurtosis tests were conducted. The sample had a normal distribution due to the fact that skewness and kurtosis values were between +1.96 and −1.96 [78].

4. Results

Following the application of explanatory factor analysis through SPSS in the study, three questions from the Feasibility scale (i.e., Industry1, Industry5, Industry6), four questions from the SDGs scale (i.e., SDG1, SDG2, SDG15, SDG17), whose factor load was below 0.3, were excluded. It became possible to make a more reliable and accurate analysis when the questions with factor load below 0.3 were excluded [78]. Moreover, KMO (Kaiser–Meyer–Olkin sampling measure) sampling validation, Bartlett's test of sphericity showing that significant factors could be obtained from the research analysis, and Cronbach's alpha for reliability were performed and the results are displayed in Table 3. The results (i.e., KMO > 0.60, Bartlett's test of sphericity < 0.05, Cronbach's alpha > 0.60) [78,79] suggested that the data could be applied tests.

Table 3. Reliability and validity.

Variables	Items	Loading	Cronbach's Alpha	KMO	Bartlett's Test of Sphericity (<i>p</i>)
Feasibility	industry2	0.903	0.817	0.794	477.505; <i>p</i> < 0.001
	industry3	0.834			
	industry4	0.768			
	industry7	0.662			
SDG (infrastructure)	SDG13	0.896	0.877	0.927	2747.828; <i>p</i> < 0.001
	SDG14	0.825			
	SDG12	0.800			
	SDG9	0.767			
	SDG10	0.707			
	SDG11	0.634			
	SDG6	0.778			
SDG (social)	SDG8	0.765	0.913		
	SDG5	0.593			
	SDG3	0.535			
	SDG7	0.488			
	SDG4	0.434			
	SDG16	0.386			

So, as to reveal the coherence of the result obtained through exploratory factor analysis, confirmatory factor analysis was practiced upon the scales. The interpretation of confirmatory factor analysis was made in accordance with the criteria of “for CMIN/DF $0 < \chi^2/sd \leq 3$ Good Coherence; $3 < \chi^2/sd \leq 5$ Acceptable Coherence, for TLI $0.95 < TLI \leq 1$ Good Coherence; $0.90 < TLI \leq 0.94$ Acceptable Coherence, for GFI $0.95 < GFI \leq 1$ Good

Coherence; $0.90 < GFI \leq 0.94$ Acceptable Coherence, for $RMSEA 0 \leq RMSEA \leq 0.05$ Good Coherence, $0.05 \leq RMSEA \leq 0.08$ Acceptable Coherence [80]. However, it was stated that the coherence of NFI (Normed Fit Index) value would be appropriate as $NFI > 0.80$ in the literature [80–84]. The results of the analysis made through the AMOS program are presented in Table 4 and the values are appropriate for making an analysis.

Table 4. Confirmatory factor analysis.

Scale	χ^2 (df)	TLI	GFI	NFI	RMSEA
Feasibility	0.408	1.000	0.999	0.998	0.000
SDGs	3.058	0.941	0.927	0.936	0.079

In order to test the stated hypotheses and the model, structural equation, modeling (SEM) was utilized through the Smart PLS (version 3.3.2) program. In the course of program use, firstly, the reliability tests were conducted. It was found that the reliability test results (i.e., Cronbach's alpha > 0.60 , rho_A > 0.70 , composite reliability > 0.70 , AVE > 0.50) were appropriate for making tests [85], which are displayed in Table 5. Discriminant validity and cross-loading correlation rates were found by using the rates of heterotrait-monotrait (HTMT). It was measured as 0.832 between SDGs of Social Effect and SDGs of Infrastructure, 0.424 between SDGs of Social Effect and Feasibility, and as 0.448 between SDGs of Infrastructure and Feasibility. The values fulfill the criteria of $HTMT < 0.85$ [78,85].

Table 5. Model reliability.

Items	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
SDG infs	0.913	0.920	0.932	0.697
SDG social	0.877	0.883	0.905	0.575
feasibility	0.817	0.834	0.880	0.648

In terms of evaluating the structural model, firstly, the q^2 values were determined. It was measured as 0.163 between SDGs of Social Effect and Feasibility and 0.278 between SDGs of Infrastructure and Feasibility. As the measurement was > 0 , the presupposition that there would be a low level impact was accepted. The R^2 value was found to be 0.172, which shows that there was a low-density impact [85]. The general coherence indexes of the analysis are as follows; $SRMR = 0.068$, $d_ULS = 0.705$, $d_G = 0.275$, χ^2 -square = 532.933, $NFI = 0.845$ (accepted if > 0.80) [80–84], and $RMS\ theta = 0.157$. The model is coherent and the detailed data regarding the model are presented in Figure 3.

The bootstrapping technique with 5000 resamples was used to evaluate the path coefficients and their significance levels. In this way, the validity of the hypotheses was tested and the results are displayed in Table 6. As a result, H1 hypothesis was rejected and H2 hypothesis was accepted.

Table 6. Hypothesis test result.

Hypothesis	Suggested Effect	Path Coefficients	t-Value	p-Values	%95 Bca CI	Support
H1: SDG (social) → Feasibility	+	0.163	1.722	0.085	(0.014; 0.326)Sig.	No
H2: SDG (infrastructure) → Feasibility	+	0.278	2.940	0.003	(0.005; 0.452)Sig.	Yes

Note: Bca CI: bias corrected confidence interval.

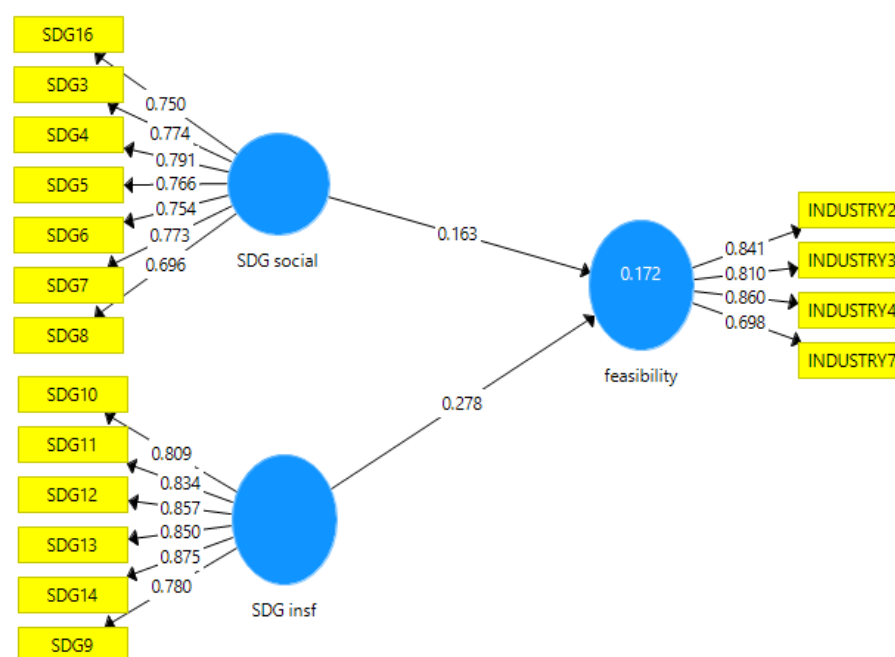


Figure 3. Model validity.

5. Discussion

In the present study which examined the effects of Society 5.0 practice existing in Japan in accordance with Sustainable Development Goals, it was found that SDG 9–14 had low-density effect. Although the same effect was observed with Industry 4.0, there are many factors that require the effect of Industry 4.0 in Turkey. In this respect, the business relationship between Turkey and Germany and the population of Turkish people in Germany cause commercial and cultural relationships between those two countries to become more effective.

It is known that some Turkish firms practice Industry 4.0 activities in accordance with demands of their German business partners while some others make necessary investments for those activities [86]. Although Turkey has an export value costing 16.617 billion dollars for 2019, it has an import value costing 19.280 billion dollars from Germany [87]. Hence, it is realized that Turkish businesses have switched to Industry 4.0 practices so as not to lose the market in Germany and to reduce cost pressure. It was found that enough factor load was not formed for the Industry 1 question regarding the feasibility of Industry 4.0 in Turkey due to available practices. Moreover, the questions regarding cost and production potential (i.e., Industry 5–6) are thought not to be comprehended accurately due to new transition to Industry 4.0 practice and high costs.

When the other questions with no significant load values are examined, not enough factor load could be reached due to the fact they involved questions which were closely related to the country's agenda and political view. During the period when the survey was conducted, great debates related to poverty and famine arose in the Turkish Grand National Assembly [88]. The news regarding cruel treatment of animals [89], the sanction decision by the USA against Turkey, and the European Union's similar plans of sanctions against Turkey suggest that the participants avoided answering the questions having political content [90].

Despite the fact that the 7 questions, which consisted intensely of social issues among SDG elements (i.e., SDG 3–8, SDG-16), were expected to have an influence upon Society 5.0, they were found to have no significant impact. Although those questions in fact focused on real problems and a bleeding wound of Turkey, such an effect is thought to result from specific conditions of the participants. For example, the SDG 5 question measures gender equality and suggests that the women should take part more in business life. However, the places where women and men are proportionately balanced are universities in Turkey

as 175.584 academicians in total are comprised by the women with a rate of 45% (i.e., 79.408) [91].

When the six questions (i.e., SDG 9–14) which are believed to exist based upon infrastructural problems are examined, an important shortcoming is observed. Although it was thought that the infrastructural problems determined through questions would influence the practices of Industry 4.0 and Society 5.0 to a large extent, the research result showed that the impact would be lower and at a moderate rate. For instance, the practice of Society 5.0 in Turkey requires serious transformations firstly in internet infrastructure. Turkey was on the 102th rank with 5.27 Mbps in the list with 207 countries according to internet speed measurement in 2019 [92]. In the current situation, the inadequacy of internet infrastructure showed itself in the international arena as well. The practice of Society 5.0 in which the whole system is built upon internet systems requires firstly the arrangement of internet infrastructure in Turkey. In addition, protection of patent and trademark rights is of great significance for creating new practices in Turkey.

Even though the concepts of favoritism and inequality are not valid only in Turkey, it is known that there are some privileged groups. A study conducted in the USA revealed that the male and female surgeons doing the same jobs had different payments. While male surgeons earned \$131.252 in a year according to the amount of operations performed, the male surgeons was observed to earn \$62.101 [93]. When the number of rectors and deans in Turkey is considered, it is possible to state that a similar situation is experienced between male and females.

In many scenarios existing with Society 5.0, the government's leading role comes to the fore in terms of infrastructure systems and practices. Nevertheless, how small and medium sized enterprises (SME) can keep up with this transformation displays a great uncertainty. Small and medium sized enterprises constitute 99.5% of the manufacturers in Japan. In domestic departments, even simple technical support equipment, such as internet connection and digital printing remedies, is not available. It is necessary to prepare software and support special SMEs so as to perform procedures of ordering to prepare order plan, prepare the parts, to send the parts, and to manage all procedures of accountancy [94].

The biggest shortcoming of Turkey is that many applications are put into practice without planning profoundly. However, those practices in question are observed to be planned to put into practice with their own technologies and the budget is allocated for those practices by the governments in Japan and Germany. Moreover, the countries where structures that strengthen the collaboration between industry and universities are available come to the forefront. However, it is not possible to state the same situation for Turkey. Turkey builds on the technology developed by Germany and on a large German company [95]. Thus, Turkey should set a course for itself and actualize a national development and innovation attempt. In its current situation, Turkey will miss many opportunities and lose its potential of being low-cost labor which is its most significant advantage, as it brings up the rear rather than being the leader or follower.

Industry 4.0 confronts us as a development plan to achieve skilled labor in Germany which feels itself incompetent by giving priority to industrial production and to draw back the production which shifted towards Far Eastern countries to Germany. At the stage of applying Industry 4.0, it was aimed that human labor was decreased and replaced by other technologies such as sensors, robots, and artificial intelligence. Through Society 5.0, however, it was intended that the technology used in Industry 4.0 could be used by the whole society in accordance with the aims of SDGs, and goals would be created accordingly. Even though they share similarities in terms of technology created and used, Industry 4.0 aims at industrial production while Society 5.0 aims at the whole society. Industry 4.0 calls for more economical, error-free, and faster production through use of new technologies [96]. The businesses are expected to adopt Industry 4.0 by making changes in their organizational structure so as to be able to maintain their competition advantage and to accommodate themselves to market conditions [97]. The changes in organizational structures benefit the businesses and countries economically, ecologically, and socially [98].

Decreasing carbon emission, decreasing recycling actions and performing more effective recycling processes, producing more environmentally friendly products, providing more opportunities for the employees to take part in management positions instead of heavy and contaminating jobs thanks to more effective production, form several of the benefits provided by Industry 4.0 [75,96,98,99]. Those developments aim at providing benefits especially for Japan and Germany. In this way, the price of products produced in Japan and Germany will fall, which in turn will increase competition and customer satisfaction. On the other hand, the negative effect formed by Industry 4.0 and Society 5.0 will be mostly felt by the developing and underdeveloped countries. The businesses which have canalized their productions towards countries such as Turkey, Brazil, China, Vietnam, and Bangladesh will move their productions back to their own countries due to the high cost of labor force. Moreover, the competition conditions, as well as faster, more effective, and less costly production structure, will weigh against small firms.

The main limitation of the study involves carrying out the study only with the academicians at a state university in Kars, Turkey. However, it becomes impossible to get information from the general public due to the fact that the topic is a current one and involves many technological elements. Bearing this in mind, investigating Society 5.0 is thought to provide many benefits in terms of local authorities, SMEs, disaster management, human resources management, and empowering women labor.

Author Contributions: Conceptualization, Y.Z., S.N. and E.T.; methodology, E.K. and O.K.; software, Y.Z.; validation, Y.Z., S.N. and E.T.; formal analysis, Y.Z., S.N., E.K. and O.K.; investigation, Y.Z., S.N., E.K. and E.T.; resources, O.K. and E.T.; data curation, Y.Z., S.N. and E.K.; writing—original draft preparation, Y.Z., S.N. and E.K.; writing—review and editing, Y.Z., S.N., E.K., O.K. and E.T.; visualization, Y.Z. and S.N.; supervision, Y.Z.; project administration, Y.Z. and S.N.; funding acquisition, Y.Z., S.N., E.K., O.K. and E.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The data collection was carried out in accordance with Research Ethics Committee Approval (i.e., dated 14 January 2021, numbered 17, decision number 16) of Kafkas University Social Sciences Ethics Committee.

Informed Consent Statement: Not Applicable.

Data Availability Statement: Not Applicable.

Conflicts of Interest: The authors do not declare a conflict of interest.

References

1. Kagermann, H.; Lukas, W.; Wahlster, W. Industrie 4.0—Mit Dem Internet Der Dinge Auf Dem Weg Zur 4. Industriellen Revolution. *VDI Nachr.* **2011**, *13*, 2–3.
2. Mourtzis, D.; Vlachou, E. A cloud-based cyber-physical system for adaptive shop-floor scheduling and condition-based maintenance. *J. Manuf. Syst.* **2018**, *47*, 179–198. [CrossRef]
3. Lorenz, M.; Rüßmann, M.; Waldner, M.; Engel, P.; Harnisch, M.; Justus, J. Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries. Available online: https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries (accessed on 22 December 2020).
4. Mariani, M.; Borghi, M. Industry 4.0: A bibliometric review of its managerial intellectual structure and potential evolution in the service industries. *Technol. Forecast. Soc. Chang.* **2019**, *149*, 119752. [CrossRef]
5. Yıldız, T. Examining the Concept of Industry 4.0 Studies Using Text Mining and Scientific Mapping Method. *Proc. Comput. Sci.* **2019**, *158*, 498–507. [CrossRef]
6. Zhou, J.; Li, P.; Zhou, Y.; Wang, B.; Zang, J.; Meng, L. Toward New-Generation Intelligent Manufacturing. *Engineering* **2018**, *4*, 11–20. [CrossRef]
7. Carayannis, E.G.; Draper, J.; Bhaneja, B. Towards Fusion Energy in the Industry 5.0 and Society 5.0 Context: Call for a Global Commission for Urgent Action on Fusion Energy. *J. Knowl. Econ.* **2020**, 1–14. [CrossRef]
8. Mavrodieva, A.V.; Shaw, R. Disaster and Climate Change Issues in Japan's Society 5.0—A Discussion. *Sustainable* **2020**, *12*, 1893. [CrossRef]

9. Web of Science. Please Sign in to Access Web of Science. Available online: <https://login.webofknowledge.com/error/Error?Error=IPError&PathInfo=%2F&RouterURL=https%3A%2F%2Fwww.webofknowledge.com%2F&Domain=.webofknowledge.com&Src=IP&Alias=WOK5> (accessed on 22 December 2020).
10. Fukuyama, M. Society 5.0: Aiming for a New Human-Centered Society. *Jpn. Spotlight* **2018**, *27*, 47–50.
11. Roblek, V.; Meško, M.; Bach, M.P.; Thorpe, O.; Šprajc, P. The Interaction between Internet, Sustainable Development, and Emergence of Society 5.0. *Data* **2020**, *5*, 80. [\[CrossRef\]](#)
12. Rathee, G.; Sharma, A.; Kumar, R.; Iqbal, R. A Secure Communicating Things Network Framework for Industrial IoT using Blockchain Technology. *Ad Hoc Netw.* **2019**, *94*, 101933. [\[CrossRef\]](#)
13. Tabaa, M.; Monteiro, F.; Bensag, H.; Dandache, A. Green Industrial Internet of Things from a smart industry perspectives. *Energy Rep.* **2020**, *6*, 430–446. [\[CrossRef\]](#)
14. Moghaddam, M.; Cadavid, M.N.; Kenley, C.R.; Deshmukh, A.V. Reference architectures for smart manufacturing: A critical review. *J. Manuf. Syst.* **2018**, *49*, 215–225. [\[CrossRef\]](#)
15. Culot, G.; Nassimbeni, G.; Orzes, G.; Sartor, M. Behind the definition of Industry 4.0: Analysis and open questions. *Int. J. Prod. Econ.* **2020**, *226*, 107617. [\[CrossRef\]](#)
16. Holroyd, C. Technological innovation and building a ‘super smart’ society: Japan’s vision of society 5.0. *J. Asian Public Policy* **2020**, 1–14. [\[CrossRef\]](#)
17. Anadolu Agency Bakan Varank. 4. Sanayi Devrimi Merkezi’ni Ülkemize Kazandırdık. Available online: <https://www.aa.com.tr/tr/ekonomi/bakan-varank-4-sanayi-devrimi-merkezini-ulkemize-kazandirdik/2070621> (accessed on 20 December 2020).
18. Bedolla, J.S.; D’Antonio, G.; Chiabert, P. A Novel Approach for Teaching IT Tools within Learning Factories. *Proc. Manuf.* **2017**, *9*, 175–181. [\[CrossRef\]](#)
19. Lu, Y. Industry 4.0: A survey on technologies, applications and open research issues. *J. Ind. Inf. Integr.* **2017**, *6*, 1–10. [\[CrossRef\]](#)
20. Witkowski, K. Internet of Things, Big Data, Industry 4.0—Innovative Solutions in Logistics and Supply Chains Management. *Proc. Eng.* **2017**, *182*, 763–769. [\[CrossRef\]](#)
21. Santos, M.Y.; Sá, J.O.; Andrade, C.; Lima, F.V.; Costa, E.; Costa, C.; Martinho, B.; Galvão, J. A Big Data system supporting Bosch Braga Industry 4.0 strategy. *Int. J. Inf. Manag.* **2017**, *37*, 750–760. [\[CrossRef\]](#)
22. Bortolini, M.; Ferrari, E.; Gamberi, M.; Pilati, F.; Faccio, M. Assembly system design in the Industry 4.0 era: A general framework. *IFAC Pap. Online* **2017**, *50*, 5700–5705. [\[CrossRef\]](#)
23. Trappey, A.J.; Trappey, C.V.; Govindarajan, U.H.; Chuang, A.C.; Sun, J.J. A review of essential standards and patent landscapes for the Internet of Things: A key enabler for Industry 4.0. *Adv. Eng. Inform.* **2017**, *33*, 208–229. [\[CrossRef\]](#)
24. Lee, J.; Bagheri, B.; Kao, H.-A. A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems. *Manuf. Lett.* **2015**, *3*, 18–23. [\[CrossRef\]](#)
25. O’Donovan, P.; Gallagher, C.; Bruton, K.; O’Sullivan, D.T. A fog computing industrial cyber-physical system for embedded low-latency machine learning Industry 4.0 applications. *Manuf. Lett.* **2018**, *15*, 139–142. [\[CrossRef\]](#)
26. Legat, C.; Vogel-Heuser, B. A configurable partial-order planning approach for field level operation strategies of PLC-based industry 4.0 automated manufacturing systems. *Eng. Appl. Artif. Intell.* **2017**, *66*, 128–144. [\[CrossRef\]](#)
27. Miśkiewicz, R.; Wolniak, R. Practical Application of the Industry 4.0 Concept in a Steel Company. *Sustainability* **2020**, *12*, 5776. [\[CrossRef\]](#)
28. Kaygin, E.; Zengin, Y.; Topçuoğlu, E. Endüstri 4.0’ akademik bakış. *Atatürk Univ. İktis. İdari Bilim. Derg.* **2019**, *33*, 1065–1081.
29. Müller, J.M. Assessing the barriers to Industry 4.0 implementation from a workers’ perspective. *IFAC Pap. Online* **2019**, *52*, 2189–2194. [\[CrossRef\]](#)
30. De Pascale, A.; Arbolino, R.; Szopik-Depczyńska, K.; Limosani, M.; Ioppolo, G. A systematic review for measuring circular economy: The 61 indicators. *J. Clean. Prod.* **2021**, *281*, 124942. [\[CrossRef\]](#)
31. Chang, V.; Xu, Y.K.; Zhang, J.; Xu, Q. Research on Intelligent Manufacturing Development Approach for China’s Local Valve Industry. *Smart Sustain. Built Environ.* **2020**. [\[CrossRef\]](#)
32. Cabinet Office Government of Japan. Report on the 5th Science and Technology Basic Plan. Available online: https://www8.cao.go.jp/cstp/kihonkeikaku/5basicplan_en.pdf (accessed on 22 December 2020).
33. Pereira, A.G.; Lima, T.M.; Charrua-Santos, F. Industry 4.0 and Society 5.0: Opportunities and Threats. *Int. J. Recent Technol. Eng.* **2020**, *8*, 3305–3308. [\[CrossRef\]](#)
34. Kansha, Y.; Ishizuka, M. Design of energy harvesting wireless sensors using magnetic phase transition. *Energy* **2019**, *180*, 1001–1007. [\[CrossRef\]](#)
35. Deguchi, A.; Hirai, C.; Matsuoka, H.; Nakano, T.; Oshima, K.; Tai, M.; Tani, S. What Is Society 5.0? In *Society 5.0: A People-Centric Super-Smart Society*; Springer: Singapore, 2020; pp. 1–23. ISBN 9789811529894.
36. Dantas, T.; De-Souza, E.; Destro, I.; Hammes, G.; Rodriguez, C.; Soares, S. How the combination of Circular Economy and Industry 4.0 can contribute towards achieving the Sustainable Development Goals. *Sustain. Prod. Consum.* **2021**, *26*, 213–227. [\[CrossRef\]](#)
37. Wang, Q.; Liu, X.; Liu, Z.; Xiang, Q. Option-based supply contracts with dynamic information sharing mechanism under the background of smart factory. *Int. J. Prod. Econ.* **2020**, *220*, 107458. [\[CrossRef\]](#)
38. Goh, S.K.; McNown, R.; Wong, K.N. Macroeconomic implications of population aging: Evidence from Japan. *J. Asian Econ.* **2020**, *68*, 101198. [\[CrossRef\]](#)

39. The Ministry of Economy, Trade and Industry New Industrial Structure Vision. Available online: https://www.meti.go.jp/english/publications/pdf/vision_171222.pdf (accessed on 22 December 2020).
40. Heller, P.S. The challenge of an aged and shrinking population: Lessons to be drawn from Japan's experience. *J. Econ. Ageing* **2016**, *8*, 85–93. [\[CrossRef\]](#)
41. Wang, J.; Yang, Z.; Qian, X. Driving factors of urban shrinkage: Examining the role of local industrial diversity. *Cities* **2020**, *99*, 102646. [\[CrossRef\]](#)
42. Sugiyama, M.; Fujimori, S.; Wada, K.; Endo, S.; Fujii, Y.; Komiyama, R.; Kato, E.; Kurosawa, A.; Matsuo, Y.; Oshiro, K.; et al. Japan's long-term climate mitigation policy: Multi-model assessment and sectoral challenges. *Energy* **2019**, *167*, 1120–1131. [\[CrossRef\]](#)
43. Xue, M.; Wang, Q.; Lin, B.-L.; Tsunemi, K. Mitigation of greenhouse gas and reactive nitrogen from the Japanese passenger car fleet. *J. Clean. Prod.* **2020**, *277*, 123440. [\[CrossRef\]](#)
44. Taniguchi-Matsuoka, A.; Shimoda, Y.; Sugiyama, M.; Kurokawa, Y.; Matoba, H.; Yamasaki, T.; Morikuni, T.; Yamaguchi, Y. Evaluating Japan's national greenhouse gas reduction policy using a bottom-up residential end-use energy simulation model. *Appl. Energy* **2020**, *279*, 115792. [\[CrossRef\]](#)
45. Watabe, A.; Leaver, J.; Ishida, H.; Shafiei, E. Impact of low emissions vehicles on reducing greenhouse gas emissions in Japan. *Energy Policy* **2019**, *130*, 227–242. [\[CrossRef\]](#)
46. Kuriyama, A.; Tamura, K.; Kuramochi, T. Can Japan enhance its 2030 greenhouse gas emission reduction targets? Assessment of economic and energy-related assumptions in Japan's NDC. *Energy Policy* **2019**, *130*, 328–340. [\[CrossRef\]](#)
47. Zheng, Q.; Watanabe, M.; Iwatate, Y.; Azuma, D.; Shibasaki, K.; Hiraga, Y.; Kishita, A.; Nakayasu, Y. Hydrothermal leaching of ternary and binary lithium-ion battery cathode materials with citric acid and the kinetic study. *J. Supercrit. Fluids* **2020**, *165*, 104990. [\[CrossRef\]](#)
48. Li, Y.; Qian, X.; Zhang, L.; Dong, L. Exploring spatial explicit greenhouse gas inventories: Location-based accounting approach and implications in Japan. *J. Clean. Prod.* **2017**, *167*, 702–712. [\[CrossRef\]](#)
49. Shaw, R. Thirty Years of Science, Technology, and Academia in Disaster Risk Reduction and Emerging Responsibilities. *Int. J. Disaster Risk Sci.* **2020**, *11*, 414–425. [\[CrossRef\]](#)
50. Michna, A.; Kmiecik, R. Open-Mindedness Culture, Knowledge-Sharing, Financial Performance, and Industry 4.0 in SMEs. *Sustainable* **2020**, *12*, 9041. [\[CrossRef\]](#)
51. Fukuda, K. Science, technology and innovation ecosystem transformation toward society 5.0. *Int. J. Prod. Econ.* **2020**, *220*, 107460. [\[CrossRef\]](#)
52. KeidanrenSDGs. Keidanrens. Available online: <https://www.keidanrendsgs-world.com/post/about-this-website> (accessed on 19 December 2020).
53. Türkiye Cumhuriyeti Dışişleri Bakanlığı. Birleşmiş Milletler Teşkilatı ve Türkiye. Available online: <http://www.mfa.gov.tr/birlesmis-milletler-teskilati-ve-turkiye.tr.mfa> (accessed on 22 December 2020).
54. Campagnolo, L.; Davide, M. Can the Paris deal boost SDGs achievement? An assessment of climate mitigation co-benefits or side-effects on poverty and inequality. *World Dev.* **2019**, *122*, 96–109. [\[CrossRef\]](#)
55. Biggeri, M.; Clark, D.A.; Ferrannini, A.; Mauro, V. Tracking the SDGs in an 'integrated' manner: A proposal for a new index to capture synergies and trade-offs between and within goals. *World Dev.* **2019**, *122*, 628–647. [\[CrossRef\]](#)
56. Byerlee, D.; Fanzo, J. The SDG of zero hunger 75 years on: Turning full circle on agriculture and nutrition. *Glob. Food Secur.* **2019**, *21*, 52–59. [\[CrossRef\]](#)
57. Wakunuma, K.; Jiya, T.; Aliyu, S. Socio-ethical implications of using AI in accelerating SDG3 in Least Developed Countries. *J. Responsible Technol.* **2020**, *4*, 100006. [\[CrossRef\]](#)
58. McKay, V.I. Learning for development: Learners' perceptions of the impact of the Kha Ri Gude Literacy Campaign. *World Dev.* **2020**, *125*, 104684. [\[CrossRef\]](#)
59. Yount, K.M.; Crandall, A.; Cheong, Y.F. Women's Age at First Marriage and Long-Term Economic Empowerment in Egypt. *World Dev.* **2018**, *102*, 124–134. [\[CrossRef\]](#)
60. Fehri, R.; Khelifi, S.; Vanclooster, M. Disaggregating SDG-6 water stress indicator at different spatial and temporal scales in Tunisia. *Sci. Total. Environ.* **2019**, *694*, 133766. [\[CrossRef\]](#)
61. Nam-Chol, O.; Kim, H. Towards the 2 °C goal: Achieving Sustainable Development Goal (SDG) 7 in DPR Korea. *Resour. Conserv. Recycl.* **2019**, *150*, 104412. [\[CrossRef\]](#)
62. Rai, S.M.; Brown, B.D.; Ruwanpura, K.N. SDG 8: Decent work and economic growth—A gendered analysis. *World Dev.* **2019**, *113*, 368–380. [\[CrossRef\]](#)
63. Cervelló-Royo, R.; Moya-Clemente, I.; Perelló-Marín, M.; Ribes-Giner, G. Sustainable development, economic and financial factors, that influence the opportunity-driven entrepreneurship. An fsQCA approach. *J. Bus. Res.* **2020**, *115*, 393–402. [\[CrossRef\]](#)
64. Horn, P.; Grugel, J. The SDGs in middle-income countries: Setting or serving domestic development agendas? Evidence from Ecuador. *World Dev.* **2018**, *109*, 73–84. [\[CrossRef\]](#)
65. Rozhenkova, V.; Allmang, S.; Ly, S.; Franken, D.; Heymann, J. The role of comparative city policy data in assessing progress toward the urban SDG targets. *Cities* **2019**, *95*, 102357. [\[CrossRef\]](#)
66. Sala, S.; Castellani, V. The consumer footprint: Monitoring sustainable development goal 12 with process-based life cycle assessment. *J. Clean. Prod.* **2019**, *240*, 118050. [\[CrossRef\]](#)

67. Ma, W.; De Jong, M.; De Bruijne, M.; Mu, R. Mix and match: Configuring different types of policy instruments to develop successful low carbon cities in China. *J. Clean. Prod.* **2021**, *282*, 125399. [CrossRef]
68. Okafor-Yarwood, I. Illegal, unreported and unregulated fishing, and the complexities of the sustainable development goals (SDGs) for countries in the Gulf of Guinea. *Mar. Policy* **2019**, *99*, 414–422. [CrossRef]
69. Opoku, A. Biodiversity and the built environment: Implications for the Sustainable Development Goals (SDGs). *Resour. Conserv. Recycl.* **2019**, *141*, 1–7. [CrossRef]
70. Calvo, T.; Razafindrakoto, M.; Roubaud, F. Fear of the state in governance surveys? Empirical evidence from African countries. *World Dev.* **2019**, *123*, 104609. [CrossRef]
71. Lamichhane, S.; Eğilmez, G.; Gedik, R.; Bhutta, M.K.S.; Erenay, B. Benchmarking OECD countries' sustainable development performance: A goal-specific principal component analysis approach. *J. Clean. Prod.* **2021**, *287*, 125040. [CrossRef]
72. T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı. Sürdürülebilir Kalkınma Türkiye. Available online: <http://www.surdurulebilirlikkalkinma.gov.tr/#hakkinda> (accessed on 22 December 2020).
73. Diz, D.; Morgera, E.; Wilson, M. Marine policy special issue: SDG synergies for sustainable fisheries and poverty alleviation. *Mar. Policy* **2019**, *110*, 102860. [CrossRef]
74. Aust, V.; Morais, A.I.; Pinto, I. How does foreign direct investment contribute to Sustainable Development Goals? Evidence from African countries. *J. Clean. Prod.* **2020**, *245*, 118823. [CrossRef]
75. Chen, M.; Sinha, A.; Hu, K.; Shah, M.I. Impact of technological innovation on energy efficiency in industry 4.0 era: Moderation of shadow economy in sustainable development. *Technol. Forecast. Soc. Chang.* **2021**, *164*, 120521. [CrossRef]
76. YÖK. Yükseköğretim Kurulu. Available online: <https://akademik.yok.gov.tr/AkademikArama/view/searchResultviewListAuthorAndUniversities.jsp> (accessed on 23 December 2020).
77. Büyüköztürk, Ş.; Çakmak, E.; Akgün, Ö.E.; Karadeniz, Ş.; Demiral, F. *Bilimsel Araştırma Yöntemleri*; Pegem Yayıncılık: Ankara, Turkey, 2012; ISBN 978-9944-919-28-9.
78. Hair, J.F.; Black, C.W.; Babin, B.J.; Anderson, R.E. *Multivariate Data Analysis*, 7; Pearson Education Limited: Essex, UK, 2014; ISBN 978-1-292-02190-4.
79. Denis, D.J. *SPSS Data Analysis for Univariate, Bivariate, and Multivariate Statistics*; John Wiley & Sons, Inc.: Hoboken, NJ, USA, 2019; ISBN 978-1-119-46580-5.
80. Hooper, D.; Coughlan, J.; Mullen, M.R. Structural Equation Modelling: Guidelines for Determining Model Fit. *Electron. J. Bus. Res. Methods* **2008**, *6*, 53–60.
81. Koyuncu, I.; Kılıç, A.F. The Use of Exploratory and Confirmatory Factor Analyses: A Document Analysis. *Eğitim Bilim.* **2019**, *44*. [CrossRef]
82. Ramlall, I. Model Fit Evaluation. In *Applied Structural Equation Modelling for Researchers and Practitioners*; Emerald Group Publishing Limited: Bingley, UK, 2016; pp. 61–74. ISBN 978-1-78635-882-0.
83. Marsh, H.W.; Balla, J. Goodness of fit in confirmatory factor analysis: The effects of sample size and model parsimony. *Qual. Quant.* **1994**, *28*, 185–217. [CrossRef]
84. Marsh, H.W.; Hau, K.-T. Assessing Goodness of Fit. *J. Exp. Educ.* **1996**, *64*, 364–390. [CrossRef]
85. Hair, J.; Hollingsworth, C.L.; Randolph, A.B.; Chong, A.Y.L. An updated and expanded assessment of PLS-SEM in information systems research. *Ind. Manag. Data Syst.* **2017**, *117*, 442–458. [CrossRef]
86. Dil, E.; Esmer, A.H. Firmaların Endüstri 4.0 Stratejilerine Dair Bir Araştırma. *Strat. Yönetim Araşt. Derg.* **2020**, *3*, 85–110.
87. Turkey Statistical Institute (TURKSTAT) Home Page. Available online: <https://www.tuik.gov.tr/Home/Index> (accessed on 23 December 2020).
88. BBB News. Şahin Tin. Meclis'te "kuru ekmek" tartışmasında kim ne dedi? *BBC News Türkçe*, 15 December 2020.
89. Yücel Bulut. Haluk Levent, cinsel saldırıya uğrayan buzağı ve annesini satın aldı. *Yücel Bulut*, 16 December 2020. Available online: <https://www.hurriyet.com.tr/kelebek/magazin/haluk-levent-cinsel-saldiriya-ugrayan-buzagi-ve-annesini-satin-aldi-i-41690057> (accessed on 23 December 2020).
90. BBC News. ABD yaptırımlarının savunma sanayisine etkisi: "Üretim ve ihracat olumsuz etkilenebilir.". *BBC News Türkçe*, 17 December 2020.
91. Yükseköğretim Bilgi Yönetim Sistemi Home Page. Available online: <https://istatistik.yok.gov.tr/> (accessed on 23 December 2020).
92. Sade, G.; Ülkelerin İnternet Hızı Sıralaması: Türkiye 102. Basamağa Geriledi. Available online: <https://tr.euronews.com/2019/08/16/ulkelerinde-internet-hizi-sralamasi-turkiye-102-basamaga-geriledi-zirvede-tayvan-var> (accessed on 23 December 2020).
93. Weiss, A.; Parina, R.; Tapia, V.J.; Sood, D.; Lee, K.C.; Horgan, S.; Freischlag, J.A.; Blair, S.L.; Ramamoorthy, S.L. Assessing the domino effect: Female physician industry payments fall short, parallel gender inequalities in medicine. *Am. J. Surg.* **2018**, *216*, 723–729. [CrossRef] [PubMed]
94. Weng, J.; Mizoguchi, S.; Akasaka, S.; Onari, H. Smart manufacturing operating systems considering parts utilization for engineer-to-order production with make-to-stock parts. *Int. J. Prod. Econ.* **2020**, *220*, 107459. [CrossRef]
95. Nazlıcan, B.D.; Meçik, O. Türkiye'de Endüstri 4.0' ın İşgücü Piyasasına Etkileri: Firma Beklentileri. *Süleyman Demirel Univ. İktis. İdari Bilim. Fak. Derg.* **2018**, *23*, 1581–1606.
96. Birkel, H.; Müller, J.M. Potentials of industry 4.0 for supply chain management within the triple bottom line of sustainability—A systematic literature review. *J. Clean. Prod.* **2021**, *289*, 125612. [CrossRef]

-
97. Cirillo, V.; Rinaldini, M.; Staccioli, J.; Virgillito, M.E. Technology vs. Workers: The Case of Italy's Industry 4.0 Factories. *Struct. Chang. Econ. Dyn.* **2021**, *56*, 166–183. [[CrossRef](#)]
 98. Rahman, S.M.; Perry, N.; Müller, J.M.; Kim, J.; Laratte, B. End-of-Life in industry 4.0: Ignored as before? *Resour. Conserv. Recycl.* **2020**, *154*, 104539. [[CrossRef](#)]
 99. Müller, J.M.; Voigt, K.-I. Sustainable Industrial Value Creation in SMEs: A Comparison between Industry 4.0 and Made in China 2025. *Int. J. Precis. Eng. Manuf. Technol.* **2018**, *5*, 659–670. [[CrossRef](#)]