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Energy Efficiency in the Industry 4.0 Era: Attributes of Teal Organisations

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Abstract: The rapid development of innovations in the industry 4.0 era led to new or evolved companies. At the same time, the accepted concept of carbon-free development requires building a new philosophy for the company's management. The paper aims to analyse the key attributes of teal organisations (as a new type of a company) from the energy sector (as a core sector for carbon-free transformation). The paper summarises the core features of teal organisations and their attributes. In the paper, three hypotheses are tested: innovations and technologies are the most used attributes among teal organisations from the energy sector; organisational and corporate culture are the least used attributes among teal organisations from the energy sector; in the energy sector, the companies that have the attributes of teal organisations primarily work in countries with a high level of innovation and information technologies (as a core indicator of Industry 4.0) and economic development. For testing the hypotheses, the following methods are applied: a Friedman test, a paired-samples *t*-test, the principal components analysis, a correlation analysis, an ANOVA test (analysis of variance), and a regression analysis. The online survey generates the data for analysis. The object of the research is the workers from the energy sector companies from five countries (Poland, Ukraine, Georgia, Slovakia, and Romania). The findings of the statistical analysis confirm the first and second hypotheses. Companies in the energy sector mostly use innovations and technologies as the attributes of teal organisations. The regression analysis results show that an increase of 1% of patent applications leads to an increased energy efficiency of 1.29%. Additionally, the implemented features of teal organisations in the energy sector allow for improving the country's energy efficiency, which, as a consequence, then boosts carbon-free development.

Keywords: company; organisation; teal company; evolutionary organisation; decarbonisation;innovation

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1. Introduction

Considering the Green Deal Policy, EU countries declared the ambitious goal to become climate-neutral by 2050 through reducing emissions by at least 55% by 2030, compared to 1990 levels [1]. In the first stage, this requires changes and reforms in the energy sectors. This necessitates building new philosophies of management at both the government and company levels. Additionally, the bottom-up approach is more effective than if the government tries to implement the mechanisms that companies do not accept from energy sectors and society. Furthermore, the tendencies noted above require reorientation of the management and organisation model considering the sustainable development principles, goals of the Green Deal Policy and using the achievements of Industry 4.0 (innovations, technologies, etc.). A new paradigm of management at energy companies should be available for getting accustomed to new changes in the market. Considering [2–5], the teal organisation could be characterised as the evolutionary company with a well-developed organisational model that is flexible, quick to adapt to the endogenous and

exogenous changes, and that ensures the sustainable growth of the company. This paper aims to analyse the key attributes of teal organisations (as a new type of a company) from the energy sector (as a core sector for carbon-free transformation). The paper has the following structure: a literature review—summarising the scientific background in the research on teal organisations in achieving the goals of climate-neutral and sustainable development; materials and methods—describing the methods to achieve the paper's aims and to test the hypothesis highlighted; results—explanation of findings; discussion—a comparative analysis of the results obtained with the previous research; conclusion—summarising of the research findings and options of their implementation.

2. Literature Review

Globalisation, development of disruptive technologies, and reorientation to sustainable development policy require transformation of a paradigm of a company's management. The top management should quickly react to the new trends and get accustomed to them, which allows them to increase their competitiveness in the market. These trends result in developing a new type of a company—a teal or evolutionary organisation. The concept of the evolutionary organisation was developed by Frederic Laloux [6] as a new philosophy of management. Kamo and Phillips [7], on the example of IT companies Microsoft, Intel, and Netscape, highlight the core indicators which characterise the evolutionary organisations: agent, non-linearity, decentralisation, the edge of chaos, parallelism, emergence, weak butterfly effect, novelty, internal rule, recombination, no-optimal and speed, diversity. At the same time, Laloux [6] identified three milestones in teal organisations: evolutionary goals, self-managed, and wholeness.

2.1. Evolutionary Goals and Industry 4.0

The companies from energy sectors could not achieve their evolutionary goals (neutral climate targets, developing smart technologies, etc.) without innovation technologies available due to Industry 4.0 [8,9]. In this case, the crucial role belongs to government policy in the energy sector that supports and enhances the implementation of innovative technologies. Using the fully modified OLS and dynamic OLS panel cointegration techniques and the generalised method of moments in papers [10–25], the scientists prove that effective government policy allows for bridging the energy efficiency gap and cutting greenhouse gas emissions on the way to climate-neutral development. Based on the example of the Polish steel industry in the era of Industry 4.0, the authors [26] confirm the hypothesis linking investment in green innovations and the companies' energy efficiency. Paper [27] generalises the positive effect of implementing the cyber-physical production systems in companies of the energy sector. The most cited paper (considering Scopus), [28], confirmed that evolutionary management could not be realised without innovations. Arakji and Lang in [29] analyse the diffusion of innovations as the core elements of companies' evolution. On the example of the EU countries, Borowski [30–33] confirms the hypothesis that blockchain and artificial intelligence allow reducing energy consumption in the industrial sector. For Sub-Saharan Africa, Kunkel and Matthess [34] allocate the direct and indirect effect of information technologies on energy sector development. A similar conclusion is made by the [35,36]. Thus, the countries that pursue effective policy on research and development and diffusion of green innovations have a favourable climate for developing teal organisations in the energy sector. Teal organizations have the evolutionary goalsto positively affect society and world development. This differs from teal organizations from other types of business models that aim to maximize the profit. Thus, one of the examples of evolution goals—"using business to encourage for finding ways to overcome ecological issues". In this case the first hypothesis of the investigation is:

Hypothesis 1 (H1). *Innovations and technologies are the most used attributes among teal organisations from the energy sector.*

2.2. Self-Managed and Corporate Culture

Developing new technologies and spreading innovations lead to continuous improvement in human capital skills. At the same time, Industry 4.0 causes changes in the corporate culture where each worker should feel part of the team and understand their role in the company's development [37–40]. Yousef [41] concludes that management where workers trust their leader or have options for self-development is more effective than authoritarian management. Andriopoulos [42] identifies five features of the company's management that should consider fostering creativity and performance of the organisation: the company's climate; the leadership style; the internal culture; the option for self-development; links and distance between management and workers. The research [43], based on the survey of 270 respondents, tests the 11 hypotheses related to the connection between corporate cultures and core determinants. The correlation analysis applied confirms that leadership and motivation are the core elements of the corporate culture for the flexible and rapid growth of the companies. Based on findings of structural equation modelling, the authors [44] prove that diffusion of green innovations is not effective without the company's acceptable culture. Additionally, they analyse green innovation culture as a mediator in the chain "green human resource management—green competitive advantage". They confirm the statistically significant impact of green abilities on self-development (training and education), motivation (material and moral), and opportunities (involvement and leadership) on the companies' green growth. The authors [45] also confirm that green innovations require the relevant culture and green-consciousness among stakeholders. Based on the analysis of Fortune 500 firms, paper [46] identifies six core elements of positive corporate culture: self-development of the staff; transparency; awareness of the company's goals and mission; top-management openness; tolerant behaviour; recognition of the achievements and considering the results. The findings noted above posit that a developing environment has the company take pro-active measures to improve the corporate culture and develop the relevant conditions for the labour force's self-development.

2.3. Wholeness and Organisations' Structure

Simetinger and Zhang [47] confirm that the spread of Industry 4.0 has changed organisational structure and the employees' role. They proposed to develop the maturity models for the companies, which allow for involving all employees into the company's operation. In paper [48], the authors proposed using the multi-agent incorporated hierarchical ensemble model, which is based on the principles of neuro-evolution strategy. They suggested that this model allows achieving convergence among all departments and their workers. Fombrun and Wally analyse 95 American companies that demonstrate stable growth in a rapidly changing external environment [49]. They prove that companies should work as a synchronised mechanism, eliminate bureaucratisation, and develop decentralisation in the management system. In such an approach, all employees have equal responsibilities in the company's management.

The findings of paper [50] showed that a lean organisational structure adopts quickly to implement new technologies and innovations. Using a survey, the authors [51] analyse the relationship between a company's structure and its performance in an example of Malaysian firms. They highlight that a company's structure is a core element influencing its performance. In this case, the organisational structure should work as a single mechanism and synchronise operation of all parts (departments) of the company. A similar conclusion is made by the authors in paper [52], who maintain that for big holdings, inefficient organisational structure changes lead to a decline in the company's performance. Using the hierarchical multiple regression and multiple group analysis procedure, Gokus [53] confirms the hypothesis that the organisational structure is a mediator between communications with customers and the company's strategy. In an example of Chinese companies, Wei et al. [54] prove that the development culture has a direct effect on the company's performance. Busse [55] criticises continuous transformations of the organisational structure. However, they confirm the role of employees' value priorities in the company's success.

The findings of the analyses noted above conclude that the companies' operation passes a few stages of the development, and a teal organisation is the highest level of evolution that merges the best achievements of disruptive innovations and operates on sustainable development principles. In general, teal approaches were implemented in the companies with high qualified labour where they not only have options for self-development but also are responsible for the decisions, are independent, and work as a team. Furthermore, for the energy sector achieving the maximum level of self-organization and liner structure of the organization is limited, and methods could be combined or different in other parts of the organization and corporate culture. Thus, the second hypothesis of the paper is:

Hypothesis 2 (H2). *Organisational structure and corporate culture are the least used attributes among teal organisations from the energy sector.*

2.4. Teal Organisations, Industry 4.0, and Energy Efficiency

Accepting new Green Deal policy requires transformation of a paradigm of the company's management. If first requires reorienting the companies' management in the energy sector. Thus, paper [56] based on a questionnaire analysed the readiness of the companies to implement achievements of Industry 4.0 on the way to meet the target of Green Deal Policy. Industry 4.0 provokes the developing of disruptive innovations that lower the negative impact on the environment and increase the energy efficiency of the country. Fritzsche et al. [57], with a summary of the literature, showed that Industry 4.0 is closely connected to energy efficiency. They highlight that it requires improving government policy for green innovations among industrial sectors. In the case for MENA countries, the authors [58] conclude the positive effect of innovations on energy efficiency. At the same time, the shadow economy decreases the energy efficiency of countries. The authors prove the positive effect on energy efficiency from the implementation of economic reform in the country. Using the fully modified OLS and dynamic OLS panel cointegration techniques and the generalised method of moments, papers [10–25] prove the role of government policy in decreasing the energy efficiency gap and increasing the country's energy security. The findings in paper [59] prove that smart and innovation technologies lower energy costs and increase energy efficiency. Based on the example of the Polish steel industry in the era of Industry 4.0, paper [26] confirms the hypothesis of the link between investment in green technologies and the energy efficiency of companies. For this purpose, the authors use Gretl software.

Using comparison analysis, the scientists [60] highlight that developing the smart grid is a core goal for decreasing energy losses and increasing energy efficiency. Additionally, papers [61–63] confirm that innovation technologies boost development of renewable energy and as a consequence lead to increasing the energy efficiency of the country. Junker and Domann [64] analyse the energy management at the company level and confirm the core role of Industry 4.0 that increases the energy efficiency of the business sector. In paper [27] the Industry 4.0 is analysed as the catalysator of energy cost reduction in batch production. Thus, the authors generalise the positive effect from the implementation of the cyber-physical production systems in the company. Borowski [30], using an example of EU countries, confirms the hypothesis that blockchain and artificial intelligence reduces energy consumption in the industrial sector and increases energy efficiency. In an example of Sub-Saharan Africa, Kunkel and Matthess [34] examine the direct and indirect effect of information technologies on the development of the energy sector. They highlight that information technologies decrease the gap between energy production and disruption. The results of the aforementioned analysis conclude that the efficiency of implementing available innovations under the Industry 4.0 increases the energy efficiency of the countries. At the same time, the core role in providing energy efficiency is the business sector and efficient management of the company.

Paper [30] proved the necessity of EU energy transformation to achieve the goals of a carbon-free economy by year 2050. At the same time the analysis of National Energy and

Climate Plans (NECPs) confirmed the actuality of implementing the modern instruments for reaching the targets of Green Deal Policy by EU countries. The focus of the investigation is the process of developing and implementing the mechanism of innovative energy sector development under the Industry 4.0 revolution. Considering the analyses noted above, the third hypothesis of the investigation is:

Hypothesis 3 (H3). *The country's energy efficiency depends on the economic development, innovation, and information technologies (as a core indicator of Industry 4.0) and the development of teal organisations in the energy sector.*

3. Materials and Methods

3.1. Participants and Procedures

The data for analysing the perception level of teal organisations' attributes in the Industry 4.0 era are collected using an online survey. The object of the research is the workers of energy sector companies from five countries (Poland, Ukraine, Georgia, Slovakia, and Romania). Noting that under the program of ENTSO-E, EU countries have 82 interconnections with ten neighbouring countries, including Ukraine, in energy systems and trading. Ukraine has boundaries with three EU countries (Poland, Slovakia, and Romania), which allows for the integration of Ukraine into ENTSO. Georgia is a potential candidate for EU membership, and it has already passed the stage of EU integration, including in the energy policy. As the EU orients to strengthen the cooperation with potential candidates (such as Ukraine and Georgia), the objects of the investigation were EU counties (Poland, Slovakia, and Romania) and potential candidates (Ukraine, Georgia).

The purpose of the survey and a short explanation of the teal organisation concept are sent to the respondents through email and social networks (Facebook Messenger, LinkedIn, and WhatsApp). The online survey was held during January–May 2021. The answers from 393 respondents were collected. The total number of companies was 40. With the purpose of estimating the attitude and awareness of teal organisations among not only companies' management but also the whole staff, all respondents were considered. The core concept of a teal organization is involving all workers in achieving the company's mission and being self-responsible people, especially in reaching the goals of carbon-free development. The questionnaire contains two blocks of questions: The first block identifies the role in the organisation; the second block contains question on core dimensions (attributes) of the teal organisations in the energy sector (the innovations and technologies; corporate culture; organisational culture). The second block contains six questions for each dimension relevant to the attributes of teal organisations.

The structure of the respondents' sample in each country are shown in Table 1.

Table 1. The structure of respondents' sample in each country.

Country	Total Number of Companies	Respondents		Workers	Top Management
		Total Number	Share in the Total Number		
Poland	8	71	0.18	48	23
Ukraine	8	71	0.18	46	25
Georgia	7	78	0.20	55	23
Slovakia	9	93	0.24	65	28
Romania	8	80	0.20	53	27

The respondents estimate the attributes of teal organisations using the Likert scale (0—strongly disagree; 5—strongly agree). Table 2 contains the descriptive statistics of the respondents' answers on estimating the attribute of the teal organisations. The estimation of each indicator (innovations and technologies, organisational structure, corporate culture) is calculated as the average values of all components.

Table 2. The descriptive statistics of each attribute of the teal organisations considering the respondents' answers.

Variables	Dimensions	Mean				
		Sl	**Ukr**	**Gr**	**Pl**	**Ro**
Innovations and technologies (IT)	The company priorities the investments in modern technologies (IT_1)	4.81	3.98	3.95	4.22	4.43
	The company ensures that all processes carried out in the company are innovative (IT_2)	4.20	3.44	3.41	3.71	3.88
	The employees have tools at their disposal that use modern technologies (IT_3)	4.02	3.33	3.32	3.65	3.81
	The employees could learn and develop (IT_4)	4.28	3.49	3.45	3.77	3.94
	The employees could constantly develop professionally (IT_5)	4.19	3.41	3.39	3.71	3.88
	The company gives open space for creative and innovative activities (IT_6)	4.42	3.61	3.57	3.87	4.04
	Cronbach alpha			0.77		
Corporate culture (CC)	The company relationships are based on teamwork (CC_1)	3.00	2.54	2.56	2.85	2.93
	The employees know the company's goals and try to achieve a common goal (CC_2)	3.06	2.54	2.50	2.80	2.96
	Competition has been replaced by partnership and cooperation (CC_3)	2.80	2.45	2.53	2.79	2.87
	The members of the team have the ability of self-management (CC_4)	4.05	3.31	3.30	3.63	3.79
	All company activities are transparent (CC_5)	3.16	2.56	2.53	2.78	2.89
	The actions of the employees are based on mutual trust (CC_6)	3.06	2.49	2.48	2.76	2.85
	Cronbach alpha			0.75		
Organisational culture (OC)	The company has a decentralised structure (OC_1)	3.06	2.49	2.49	2.80	2.90
	The company structure is flat and horizontal (OC_2)	3.13	2.56	2.54	2.80	2.92
	There is no hierarchy of positions in the company (OC_3)	3.10	2.66	2.70	2.99	3.10
	All employees of the company are equal, regardless of experience, seniority, or positions held (OC_4)	2.74	2.47	2.53	2.77	2.83
	In the company, no one gives orders to anyone because everyone knows their tasks and responsibilities (OC_5)	2.94	2.54	2.55	2.84	2.96
	The employees participate in shaping changes in the company (OC_6)	3.17	2.44	2.40	2.79	2.85
	Cronbach alpha			0.73		

Note: Pl—Poland, Ukr—Ukraine, Gr—Georgia Sl—Slovakia, Ro—Romania.

The findings in Table 2 allow us to conclude that the respondents' answers are consistent, as the Cronbach alpha is in the interval 0.73–0.75.

Considering the new wave of decarbonisation, the teal organisations in the energy sector should provide innovative technologies that decrease emissions and increase energy efficiency. The EU countries declare the 2030 target to decrease energy consumption by at least 32.5%. It means that primary energy consumption should be no more than 1273 Mtoe and final energy consumption no more than 956 Mtoe in 2030.

Considering the official reports, Poland and Ukraine have the highest volume of primary energy consumption. In 2019, Poland consumed 98.13 million tonnes of oil equivalent, and Ukraine consumed 74.98 million tonnes of oil equivalent. However, in Ukraine, the volume of primary energy consumption has already rapidly declined since 2003. On the contrary, since 2015, Poland has increased the volume of primary energy consumption. Romania, Slovakia, and Georgia have the lowest level of primary energy consumption among EU countries.

3.2. Data Analysis

At the first stage of testing the first and the second hypotheses, the respondents' perceptions about the priority of using the teal organisations' attributes from the energy sector are identified by using the Friedman test (considering the data for all countries on all

components: innovations and technologies, organisational structure, and corporate culture). The results of the Friedman test determine the statistically significant differences among perceptions about the teal organisations' attributes. Additionally, the paired-sample t-test compares the average value for each attribute in order to identify whether the attribute with the highest average value is more statistically significant than other attributes involved in this variable.

At the next stage, factor analysis (principal components analysis) is applied. This method indicates the factor load of each of the attributes. The correlation analysis estimates the relationship among attributes of teal organisations. The Kaiser–Meyer–Olkin (KMO) indicator (which estimates the proportion of variables' variance that the core factors could describe) and Bartlett's test of sphericity (which indicates the existence or absence of a significant correlation among the attributes' value) determine the possibility to apply the factor analysis.

The ANOVA test is applied for empirical justification of the third hypothesis. It determines the statistically significant differences among the levels of respondents' perceptions of the priority of teal organisations' attributes from the energy sector. Considering papers [12–21,61], the research model on determinants of increasing the country's energy efficiency could be written as a functional dependence:

$$EE = f(GDP,\ TECH,\ ICT,\ Teal) \quad (1)$$

Considering Equation (1), energy efficiency is the function of the level of innovation (*TECH*), information technologies (*ICT*), economic development (*GDP*):

$$lnEE_{it} = \alpha_0 + \alpha_1 lnTECH_{it} + \alpha_2 lnICT_{it} + \alpha_3 Teal_{it} + \alpha_4 lnGDP_{it} + u_{it} \quad (2)$$

where *EE* is the energy efficiency of a country i at time t, *TECH* is a patent application collected from World Bank [65], *ICT* is information technologies, teal is the rank value of a country by the attributes of a teal company, *GDP* is *GDP* per capita collected from the World Bank [65], $\alpha_0 \ldots \alpha_4$ are the searched coefficients, and u_{it} is a stochastic error.

The country's energy efficiency (dependent variable) is measured by the World Energy Trilemma Index, which is calculated by the experts of the World Energy Council [66]. The Energy Trilemma Index merges three core dimensions:

- Energy security—estimates the efficiency of the country's energy policy, reliability, and resilience of the energy infrastructure;
- Energy equity—estimates the equal access to affordable energy resources;
- Environmental sustainability—estimates the capacity to avoid and overcome the negative anthropogenic impact and climate changes [66].

Thus, considering papers [12,61], *GDP* has a causal effect on energy efficiency. Furthermore, papers [10–12,25–27,30,34,56–64,67] confirm that patent application and information technologies decrease energy loses and increase energy efficiency. In this case, the exogenous factors of model (2) are patent applications, information technologies, the rank value of a country by the attributes of a teal company, and *GDP*.

As the data are limited, in this research as well as in paper [67], the number of Internet and mobile users per population is used to measure *ICT*. The data are collected from the World Bank [65].

4. Results

The highest average value of each attribute in the component innovations and technologies, corporate culture, and organisational structure comprises the following:

- The company priorities in the investments in modern technologies (IT_1)—the value is in the interval from 3.95 to 4.81 depending on country;
- The members of the team have the ability to self-management (CC_4)—the value is in the interval from 3.30 to 4.05;

- The employees participate in shaping transformations in the company (OC_6)—the value is in the interval from 2.40 to 3.17.

Each attribute among six has an average value that describes the significance of the component as compared with others. The average value of «innovations and technologies» is higher than other components among the respondents—from 3.42 to 4.21—depending on the country. Table 3 contains the findings of the Friedman test and paired-sample *t*-test.

Table 3. The empirical results of the Friedman test and paired-sample t-test.

Dimensions	Friedman Test		Paired-Sample *t*-Test	
	χ^2	*p*-Value	t Value	*p*-Value
Innovations and technologies/The company prioritises the investments in modern technologies	83.23	0.00 *	3.22	0.000 *
Corporate culture/The members of the team have the ability to self-management	30.18	0.00 *	3.01	0.003 *
Organisational structure/The employees participate in shaping transformations in the company	98.43	0.00 *	4.05	0.002 *

*—statistical significance is at 1% level.

The findings in Table 3 do not confirm statistically significant differences between respondents' perception of attributes of teal companies "Innovations and technologies", "Corporate culture" and "Organisational structure". The most significant attributes in the framework of each group are: the company's priorities in investing into modern technologies; the members of the team have the ability to self-management; the employees participate in shaping transformations in the company. These findings imply that attributes of teal organisations are relevant for companies in energy sector.

The findings of the correlation analysis (Table 4) confirm the strong relationships between the attributes. The pairwise correlation coefficient is in the interval from 0.65 to 0.99. Based on Chaddock's scale [68], the strong direct correlation (very high [0.9–0.99]) is determined between attributes' groups "Innovations and technologies"-"Corporate culture" and "Innovations and technologies"-"Organisational structure" for: IT_1-CC_1, IT_2-CC_1, IT_3-CC_1, IT_4-CC_1, IT_5-CC_1, IT_1-CC_2, IT_2-CC_2, IT_3-CC_2, IT_4-CC_2, IT_5-CC_2, IT_1-CC_3, IT_2-CC_3, IT_3-CC_3, IT_4-CC_3, IT_5-CC_3, IT_1-CC_4, IT_2-CC_4, IT_3-CC_4, IT_4-CC_4, IT_5-CC_4, IT_6-CC_4, IT_1-CC_5, IT_2-CC_5, IT_3-CC_5, IT_4-CC_5, IT_5-CC_5, IT_6-CC_5, IT_1-CC_6, IT_2-CC_6, IT_3-CC_6, IT_4-CC_6, IT_5-CC_6, IT_6-CC_6, IT_1-OC_1, IT_2-OC_1, IT_3-OC_1, IT_4-OC_1, IT_5-OC_1, IT_1-OC_2, IT_2-OC_2, IT_3-OC_2, IT_4-OC_2, IT_5-OC_2, IT_6-OC_2, IT_3-OC_3, IT_5-OC_3.

Table 4. The findings of the correlation analysis.

	IT_1	IT_2	IT_3	IT_4	IT_5	IT_6	CC_1	CC_2	CC_3	CC_4	CC_5	CC_6	OC_1	OC_2	OC_3	OC_4	OC_5	OC_6
IT_1	1.00																	
IT_2	1.00	1.00																
IT_3	0.97	0.96	1.00															
IT_4	1.00	1.00	0.97	1.00														
IT_5	0.99	0.99	0.96	0.99	1.00													
IT_6	1.00	1.00	0.96	1.00	0.99	1.00												
CC_1	0.90	0.90	0.90	0.89	0.91	0.88	1.00											
CC_2	0.97	0.96	0.92	0.97	0.96	0.97	0.79	1.00										
CC_3	0.98	0.98	0.96	0.99	0.98	0.98	0.83	0.97	1.00									
CC_4	1.00	0.99	0.97	0.99	0.99	0.99	0.92	0.94	0.98	1.00								
CC_5	0.96	0.95	0.91	0.95	0.95	0.95	0.94	0.91	0.90	0.95	1.00							
CC_6	0.93	0.92	0.91	0.92	0.94	0.92	0.97	0.87	0.87	0.93	0.98	1.00						
OC_1	0.92	0.92	0.91	0.92	0.93	0.91	0.98	0.86	0.87	0.93	0.96	0.98	1.00					
OC_2	0.94	0.93	0.91	0.94	0.94	0.93	0.96	0.89	0.89	0.94	0.98	0.98	0.98	1.00				
OC_3	0.88	0.88	0.90	0.87	0.91	0.85	0.98	0.77	0.83	0.91	0.89	0.93	0.95	0.93	1.00			
OC_4	0.73	0.73	0.77	0.72	0.76	0.69	0.94	0.68	0.65	0.77	0.80	0.85	0.89	0.85	0.95	1.00		
OC_5	0.74	0.74	0.78	0.73	0.75	0.71	0.89	0.61	0.68	0.77	0.78	0.83	0.85	0.82	0.89	0.89	1.00	
OC_6	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.82	0.82	0.87	0.90	0.92	0.88	0.90	0.83	0.75	0.76	1.00

The value indicator Kaiser-Meyer-Olkin measure of sampling adequacy (for each attribute approaching 1) and the Bartlett's test (less than 0.05) indicate that factor analysis could be applied to determine the data structure. The findings of the principal component analysis (Table 5) conclude that the first component is explained by 90.4% of the individual components' deviations, the second—5.9%. In total (total share, %), two components explain 96.3% of the total variance, indicating a high degree of factorisation.

Table 5. The findings of the principal component analysis.

Eigenvalues											
Number	**Value**		**Difference**		**Proportion**		**Cumulative Value**		**Cumulative Proportion**		
1	16.266		15.204		0.904		16.266		0.904		
2	1.062		0.808		0.059		17.329		0.963		
3	0.254		0.090		0.014		17.583		0.977		
Eigenvectors (loadings):											
Variable	**PC 1**	**PC 2**	**PC 3**	**Variable**	**PC 1**	**PC 2**	**PC 3**	**Variable**	**PC 1**	**PC 2**	**PC 3**
IT_1	0.245	−0.172	0.096	CC_1	0.239	0.248	0.004	OC_1	0.241	0.149	−0.125
IT_2	0.243	−0.173	0.123	CC_2	0.229	−0.346	−0.076	OC_2	0.242	0.072	−0.228
IT_3	0.243	−0.085	0.230	CC_3	0.235	−0.277	0.208	OC_3	0.234	0.268	0.253
IT_4	0.243	−0.185	0.096	CC_4	0.240	−0.111	0.162	OC_4	0.207	0.506	0.155
IT_5	0.244	−0.130	0.111	CC_5	0.242	−0.012	−0.300	OC_5	0.205	0.441	0.230
IT_6	0.241	−0.219	0.042	CC_6	0.241	0.103	−0.309	OC_6	0.225	0.057	−0.656

The most significant loading of the first component is demonstrated by the following attributes: IT_1—0.245, IT_5—0.244, IT_2—0.243, IT_3—0.243, CC_5—0.242, OC_2—0.242. The positive value of the factors, which determine the principal components (Table 5), confirm the well-structured analysed data. The statistical analysis confirms the hypothesis that innovations and technologies are the most used attributes among teal organisations from the energy sector (H1); organisational structure and corporate culture are the least used attributes among teal organisations from the energy sector (H2). It confirms that the innovations (as element of teal organisation) are whispered among companies from energy sector. At the same time, the core issue for the companies from the energy sector is involving the workers to manage and cultivate the corporate culture. In this case, the companies from the energy sector should develop organisational structure and corporate culture in light of the concept of teal organisations.

The findings of the ANOVA test for respondents' perceptions of teal organisations' attributes among the countries analysed are shown in Table 6.

Table 6. The findings of the ANOVA test.

Countries	**Innovations and Technologies**				**Corporate Culture**				**Organisational Culture**			
	Mean	**SD**	**TS**	***p*-Value**	**Mean**	**SD**	**TS**	***p*-Value**	**Mean**	**SD**	**TS**	***p*-Value**
Poland	4.21	1.10			3.62	0.95			3.02	0.76		
Ukraine	3.45	0.57			2.96	0.46			2.52	0.38		
Georgia	3.42	0.50	27.44	0.00	2.96	0.46	24.31	0.00	2.54	0.48	17.02	0.00
Slovakia	3.74	0.68			3.26	0.61			2.83	0.55		
Romania	3.91	0.74			3.39	0.64			2.92	0.59		
Bartlett's test for equal variances			chi2 = 102.35 Prob > chi2 = 0.00				chi2 = 74.96 Prob > chi2 = 0.00				chi2 = 45.29 Prob > chi2 = 0.00	

Note: SD—standard deviation, TS—test statistic.

The empirical results of the ANOVA test (Table 6) showed that the p-value is 0.00 for all analysed attribute groups. This confirms the statistically significant differences between teal organisations' attributes among the countries analysed. The findings of Bartlett's test

for equal variances are statistically significant (p-value = 0.00). The relevant statistically significant level chi2 is 102.35 for attributes innovations and technologies, 74.96 for corporate culture, and 45.29 for organisational culture. This does not support the assumption of dispersions' homogeneity. The highest total level of teal organisations' attributes is shown by the energy sector companies in Slovakia (1st place), Romania (2nd place), and Poland (3rd place). The lowest level is demonstrated by the non-EU members Ukraine (4th place) and Georgia (5th place). Thus, the management of the company in the energy sector should orient on core attributes of teal organisations such as developing the self-management and involving the staff to achieving of the company's goals.

The regression analysis findings of the panel data considering the categorical independent variables (level of respondents' perceptions of teal organisations' attributes) is shown in Table 7.

Table 7. The result of the regression analysis for testing Hypothesis H3.

Hypothesis	Coef.	Std. Err.	t-Statistic	Prob.
$TECH$	0.013	0.020	3.180	0.004 *
ICT	−0.472	0.763	−0.620	0.542
GDP	0.007	0.003	2.490	0.021 **
$Teal_{\text{Romania}}$	2.767	1.343	2.060	0.051 ***
$Teal_{\text{Poland}}$	4.532	2.583	1.750	0.093 ***
$Teal_{\text{Ukraine}}$	5.677	2.302	2.470	0.022 **
$Teal_{\text{Georgia}}$	1.121	1.066	1.050	0.304

*, **, ***—statistical significance is at 1%, 5%, and 10% levels; all data in logarithmic.

The regression analysis findings confirm that $TECH$ has the highest impact on energy efficiency at a statistically significant level (p-value = 0.000). Increasing $TECH$ by 1% leads to enhancing energy efficiency by 1.29%. The indicator ICT has a negative impact on the energy trilemma index, but it is not a significant value. The determination coefficient of the model is 61.08%. The F-ratio of 4.96 with a p-value of 0.0017 shows that the model, as a whole, fits significantly.

The regression coefficient for the first comparison variable between the first place of the categorical variable (the level of teal organisations attributes' expression) and the second is 2.767; between 2rd and 3rd places is 4.532; 3th and 4th places is 5.677; 4th and 5th places is 1.121. These results are statistically significant, except for the 4th and 5th places. This indicates that developing innovations and effective implementation of the available achievements of Industry 4.0 and spreading the concept of teal organisation in the energy sector increases the country's energy efficiency. As Ukraine and Georgie are going to become members of the EU, they should synchronise the relevant policies on innovative development in the energy sector not only at the macrolevel but also at the business level. It will cultivate the innovations and spread the concept of teal organisations.

5. Discussion

The results prove that innovations and technologies are the most used attributes among teal organisations from the energy sector. Similar conclusions are obtained in papers [29–34]. In this case, the management of the companies that aim to transform into teal organisations should introduce available innovations into the companies' operation. Additionally, new technologies decrease the emissions from the companies' operation. Considering the findings for the teal organisations from the energy sector, the attributes of corporate culture and structure are less used compared to innovations and technologies. This conclusion is opposite to findings in [42,43,46,50]. The third hypothesis (teal organisations, economic development, information and innovation technologies influence the energy efficiency of the country) is confirmed. The regression analysis findings show that EU members (Poland, Romania, and Slovakia) and non-members (Ukraine and Georgia) have significantly different approaches to managing energy sectors. In this case, the EU

countries have a better position on energy efficiency. Such findings correspond to the countries' rating on the World Energy Trilemma Index [66]. Additionally, in the EU countries, the teal organisations in energy sectors are more widespread compared to those in Ukraine and Georgia. This indicates that the spread of teal organisations in the energy sector requires the government to develop the appropriate conditions for research and development, which are the basis for innovation growth as the achievements of Industry 4.0.

6. Conclusions

The rapid development of innovation and technologies, intensification of ecological issues, and reorientation to carbon-free development has caused transformations of the management paradigm at energy sector companies. It leads to the development of teal organisations with the following characteristics: evolutionary goals, self-management, wholeness. The results of the principle component analysis show that innovations and technologies are the most used attributes among teal organisations from the energy sector. It concludes that teal organisations in the energy sector actively use innovations and technologies. At the same time, it is necessary to strengthen the corporate culture and organisational structure, as teal organisations are based on human oriented development theory, openness, and transparency of the companies' management. Considering the Friedman test and paired-sample *t*-test, the most affected factors are self-management and participation in shaping changes in the company. In this case, management of teal organisations from the energy sector should implement programs for employees' development, change the organisational structure of the company through involving their workers in management, and share aims and goals of the company among employees. The regression analysis results show that increasing patent applications by 1% leads to increased energy efficiency of 1.29%. Additionally, implementing features of teal organisations in the energy sector improves the country's energy efficiency, which, as a consequence, boosts carbon-free development. The acceptance of innovative model development requires solving a vast range of issues from regulation to relevant transformation at the company's level, which should focus on implementing an evolutionary business model. Furthermore, the developing the public policy on enlarging the innovations and spreading core principals of teal organisation should be realised at all levels of the energy sector: government, region, and business. It can achieve the synergy effect from spreading the teal organisations under Industry 4.0.

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References

1. Transforming our Economy and Societies. Available online: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en (accessed on 20 June 2021).
2. Romero, A.M.; Uruburu, Á.; Jain, A.; Ruiz, M.A.; Muñoz, C.G. The path towards evolutionary—Teal organizations: A relationship trigger on collaborative platforms. *Sustainability* **2020**, *12*, 9817. [CrossRef]
3. Kurki, S.; Wilenius, M. Trust makes this organisation unique. *Eur. J. Futur. Res.* **2016**, *4*, 23. [CrossRef]
4. Chigrin, O.; Pimonenko, T. The ways of corporate sector firms financing for sustainability of performance. *Int. J. Ecol. Dev.* **2014**, *29*, 1–13.
5. Jack, R. Building teal organizations with servant leadership? In *Practicing Servant Leadership*; Palgrave Macmillan: Cham, Switzerland, 2018; pp. 187–207.
6. Laloux, F. *Reinventing Organisations*; Uitgeverij LannooCampus Nederland: Leuven, Belgium, 2016.

7. Kamo, J.; Phillips, F. The evolutionary organization as a complex adaptive system. In Innovation in Technology Management. In Proceedings of the The Key to Global Leadership, PICMET '97, Portland, OR, USA, 31 July 1997; pp. 325–330.
8. Lipkova, L.; Braga, D. Measuring commercialisation success of innovations in the EU. *Mark. Manag. Innov.* **2016**, *4*, 15–30.
9. Pająk, K.; Kvilinskyi, O.; Fasiecka, O.; Miskiewicz, R. Energy security in regional policy in Wielkopolska region of Poland. *Econ. Environ.* **2017**, *2*, 122–138.
10. Lyulyov, O.; Pimonenko, T.; Kwilinski, A.; Us, Y. The heterogeneous effect of democracy, economic and political globalisation on renewable energy. In *E3S Web of Conferences*; EDP Sciences: Les Ulis, France, 2021; Volume 250, p. 03006.
11. Chygryn, O.; Lyulyov, O.; Pimonenko, T.; Mlaabdal, S. Efficiency of oil-production: The role of institutional factors. *Eng. Manag. Prod. Serv.* **2020**, *12*, 92–104. [CrossRef]
12. Lyulyov, O.; Pimonenko, T.; Kwilinski, A.; Dzwigol, H.; Dzwigol-Barosz, M.; Pavlyk, V.; Barosz, P. The impact of the government policy on the energy efficient gap: The evidence from Ukraine. *Energies* **2021**, *14*, 373. [CrossRef]
13. Azam, M.; Khan, A.Q. Testing the environmental kuznets curve hypothesis: A comparative empirical study for low, lower middle, upper middle and high income countries. *Renew. Sustain. Energy Rev.* **2016**, *63*, 556–567. [CrossRef]
14. Al-mulali, U.; Fereidouni, H.G.; Lee, J.Y.; Sab, C.N.B.C. Examining the bi-directional long run relationship between renewable energy consumption and GDP growth. *Renew. Sustain. Energy Rev.* **2013**, *22*, 209–222. [CrossRef]
15. Apergis, N.; Payne, J.E. Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy* **2010**, *38*, 656–660. [CrossRef]
16. Niebel, T. ICT and economic growth—Comparing developing, emerging and developed countries. *World Dev.* **2018**, *104*, 197–211. [CrossRef]
17. Ishida, H. The effect of ICT development on economic growth and energy consumption in Japan. *Telemat. Inform.* **2015**, *32*, 79–88. [CrossRef]
18. Khan, N.; Baloch, M.A.; Saud, S.; Fatima, T. The effect of ICT on CO_2 emissions in emerging economies: Does the level of income matters? *Environ. Sci. Pollut. Res.* **2018**, *25*, 22850–22860. [CrossRef]
19. Shabani, Z.D.; Shahnazi, R. Energy consumption, carbon dioxide emissions, information and communications technology, and gross domestic product in Iranian economic sectors: A panel causality analysis. *Energy* **2019**, *169*, 1064–1078. [CrossRef]
20. Shahbaz, M.; Raghutla, C.; Song, M.; Zameer, H.; Jiao, Z. Public-private partnerships investment in energy as new determinant of CO_2 emissions: The role of technological innovations in China. *Energy Econ.* **2020**, *86*, 104664. [CrossRef]
21. Pan, X.; Uddin, K.; Han, C.; Pan, X. Dynamics of financial development, trade openness, technological innovation and energy intensity: Evidence from Bangladesh. *Energy* **2019**, *171*, 456–464. [CrossRef]
22. Miśkiewicz, R. Efficiency of electricity production technology from post-process gas heat: Ecological, economic and social benefits. *Energies* **2020**, *13*, 6106. [CrossRef]
23. Miśkiewicz, R. The impact of innovation and information technology on greenhouse gas emissions: A case of the visegrád countries. *J. Risk Financ. Manag.* **2021**, *14*, 59. [CrossRef]
24. Saługa, P.W.; Szczepańska-Woszczyna, K.; Miśkiewicz, R.; Chłąd, M. Cost of equity of coal-fired power generation projects in poland: Its importance for the management of decision-making process. *Energies* **2020**, *13*, 4833. [CrossRef]
25. Petroye, O.; Lyulyov, O.; Lytvynchuk, I.; Paida, Y.; Pakhomov, V. Effects of information security and innovations on country's image: Governance Aspect. *Int. J. Saf. Secur. Eng.* **2020**, *10*, 459–466. [CrossRef]
26. Wolniak, R.; Saniuk, S.; Grabowska, S.; Gajdzik, B. Identification of energy efficiency trends in the context of the development of industry 4.0 Using the polish steel sector as an example. *Energies* **2020**, *13*, 2867. [CrossRef]
27. Nota, G.; Nota, F.; Peluso, D.; Lazo, A.T. Energy efficiency in industry 4.0: The case of batch production processes. *Sustainability* **2020**, *12*, 6631. [CrossRef]
28. Meeus, M.T.; Oerlemans, L.A. Firm behaviour and innovative performance: An empirical exploration of the selection—Adaptation debate. *Res. Policy* **2000**, *29*, 41–58. [CrossRef]
29. Arakji, R.Y.; Lang, K.R. Adoption and diffusion of business practice innovations: An evolutionary analysis. *Int. J. Electron. Commer.* **2010**, *15*, 145–168. [CrossRef]
30. Borowski, P. Digitization, digital twins, blockchain, and industry 4.0 as elements of management process in enterprises in the energy sector. *Energies* **2021**, *14*, 1885. [CrossRef]
31. Kwilinski, A. Implementation of blockchain technology in accounting sphere. *Acad. Account. Financ. Stud. J.* **2019**, *23*, 1–6.
32. Miskiewicz, R. Knowledge and innovation 4.0 today's electromobility. In *Sustainability, Technology and Innovation 4.0*; Makieła, Z., Stuss, M.M., Borowiecki, R., Eds.; Routledge: New York, NY, USA, 2021; pp. 256–275.
33. Rzepka, A.; Miśkiewicz, R.; Prachowski, J. Development opportunities and challenges for organizations striving for teal in economy 4.0 on the basis of research. In *Self-Management, Entrepreneurial Culture, and Economy 4.0: A Contemporary Approach to Organizational Theory Development*; Rzepka, A., Olesiński, Z., Jędrych, E., Eds.; Routledge: New York, NY, USA, 2021; pp. 217–236.
34. Kunkel, S.; Matthess, M. Digital transformation and environmental sustainability in industry: Putting expectations in Asian and African policies into perspective. *Environ. Sci. Policy* **2020**, *112*, 318–329. [CrossRef]
35. Maris, G.; Flouros, F. The green deal, national energy and climate plans in Europe: Member States' compliance and strategies. *Adm. Sci.* **2021**, *11*, 75. [CrossRef]
36. Masharsky, A.; Azarenkova, G.; Oryekhova, K.; Yavorsky, S. Anti-crisis financial management on energy enterprises as a precondition of innovative conversion of the energy industry: Case of Ukraine. *Mark. Manag. Innov.* **2018**, *3*, 345–354. [CrossRef]

37. Sokolovska, A.; Zatonatska, T.; Stavytskyy, A.; Lyulyov, O.; Giedraitis, V. The impact of globalization and international tax competition on tax policies. *Res. World Econ.* **2020**, *11*, 1. [CrossRef]
38. Butko, M. Innovations in human resources management in Eurointegration conditions: Case for Ukrainian agro-industrial complex. *Mark. Manag. Innov.* **2019**, *2*, 74–82. [CrossRef]
39. Tkachenko, V.; Kwilinski, A.; Klymchuk, M.; Tkachenko, I. The economic-mathematical development of buildings construction model optimization on the basis of digital economy. *Manag. Syst. Prod. Eng.* **2019**, *27*, 119–123. [CrossRef]
40. Gallo, P.; Mihalcova, B.; Vegsoova, O.; Dzurov-Vargova, T.; Busova, N. Innovative trends in human resources management: Evidence for the health care system. *Mark. Manag. Innov.* **2019**, *2*, 11–20. [CrossRef]
41. Yousef, D.A. Organizational commitment: A mediator of the relationships of leadership behavior with job satisfaction and performance in a non-western country. *J. Manag. Psychol.* **2000**, *15*, 6–24. [CrossRef]
42. Andriopoulos, C. Determinants of organisational creativity: A literature review. *Manag. Decis.* **2001**, *39*, 834–841. [CrossRef]
43. Košičiarová, I.; Kádeková, Z.; Štarchoň, P. Leadership and motivation as important aspects of the international company's corporate culture. *Sustainability* **2021**, *13*, 3916. [CrossRef]
44. Muisyo, P.K.; Qin, S.; Ho, T.H.; Julius, M.M. The effect of green HRM practices on green competitive advantage of manufacturing firms. *J. Manuf. Technol. Manag.* **2021**. [CrossRef]
45. Pimonenko, T.; Prokopenko, O.; Dado, J. Net zero house: EU experience in ukrainian conditions. *Int. J. Ecol. Econ. Stat.* **2017**, *38*, 46–57.
46. Maldonado, T.; Vera, D.; Ramos, N. How humble is your company culture? And why does it matter? *Bus. Horizons* **2018**, *61*, 745–753. [CrossRef]
47. Simetinger, F.; Zhang, Z. Deriving secondary traits of industry 4.0: A comparative analysis of significant maturity models. *Syst. Res. Behav. Sci.* **2020**, *37*, 663–678. [CrossRef]
48. Su, K.-W.; Yu, M.-C.; Leu, J.-S. A neuroevolution strategy using multi-agent incorporated hierarchical ensemble model. In Proceedings of the Genetic and Evolutionary Computation Conference Companion, Kyoto, Japan, 15–19 July 2018; ACM Press: New York, NY, USA, 2018; pp. 171–172.
49. Fombrun, C.J.; Wally, S. Structuring small firms for rapid growth. *J. Bus. Ventur.* **1989**, *4*, 107–122. [CrossRef]
50. Cimini, C.; Boffelli, A.; Lagorio, A.; Kalchschmidt, M.; Pinto, R. How do industry 4.0 technologies influence organisational change? An empirical analysis of Italian SMEs. *J. Manuf. Technol. Manag.* **2020**, *32*, 695–721. [CrossRef]
51. Mustapa, I.R.; Malak, S.S.D.A. Employing organizational capacity components in enhancing corporate performance. *Humanit. Soc. Sci. Rev.* **2019**, *7*, 174–182. [CrossRef]
52. Kim, H.; Kim, W.; Park, K.S. The Effect of structural changes in the organizational form of business groups: Evidence from Korea. *Asia Pac. J. Financ. Stud.* **2012**, *41*, 286–312. [CrossRef]
53. Gokus, O. The moderating roles of company structure and external environment on market orientation and business strategy types. *Acad. Mark. Stud. J.* **2015**, *19*, 190–209.
54. Wei, L.-Q.; Liu, J.; Zhang, Y.; Chiu, R.K. The role of corporate culture in the process of strategic human resource management: Evidence from Chinese enterprises. *Hum. Resour. Manag.* **2008**, *47*, 777–794. [CrossRef]
55. Busse, R. Corporate culture, organizational change and meaning at work-linking human resources with business ethics. *Hum. Syst. Manag.* **2014**, *33*, 47–50. [CrossRef]
56. Benešová, A.; Basl, J.; Tupa, J.; Steiner, F. Design of a business readiness model to realise a green industry 4.0 company. *Int. J. Comput. Integr. Manuf.* **2021**, *34*, 920–932. [CrossRef]
57. Fritzsche, K.; Niehoff, S.; Beier, G. Industry 4.0 and climate change—Exploring the science-policy gap. *Sustainability* **2018**, *10*, 4511. [CrossRef]
58. 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]
59. Ma, S.; Zhang, Y.; Liu, Y.; Yang, H.; Lv, J.; Ren, S. Data-driven sustainable intelligent manufacturing based on demand response for energy-intensive industries. *J. Clean. Prod.* **2020**, *274*, 123155. [CrossRef]
60. Lyulyov, O.; Vakulenko, I.; Pimonenko, T.; Kwilinski, A.; Dzwigol, H.; Dzwigol-Barosz, M. Comprehensive assessment of smart grids: Is There a universal approach? *Energies* **2021**, *14*, 3497. [CrossRef]
61. Us, Y.; Pimonenko, T.; Lyulyov, O. Energy efficiency profiles in developing the free-carbon economy: On the example of Ukraine and the V4 countries. *Polityka Energetyczna Energy Policy J.* **2020**, *23*, 49–66. [CrossRef]
62. Prokopenko, O.; Cebula, J.; Chayen, S.; Pimonenko, T. Wind energy in israel, poland and ukraine: Features and opportu-nities. *Int. J. Ecology Dev.* **2017**, *32*, 98–107.
63. Cebula, J.; Chygryn, O.; Chayen, S.V.; Pimonenko, T. Biogas as an alternative energy source in Ukraine and Israel: Current issues and benefits. *Int. J. Environ. Technol. Manag.* **2018**, *21*, 421. [CrossRef]
64. Junker, H.; Domann, C. Towards industry 4.0 in corporate energy management. *Ecosyst. Sustain. Dev. XI* **2017**, *1*, 49–56. [CrossRef]
65. The World Bank (IBRD). Data Bank. 2019. Available online: https://data.worldbank.org/ (accessed on 10 January 2021).
66. World Energy Council. Available online: https://www.worldenergy.org/publications (accessed on 20 June 2021).

67. Usman, A.; Ozturk, I.; Hassan, A.; Zafar, S.M.; Ullah, S. The effect of ICT on energy consumption and economic growth in South Asian economies: An empirical analysis. *Telemat. Inform.* **2021**, *58*, 101537. [CrossRef]
68. Ongdash, A.O.; Omirtay, A.D.; Bayetova, M.T.; Ongdashuly, E. Economic growth modeling for the Republic of Kazakhstan based on the higher energy efficiency level. *Int. J. Energy Econ. Policy* **2020**, *10*, 396. [CrossRef]