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Smart Organizations as a Source of Competitiveness and Sustainable Development in the Age of Industry 4.0: Integration of Micro and Macro Perspective

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Abstract: The Industry 4.0 Revolution that is taking place nowadays means that organizations face not only new opportunities, but also challenges related to the identification of their role in creating a modern smart world. The economies of many countries are under the significant and growing influence of various types of organizations, not only strong international business corporations, but also, more and more often, smaller but intelligent ones called smart organizations IR 4.0. Due to their unique characteristics, intelligent organizations are better able than others to cope with technological breakthroughs, social, and cultural problems as well as to compete effectively and develop in an environmentally sustainable way. With their growing potential, they are strengthening the economies of their countries of origin and daily operation. Their growing role is also visible in the processes of shaping competitiveness and achieving the sustainable development objectives of the European Union (EU). The countries that are able to organize an environment on their territory that is conducive to the smart organization's development are clear examples not only of a high market competitiveness, but also of a dynamically growing commitment to the effective implementation of the challenges associated with the 17 objectives of sustainable development of the contemporary EU, according to the 2030 Agenda for Sustainable Development. This allows for a conclusion that the identification of the key factors for a smart organization's development makes it possible to monitor and provide targeted support for the development not only of these organizations, but also for the competitiveness and sustainability of individual countries, both from the EU and other regions of the world. In light of the above, the aim of this article is therefore to propose an effective tool to monitor the use of power of smart organizations in the processes of building the competitiveness and sustainable development of countries, with particular reference to the EU. To achieve this objective, we constructed a synthetic power of smart organizations index (PSOI) based on previously collected data from EUROSTAT. This tool allows for the integration of micro (organization level) and macro (country level) economic aspects into a single construct. Based on the analysis of its results, countries wishing to actively engage in the development of their own and the EU's smartness and sustainability can be offered several more or less intense navigation paths to market success, based on the development of smart organizations.

Keywords: Industry 4.0; smart technologies; sustainability; smart and sustainable organizations; smart and sustainable EU

Citation: Adamik, A.; Sikora-Fernandez, D. Smart Organizations as a Source of Competitiveness and Sustainable Development in the Age of Industry 4.0: Integration of Micro and Macro Perspective. *Energies* **2021**, *14*, 1572. https://doi.org/10.3390/en14061572

Academic Editor: Patrycja Hąbek

Received: 12 February 2021
Accepted: 10 March 2021
Published: 12 March 2021

1. Introduction

We are witnessing the fourth industrial revolution, the so-called Industry 4.0 Revolution, so we live in the smart world of IR 4.0 transition [1–4]. This world brings not only new opportunities and challenges, but also new requirements in terms of the concepts and principles of effective operation and competition on the IR 4.0 scale. This applies to both the social and economic spheres [5,6] as well as their interconnection, impact [7], and

even dependence [8]. This is due, among other things, to the deepening and dynamically propagating role of modern technologies, especially information science and information technologies, albeit not only [9]. Based on their effective use, new smart competencies, smart employees, smart managers, smart products [10], smart projects, smart technologies, smart factories [11], smart organizations, and smart industries [12,13] are born, and furthermore, smart cities [14–18], regions [19,20], and countries or economies. As a result, we create for everyone a smart Europe, smart world, and generally a smart future [21].

In 2012, the World Economic Forum published "The Europe 2020 Competitiveness Report: Building a More Competitive Europe". This Report researched and monitored the extent to which the EU was making progress to achieve the competitiveness goals set in its "Europe 2020" strategy to achieve smart, sustainable, and inclusive growth. Its reading inspired the authors to start looking for potential sources (i.e., concrete catalysts of success) with a specific smart character. Questions also arose as to whether only new technologies significantly influenced this character, or whether there were any other conditions (e.g., social) with equally important impact, and how to what extent smart organizations contribute to achieving the EU's sustainable development goals. It was not easy to find answers to these questions.

The analysis was greatly supported by the results of the report "The EU Regional Competitiveness Index 2019 [22] and the World Economic Forum (WEF).

As a preliminary remark, it has been assumed that after the World Economic Forum (WEF), the phenomenon responsible for the smartness of Europe involves competitiveness and sustainability at the national level, which is generally seen as "a set of institutions, policies, and factors that determine the level of productivity of a country". However, such a broad and, on the other, aggregated approach was not satisfactory. Further research has drawn the authors' attention to the special role of "regions" in the analyzed phenomenon. According to Meyer-Stamer [23], "we can define (systemic) competitiveness of a territory as the ability of a locality or region to generate high and rising incomes and improve the livelihoods of the people living there" [24]. However, this approach still did not provide a clear answer to the question raised, as this definition is based entirely on the benefits to people living in a region and does not assess the strengths or weaknesses of companies. A step in the right direction came in the form of the approach proposed by Lewis Dijkstra used in 2019 in "the EU regional competitiveness index 2019". The author noted that "Regional competitiveness is the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work" [25]. This approach drew the attention of the authors of the study to the special role of companies, or more broadly, organizations. On the one hand, they select, collect, process, develop, and exploit the smart resources and skills available in their surroundings (city, region, country); on the other, it is their smart (smartness) activity that determines and delineates the dynamics of wider socio-economic, sustainable development, or the competitiveness of individual cities, regions, economies, and even larger economic systems including the EU. Further analysis also strongly confirmed the important links between organizational smartness, the achievement of sustainability goals, and competitiveness.

Therefore, it seemed crucial to identify the essence and specificity of the activity, and the real role in a contemporary smart EU/world of the so-called smart organizations. A literature review of the issue showed a significant research gap. Both the Web of Science and Scopus databases show a clear lack of research in this area. While numerous results of research on the competitiveness of countries, regions, industries, or selected types of organizations are available, there are no such analyses for their specific "smart" varieties. Much has been written about the specificity and role of different types of organizations in today's economy, but there is still little research on deepening the knowledge on smart organizations. Even queries in research databases for terms that are close to "smart firm", "smart business", or "intelligent organization" did not improve the situation (see Table 1).

Table 1. Systematic review of the literature on "smart organization" and related terms in the Web of Science and Scopus databases (2020).

Search Research by Title	WoS/Generally	WoS/Busines, Management and Economics	Scopus/Generally	Scopus/Business, Management, and Accounting
	Analyze search results (number of papers)			
"Smart business"	52	26	97	47
"Intelligent organization"	29	12	52	18
"Smart organization"	11	10	37	26
"Smart firms"	1	1	4	4

Source: Own studies based on the WoS and Scopus databases.

Therefore, considering the era in which we live, there seems to be a significant research gap. Other reasons for undertaking this research topic include:

1. A lack of effective, systematic, integrated approach, and cooperation between various groups of stakeholders including businesses, consumers, politicians, the world of science, and non-governmental organizations to build competitiveness and achieve the 2030 Agenda for Sustainable Development Goals.
2. A lack of easy-to-use and clear tools for monitoring the maturity of smart organizations that influence the level of competitiveness and the achievement of sustainable development goals in countries of their operation.
3. A lack of established ways to support the navigation of countries wishing to accelerate the processes of building competitiveness and achieving sustainable development goals.

The aim of the study was to reduce these gaps.

Many years of research on the issue have allowed the authors to put forward a thesis that the sources of success, sustainability, or simply competitiveness of each of the "smart entities" (cities, regions, countries) depend on the "power" and maturity of the smart organizations/companies cooperating with them. In order to join the discussion on the so-called factors supporting the construction of smart and sustainable Europe, it was assumed that the main goal of the paper was to identify and map the key variables of smart organization IR 4.0 as well as to propose and verify a tool for monitoring the manner of building the sustainability and competitiveness of smart Europe IR 4.0 based on the Power of Smart Organizations Index (PSOI).

With the above in mind, subsequent parts of the study attempted to bring closer the specificity of organizations in the Age of Industry 4.0. It started with a description of the requirements of the IR 4.0 Age and the concept of "smart", then an attempt was made to identify the essence of smart and sustainable organizations as well as the sources and consequences of smart organizations' "power". The next step involved describing the concept and methodology of the empirical studies undertaken to achieve the objectives of the study and to discuss the collected results. In Section 5, there are references to studies by other researchers on the issue as well as an indication of the proposed directions of further research. In Section 6, research conclusions are proposed. Theoretical considerations were based on a review of the world literature on management sciences, organizational sciences, and strategic management, with particular emphasis on the requirements of the Industry 4.0 Age. Empirical analyses were carried out on the basis of Eurostat data for 2018 and 2019 for the 28 EU Member States, based on the proprietary synthetic Power of Smart Organization Index (PSOI).

2. Organizations in the Age of Industry 4.0

2.1. The Specifics of the Age of Industry 4.0 and the Concept of "SMART"

The starting point for the analyses was understanding the specificity of the Industry 4.0 (IR 4.0) Age. It is related to increasing globalization, the ever-accelerating pace of techno-

logical, social, and cultural progress, and the consequent fourth industrial revolution—the so-called Information Technology (IT) revolution. Together, they form a specific environment for modern organizations, in which two functional realities: real (PR—physical reality) and virtual (cyberspace, VR—virtual reality), merge. This leads to the development of various networks of cooperation between organizations (network cooperation, virtual network), computer-based advanced technologies, digital solutions, robotics (CPS—Cyber-Physical Systems), real-time big data processing (BDA—Big Data Analytics), Internet connections (IoT—Internet of Things, IoS—Internet of Services), close, partnership-oriented relations between people (Cooperation, Partnering, Team Working), and organizations (SP—Strategic Partnering, KP—Knowledge Partnering, Coopetition) as well as relations between machines themselves (M2M—Machine to Machine Communications, Artificial Intelligence, Neural Networks) [26–28]. It is therefore an extended conceptual unit, meaning a knowledge-based and innovative solution-based integration/cooperation of intelligent people, machines, and systems, resulting in changes in production and service processes in order to increase their quality, speed, power, and flexibility (e.g., in terms of available capacities, and assortment in order to customize them more strongly) [2,29,30]. In this way, it poses specific competence, technological, and organizational challenges to modern market players [31–37].

In order to meet them, contemporary organizations or other stakeholders should be part of the essence of the smart concept/state [28]. Smart means that innovations are implemented in an intelligent, proactive, purposeful, aspirational, and goal-oriented manner, which leads to the achievement of a desired future [38]. The smart state is dependent on factors such as the environment, culture, and the value system of a given person or organization. Nevertheless, the overall concept of a smart future should be based on the search for a living environment that is superior to what is present now [39]. The smart state should support the development of intelligent solutions to complex strategic problems, in order to ensure human functioning [40] and, as such, requires much more from modern organizations and their environment than just owning and operating smart gadgets, ICTs, convergence strategies, and government support. It has to be based on a solid foundation of future-oriented soft innovations such as social justice, rule of law, transparency, accountability, cohesive collective wisdom of people, sustainable development, social cohesion, and shared visions and goals [41,42]. Against such a background, people's knowledge and information become a new currency by leveraging networks and devices they share to navigate any exchanges and negotiations, be they individual or social, personal, or professional, driven by human interactions or machine interfaces, in order to generate added value by producing huge amounts of data in need of processing and analysis [43].

In conclusion, the attribute of a "smart state" comes from the manner in which an organization develops and uses knowledge as an integrated resource that combines the expertise provided by human resources with the support offered by technology-based platform [44]. The concept of a smart organization is thus based on the usage and justification that lead to harnessing information-age tools and management practices within an organization in a specific way. This makes the smart world an alluring prospect that involves intelligence that permeates into things that surround us including physical and virtual objects, social interactions, and human thinking. One ultimate goal of such a smart world is an integrated hyperspace made of virtual, physical, social, and thinking dimensions. This would involve complex interconnections and intelligent relations between the perception of the physical world, interactions in the virtual sphere, social correlation, and cognitive thinking interwoven into every possible aspect of our daily lives [21,45,46].

2.2. Smart and Sustainable Organizations

Modern economies are under the significant and growing influence of various types of organizations, not only strong, international business corporations, but also increasingly smaller but intelligent organizations that are now known as smart organizations

IR 4.0. [44,47–51]. Research and development (R&D) contributed substantially to the emergence of smart organizations [52].

Generally speaking, organizations are open social and technical systems with their own specific objectives and an adequately adapted organizational structure. However, smart organizations have specific requirements for each of these elements (social, technical, goal, and structure resources used) because of their focus on the needs of the Age of Industry 4.0.

The term "intelligent organization" evolved in the 1990s due to the development of ICT, dynamically changing economic surroundings and the growth in market competition [53]. Within the European Commission's research program, "Information Society Technologies", the term "smart organization" was coined for organizations that are "knowledge-driven, inter-networked, and dynamically adaptive to new organizational forms and practices, learning as well as agile in their ability to create and exploit the opportunities offered" [54]. An intelligent/smart organization is marked by a transitory layout and agile structure [44] learning organization, with the capacity for creating, gaining, organizing, and sharing knowledge and using it for the purpose of increasing the operational effectiveness, sustainable development, and competitiveness in the global market. A smart organization is one that bases its philosophy of operation on sustainability and knowledge management. Knowledge resources include data concerning one's customers, products, processes, environment, etc. both in a codified (documents, databases) and non-codified (the employees' knowledge) form. Such co-dependency of these elements, when put in practice, would have to employ advanced ICT solutions embedded into the framework of an economic organization's ICT system. An intelligent organization uses not only technical and technological solutions, but also social, environmental, and organizational innovations. The area of their operation is the implementation of virtual processes in the environment of extensive ICT networks (their technological platform of choice is most frequently the Internet), aimed at the coordination and integration of many, often very diverse business partners in their supply chain [54].

These types of entities are of particular value to their environment (e.g., to the EU and its goals of sustainable development) as they navigate the environment wisely, avoiding defeats and achieving relatively numerous successes. The achievement of the assumed objectives is accomplished, in their case by generating and selecting information from their own (and other entities') experience, which is transformed into professional knowledge and the ability to use it efficiently. These actors have a particular ability for continuous learning as they have the ability to create, acquire, organize, sustain, and share knowledge as well as use it to modify their organizational behavior. In addition to learning processes and the systematic collection and processing of data and information into useful knowledge, they are also able, through the definition and implementation of appropriate internal structures, to create appropriate conditions for the dissemination and use of the knowledge thus accumulated. An intelligent organization seen in this way (smart) can be seen as a metaphor, an endless process of organizational improvement of structure and method of operation, realized through methodical gaining and applying knowledge in order to survive and further develop in a sustainable manner [21,55].

Some also view smart and sustainable organizations as examples of business networking, understood as one of the most important abilities that will be demanded of businesses in the Age of Industry 4.0. This is because a smart organization operates in a self-made "knowledge environment", an infosphere that exceeds its purely technical activity. The concept of an infosphere can be understood as a certain collection of ICT equipment, software, and human capital as well as structural data and information that can be directly accessed by people in their working environments [55]. In this way, smart, as an attribute, stems from the manner in which the organization develops and uses knowledge as an integrated resource, combining the expertise of its human force, environmental sustainability, and the support offered by the technological platform it uses [40]. As a result, the productivity growth of smart organizations is a consequence of the organizational changes enabled

by technological innovation, not the technologies themselves, and will only be achieved by organizations that adopt new forms of work, along with new technologies [56,57]. Advanced technologies used by organizations also provide the potential to build new relationships, organizational forms, and new experiences on a wider scale. Products and services equipped with smart technologies offer innovative features that transform their design, manufacture, delivery, and use. As seen above, organizational sustainability is closely linked to smartness. According to the original definition of sustainability, it is "the process of meeting the developmental aspirations of the present generation in such a way that the same aspirations can be fulfilled by future generations" [58,59]. In the environmental context, its main premise is to warn against the increasing exploitation of natural resources under pressure from the intensification of economic processes. Nowadays, however, the prevailing view is that the concept of "sustainability" has a broader dimension and refers not only to environmental aspects, but also to economic, social, and spatial ones in the context of the functioning of various organizations. It can therefore be assumed that it is a process that ensures high ecological, economic, social, and spatial standards for all currently cooperating entities, as well as all future generations, in accordance with the principles of intra- and inter-generational equity. A similar definition has been formulated by the UN World Commission on Environment and Development, which states that sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [59].

From an organization's perspective, however, it is assumed that the long-term prosperity of a company depends on paying attention to the three aspects of sustainability: social, environmental, and economic. Therefore, if sustainable development of a smart organization depends on its interdependence within the three subsystems—environmental, economic and social—then the effective management of such an organization must be reflected in appropriate conditions for the proper and sustainable use of its potential resources, skills, and relationships. It is widely accepted that advanced technologies including ICTs have a positive impact on the environment (e.g., through the reduction of greenhouse gases (GHG) or through the application of smart or robotic solutions and production optimization in various sectors such as manufacturing, energy, and agriculture, improving energy efficiency). They can also be used to support the achievement of sustainability and environmental goals by supporting the flow of information in production processes [60].

Advanced technologies are also linked to social sustainability, both from a micro and macro perspective. From an organizational standpoint, the use of advanced technologies improves ergonomics, worker safety, and facilitates risk assessment [61]. On the other hand, from a macro perspective, a link can be seen between the incorporation of advanced technologies in product manufacturing and modeling, transforming digital designs into physical objects without the need for tools, and sustainable social outcomes such as equivalent opportunities for all parties in societies and markets, user-oriented goods and services, increased customer value, possible health benefits for workers/people, and an impact on the industrial work situation [62].

Sustainability skills and environmental awareness are now a priority for many smart/intelligent organizations, both in the private and public sectors, and are also key features of sustainable organizations. Their common response to changes in their environment is to implement innovative, sustainable processes in order to have a positive impact on the environment as well as to create robust social, relational, and financial capital. In this way, smart and sustainable organizations are not only able to meet their own objectives, but are also prepared to meet more ambitious, often social or environmental challenges. Currently, the objectives of the Agenda for Sustainable Development of the EU are key in this respect [63]. They signal the need to fight poverty, raise the quality of life, and care for the environment. More and more often, smart and sustainable organizations are not only technologically or relationally developed, but also strongly involved in CSR and environmental activities including renewable energy investments.

2.3. Problem Definition

In this paper, the key variables of smart organization IR 4.0 were identified, modeled, and analyzed. Bearing in mind the above considerations, the following hypotheses were made, as shown in Figure 1.

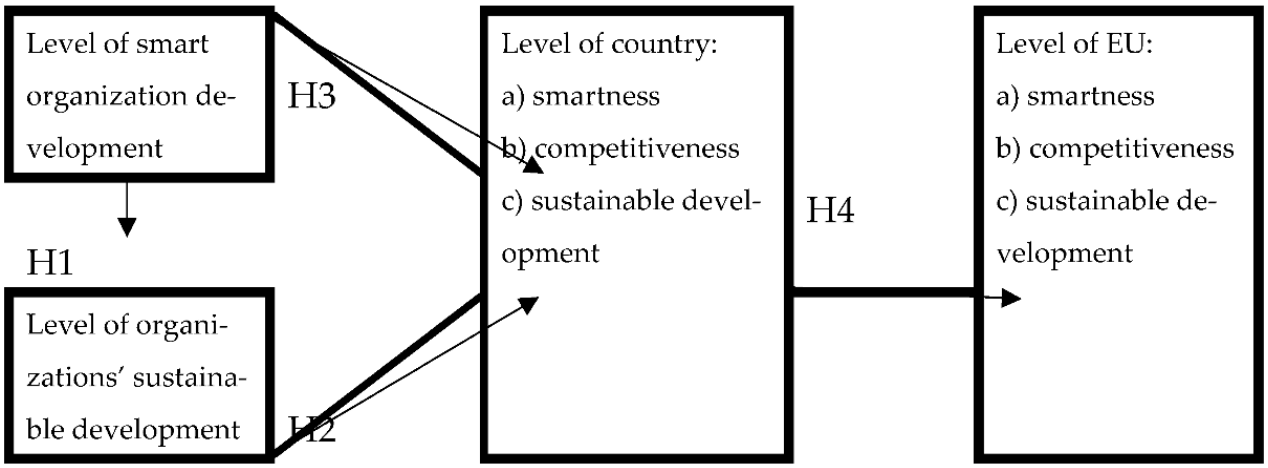

Figure 1. Hypotheses.

Hypothesis 1 (H1). *There is a positive relationship between the level of smart organization development and the degree of sustainable development strategy implementation in EU countries.*

Hypothesis 2 (H2). *There is a positive relationship between companies' attitudes toward sustainable development and the level of competitiveness and sustainability in EU countries.*

Hypothesis 3 (H3). *There is a positive relationship between the level of smart organizations' development and the level of (a) smartness, (b) competitiveness, and (c) sustainable development in EU countries.*

Hypothesis 4 (H4). *The smartness of particular EU countries determines the smartness, competitiveness, and sustainability of Europe as a whole.*

2.4. Research Objectives

The paper focused on studying the concept of "smart organization" and providing a map for the usage of various factors as sources of smart organization development in the smart and sustainable EU in the Industry 4.0 era.

Its objectives are as follows:

1. To identify and evaluate the use of crucial factors of "power of smart organization" in smart and sustainable EU IR 4.0,
2. To indicate paths for more effective EU navigation toward smart and sustainable EU IR 4.0. based on power of smart organizations.

The following research questions have been formulated for the purposes set out above:

Q1. What is the uniqueness and "power" of smart organizations?

Q2. What are the main benefits of building strong smart organizations?

Q3. How can the "power" of smart organizations in a country be monitored?

Q4. How does the development and use of the "power" of smart organizations in the EU look like?

Q5. How smart organizations can support sustainable development of EU?

For this purpose, the Power of Smart Organization Index and roadmap of smart and sustainable EU were constructed. Answering the above research questions and verifying

the hypotheses will allow the integration of the micro and macro perspective and will be a contribution to research on the value of smart and sustainable organizations.

3. Identification of Possible Sources of Power for Smart Organization IR 4.0

An intelligent/smart organization is an economic system that effectively uses a considerable number of special, new IR 4.0 technologies (e.g., ICT) as well as organizational and human knowledge and competencies (see the collection in Figure 2, column 1). In this way, it is a type of organization, in which people and machines interact in technologically dense environments [64], thus enacting what has been called "sociomateriality" [65].

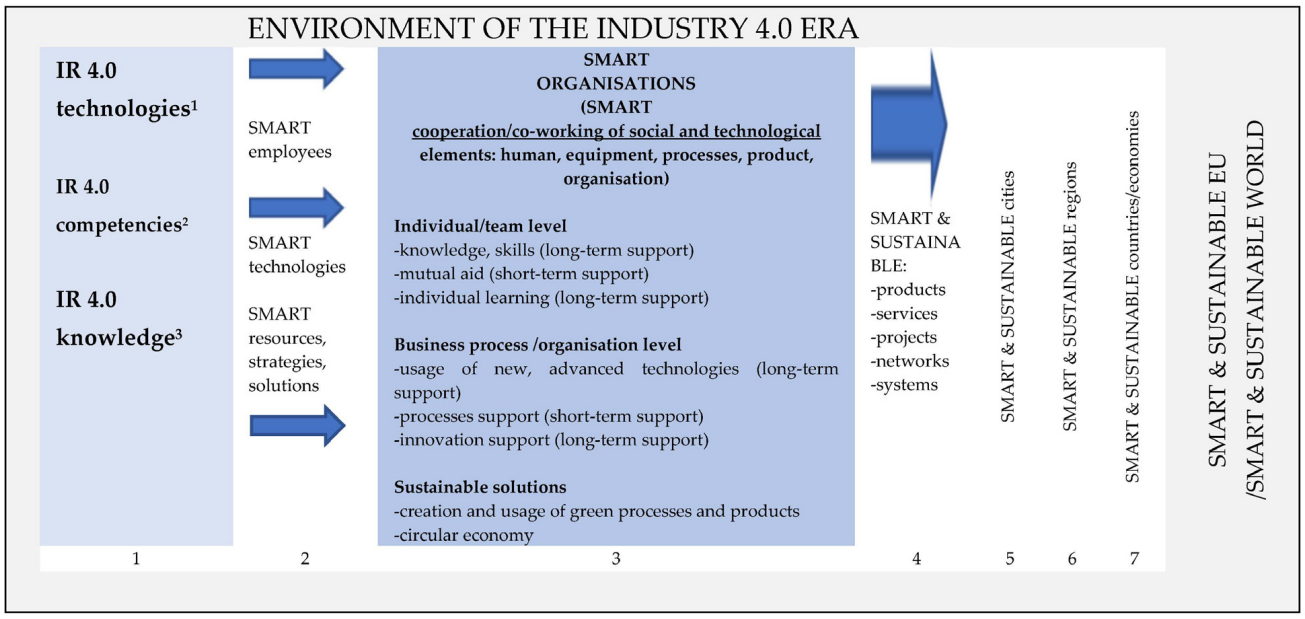

Figure 2. Smart organizations in the SMART and SUSTAINABLE EU/SMART and SUSTAINABLE WORLD [1] ICT: technologies used for digitization, simulation, and forecasting, integrated software, machine to machine communication (M2M), cloud computing, innovative methods for collection and processing big data, cybersecurity, cyber-physical systems (CPS), Internet of Services (IoS), Internet of Things (IoT); advanced technologies: virtual reality (VR), augmented reality (AR), digital twins, neural networks (NN), mass customization; artificial intelligence (AI), autonomous robots (AR); [2] competencies: substantive knowledge, ability to learn, ability to work as a team; ability to work in a multicultural environment; ability to work remotely; knowledge of foreign languages and IT; ability to share knowledge; attitudes: the desire for continuous development, goal orientation, openness to new experiences, creativity, flexible thinking, agility, high tolerance of uncertainty, social responsibility; [3] about: key resources: knowledge, employees, dynamic skills, relations, new technologies; strategies for development and competitiveness: varied, proactive, agile, innovative, flexible, dynamic; advantage-building strategies: qualitative, dispersed, intangible, non-realistic, unstable, synergy-oriented; modern functional strategies: HRM, logistic, marketing, production, financial, etc.; about key solutions:-relational strategies based on strategic partnership, cooperation, networking, alliances, sharing economy (C2C, B2C, B2B), co-creation, ambidexterity; management strategy: knowledge-based (Knowledge Partnering, Open Knowledge), innovation-based (Open Innovation), resource-based (Open Resources); service and customer orientation; leading structural solutions, corporate social responsibility of the organizations: decentralization of power; horizontal and flexible organizational structures; dominance of horizontal communication; organic model; cultural openness; empowerment; work in creative tasks and project teams; quick decision-making process; short communication channels, knowledge sharing between departments; recommended structures: networks, matrices, hybrid, based on teams.

In this way, smart and sustainable organizations, on one hand, accumulate what is most valuable in a given region and, on the other, distribute their achievements by means of their activity, through which they determine and support the pace of development of their environment (i.e., also cities, regions, or countries/economies from which they originate and in which they operate, Figure 2, columns 5, 6, 7). They become not only stimulators,

but even a "source" of competitiveness, sustainability, and catalysts of the fulfilment of goals of the sustainable development of EU. Thus, smart organizations are organizations with the capacity for creating, acquiring, classifying, and sharing knowledge as well as applying it to increase their global market effectiveness and competitiveness [39,51]. Their strength determines the implementation of the key contemporary objectives of sustainable development of the world in Age of IR 4.0 (Smart World IR 4.0). They are the blueprints to achieving a better and more sustainable future for all and address the global challenges we are facing and that we should achieve by 2030. For a more complete exploitation of their possibilities, it is necessary to understand the specificity of crucial sources of their "power", related to both technical and social aspects. These observations above seem to answer the first two research questions (Q1–Q2).

3.1. A Brief Description of the Crucial Technological Sources of Power of Smart Organization IR 4.0

3.1.1. Integrated Software

A tightly interconnected suite of several applications that share a common database and user interface. In practice, it is a web of complex software applications that handle tasks such as accounting, financial consolidation, and inventory management. This is a type of organization architecture. When analyzed using advanced algorithms, such information can, for example, help managers in understanding how to earn customer loyalty, develop marketing campaigns, improve their products, and provide services tailor-made to the preferences and needs of their customers. The knowledge of such preferences may allow entrepreneurs to craft content that will be able to satisfy them. The key purpose of employing such analytical solutions in organizations is thus to make good decisions according to up-to-date and aggregated data [52,66,67].

3.1.2. Innovative Methods of Big Data Collection and Processing

Big data processing uses analytical tools or programming models to use large-scale data to bring out information useful for support and decision-making. Big datasets are typically stored in a large number of commodity servers, so conventional software tools such as message passing interface (MPI) cannot manage them successfully [66–68].

3.1.3. Internet of Things (IoT)

The IoT is a dynamic global "network of physical objects, systems, platforms, and applications" that are capable of communicating and sharing intelligence among themselves, their external environment, and people. The IoT, thanks to its individual identification system, enables "things"—such as RFID (Radio-Frequency Identification) tags, sensors, and actuators—to interact and collaborate with each other to achieve common goals. Three characteristics that distinguish the Internet of Things are context, ubiquity, and optimization. This leads directly to the creation of new and improved products (services), enabling a visible jump in economic productivity [69–73]. The Internet of Services, or IoS, "is part of the Internet, which represents services and their functionality as components provided by different providers, available for use on request and characterized by the possibility of mutual integration. IoS is used to flexibly build value networks by dynamically configuring services selected from various resources available in the network" [74,75].

3.1.4. Cyber-Physical Systems (CPS)

Cyber-physical systems are "a combination of the computing layer and physical processes . . . most often in the form of embedded systems and networks for monitoring and controlling physical processes. They allow collecting, processing, and influencing the physical processes of production of personalized products with a reduced human contribution. Thanks to them, the production process control system operates in a feedback loop. In this case, the physical processes are the data source for calculating the control signal of the selected executables." [72,75–78].

3.1.5. Cloud Computing (CC)

Cloud computing is "the delivery of different services through the Internet. These resources include tools and applications like data storage, servers, databases, networking, and software; it is a model allowing access through the network to computing resources that can be provided and based on the use of services provided by an internal or external service provider" [79]. A component of cloud computing is cloud-based manufacturing (CMB), which can be described as a networked model of a production system that, from its diverse and distributed production resources, creates temporary, reconfigurable cyber-physical production lines. The use of network models enables the allocation of production resources in response to the customer's request, which contributes to increased productivity and reduces the cost of product life [80,81]. By using tools available in a cloud, organizations are able to reduce ICT costs, break geographic barriers, and gain access to data at any time and place. A cloud is a factor that puts other SMAC components together [52].

3.1.6. Neural Networks (NN)

Neural networks are a collection of algorithms that are loosely modeled on the human brain. They are mainly employed for pattern recognition, performed by interpreting data obtained from various sensors using a kind of machine perception, labelling, or clustering of raw input. Such patterns are numerical and vector-based, so real-world data such as images, sound, text, or time series have to first be translated into numbers. Neural networks are thus useful in cluster and classifying data in applications such as almost real-time language translation. Overcoming the language barriers may open a new age in global business relations including the implementation of highly efficient and fast operations by globally connected enterprises [82,83].

3.1.7. Direct Communication between Machines (M2M)

Direct communication between machines is the technology connecting machines at a distance from each other by using ICT; most of these connections are controlled by software. The machines communicate between them (and their users) remotely. Hence, the process (and the machines themselves) can be managed from anywhere. The structure of M2M networks resemble LAN or WAN layouts, which is why the name Internet of Things is frequently used to describe them. They are, however, exclusively used to provide a communication protocol to machines, sensors, and controllers. Devices connected in this way are able to send the information they collect to other devices in the network, which in turn allows the user to assess the state of the whole network and react accordingly by sending commands to such networked devices [84–87].

3.1.8. Cybersecurity

Cybersecurity is the practice of securing systems, networks, and software applications from digital attacks, usually meant to access, alter, or destroy sensitive information; extort money from users; or interrupt their business processes. In order to work properly, a cybersecurity solution has to comprise a system of multiple layers of protection across the computers, networks, applications, or data that require safe keeping. In an organization, effective defense against such attacks also involves the cooperation between people, processes, and technology [88,89].

3.1.9. Artificial Intelligence (AI)

Artificial Intelligence is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with sentient beings. The term is used in reference to systems developed to exhibit intellectual processes characteristic of humans such as reasoning, discovering meaning, generalizing, or learning from past experience. There are already applications that may be said to be on par with human experts and professionals when performing certain tasks. In this limited sense, artificial intelligence may be found

in applications such as medical diagnostics, search engines, and voice or handwriting recognition [90,91].

3.1.10. Digitization, Digitalization

Digitization, or digitalization, essentially refers to taking analogue information and encoding it into zeroes and ones so that computers can store, process, and transmit such information; hence, it is the way in which many domains of social life are restructured around digital communication and media infrastructures, and how people interact. "Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities." It is the process of moving to a digital business by employing digital technologies and information to transform business operations [92–95].

3.2. Brief Description of Crucial Social Sources of Power in Smart or Ganizations IR 4.0

3.2.1. Ability to Work Remotely

The term "remote work" simply means any work that does not require an employee to commute to an office. Remote work thus means professional duties performed from home or any location outside of formal employer's premises (such as a café or a co-working space) on a full-time or near full-time basis (four or more days a week), very often [55,96,97]. The increasing prevalence of full-time remote work is changing the dynamics in local contexts and creates new paths in regional development [98].

3.2.2. Knowledge of Foreign Languages

As the global business environment is getting increasingly integrated, the ability to communicate in multiple languages becomes a necessity as forging lasting, stable international business relationships often starts with direct communication in the client's native language. Thus, any multilingual person has an automatic advantage over their peers when competing for jobs and promotions to higher positions. Globalization has given rise to the creation of global teams. These global teams (GVT) operate in a globally dispersed work environment, and are characterized by a high degree of heterogeneity in multiple dimensions including the nationality of members, geographical location, and languages spoken; differences in linguistic capabilities can influence the effectiveness of knowledge sharing and cognitive resources can be easily depleted because of foreign language anxiety, which in turn can negatively influence effectiveness when performing tasks as well as personal and organizational development [99,100].

3.2.3. Individual Usage of the Internet

Internet access improves opportunities for education, employment, governance, and social life. Studies have shown that demographic attributes influence an individuals' actions even before they engage in a given behavior. Gender, age, and income are amongst the significant determinants of Internet usage [101]. The influence of Internet usage on workers' well-being is four-fold. First, it provides users with unprecedented access to data and information. Second, Internet technologies have resulted in the creation of new activities and services, and, consequently, brand-new occupations that widen the employment perspectives of skilled workers. Third, Internet use in a professional environment may be a way to save time, with employees performing time-consuming and repetitive tasks in a more efficient way. Finally, the Internet is cheap and simple long-distance communication between employees has become viable. This in turn provides brand new methods of internal communication and leadership as well as facilitate information flow between managers and employees [102].

3.2.4. Openness to New Experiences

Human psychological traits influence success and long-lasting action in extreme situations [103]. With a rapid increase in the amount of knowledge that is the keystone of the information era, openness is crucial for an organization to survive and maintain its

competitive advantage. Such openness is also positively related to employee creativity as employees open to new experiences are more creative when their leaders' expectations of creativity are high [104].

3.2.5. Ability to Share Knowledge

Knowledge sharing among employees is a function of their motivation, opportunity, and ability (MOA) to do so. The interaction among motivation, opportunity, and ability drives knowledge-sharing behavior. It forms a dynamic and coordinated system that should be considered and analyzed as such [105]. Knowledge sharing means the provision of information and know-how to help others perform their tasks and collaborate on solving problems, new ideas, or implementing policies and procedures. Knowledge sharing is vital for an organization to develop its competitive advantage, and it is an integral part of the knowledge management process [106–110].

3.2.6. Possession of IT Knowledge

As information and communication technologies (ICTs) are becoming ubiquitous, new activities, opportunities, and resources for learning emerge, while the learning potential of traditional contexts such as family, schools, and companies is also expanding. Knowledge and practical skills in this scope including computer literacy, the use and development of the latest software, applications, systems, and accompanying devices, serve as a ladder to professional, market, and even social success [111–113].

3.2.7. Ability to Learn the Desire for Continuous Development, Lifelong Learning

The ability to learn and the desire for continuous development and lifelong learning has three dimensions: (1) vertical education is primarily school education, covering levels from kindergarten to university (including postgraduate studies); (2) horizontal education takes place in extracurricular educational institutions and also serves cultural education; and (3) in-depth education is a lifestyle (including leisure activities) associated with life-long learning. The idea of lifelong learning therefore means maintaining the continuity and regularity of the learning process, but it also indicates the multidimensionality and versatility of learning [114,115].

3.2.8. Possession of Substantive Knowledge

Possession of substantive knowledge refers to knowledge developed by people in academic communities. Substantive knowledge is the content that teachers communicate as ascertained fact, whether common conception or reasonable grasp of reality [116,117].

3.2.9. Creativity

Creativity is the ability to produce original and unusual ideas or to make something new or innovative. Creativity is characterized by the ability to perceive the world in new ways, find hidden patterns, make relationships between apparently unrelated aspects, and find solutions. Creativity covers two processes: thinking and then producing. "Creativity is a combinatorial force: it is our ability to tap into our 'inner' pool of resources—knowledge, insight, information, inspiration, and all the fragments populating our minds—that we have accumulated over the years just by being present and alive and awake to the world, and to combine them in extraordinary new ways" [118–120].

3.2.10. Work in Partnership (Teamwork)

Working in teams is meant as a means for employees to cover for one another and provide consistent, continuous support, share information they may need, develop ideas together as well as combine their respective skills and knowledge. Teamwork provides groups of individuals with diverse skills and talents with an opportunity work together to achieve a common goal. Working with teammates, sharing ideas, improving the work of others, and helping one another to form a good team is thus crucial [108]. It is also

important to form close relations with new and existing partners to be able to overcome challenges and reconcile interests. The development of partnerships should be promoted among different participants to increase the amount of collective knowledge, test ideas, and expand dialogue [121].

4. Methods and Test Results

In order to achieve the research objectives and answers to Q3–Q5, a synthetic Power of Smart Organizations Index (PSOI) was developed. In the first step of its construction, based on a review of the world literature on the issue (Section 1) and expert research (interviews were conducted with 10 experts who are members of the international OPI 4.0 Research Group initiated by the employees of the Lodz University of Technology and operating on the ResearchGate platform), 10 technical and 10 social factors characterizing the way smart organizations operate in the IR 4.0 age were isolated. Their synthetic description is presented above (Section 2). In order to establish their real role in the smart EU competitiveness and sustainable development processes, the next step was to find their practical counterparts in the form of detailed indicators regularly reported by Eurostat. The final selection of indicators was based on their availability in all countries and years surveyed. The result of these activities is presented in Table 2, which is a summary of the sub-variables ultimately used to build the synthetic PSOI.

Table 2. Indicators of organizational smartness.

Technological Indicators (T)		Social Indicators (S)	
Enterprises whose business processes are automatically linked to those of their suppliers and/or customers (%)	T1	Individuals with broadband access to the Internet (%)	S1
Enterprises with Big Data analysis (%)	T2	Individuals in science and technology (%)	S2
Enterprises with broadband access to the Internet (%)	T3	Employees using computers with access to the Internet (%)	S3
Enterprises with integration of internal processes (%)	T4	Individuals ordering or purchasing goods or services over the Internet for private use (%)	S4
Enterprises using cloud computing services (%)	T5	Individuals obtaining information from websites of public authorities (%)	S5
Enterprises sending electronic invoices suitable for automatic processing (%)	T6	Students of information and communication technologies as the share of students in total (%)	S6
Enterprises providing portable devices to the persons employed (%)	T7	Adult learning and training in the last 4 weeks (%)	S7
ICT risk assessments in enterprises (%)	T8	Individuals with achievement in reading, maths, or science (%)	S8
Enterprises that employ ICT specialists (%)	T9	Submitting completed forms, in % of total individuals	S9
Enterprises with high and very high level of the digital intensity index (%)	T10	Individuals use of cloud services (%)	S10

Source: Own elaboration from the Eurostat database.

For the next step, data for the above sub-indicators were collected for the 28 EU countries for the period 2018–2019 [122]. After they were systematized in the database and divided into two complementary partial dimensions—technological and social—individual sub-indicators were standardized with the following formula:

$$z = \frac{x - \mu}{\delta}$$

where

z is the standardized sub-indicator;
x is the variable for a specific country;
μ is the mean; and
δ is the standard deviation.

4.1. Power of Smart Organizations Index (PSOI)—Basic Analysis

For such isolated variables, a synthetic Power of Smart Organizations Index (PSOI) was constructed to accumulate the total power of their impact. For ease of analysis, it was assumed that the individual indicators were equivalent. It was therefore not necessary to rank them. To improve the readability of the index, two complementary dimensions were identified: the technological dimension of the Power of Smart Organizations Index/Technological (PSOI/T) and the social dimension of the Power of Smart Organizations Index/Social (PSOI/S) (all data were deposited in a repository: Sikora-Fernandez, Dorota (2020), "smart organizations in the EU-28", Mendeley Data, V1, doi:10.17632/9td5chzm5g.1, accessed on 15 June 2020). Overall PSOI RANK and partial PSOI/T RANK and PSOI/S RANK results are presented in Table 3.

Table 3. Power of Smart Organization ranks.

	PSOI RANK	Result	PSOI/T RANK	Result	PSOI/S RANK	Result
1	Finland	31.99	Finland	17.90	Denmark	14.13
2	Denmark	28.41	Denmark	14.28	Finland	14.09
3	Netherlands	20.66	Netherlands	10.31	Sweden	13.96
4	Sweden	20.50	Belgium	6.84	Netherlands	10.35
5	Ireland	10.41	Sweden	6.55	Estonia	8.55
6	United Kingdom	8.87	Ireland	3.62	United Kingdom	7.70
7	Belgium	7.86	Slovenia	2.94	Ireland	6.79
8	Luxembourg	6.38	Malta	2.15	Luxembourg	5.77
9	Estonia	4.93	Portugal	1.84	Germany	3.14
10	Germany	4.56	Lithuania	1.54	Austria	2.49
11	France	3.55	Germany	1.41	France	2.18
12	Austria	2.26	France	1.37	Spain	2.11
13	Spain	1.94	United Kingdom	1.16	Belgium	1.02
14	Slovenia	1.52	Luxembourg	0.62	Slovenia	−1.42
15	Malta	0.66	Spain	−0.16	Malta	−1.49
16	Lithuania	−1.74	Austria	−0.23	Latvia	−2.33
17	Czechia	−5.20	Italy	−2.18	Hungary	−2.89
18	Portugal	−5.51	Czechia	−2.25	Czechia	−2.95
19	Cyprus	−8.05	Cyprus	−2.77	Lithuania	−3.28
20	Poland	−8.15	Poland	−3.09	Poland	−5.07
21	Latvia	−9.63	Estonia	−3.61	Cyprus	−5.28
22	Italy	−10.16	Croatia	−3.93	Slovakia	−7.02
23	Croatia	−11.61	Slovakia	−5.06	Portugal	−7.35
24	Slovakia	−12.07	Latvia	−7.30	Croatia	−7.67
25	Hungary	−14.42	Greece	−8.94	Italy	−7.99
26	Greece	−17.97	Bulgaria	−10.42	Greece	−9.03
27	Romania	−25.81	Hungary	−11.53	Romania	−12.76
28	Bulgaria	−27.64	Romania	−13.05	Bulgaria	−17.23

Source: Own elaboration.

In the next step, the results of the studies (PSOI RANK) were compared with the current EU Competitiveness Reports and The Leaving-No-One-Behind Report [123].

4.2. Power of Smart Organizations Index (PSOI)—Comparative Analysis

In the next step, the results of the studies (PSOI RANK) (graphical representation of the test results is shown in Figure 3) were compared with the current EU Competitiveness Reports and The Leaving-No-One-Behind Report.

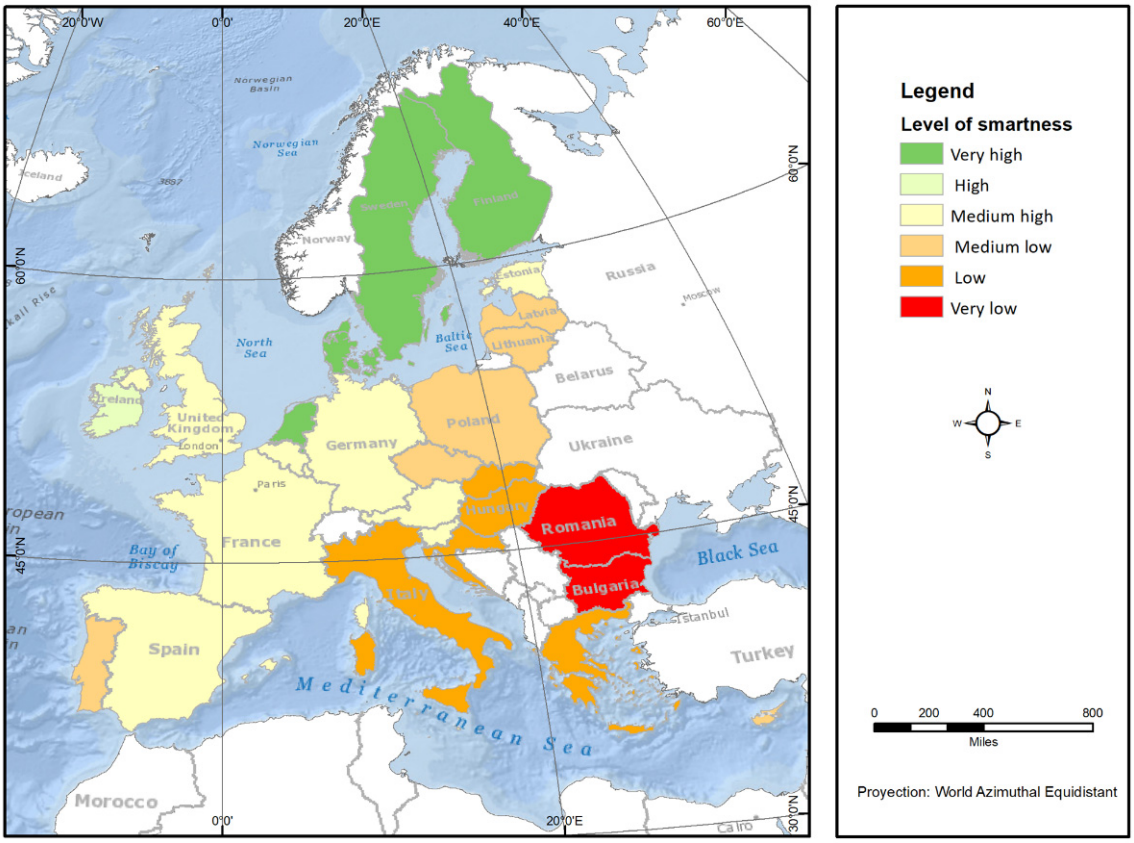

Figure 3. Level of EU smartness.

Comparing the level of smart (smartness) of organizations in individual EU countries (PSOI RANK) with the level of their competitiveness and sustainability in several reports, it can be seen that the PSOI confirms the trends visible, among others, in the Europe 2020 Competence Report and in the report "The EU Regional Competitiveness Index 2019" [124,125] as well as in the Europe Sustainable Report [124].

As can be seen from the above summaries, the smartness of organizations in the Age of Industry 4.0 is crucial for the actual sustainability of a country, which in turn has a major impact on the competitiveness of this country. However, it is important not only to have the right technologies and skills, but also the adequate level of their development and use. The achievements of countries with very high levels of development of smart organizations (PSOI results rank 1–5, Table 4) signal the importance of the need for balanced and high development in both technological and social dimensions. The positions of other countries are the consequences, on one hand, of uneven development (PSOI results rank 6–16, Table 4) and, on the other, weak development in both dimensions (PSOI results rank 17–28, Table 4).

In light of the confirmation of the association of the smartness of organizations and sustainability and competitiveness of countries, analyses were undertaken to deepen the factors generating the high level of EU smartness (Table 4, column 4). The research was conducted in several stages. It was decided at the outset to determine the current state of development of the EU smartness generating factors, and in the next step, to determine the desired state and possible paths to its achievement.

Table 4. EU smartness vs. competitiveness vs. sustainability.

	PSOI RANK	Result	Level of SMART	PSOI/T RANK	PSOI/S RANK	Competitiveness in EU RANK	2019 SDG/LNOB Index Rank	2020 SDG/LNOB Index Rank
1	Finland	31.98	20– . . . very high	1	2	6	3/1	$\frac{1}{2}$
2	Denmark	28.41		2	1	5	1/3	3/6
3	Netherlands	20.65		3	4	1	7/2	14/4
4	Sweden	20.50		5	3	3	2/4	2/5
5	Ireland	10.40	10–20 high	6	7	12	13/10	18/14
6	United Kingdom	8.86	0–10 medium high	13	6	4	12/8	15/12
7	Belgium	7.86		4	13	10	11/12	13/13
8	Luxembourg	6.38		14	8	8	17/11	26/16
9	Estonia	4.93		21	5	14	10/15	12/18
10	Germany	4.55		11	9	2	5/7	6/11
11	France	3.54		12	11	7	6/9	9/10
12	Austria	2.25		16	10	9	4/6	4/8
13	Spain	1.94		15	12	11	14/14	21/15
14	Slovenia	1.51		7	14	17	9/5	7/9
15	Malta	0.65		8	15	19	24/17	27/22
16	Lithuania	−1.73	0–(−10) medium low	10	19	20	23/24	25/25
17	Czech	−5.19		18	18	15	8/13	10/17
18	Portugal	−5.51		9	23	16	15/20	22/24
19	Cyprus	−8.04		19	21	23	28/25	29/28
20	Poland	−8.15		20	20	18	16/16	16/19
21	Latvia	−9.63		24	16	21	20/21	20/26
22	Italy	−10.16	(−10)–(−20) low	17	25	13	18/18	23/20
23	Croatia	−11.60		22	24	28	22/22	24/21
24	Slovakia	−12.07		23	22	22	19/19	17/23
25	Hungary	−14.42		27	17	24	21/23	19/27
26	Greece	−17.97		25	26	27	25/26	28/29
27	Romania	−25.80	(−20)– . . . ./very low	28	27	26	27/28	30/31
28	Bulgaria	−27.64		26	28	25	26/27	31/30

Source: Own elaboration.

4.3. Power of Smart Organizations Index (PSOI)—In-Depth Analysis

In order to implement the first stage of in-depth analysis, an attempt was made to establish five crucial factors of smart and sustainable organization in all EU countries examined, identifying those with the highest overall values. This procedure was aimed at isolating the "five crucial factors" most relevant to the construction of Smart EU 4.0. These are summarized in Table 5.

This analysis made it possible to determine which of the factors were most common in the EU countries studied and to obtain an EU mean result. The number of indications for individual factors is, in the authors' opinion, an indicator of their current role and strength in the process of building smart and sustainable EU 4.0 (Table 5, column 8). Particularly important catalysts for smartness, competitiveness, and sustainable development of EU have proven to be enterprises with the following: broadband access to the Internet (T3), ICT risk assessments (T8), business processes automatically linked to those of their suppliers and/or customers (T1), ICT specialists employed (T9), and integration of internal processes (T4). Table 5 therefore illustrates the current state of development of smart EU 4.0. However, it is not fully satisfactory, as it is distorted by data from economically weaker and less market-competitive EU Member States (the BOTTOM 10).

Table 5. The "crucial five" indicators for Smart EU IR 4.0.

The "Crucial Five" for Smart EU IR 4.0						Rank	Indicator
Finland	T3	T5	T6	T8	T9	1	T3 (12)
Denmark	T3	T4	T7	T10	S3	2	T8 (11)
Netherlands	T3	S1	S5	S4	T8	3	T1 (10)
Sweden	S7	S10	S9	S3	T10	4	T9 (10)
Ireland	S8	T8	T2	T5	T9	5	T4 (9)
United Kingdom	T9	T10	S1	S2	S4	6	T10 (8)
Belgium	T1	T2	T3	T4	T10	7	S6 (8)
Luxembourg	S2	S1	S4	S7	S10	8	S8 (8)
Estonia	S5	S6	S7	S8	S9	9	T7 (9)
Germany	T1	S4	S5	S6	T7	10	S1 (7)
France	T3	T4	T7	S3	S7	11	T2 (6)
Austria	T7	S5	T4	S3	S9	12	T6 (6)
Spain	T6	S8	T4	S1	S10	13	S3 (6)
Slovenia	T6	T9	T10	T3	S8	14	S4 (6)
Malta	T2	T8	T9	S6	T10	15	S5 (6)
Lithuania	T1	T4	T10	T3	T4	16	S9 (6)
Czech	S6	T8	T3	T4	T9	17	S2(5)
Portugal	T8	T9	T1	T4	T3	18	S7 (5)
Cyprus	T9	S1	S2	S10	T1	19	S10 (4)
Poland	T7	S8	T1	S6	T9	20	T5 (3)
Latvia	T3	S6	S2	S8	S9		
Italy	T6	S7	T8	T3	T8		
Croatia	S8	T9	T1	T5	T2		
Slovakia	S4	T10	T1	T3	T8		
Hungary	S6	S9	S5	S1	S8		
Greece	S2	S4	S5	S9	T8		
Romania	S6	T7	T6	T2	S1		
Bulgaria	T1	T6	T7	T8	T2		

Source: Own elaboration.

In order to determine the desired state, leading to high and very high smartness and competitiveness in the EU, the TOP 10 EU countries were subjected to detailed research on the PSOI RANK. For a clearer visualization and better understanding of the specifics of their development paths, their smartness was analyzed in comparison with the BOTTOM 10 countries.

A further attempt was therefore made to assess the strength and repeatability of the individual PSOI factors in the EU countries that ranked the first 10 (TOP 10) and the last 10 (BOTTOM 10) in the PSOI ranking (Table 6). Factors that presented the three highest and three lowest values in each country were considered.

Table 6. TOP 10 vs. BOTTOM 10 of PSOI RANK.

PSOI													
TOP 10							BOTTOM 10						
Country	**+++**	**++**	**+**	**− − −**	**− −**	**−**	**Country**	**+++**	**++**	**+**	**− − −**	**− −**	**−**
Finland	T6	T5	T10	S10	T4	S4	Cyprus	T9	S2	S10	S8	T2	T9
Denmark	S5	T10	S10	S6	T2	S1	Poland	T7	S8	S1	S10	S1	T7
Netherlands	S5	T2	S1	S6	T6	S8	Latvia	T3	S5	S9	T1	S5	T10
Sweden	S7	S10	S3	T1	T2	T7	Italy	T6	T7	T3	S6	S2	S9
Ireland	T8	T2	S6	T4	T1	T7	Croatia	T1	S8	T5	S10	S4	T4
United Kingdom	S4	S1	S10	T6	T1	T2	Slovakia	S4	T1	S6	S2	S9	S1
Belgium	T4	T1	T2	S6	T7	S7	Hungary	S6	S5	S9	T4	T1	T2
Luxembourg	S2	S1	S10	T7	S8	S3	Greece	T4	T2	S5	T3	T5	T1
Estonia	S6	S9	S8	T8	T9	T7	Romania	T2	T6	S10	T3	S2	T9
Germany	T1	S4	T7	S9	T4	T9	Bulgaria	T1	S6	T7	S4	S8	S3

Where +++ is the strongest factor in the country, ++ is the second-strongest factor, + the third-strongest factor and − − − is the weakest factor in the country, − − is the second-weakest factor, − is the third-weakest factor. Source: Own elaboration.

Table 6 shows that the high level of TOP 10 smartness is more often influenced by social factors related to the ability to use advanced technologies in organizations. They prevailed in the strengths of the TOP 10 countries (S × 18/T × 12), while weaknesses in this group were rather related to technological factors (T × 19/S × 11). Most often (each × 3), two social factors were indicated here, namely the individual's broadband access to the Internet (S1), use of cloud services (S10), and one technological factor, namely the enterprise's high and very high level of digital intensity (T10). In the strengths of the BOTTOM 10 countries, social factors were as important as technological ones (T × 15/S × 15) but, unfortunately, they were much less developed than in the TOP 10. A similar situation occurred in the weaknesses of this group, where technological factors occurred a similar number of times as social ones (T × 14/S × 16). These are quite significant differences. Another is that while the most popular indicators in the TOP 10 were T1, T2, T10, S1, and S10, in the BOTTOM 10, they were T1, T7, S5, and S6. Only T1 connected these groups. This means that weaker countries have shortcomings in the development of crucial success factors T2, T10, S1, and S10. The TOP 10 countries can therefore be considered as benchmarks that have experience in the development of these smart activities.

To gather more information on potential benchmarks in EU smartness and sustainability, the next step of the analysis focuses on the development paths and achievements of the TOP 10 countries. By identifying the countries with the highest values for individual PSOI indicators (T1–T10 and S1–S10), potential benchmarks were isolated in ranges (Table 7). For example, T1–Germany, T2–the Netherlands, T3–Finland, Denmark, the Netherlands, T4–Belgium, etc. seem to be a good benchmark for the successful development of T and S indicators (values in bold in Table 7). A closer look at them show that in technical aspects, the strongest support can be found in Finland and Denmark, while Denmark and Sweden are leading in social aspects.

Table 7. Indicators with the highest values in the TOP 10 group.

	Finland	Denmark	Netherlands	Sweden	Ireland	United Kingdom	Belgium	Luxembourg	Estonia	Germany
T1	1.07	1.25	0.54	−0.52	−0.69	−0.69	1.78	0.37	−0.16	2.48
T2	1.31	0.34	1.89	−0.44	1.50	−0.44	1.50	0.73	−0.24	0.53
T3	0.98	0.98	0.98	0.29	0.06	−0.17	0.52	0.29	−0.17	−0.17
T4	0.76	1.51	1.29	0.13	−0.83	0.13	1.82	0.55	−1.04	−0.72
T5	2.43	1.82	1.28	1.89	1.08	0.88	0.74	−0.27	0.34	−0.47
T6	3.22	1.80	−0.14	0.68	−0.26	−0.73	−0.20	−0.50	−0.08	−0.44
T7	1.65	2.19	1.07	0.00	−0.62	0.84	−0.58	−0.77	−0.50	1.11
T8	2.18	1.26	1.60	1.51	1.68	0.76	0.76	−0.24	−0.91	0.01
T9	1.87	0.69	0.43	1.21	1.08	0.56	−0.05	0.56	−0.75	−0.49
T10	2.43	2.44	1.36	1.79	0.62	0.03	0.54	−0.10	−0.09	−0.44
S1	1.10	0.59	1.77	1.43	0.59	1.43	0.26	1.43	0.59	0.59
S2	1.30	1.05	0.97	1.39	1.09	1.05	0.72	1.73	0.61	0.13
S3	1.75	1.99	1.50	2.07	0.36	0.77	0.68	−0.38	−0.29	0.60
S4	0.86	1.63	1.41	1.30	0.26	1.58	0.37	0.97	0.37	1.25
S5	1.51	2.66	2.01	0.60	−0.10	0.50	−0.30	0.65	0.55	0.95
S6	2.38	−0.29	−1.02	−0.29	1.38	−0.29	−0.80	0.37	2.10	1.04
S7	2.06	1.62	0.92	2.70	0.09	0.36	−0.44	0.87	1.01	−0.44
S8	1.13	0.86	0.31	0.59	1.32	0.71	0.27	−0.62	1.40	0.33
S9	1.41	1.82	1.11	1.87	0.61	0.41	0.01	−0.29	1.72	−0.89
S10	0.59	2.21	1.36	2.29	1.19	1.19	0.25	1.02	0.51	−0.43

Source: Own elaboration.

As a result of the multifaceted and multi-stage analyses described above, countries wishing to actively engage in the development of their and the EU's smartness, sustainable development, and competitiveness can be offered several navigation paths to market success based on the development of the smart and sustainable organization. These may be more or less intense, depending on the chosen benchmark and the initial state of the country (i.e., the PSOI ranking).

The first one, based on slow technological development, appears to be the navigation path toward the medium level of smart and sustainable EU 4.0 ("crucial five" smart EU 4.0,

Table 5). This pathway should aim to achieve the highest possible levels for the following indicators:

1. T1—Business processes automatically linked to suppliers and/or customers,
2. T3—Broadband access to the Internet,
3. T4—Integration of internal processes in enterprises,
4. T9—ICT specialists in enterprises, and
5. T10—High and very high level of the digital intensity index in enterprises.

The second, more dynamic, and at the same time more diversified (because it is based on the uniform development of social and technical factors) path may turn out to be a path based on the observation of the smart activity of the TOP 10 countries (Table 6). This path requires the following indicators to be increased:

1. T1—business processes automatically linked to suppliers and/or customers,
2. T2—Big Data analysis in enterprises,
3. T10—high and very high level of the digital intensity index in enterprises,
4. S1—individuals with broadband access to the Internet, and
5. S10—individual use of cloud services.

The third one, which is ambitious and requires costly, dynamic technological development, but is consequently highly effective, will be to observe the leader of smart and sustainable EU IR 4.0—the country in first place in the PSOI rank—currently Finland (Table 4). In this case, the following indicators should be strengthened:

1. T3—broadband access to the Internet,
2. T5—enterprises using cloud computing services,
3. T6—enterprises sending electronic invoices suitable for automatic processing,
4. T8—ICT risk assessments in enterprises, and
5. T9—ICT specialists in enterprises.

By generating an environment that is conducive and supportive to the development of the key parameters for smart organization development (actions/programs/investments expanding their activities in the mentioned T and S factors), the authorities of particular countries may have a chance to more consciously and effectively stimulate not only the smartness and competitiveness of these organizations, but also of the whole economy. The stimulation of the development of smartness at the micro level, in the era of globalization, widely understood networks (including social, environmental, technical), borderless organization, and modern technologies of the Industry 4.0 era have a significant and relatively fast reflection not only at the regional (mezzo), but also at the macro level (international, European, and even global).

It seems that the above analyses and the resulting observations make it possible to positively verify hypotheses H1–H4 posed at the beginning of the study. They also provide answers to research questions Q3–Q5.

4.4. Power of Smart Organizations Index (PSOI)—Fragmentary Analysis

Considering that smart organizations contribute to the 17 Sustainable Development Goals, it was decided to check whether their existence in a given country translates into specific actions in this aspect. The 7th goal of the 2030 Agenda for Sustainable Development (Affordable and Clean Energy) is one example. An R Pearson test was conducted to detect the correlation between PSOI and share of renewable energy in gross final energy consumption in EU countries (Eurostat data).

Looking into that source of confirmation of the impact of smart organization on the competitiveness of the EU as well as the pace and level of implementation of the EU's sustainable development, a statistically significant relationship was found between the PSOI indicator proposed in the study and the energy efficiency and the ability to acquire and use renewable energy, which have been strategic for the entire sustainable world in recent years. On a macro scale, the share of renewable energy in gross final energy consumption in individual EU countries is as shown in Table 8.

Table 8. Share of renewable energy in gross final energy consumption.

SRE		PSOI		R Pearson
Sweden	56.39	Finland	31.98	
Finland	43.08	Denmark	28.41	
Latvia	40.97	Netherlands	20.65	
Denmark	37.2	Sweden	20.5	
Austria	33.62	Ireland	10.4	
Estonia	31.88	United	8.86	
Portugal	30.61	Belgium	7.86	
Croatia	28.46	Luxembourg	6.38	
Lithuania	25.46	Estonia	4.93	
Romania	24.29	Germany	4.55	
Slovenia	21.66	France	3.54	
Bulgaria	20.59	Austria	2.25	
Greece	19.67	Spain	1.94	
Spain	18.35	Slovenia	1.51	0.958413759
Italy	18.16	Malta	0.65	
Germany	17.35	Lithuania	−1.73	
France	17.21	Czech	−5.19	
Slovakia	16.89	Portugal	−5.51	
Czech Republic	16.24	Cyprus	−8.04	
Cyprus	13.8	Poland	−8.15	
Hungary	12.61	Latvia	−9.63	
United Kingdom	12.33	Italy	−10.16	
Poland	12.16	Croatia	−11.60	
Ireland	11.98	Slovakia	−12.07	
Belgium	9.92	Hungary	−14.42	
Netherlands	8.76	Greece	−17.97	
Malta	8.48	Romania	−25.80	
Luxembourg	7.04	Bulgaria	−27.64	

Source: Eurostat database, 2020.

The above data show that there is a high level of correlation between the ability of individual EU countries to develop the potential of smart organizations and their "smartness of country", and the achievements of these countries (and the EU as a whole) in the use of renewable energy. This means that countries where organizations have, to a large extent, reached the level of smart development, are not only proficient in the use of new technologies and the accompanying knowledge but are also able and willing to consciously combine economic, technical, social, and environmental aspects. In this way, they realize significant benefits for themselves and their environment, not only economic but also social such as those resulting from the implementation of sustainable development objectives in the field of care for the environment (the 7th Sustainable Development Goal). Therefore, it can be expected that their support will not only be visible, but also very important for the implementation of the other 16 EU sustainability goals for the coming years [63].

5. Discussion

The analyses carried out showed that research on the essence and role of smart and sustainable organizations in the modern economy (IR 4.0 era) is an important and topical issue [30,57]. Unfortunately, it is still neglected. While attempts have been made to define them [47], their specificity, effectiveness, or development possibilities are still rarely examined [19]. Moreover, their individual cases are more often described than the activity of a larger number of such entities and their impact on the modern economy has been reported. More comprehensive smartness analyses tend to focus on cities and regions [14–18] rather than individual countries or larger systems such as the EU. EU countries have been analyzed in various summary documents either from the perspective of competitiveness or sustainable development [124,126,127], but there have been few attempts to take an integrated approach to these two aspects together. The few studies

that have analyzed the above or similar issues, however, confirm in different ways the phenomena identified in this paper [7,10]. It can be seen that the results of the development of smart and sustainable organizations have a positive impact on the contemporary economy [7,10,126], industry [45,57], and society [127,128], and thus on their competitiveness and achieving objectives of sustainable development according to the 2030 Agenda for Sustainable Development.

The tool we proposed (PSOI) in this paper allowed us to integrate the above-mentioned areas of analysis into a single construct, based on the observation of the smart organizations' determinants of the development and their impact on the smartness and sustainability of their countries of operation. Our research also contributes to the discussion on the significance of the features of smartness and their value as drivers of competitiveness and sustainable development both at the micro (organizations) and macro (countries) levels. It seeks to offer an integrated approach to this issue. It therefore complements, and to some extent consolidates, previous research on corporate sustainability [7,10,19,127–130] and ICT's impact on social, economic, and environmental development.

It is worth noting that due to its specificity, our research has a pioneering character. By identifying factors of smart organizations, it allows not only for the identification and mapping of countries in terms of competitiveness, smartness, and sustainability, but also to navigate them toward smarter and more sustainable development. These issues have not yet been analyzed and described in such an integrated way in the context of competitiveness and sustainable development of the EU as a whole as well as individual member states. Maps presented in the literature have so far only been created for different, more specific aspects such as Roadmap for the Sustainable and Smart Mobility Strategy, Roadmap for an EU Smart Sector Integration Strategy, Heat Roadmap Europe, European Roadmap Toward an Integrated Urban Mobility System, etc.

In the authors' opinion, for all countries for which data on individual PSOI factors can be collected, processes of navigation and mapping toward more competitive, smarter, and more sustainable development can be implemented. Future research directions of the power of Smart and Sustainable Organizations may comprise an analysis of their usage in the Smart and Sustainable development of different sectors, branches, or industries. In our opinion, the proposed tool (PSOI) could also be the basis for developing a platform, software, or application to systematically monitor how competitiveness and sustainability objectives are being achieved in individual countries.

6. Conclusions

In general terms, the competitiveness and sustainability of a country is understood as the capacity for long-term and effective growth, and it is usually juxtaposed in the literature with institutional conditions and the role of the human factor in shaping it. This article has allowed the competitiveness and sustainability of EU countries to be viewed from a different perspective: through smart and sustainable organizations, which distribute their achievements and thus set and support the direction of development for their whole environment.

In the opinion of the authors, there is a strong link between the level of development on a micro level (the level of an organization) and the level of development on a macro scale (the level of individual countries' economies). Therefore, it is necessary to systematically monitor the effectiveness of their development and to consciously create conditions supporting them in this respect. Dedicated tools in the field of economics, management, and ICT and mechanisms should be used (such as the efficient collection and systematic analysis of relevant statistical data, publicly available surveys of social opinion, and consultations with businesses, partnerships, and intersectoral cooperation strategies, clear rules for supporting key activities for competitiveness and sustainable development goals of a given country). The effectiveness and sophistication of the work in preparing, implementing, and operating these solutions varies from country to country. In

general, there are perceived problems in systematically navigating the development and exploitation of opportunities in today's smart organizations in a targeted manner.

The tool proposed in the study may be a solution in support of solving such issues. It can be one of the elements of monitoring both the competitiveness and sustainable development of modern economies based on the "power" of smart organizations. By tracking, in a statistically structured way, the scale and effectiveness of smart organizations (characterized by the features included in the PSOI index) both those operating in a given country and others, public authorities can compare the effectiveness of international solutions undertaken to support them. From the effectiveness of the observed experiences, conclusions, inspirations, and recommendations can be drawn for further decisions in this field. For EU countries, it seems particularly useful to use the system of navigation paths proposed in the study. These are different approaches to exploiting the potential of smart organizations, depending on national circumstances and local policies. The use of one of the paths recommended for a given research period (paths should be updated after the analysis of statistical data collected in the following year) allows for a more conscious selection of benchmark countries that may inspire specific steps in terms of, for example, Area I of the scale of investment, type of tax solutions, size of subsidies, reliefs, or whole strategies for the development of specific industries or otherwise defined areas. This is signaled by the factors assigned to each path described by specific variables included in the PSOI index proposed in the study (see more in Tables 5–7).

The proposed solution seems to be justified, as the results of the studies carried out have shown that there is a Europe of different speeds in this respect, with different levels of use of the factors influencing the level of smartness, and thus different levels of competitiveness and sustainability (see Table 4).

Choosing the right path seems all the more important given that the starting point (i.e., the level of development of smart organizations and their operating environment so far) varies from country to country. Data collected in 2020 during the testing of the tool for 28 EU countries indicate that initially, strengthening social aspects should become a priority. This means that social smartness is a basis for smart and sustainable EU 4.0. However, the main long-term objective should be a high balance of technological and social indicators. Consequently, the organization's knowledge of the factors to develop in the first place and the factors that can be achieved at a high level in the long run is important. A conscious navigation in the direction of the designated pattern/benchmark becomes extremely important on the way to smartness and sustainable development. It should be borne in mind that there may be different benchmarks for different countries, and thus different pathways for reaching the objective. A model could be, for example, the mean uniform level of smart and sustainable EU 4.0, the level of TOP 10 countries, or the level of EU leader in this field (currently Finland). It is also possible to search for an appropriate benchmark among the countries with the highest scores on a given indicator, depending on the needs of the benchmarker, and to follow them in achieving a similar level of smartness and sustainability. In addition, in the absence of a long-term strategy for building competitiveness and sustainable development based on smart organizations, short-term plans can be adopted to build on the direct competitors that are closest to the top of the PSOI ranking.

Referring to the 2030 Sustainable Development Agenda, research on the example of Goal 7 (Affordable and Clean energy) confirms that smart organizations can be expected to support most of the Sustainable Development Goals (SDGs), affecting not only the future of Europe, but also of the whole world.

Thanks to the implementation of studies of EU countries with the proposed tool (PSOI), a list of factors generating the smartness and sustainability of organizations and countries was created as well as a database, a smart EU IR 4.0 map, and a list of recommended development paths for the smartness and sustainable development of countries. They allow individual countries to identify their position and their benchmarks in terms of smartness and sustainability based on smart and sustainable organizations. They also

make it easier to choose the right path of development and navigate toward smart and sustainable EU 4.0. The integration of micro and macro perspectives proposed in the study also offers many other benefits. By systematically updating the data in the PSOI database following the publication of subsequent annual data in Eurostat and European or global competitiveness and sustainable development rankings, there also emerges the possibility of systematic, long-term monitoring of progress in the development level of smart and sustainable EU 4.0 and the competitiveness and sustainable development of EU countries based on the knowledge of smart and sustainable organizations. Therefore, it seems that the objectives set for this study have been achieved, the hypotheses were positively verified, and the research questions have received concrete answers.

The results of this research are the product of a multi-stage research process. However, it is important to mention the existing research constraints that have emerged during the course of the studies. These are mainly due to a lack of conceptual order in the literature. The concepts of IR 4.0, smartness, sustainability, and competitiveness are very broad, undefined, or defined in numerous different ways. The lack of unambiguous definitions makes them difficult to describe and assess with certainty. Another limitation was the poor availability of indicators ideally suited to the characteristics of smart organizations or comparable at the same time. As a result, their selection had to be modified on purpose. Such comparative surveys therefore require appropriate building of official statistics by the relevant institutions at the EU level. It should also be stressed that the PSOI ranking does not ideally coincide with the competitiveness and sustainability rankings, with unintended deviations in the positions of individual countries. This was due to the fact that the competitiveness and sustainability rankings were broader studies, which consisted of a larger spectrum of indicators. The large differences in performance between countries in the PSOI ranking were due to large discrepancies in the development of the digital economy and society. The worst situation is seen in the last countries to join the EU.

Author Contributions: Conceptualization, A.A. (50%) and D.S.-F. (50%); Methodology, A.A. (50%) and D.S.-F. (50%); Investigation, A.A. (50%) and D.S.-F. (50%); Resources, A.A. (50%) and D.S.-F. (50%); Writing—original draft preparation, A.A. (50%) and D.S.-F. (50%); Writing—review and editing, A.A. (50%) and D.S.-F. (50%); Visualization, A.A. (50%) and D.S.-F. (50%); Supervision, funding acquisition, A.A. (50%) and D.S.-F. (50%). All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding. Publication financed by resources from two Universities: $\frac{1}{2}$ the Faculty of Management and Production Engineering, Department of Management, Lodz University of Technology, Poland; $\frac{1}{2}$ the Faculty of Management, University of Lodz, Poland.

Data Availability Statement: Data received from Eurostat Database https://ec.europa.eu/eurostat/data/database.

Conflicts of Interest: The authors declare no conflict of interest.

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