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Smart Logistics—Sustainable Technological Innovations in Customer Service at the Last-Mile Stage: The Polish Perspective

Katarzyna Kolasińska-Morawska [1], Łukasz Sułkowski [2], Piotr Buła [1], Marta Brzozowska [3] and Paweł Morawski [4,*]

[1] Department of International Management, Management Institute, Cracow University of Economics, 31-510 Cracow, Poland
[2] Department of Management of Higher Education Institutions, Faculty of Management and Social Communication, Jagiellonian University, 30-348 Cracow, Poland
[3] Department of Management, Faculty of Law and Social Sciences, Jan Kochanowski University of Kielce, 25-369 Kielce, Poland
[4] Department of Management, Lodz University of Technology, 90-361 Lodz, Poland
* Correspondence: pawel.morawski.1@p.lodz.pl

Abstract: The present day is marked by the economic expansiveness of societies and the adoption and adaptation of intelligent technologies. In this hyper-world, customers expect a personalized offer enhanced with customized service, which results in the introduction of sustainable and intelligent solutions—among other services. What becomes important is not so much the "Primum non nocere" of creation as much as the "go smart to the future" in creating. The smart logistics concept is a representation of this trend. The subject of the article is an analysis of the impact of the application of the smart idea in the field of sustainable development on changes in logistics in customer service at the last-mile stage. The source of this article is exploratory research of secondary sources, including books, articles, and reports, which has been subjected to a critical content analysis. The obtained results made it possible to design and implement an explanatory study of online-buying habits of people based on the CAWI (*Computer Assisted Web Interview*) methodology. The collected material has become the basis for the authors to indicate the applicability of smart logistics in the field of last-mile logistics, which can be used by researchers and training institutions in the field of professionalization of management of intelligent logistics processes in customer service at the last-mile stage. The last-mile service in logistics involves reaching the largest possible number of recipients, however, it has a negative impact on the natural environment, which, of course, contradicts the concept of sustainable development, including trends that are noticeable in the logistics market, customers, and in the law. Hence, it is important to look for solutions that allow us to achieve the appropriate level of customer service in the last mile, but at the same time, take care of the natural environment. The study was narrowed down to the Polish perspective due to the growing demand for last-mile logistics services. Moreover, Poland is still a country where the concept of sustainable development is not fully understood and used. The research allowed us to indicate the directions of development of the last-mile service processes by considering the technological innovations that may support the application of the concept of sustainable development.

Keywords: smart logistics; innovations; sustainability; last mile; customer service subject

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1. Introduction

The acceleration of the technological route in the form of digitization, Internetization, virtualization, and automation has resulted in the recalibration of economies and societies during the last century (Eras 1.0; 2.0; 3.0 and 4.0). The transformations not only led to the progression of civilization, but also destruction, which has contributed to environmental degradation. Therefore, continuing on the path of socio-economic changes requires sustainability; that is, implementing only solutions that will not harm the planet, which is recognized as a natural ecosystem in line with the maxim "Primum non nocere". In order

for this fortification to be implemented, it is necessary to manage resources wisely based on intelligent methods, techniques, and technologies, i.e., "smart" action. Such behavior is inherently related to intelligent computer technologies (*ICT—Intelligent Computer Technology*), which means that socio-economic transformation is based on the implementation and availability of technologies signed with the time of existence [1].

Semiconductors, computers, robots, smartphones, the Internet, GPS (*global positioning system*), code readers, wearable technologies that are part of the Internet of Things, platforms, and applications are only examples of technological solutions, which, in the trend of sustainable development, influence enterprises and societies and force changes in the approach to creation, production, distribution, and application processes. For many years, the development of civilization was thoughtless. The advent of inventions favored people (steam engine, electricity, and internal combustion engines) but not necessarily the natural environment. Many years of this extensive economy resulted in the degradation of natural ecosystems. To stop this process, it is necessary to switch to an intelligent concept of transformation with regard for sustainable development.

In this trend, the processes of production and distribution, as well as their components—including logistics—are subject to transformations. Innovative technologies used in enterprises result in more precise organization and improvement of material, financial, and information flows. Thanks to the processes of digital transformation, logistics is becoming more and more sustainable, less invasive, and more environmentally friendly, and it could even be said that it is smarter, being more ingenious and understanding. It is simply "smart", that is, archetypal, with its actions being similar to how a thinking being adapts to changing circumstances thanks to the use of the latest technologies. Such anthropomorphization reflects the way of thinking characteristics of the 21st century. Thanks to technological progress, "smart logistics" is no longer just a fashionable slogan but a real concept implemented in modern companies conducting logistics processes. The operationalization and quantification of the term "intelligent logistics" can also be made contextually on the basis of the concepts of "smart products" or "smart services", i.e., those that took over some of their abilities from people, thus freeing them from performing work. It should also be added that intelligent products and services are evolving from the level of new technologies to the level of even newer technologies [2], which means that "smart" logistics are technology-based logistics [3,4].

To complete the introduction, it should be added that enterprises are not the only organizations that are subject to changes. Digitization also results in worldview and behavioral transformations of the recipients of the market offer. Educated and fully aware customers contribute to changes in production and distribution processes by demanding solutions in line with the pro-ecological approach. The necessity to act in accordance with the postulation of sustainable development forces the system and process recalibration of enterprises towards greening. The solution here is the increased emphasis on technology in line with the concept of a smart economy and Industry 4.0 [5], and the adoption of the idea of collaborative cooperation based on the concept of a responsible Society 5.0.

The term "Industry 4.0" was first used in 2011 at the Hannover Fair in the project of high-technique strategies implemented by the German government, the essence of which was to promote the computerization of manufacturing processes. This concept aims to integrate intelligent machines and systems, enabling the introduction of effective changes in production processes with the newly-defined role of man in the industry. Its prerogative is to increase the efficiency of operations and to introduce the possibility of flexible changes in the offered assortment [6]. Such activities are possible thanks to digitization and virtualization. Technologies enabling the implementation of Industry 4.0 include, among others: advanced production solutions, additive production, augmented reality, simulations, horizontal and vertical integration, deep learning, artificial intelligence, cloud computing, Internet of Things, cybersecurity, big data, and data analytics [7,8]. It is not only the technologies and infrastructure that have been developed that are important. People also play an important role in this process, both employees and customers of enterprises [9].

Researchers and practitioners agree that people's knowledge, competencies, and skills are becoming priceless, which indicates the transition to the next stage of development.

Although the development and implementation of the Industry 4.0 concept is at the stage of strong growth, there is more and more talk about the Industry 5.0 concept, in which the human being, supported by advanced technological solutions, will play a key role. Futhermore, here, in contrast to the focus on technology in terms of the traditional economy, there is a shift towards human nature in accordance with the broader concept of Society 5.0, which can "balance economic progress with solving social problems through a system that strongly integrates cyberspace and physical space" [10]. Thus, the concept of Economy 5.0 emerges, which refers to collaborating in terms of the innovation, creativity, and competitiveness of society and individuals to create unique ways of creating value in economic structures.

The concept of Industry 5.0, first introduced in 2015 with an emphasis on the human dimension of industry, refers to the collaboration between people and intelligent manufacturing systems, and thus goes beyond the production of goods and the offering of services for profit. The emphasis is on employee well-being, respect for limited resources, and creating a resilient industry that can handle unforeseen emergencies known as "black swans".

The holistic smart approach to the world of people and machines in the Industry 5.0 version is to enable coexistence on the basis of cooperation for the benefit of communities. An important role in this reconfiguration is assigned to cognitive technologies and artificial intelligence, which will enable the deepening of interactions between people and machines. Thanks to this cooperation between humans and intelligent robots, enterprises will be able to achieve a dimension of personalization like never before. Importantly, the Industry 5.0 concept rejects the primacy of automation by prioritizing people. According to its mainstream, technology is supposed to support people in performing their tasks [11]. Contrary to the concept of Industry 4.0, the order of importance of the components is as follows: first, people; second, processes; and, in third place, technology. Even the most advanced technology should not be above humanity. Moreover, according to this approach, technology should be auxiliary, intelligently and agilely supporting the functioning of enterprises. In this context, the idea of intelligent logistics in the area of last-mile deliveries can significantly reduce the negative impact on the natural environment.

The emerging market trends and promoted concepts strongly affect the decisions made by the managers of enterprises, including entities operating in the area of logistics. It turns out that the business models used so far do not fully work because of their incompatibility with the changing environment, especially in the area of using green energy in manufacturing processes, the use of biodegradable solutions as components of the product and packaging, and recycling and disposal. Thus, company managers are forced to constantly search for new models that would ensure an increase in competitiveness on the basis of agile adaptability through the adoption of proven intelligent patterns of conceptual solutions.

In this context, "e-logistics", as one of the variations of "smart logistics", becomes an essential area for supporting enterprise management processes. The core of e-logistics is the Internet and IT systems, which in logistics processes constitute the backbone of the concept of electronic supply chain management [12,13]. E-logistics is not related to the physical transport of raw materials and products, but concerns "virtual" resource planning and the coordination of all processes aimed at maximum automation and improvement through the use of computer networks for this purpose [14]. The key factors driving "smart logistics" are a new way of economic cooperation in the field of resource planning and new activities, with effective information exchange as well as openness and flexibility for the customer.

One of the executive areas of smart logistics is a particularly interesting area of reflection in the field of transformations—in accordance with the concept of sustainable

development in the spirit of smart. Namely, it is last-mile logistics, which has undergone an intensive technological and ecological transformation in recent years.

The aim of the article is to show the impact of the application of intelligent technological innovations on changes in logistic customer service at the last-mile stage in the context of sustainable development from the Polish perspective.

This formulation of the goal is dictated by the increasing volume of online purchases in the world and in Poland. For a dozen or so years now, many companies that use new technologies in their DNA have been operating on the Internet in various sales models. However, as a component of the transaction process, selling alone is insufficient. Finalization in the form of delivering the purchased resource to the customer is also important. This is where the logistics of deliveries becomes a priority. Currently, it is not enough to be present in the virtual market (virtual community, collaboration platform, e-mall), to have a sales website (www.), and/or presence on auction sites; it becomes critical in the implementation of the transaction, i.e., delivery to the customer—the so-called last mile.

The necessity of logistics was exemplified in 2019 by the outbreak of the COVID-19 epidemic (this acronym was created by combining three English words and a number: CO—crown, VI—virus, D—disease, 19-year), which in a very short time was recognized as a pandemic (the number of people infected with coronavirus in the world since the beginning of the pandemic has exceeded 502 213 040—as of 1 April 2022 [15]). The announced lockdowns forced customers to switch from stationary shopping to online shopping. In most countries during the pandemic, sales and purchases on the Internet became the only possible form of presentation of the offer and participation in transaction processes for both entrepreneurs and customers [16]. The fate of organizations and people have been dependent on technology and companies operating on the logistics services market, i.e., couriers, express, and parcels (*CEP = couriers-express-parcel*). The online stores of logistics service providers have redefined their action plans and have rapidly adapted to the new challenges brought by the pandemic.

After more than two years of the COVID-19 pandemic, the first analyses and summaries can be made, especially in the area of innovations introduced by companies from the CEP industry in the field of customer logistics. At the same time, it is worth considering the experiences of customers of the CEP industry services acquired during the pandemic by obtaining answers to the following questions:

- Which of the environmental indications of the concept of sustainable development are particularly important for enterprises and customers operating in the virtual reality of the Internet?
- Whether, and to what extent, intelligent technological innovations in the area of last mile services during the COVID-19 pandemic have been accepted and appreciated by customers?
- Do customer experiences acquired by clients during the COVID-19 pandemic result in an increase in their expectations regarding the greening of the technology of delivery services offered by the CEP industry in the area of last-mile logistics?
- Whether, and to what extent, the innovative technological solutions used during the COVID-19 pandemic may contribute to the recalibration of processes in the area of logistic customer service during the last-mile stage in the future?
- In what direction is the green transformation of the CEP industry going?

Data from the global report "COVID-19 and e-commerce: a global review", which was prepared by the United Nations Conference on Trade and Development (*UNCTAD*), indicated an increase in the share of e-commerce in global trade from 14% in 2019 to nearly 17% in 2020. Increasing tendencies are also indicated by the report "E-commerce in Poland-corporate development strategies" by Mazars, Noerr, and SpotData, according to which the Polish e-commerce market in 2020 was worth PLN 70 billion. In addition, with an annual increase of several percent, the time of the pandemic turned out to be record-breaking with e-commerce growth peaking year-on-year (2019 to 2020) by an order of magnitude of 43%.

Furthermore, although specialists are of the opinion that, after the pandemic, the increasing tendency will slow down, the habits for online shopping will certainly remain both in the world and Poland [17].

During the COVID-19 pandemic, adjusting the market to the requirements of customers-consumers buying on the Internet has consistently resulted in an increase in the importance of logistic customer service [18] oscillating around digitization as never before. The growing demand from customers coming from e-commerce made courier services not only a way to conveniently shop, but also a method for safe shopping [19]. The sanitary guidelines have transformed the ways that courier services deliver, trending towards digitization; cashless payments, electronic signatures, confirmations using one-time pin codes, parcel machines, and many other solutions have gained significance.

Providing customers with the possibility of executing transactions in accordance with the concept of sustainable development in the spirit of smart, solutions were proposed and/or strengthened that took into account the social, economic, and environmental requirements of this crisis time during the pandemic. However, considering the fact that the state of the pandemic will pass one day and the habits for online shopping will likely remain, it is worth taking a look at and assessing the smart logistics solutions in customer service at the last-mile stage, which have most intensely influenced the transformation of delivery processes. To determine whether the direction of recalibration in the area of last-mile logistics is correct, the authors decided to verify the following thesis:

The green transformation of the CEP industry is inherently related to the necessity for recalibration in logistic customer service at the last-mile stage based on intelligent technological innovations that are in line with the concept of sustainable development.

In order to be able to verify the thesis formulated in this way, four research hypotheses have been outlined:

Hypothesis 1. *The concept of sustainable development has found a real exemplification of applications among enterprises and customers operating in the virtual reality of the Internet during the COVID-19 pandemic.*

Hypothesis 2. *Customers benefiting from intelligent technological innovations in the area of CEP industry services during the COVID-19 pandemic have accepted and appreciated the diversity of service formulas at the last-mile stage.*

Hypothesis 3. *The experiences acquired by customers during the COVID-19 pandemic translate into an increase in their expectations regarding the greening of the delivery services technology offered by the CEP industry in the area of last-mile logistics in accordance with the concept of sustainable development.*

Hypothesis 4. *Innovative technological solutions used during the COVID-19 pandemic contribute to the recalibration of processes in the area of logistic customer service at the last-mile stage, contributing to the green transformation of the CEP industry.*

The research study of the collected material allowed us to determine the theoretical and practical implications resulting from the pandemic experiences of customers of the CEP industry in the field of the applicability of intelligent technological innovations at the last-mile stage. The green transformation of the CEP industry on the basis of technology in accordance with the concept of sustainable development gives rise to the recalibration of logistic customer service processes with the exemplification of various forms of automation of delivery services in the last-mile structure in the future.

2. Social Dictate of the Concept of Sustainable Development

The world, when on the brink of disaster, examines its conscience and takes action to stop extreme weather events such as heavy rains, torrential hurricanes, catastrophic droughts and their associated fires, black ice storms, raging heat waves, sea level rise,

and ocean acidification. The world is struggling with destruction, including hunger, an increased number of civilization diseases and mortality, a reduction in biodiversity, economic losses in agriculture and fishing, and a negative drinking water balance. The current transformation of the climate poses a threat to human well-being and ecosystems on Earth, which could result in devastating health, social, and economic outcomes.

It is man who has caused the current climate change, and it is man who can make recovery possible. The simulation of monthly global temperature anomalies (changes from the average) in the years 1880–2021 presented by NASA shows how the threat resulting from temperature increases has been caused by man [20]. According to research conducted by a team led by Chi Xu at Nanjing University and published in "The Proceedings of the National Academy of Science in May 2020", the Earth may experience higher temperature increases in the next 50 years than in the last six thousand years combined [21]. Based on physical sciences, researchers say that in order to save the Earth from a total climate catastrophe, by 2030 the amount of CO_2 emitted into the atmosphere must be reduced to 50% of the 2017 level. Otherwise, the temperature will increase by more than 1.5 degrees Celsius from pre-industrial levels. If this fails, the ability to mitigate the effects of climate change will be useless as climate change runs out of control. Therefore, humanity must act today by introducing ideas of redefined progress (development) in every area of activity.

The essence of an intelligent approach in the management of logistics processes in customer service at the last-mile stage should be sought as a consequence of the concept of sustainable development in the socio-economic structures of enterprises. The natural environment, society, and corporate governance are important criteria that define the value of business today. In this approach, economic development means the process of positive changes in management, both in the production and redistribution of goods and services, as well as their exchange and use for consumption purposes and the growth of socio-economic potential. This is accompanied by gradual changes in economic relations and mechanisms for the functioning of the economy, the effect of which should, by definition, ensure the preservation of the natural values of social and economic ecosystems. As a result of numerous discussions and publications on this issue almost 60 years ago, the idea of a new concept of further civilization development appeared in the way of a compromise, which was referred to as "sustainable development", "stable development", "self-sustaining development", or simply, "eco-development".

The adoption of this new concept resulted in a departure from the expansive and destructive human activities—both in relation to nature and the community—which aroused great anxiety among both environmentalists and politicians. In their opinion, the further process of environmental destruction would result in a domino effect in the form of cascading threats of a social, cultural, ethical, and technological nature to all mankind. In their opinion, it was worth setting a new path for humanity toward a harmonious existence in accordance with nature, which would lead society towards the future. The concept of sustainable development has found its representation in the terminological and operational quantification in numerous documents.

Given this, the roots of the concept of sustainable development were founded in 1969, when it was presented in the report by the UN Secretary General U. Thant, "Man and his environment", at the session of the General Assembly, in which attention was drawn to the global crisis that was being manifested by the global threat to the environment caused by human activity. Another activity was an international program, initiated by UNESCO in 1971, that created sustainable relations between people and the biosphere: "Man and Biosphere" (MAB). Then, in 1972, when the Declaration of the United Nations Conference on the Human Environment was created and adopted in Stockholm, this document described the relationship between natural resources in the environment (nature) and economic development, making an attempt at defining the concept of "sustainable development" for the first time. The effect of intensive work was the declaration of care for the human natural environment as "the right to meet the development aspirations of the present generation without restricting the rights of future generations to meet their

development needs". This wording specified the essence of economic development as a non-invasive activity for the benefit of future generations. According to the authors of the declaration, economic development should take place in a way that does not expose the natural environment to degradation. The idea of sustainable development as a concept of change was also presented in the Brundtland report, "Our Common Future", in 1987 as "development that meets the needs of the modern generation without compromising the ability of future generations to meet their own needs" [22]. This approach was supposed to mean a departure from traditionally defined economic development. The essence was to indicate the importance of economic development while respecting the ecosystems of the natural environment from which man comes and is a component. The second "Earth Summit", held in Rio de Janeiro, was a continuation of the efforts to achieve a balance in the development of economic progress and the protection of ecosystems. Two documents were adopted there that implemented the concept of sustainable development: the Rio Declaration, being the general philosophy of sustainable development, and Agenda 21, a document presenting the methods, principles, and mechanisms for the practical implementation of the assumptions of this concept in the areas of ecology (stopping environmental degradation), economy (meeting the needs of humanity while respecting the natural environment), and society (securing a subsistence level).

An important event in the process of promoting the concept of Sustainable Development was the United Nations' World Summit on Sustainable Development-Rio + 10, held in 2002 in Johannesburg. Its main goal was to review the progress in implementing the concept of sustainable development that is in line with Agenda 21. Then, after a decade, in 2012, another UN conference was held in Rio de Janeiro, this time called "Rio + 20"—the theme of which was the green economy in the context of sustainable development and the fight against poverty.

The next stage was the "2030 Agenda for Sustainable Development", which was adopted in September 2015 in New York during the 70th Session of the United Nations General Assembly. The document indicates 17 sustainable development goals that the world population should aim for in the near future, assuming their achievement in 2030 [23]. The important issues that have been taken into account include eliminating poverty and hunger; ensuring access to water, modern energy sources, well-being, and education; achieving gender equality; and, moreover, promoting an inclusive model of economic growth and inclusive models of social development, thereby reducing development inequalities, developing a sustainable model of consumption and production, halting climate change, and rebuilding a global partnership for sustainable development.

The need to strive for sustainable development is also present in Poland, which is emphasized in almost all important state documents. In Chapter I, Art. 5 of the Constitution reads: "The Republic of Poland (. . .) ensures environmental protection, guided by the principle of sustainable development" [24]. In May 1991, a document prepared by the then Ministry of Environmental Protection and Natural Resources, the "National Environmental Policy", included guidelines for linking the activities of government administration bodies and society that would serve the economic interests of the state with activities that lead to the improvement of the environment. In 2000, the "State Ecological Policy" [25] was updated, strengthening the principles of eco-development in accordance with European Union law. In 2001, the European Union established the Sustainable Development Strategy, which was approved by the European Council at the Gothenburg meeting and defined the desired directions for changes in the social, economic, and environmental perspectives. Accession countries, including Poland, were obliged to apply the law in line with EU (*European Union*) solutions. A very important document that required the concept of sustainable development to be introduced at all levels of management in Poland was the "Strategy for the sustainable development of Poland until 2025" [26], which was adopted in 1999. The strategy was designed to stimulate development processes that would have the least possible impact on the natural environment. Table 1 presents the concept of sustainable development from a time perspective.

Table 1. The concept of sustainable development from a time perspective.

Year	Facts
60's XXth century	Growing awareness of environmental problems;
1969	Man and His Environment; the report by the UN Secretary General U. Thant;
70's XXth century	End-of-the-pipe solutions; growing number of ecological organizations; dwindling natural resources; economic and demographic development, and as a result, increasing pollution;
1971	Man and Biosphere; UNESCO;
1972	The Limits of Growth–The Rome Club;
1972	Declaration of the UN Conference on the Human Environment; Stockholm;
80's XXth century	Better awareness from governments of environmental problems; initiatives and programs in industrialized countries;
1987	Brundtland Commission–first definition of sustainable development; "Our common future" report;
1991	National Environmental Policy; Poland;
1992	2nd Earth Summit in Rio de Janeiro "Environment and Development"; Agenda 21;
1999	Strategy of the Sustainable Development of Poland until 2025;
2000	State Ecological Policy; Poland;
2001	European Union Sustainable Development Strategy; Gothenburg;
2002	Rio + 10 Summit; Johannesburg;
2012	United Nations Conference Rio + 20; Rio de Janeiro;
2015	2030 Agenda for Sustainable Development, New York; 70th Session of the United Nations General Assembly; Sustainable Development Goals;

The analysis of documents created as a result of meetings of representatives of the peoples of the Earth and the documentation of Poland allows us to conclude that the essence of the concept of sustainable development comes down to an attempt to consciously reconcile the needs of societies, which means striving to achieve harmony between—often mutually exclusive—values: on the one hand, the pursuit of economic growth of countries and regions, and on the other hand, the need to preserve the state of the natural environment at a relatively high level. The essence of the stasis state is to achieve a balance between man and nature. The core of this process is the rational use of the available natural resources, limiting harmful behavior to the environment, and maintaining biodiversity. Therefore, states that have undertaken the sustainable development goals should consider those issues related to environmental protection over the course of their activities and at each stage of the decision-making process. One could say that the essence of the concept is to seek to solve as many problems as possible that plague the modern world while ensuring constant economic growth. This requires constant cooperation between all nations in such a way that prosperity and peace are available to the people of the entire planet. It is making the dream of a super-intelligent society, Society 5.0, real on a global scale.

The concept of Society 5.0 is associated with important social change and will be the result of technologies that have matured and were implemented in the 21st century in record time, which was not achieved in the previous century [27]. Digital transformation is a special type of organizational change in an enterprise, sector, supply chains, and in public administration, as well as entire economies. In a report prepared in 2011 by the MIT (*Massachusetts Institute of Technology*) Center for Digital Business and Capgemini, digital transformation was defined as the use of digital technologies to radically improve the

efficiency or achievements of an organization. This affects three areas of the organization: the organization's customer experience, operational processes, and the organization's operating models [28]. The consequence of functioning in Society 5.0 is a sharing economy based on intelligent methods of managing their flow (smart logistics).

A collaborative economy, gig economy, on-demand economy, and peer economy [29] in the classic approach consist of giving someone their own resources that are at their disposal, which are not used are available in excess, in exchange for obtaining some benefit. As a result, the resource is better used, which can lead to lower operating costs and a positive environmental impact. Such an approach is consistent with the indication of the role of business in achieving the goals of sustainable development, i.e., building prosperity while respecting nature. Another concept of Corporate Social Responsibility (*CSR*) appears in this trend, which is identified as the "responsibility of enterprises for their impact on society" [30], and according to which the implementation of a strategy aimed at stable socio-economic growth requires the involvement of all market entities whose activities and decisions affect both the closer and more distant surroundings. The integration of economic and non-economic goals by enterprises is at the basis of the concept of business activity that is understood in this way.

Smart logistics, as a shared effect of a collaborative economy and corporate social responsibility in accordance with the concept of sustainable development in relation to enterprises, refers to innovative attitudes, entrepreneurship, productivity, flexibility, and the possibility for transformation. At its core, it is a determinant of the systemic transformation of the community. This means moving to a circular resource economy, commonly referred to as circular economy. Considering the assumptions of the previous model of the linear economy, the new model is accompanied by the overarching goal of sustained improvement in resource efficiency. Irrational management, often resulting from a misconception about an unlimited amount and easy availability of resources, significantly threatens the competitiveness of economies and individual enterprises. If climate change is added to this, then the implementation of solutions leading to the formation of an alternative model of the economy, which will be based on a closed cycle, is probably the only one that will allow the added value of resources and goods to be preserved while viewing nature.

Among the undisputed benefits that result from this type of system transformation, it is necessary to point out the minimization of waste and an increase in resource productivity. On the other hand, the transition to a circular economy is a complex process, and its individual stages require numerous transformations along the value chain. The most important changes should be the assumptions concerning product design, business and market models, consumption behavior, and waste management [31]. The circular economy concept includes: EPR (*Extended Producer Responsibility*) for products introduced to the market; TAX, i.e., a system of taxation and regulation supporting the use of renewable resources; and GPP (*Green Public Procurement*), which means the promotion of "green" procurement.

Support for the implementation of the concept of a sustainable economy/green economy also results from modern automation and robotization technologies in the smart trend, which are more and more often present in the information and organizational structures of enterprises [32], thereby contributing to the improvement of processes related to design, production, logistics, supply chains, and customer service. When the supply chain covers the entire product life cycle (warranty, remanufacturing, recycling, disposal, etc.), the impact of logistic flows on the network structure is significant [33]. In this context, the concept of sustainable development with the operational execution of smart logistics in the trend of the economy of the new green era places emphasis on systemic network functioning, the essence of which is the integration of people and digitally-controlled machines, with the simultaneous use of the Internet and information technologies.

The benefits of implementing and operating in accordance with this concept primarily result from coordination activities based on ICT. The demand for the effective coordination of logistics processes in supply chains, which can be represented by distribution within the customer service area, goes beyond a given company [34]. Visionary—but quite

realistic—concepts such as the Internet of Things, industrial Internet, cloud production, and smart distribution are the engine of a revolution [35] that considers environmental balance. Despite the admiration for the Industry 4.0 concept, scientists and practitioners note [36,37] that the mere use of machines and devices, cloud computing technologies, big data, and the Internet of Things to increase the efficiency and effectiveness of enterprises is insufficient.

Sustainable development in the spirit of eco- and zero-waste economies are necessary to promote the trend of reducing the negative impact of individuals on the environment [38]. Furthermore, the reason here is not only compliance with the guidelines contained in the law, but, above all, a conscious and responsible approach to socially responsible development. The present generations shape the future of the next. In this trend, the use of technology in business transactions on the Internet (e-commerce) and smart logistics in the operational implementation of e-logistics illustrates the possibility of reconciling the idea of ecology and the rationalization of the economy. Online shopping is greener than in-store shopping due to the reduction of the carbon footprint by removing one of the resource storage links (heating/cooling) and delivering goods directly to the customer's home. Sustainable delivery allows the carrier to plan more efficient routes as well as deliver several shipments at once. The carbon footprint of delivery is calculated by dividing the transport emissions by the number of products transported; the more products that are transported to a specific location, the lower the carbon footprint. On the other hand, there is the packaging, which should be made of composted or recycled materials. Recycled or biodegradable paper and plastic are good choices in this case. Looking more broadly, the secondary market may turn out to be the future for e-commerce. Ecological purchases based on used products are becoming more and more visible in the minds of consumers.

3. Smart Client: Managing the Experience of an Aware Customer

In the 21st century, it is no longer enough to produce and distribute. A multitude of companies offering products and services are looking for sales markets/customers. As early as 1976, P. Drucker [39] wrote that the client is the target point of every entrepreneur's activity, and now it is the beginning of every activity of enterprises.

The client may be a person or legal person "who is able to pay a certain amount of money for a given good or a service offered by the company" [40]. In addition, in the transaction process, "a customer is also any person who requires professional advice and assistance during the purchase" [41]. At the same time, the client has long ceased to be the only recipient of the transaction and has become a full participant in business processes. On the one hand, the client provides the company with information about their needs, experiences, and feelings related to employees as well as products and services, which may lead to creative potential for taking up new challenges by the company, news about the offer of competitors, and ideas about the possibility of introducing changes. The company's customers are now treated as important stakeholders, that is, those who can influence the organization's activities [42]. One could even go so far as to say that clients redefine the functioning of modern enterprises.

Functioning in a complex environment means that today's customers not only have contact with bidders/enterprises but are immersed in the crucible of global trends based on factors from the macro-environment, including digitization, computerization, and Internetization, in which customers are willing to drift. The digital conversion in recent years is impressive. Increasingly higher levels of Internetization are visible. According to the We Are Social-Digital in 2022 [43] report on the Internet, social media, and mobile industry, the number of Internet users in the world in January 2022 amounted to 4.95 billion people, or 69.5% of the world's population (which is 7.91 billion). The number of Internet users increased by 192 million (+4.0%) compared to 2022. In 2022, Internet users spent 2.5 trillion hours on the Internet in total, while the average daily use of the Internet was 6 h, with 58 min per user per day. Since the appearance of the Internet, the way of life of many people in the world has changed dramatically. Relationships between people have

been taken to a virtual level in a variety of areas—from professional life to private life. Thanks to new technologies, communication is now possible at almost any time (*anytime*) and everywhere (*anyplace*), using any information medium (*anymedia*) and *anything*—not just people (*anyone*)—preferably with the use of *any network* and all services (*any service*). Due to this situation, customers willingly use the opportunities offered by the Internet, i.e., communication and shopping. According to the data of the e-commerce DB website, in 2020, the global e-commerce market reached a value of $4.213 trillion USD, and in Poland it was $13 billion USD. It should also be added that Digital Market Outlook experts forecast that in 2025 the Polish e-commerce market will reach a value of $20.2 billion USD [44].

Customers are organization independent, but organizations depend on customers. They inherently determine the existence and functioning of enterprises. This is especially visible in virtual markets. Being aware of this fact, managers take all possible actions aimed at satisfying the needs and expectations of customers. Therefore, enterprises must constantly and very carefully take care of building the value of their product or service in order to be able to strengthen their market position and increase their competitiveness in relation to other companies in the service sector. It is no longer enough to meet customer expectations, but it is now necessary to exceed them. The consequence of the development of e-society is the emergence of a new concept that describes a completely new type of customer—the consumer that business is dealing with, namely the e-customer or e-consumer. This customer is no longer afraid to buy online. This client is characterized by good information, mobility, and education who independently and consciously decides what, how, and where to buy. Moreover, it is a demanding client with a low tolerance for errors made by service providers. A distinctive feature is that the e-client/e-consumer meets their needs by making purchases very often wandering between sales channels—the worlds of cyberspace and virtual space. Thus, it forces changes in the traditional understanding of e-commerce in favor of "smart e-commerce" and "customer logistics" to "smart customer logistics". Customization and individualization are almost a sine qua non condition. It is not enough just to offer products using the technical possibilities and the universality of the Internet. It is also important to fulfill the promise that finalizes the transaction in the form of customer service and the transfer of the order. The transformations that the client has undergone have resulted in recalibration in business terms—not so much in supply and production—but in sales and customer service above all. One could say that the modern world of supply logistics is a customer-centric world; logistics systems and processes are customer focused. This means that it is not as important to strive to get to know and understand the expectations of recipients of products and services, but it is important to manage values for them. At the same time, customers also understand value as the capital of a new era, and their needs and expectations are an azimuth for the company's operations. By offering value to the customers through one-of-a-kind service, the value of the business value is built. Service is immaterial and can be experienced individually and emotively; this is its largest advantage.

In the literature, customer service is often understood in three ways: as offered and received service levels, as a specific activity, or as a management philosophy and mission of the organization [45]. Service is also treated as the ability or capability to meet the requirements and expectations of customers, mainly with regard to the time and place of ordered deliveries, using all available forms of logistics activities, including the transport, storage, and management of inventory, information, and packaging. The combined activities create a complex that is a sequential and multi-variate process that can be standardized (customer service as performance levels) with the representation of ECR (*Efficient Customer Service*). Finally, logistic customer service is recognized as a management philosophy that is a component of the DNA of enterprises [46].

In the trend of the most popular classification of logistic customer service components, B.J. LaLonde and P.H. Zinszer in 1976 [47]—and still valid in the publications of, inter alia, R.H. Ballou [48], M. Christopher [49], A. Rushton, P. Croucher, and P. Baker [50]—emphasized the division of service into process components. At the same time, virtual-

ization has forced enterprises seeking the attention and interest of customers to take such measures that will allow for the creation of sustainable competitive advantages (*sustainable competitive advantage—SCA*) based on customer service. Logistics can be an important component here, especially in terms of creating value for the customer. It is also worth noting that it is in the affective and cognitive aspect, when experiences are important, that it is possible to create emotional relationships between the company and its offer and the client. The value created is then qualified by the client as a total of benefits over the costs incurred, the first of which are achieved with a significant advantage that allows for the creation of relationships.

The concept of "Customer Experience" *(CX)* is a representation of the creation of value that shapes strong relationships between the company and the customer, i.e., collecting experiences from the customer and, on their basis, anticipating future opportunities. Experiences are much more valuable to customers than material goods themselves due to the fact that they transform into memories that are a part of each person's identity. Due to the fact that service is a process, it is associated with an affective experience. Clients desire offers that will bring significant and noticeable changes into their lives and offer social benefits in line with their values. In the process of shaping Customer Experience, it is important to know the customer by updating information, being in constant contact with the customer thanks to all possible forms of communication, being available when the customer needs help, protecting the customer from incorrect choices, appreciating activation for the company, fulfilling promises, and acting on behalf of the client.

The expectation that modern customers have towards enterprises is to conduct business with a healthy and clean planet in mind. Increasingly, customers base their purchasing preferences on the basis of the social and environmental impact of a given enterprise. The global health crisis triggered by the COVID-19 pandemic has increased consumer awareness and increased commitment to sustainable purchasing, as confirmed by consumer product and retail (*CPR—consumer product and retail*) organizations. They agree that there is a visible increase in the preferences of the offer of those producers and service providers whose products and services are pro-environmental and consistent with the idea of sustainable development. The Ericsson Consumers "Sustainability and ICT" study [51] shows that 46.0% of respondents see technological solutions as an opportunity to cope with environmental challenges. Studies indicate that, inter alia, thanks to the use of technologies such as the Internet of Things, 5G networks, or machine learning, it is possible to reduce energy consumption by up to 15.0%. Customers appreciate this. Operating from a technological environment and acting for the benefit of the environment is a field of experience desired by customers.

In addition, the sensuality of each person poses a dictum of stimulating emotions and generating experiences based on sensory stimuli, which, when aggregated in memory, form a reference point for decisions made. Individualization of the approach and personalization of the terms of service make the customer feel cared for and important. Meeting the requirements of respecting the environment and conducting business in accordance with the idea of sustainable development is a representation of this.

Positive customer experiences in the sphere of rational, emotional, and quantifiable values mean the fulfillment of promises that consider an individual approach. It is important to move away from transactional approaches in favor of a long-term and relational approach. In this case, focusing attention on the customer means literally putting yourself in your client's position, looking at the market offer through your client's eyes, perceiving market signals and arguments through your client's ears, as well as considering your client's sense of rationality and probing your client's emotions and satisfaction with purchases. This new perception of the client becomes the foundation of management strategies in enterprises and the rejection of schematic and developed procedures. Creating long-term relationships with buyers and providing them with maximum value (satisfaction) due to Customer Experience seems to be one of the most important strategic options today. The end result is the development of the client's "loyalty", which is represented in the attitude

and subjective feelings of the client, thereby resulting in attachment to a given company and its offer. A tool support in this area these days can be logistics, in terms of smart methods—especially in the area of *mass customization*, when companies want to reconcile the impossible, i.e., mass and individualization, meaning differentiation through diversity.

4. Smart Logistics as a Representation of Technological Innovations in the Face of Environmental Challenges

Being smart is one of the requirements of the modern scientific, business, and social environment. Smart is not only about being intelligent, but also about the ability to apply this intelligence in practice. The concept of being smart is not only a reference to the technologization of processes and systems, but also experiences and feelings. The concept of smart in business practices is not a novelty and has already appeared in many studies. On the other hand, in line with the processes of evolution—but also industrial revolutions—it is gaining more and more importance, and its role is increasing in the face of the multitude of applications of technology.

Smart logistics is a reference to the automation of logistics processes, the introduction of new, innovative solutions in the use of technology in logistics systems. Smart logistics is considered to be a strategy that enables perfect collaboration platforms through the use of the Internet of Things, thereby reducing the time and costs by automating processes and increasing the possibility of achieving customer satisfaction by delivering products that meet their specific requirements [52]. The beginning of smart logistics were primarily IT systems and their use in various business processes related to the broadly understood field of logistics. However, subsequent iterations of the use of smart systems include, among others, building a network of connections in supply chains using integrated logistics systems and artificial intelligence [53]. Another aspect was the use of RFID (*radio-frequency identification*) technology as a replacement for bar codes, which was implemented to revolutionize the course of logistics processes and, above all, to reduce costs [54]. Currently, smart logistics is an even wider application of ICT technologies, including the Internet of Things (IoT), AI (*artificial intelligence*), and cloud computing [55–57], but it is also a reference to the specific applications of these technologies in various logistics processes (transport, storage, production, city logistics) [58–62]. These systems are a support for the decision-making and improvement of logistics processes, and they provide relevant data for process optimization. Therefore, they are an irreplaceable tool for the utilization of possessed resources and the optimization of logistic flows in company systems as well as entire supply chains.

Considering the current trends in supply chains, their virtualization and focus on the real-time tracking of data from the physical flow of raw materials and goods plays an important role [63,64]. However, it should be remembered that it is still up to consumers to what extent supply chains develop. As well, an important issue is obtaining information from the consumer market regarding not only satisfaction, but also expectations and future requirements. The analysis of data concerning clients, and above all consumers, may be burdensome due to the variety of expectations; nevertheless, each of us is different. Still, thanks to technology, enterprises are also able to obtain this type of data—for example, through the use of IoT or AI.

Therefore, one of the challenges is the use of smart technology in last-mile logistics, which is a physical link with the consumer. Smart logistics in the last mile are also an area of interest, for example, in Logistics 4.0. The use of drones or autonomous vehicles in home deliveries was obvious [65–67]. Yet, from the perspective of the last two years and, above all, the acceleration of changes forced by the pandemic, consumers expect not only speed and accuracy, but also begin to notice other aspects related to logistics. Greater consumer awareness no longer concerns only the products and raw materials from which they were made, it is no longer just care for production technologies that do not have a negative impact on the natural environment. Increasingly, consumers are also starting to see the role of logistics processes in supply chains, and thus their impact on the surrounding

environment. Consumers' demand from logistic operators who provide last-mile services is more and more noticeable, indicating the need for greater care for the environment [68,69].

The organization of last-mile processes using intelligent technologies, i.e., smart logistics, primarily means the use of automation, robotics, and data analysis to optimize the location of collection points. It should not be forgotten that an additional criterion is the implementation of elements for sustainable development in these, however, energy-consuming, technological elements. Hence, perhaps it would be appropriate to use the term, Sustainable Smart Last Mile Logistics.

The solution to last-mile problems is identifying deliveries away from home. Until recently, the e-commerce market in particular has focused on home delivery solutions. However, it turns out that these possibilities have their drawbacks, since the recipient is usually not home during the hours when parcels are delivered by couriers, hence the term, OOH (*out-of-home*) deliveries. This means deliveries to various points from which recipients can pick up their parcels at any specific time. OOH deliveries are divided into two groups: the first option is delivery to automated parcel machines (*APM*) and the second is pick-up delivery (*PUDO*). The Out-of-home delivery in Europe 2021 report [70] shows that 40.0% more new PUDO points have been created in the EU since mid-2019, mainly due to the growing importance of the e-commerce market and the need to organize parcel delivery. At the same time, Poland has become a place where PUDO points increased by 70.0% in 2020 compared to 2019. It was probably also the effect of the Sunday trade restriction and the exception that allowed postal offices to operate. Hence, many retail chains decided to create PUDO points in their stores, thanks to which it was possible to conduct commercial activities until February 2022.

The entire OOH market certainly has a bright future ahead of it. The availability of parcel machines in Europe is constantly growing, and it is estimated that most of them are in Poland, Spain, and Germany. On the other hand, the largest number of PUDO points in Europe are in Germany, France, Great Britain, Italy, and Poland.

Parcel machines allow you to pick up the shipment at any time, however, the obstacle here may be their location and insufficient availability, especially in smaller towns. The popularity of this type of solution is certainly high, as shown by research conducted in Thailand [71], Poland [72], China [73], and Greece [74], among others. Interestingly, in 2016, research by Moroz and Polkowski [75] already indicated that this solution is environmentally friendly in last-mile deliveries, especially in the context of the expectations of young consumers from the Y generation, although young consumers did not yet consider parcel machines as ecological. Indeed, the use of parcel machines, especially those considered smart because they allow you to open a locker with a unique code, is becoming one of the more revolutionary methods for last-mile logistics. Skeptics, however, point to the need to supply this type of machine with energy, which means that they cannot be fully treated as ecological. However, work is underway on the use of renewable energy sources in powering parcel machines in order to reduce their energy consumption in the traditional sense [76]. However, the eco-friendliness of this solution is mainly based on the fact that it is one point where the courier arrives with parcels, instead of traveling around the city and emitting greenhouse gases. In addition, many users choose the parcel machines closest to their home in order to be able to reach them on foot, which also reduces CO_2 emissions. This solution is also appreciated by users because the unique codes, the possibility of using the application to operate the machine, and the ease of use guarantee both digital and health safety in light of the prevailing pandemic. An additional issue is also the availability for individual users, i.e., it is possible to send parcels in a C2C (*customer to customer*) transfer, which also allows you to handle orders from secondhand-goods exchange platforms—in relation to the concept of re-use. It is also one of the concepts of the functioning of a society that cares for the natural environment, thereby reducing consumerism and increasing the sharing economy [77].

Another way to solve last-mile problems could be with PUDO points. These points are located in stores belonging to retail chains, in local grocery stores, kiosks, gas stations, etc.

Nevertheless, this solution, apart from the use of SMS (*short message service*) notification, does not pose a major technological challenge.

Another method of OOH delivery may be mobile parcel machines in the form of autonomous robots [78] that stop in places that reach the largest possible number of recipients. Of course, these places are determined by calculations according to the adopted algorithm and based on the analysis of data from GPS—such places can be determined by artificial intelligence. In addition, they can also be autonomous cars with a semi-trailer in the form of parcel lockers. A similar solution was presented by the Estonian company, Cleveron, which deals in the production of various machines and robots for handling shipments, sales, or deliveries of food products, e.g., refrigerated parcel lockers [79]. Such machines automate the collection of parcels, are safer for recipients, and support the optimization of last-mile delivery processes.

A solution to the problem of last-mile deliveries may also be a form of action based on previous experience in the field of courier services. However, in order to increase the efficiency of these deliveries and to change the working hours so that the parcels arrive at times when the recipients are most often at home, automation can be used. Such a scenario is described by Garus, Alonso, and others [80], who proposed the use of droids instead of couriers.

Drones can also take the form of couriers. UPS Flight Forward, a division of one of the world's leading last-mile service providers, received FAA (*Federal Aviation Administration*) certification for out-of-sight drone deliveries in 2019 [81].

Of course, all these innovative last-mile delivery solutions should now meet customer expectations. Peppel et al. [82] noticed megatrends such as digitization, sustainability, and customer focus in considering customer expectations, legal requirements, and delivery service models. These elements will then determine the requirements for the last-mile service evaluation criteria from the point of view of logistics operators. These evaluation criteria have not changed for years and result from the economics of running a business (including cost effectiveness, time, and quality). For operators providing last-mile services, it will be important to both meet the expectations of customers (i.e., customers who most often shop online), but also to respond to customer expectations (i.e., e-commerce companies that outsource last-mile services).

The use of the elements of sustainable development in handling last-mile deliveries is certainly one of the requirements of the current economic and social trends. The answer to many problems resulting from the complexity of the last-mile issue can be automation, thanks to which processes can be sped up, efficiency can be increased, and the delivery rules can be changed a bit (e.g., hours). Being smart in this case can certainly turn out to be a good direction, especially in the increasingly turbulent world of VUCA (*volatility-uncertainty-complexity-ambiguity*) transformations.

5. Materials and Methods

The analysis of the topic was supported by the results of the research carried out at the turn of 2021 to 2022. The study covered the population of e-commerce customers from Poland. Due to the nature of the research, they can be classified as explanatory and descriptive. Due to the scope of measurement, the study can be classified as fragmented and deterministic, and is representative of a selected study population. The subject of the measurement was to determine the impact of technological innovations implemented in the trend of sustainable development in the logistic customer service processes at the last-mile stage on customer choices of supply bidders, and to determine the need to adapt CEP companies to the challenges of the future in the field of green logistics.

The operational basis for obtaining data were primary sources, i.e., e-commerce customers who selected the form of delivery of the order placed in the virtual space. The method of diagnostic survey was used to obtain the material. Technically, a "user-centric" (*Computer Assisted Web Interview*) Internet survey was used for this purpose. The survey questionnaire consisted of 43 closed questions, including 14 based on the scaling of atti-

tudes according to Rensis Likert, was placed on the research platform https://ebadania.pl (accessed on 20 June 2021).

The participants of the survey were respondents aged 16 and above who, in the 3 months before the survey, carried out a product purchase transaction at least once via entities operating in the Internet space. Not all people buying online at the turn of December and January 2021/2022 were tested, but rather only the sample selected for the study, which was determined using the formula for the minimum sample size.

$$n_{min} = NP\ (\alpha 2 \cdot f(1 - f))/NP \cdot e2 + \alpha 2 \cdot f\ (1 - f)$$

where:

n_{min}—is the minimum sample size
NP—the size of the study population
α—the confidence level for the results
f—fraction size
e—assumed maximum error

In the implementation, the study population was assumed to be the population of Poland who, as of 31 December 2020, were 16 years of age and above, and whose total number, according to the Central Statistical Office, was 31,811,795 people. Using the distribution of proportions of previously conducted research [83] on shopping transactions carried out on the Internet, the fraction factor was assumed to be 0.814 for people aged 16 and above who regularly use the Internet (at least once a week) and search for information about goods and services there, and 0.186 for other people. Due to the possibility of discrepancies in the measurement, the random error was 5.0%, which considered a confidence level of 0.95. After substituting the assumed values into the formula, the obtained minimum sample size was n_{min} = 233 units.

In the next stage, the physical sampling of units for the sample was carried out with the simultaneous implementation of the study. For this purpose, the method of the non-random selection of typical units with the snowball technique was used. In practice, information about the study was posted on social networks. People who met the conditions of the survey participant, age and act of purchase in the three-month period preceding the survey, were asked to click on the link and answer the questions contained in the questionnaire.

The implementation of the study allowed for the collection of data that was anonymised and encoded in the SPSS program (*Statistical Package for Social Sciences*). Then, verification and validation of the data was carried out, allowing for their verification and assessment of suitability for statistical processing. The results were obtained using information about obtaining material from a larger than initially assumed number of respondents. Ultimately, the questionnaire was completed by 658 respondents.

In terms of representativeness, due to the applied method of non-random selection of typical units for the sample with the snowball technique, it is difficult to fully assess the representativeness of the sample in a statistical sense due to the lack of compliance with the statistical randomness requirement in relation to the sampling method of the studied units. However, due to the number of surveyed units that make up the sample, the researchers attempted to make assumptions about the applicants. The accuracy and rationality of the measurements in this study were compared to the internal aspect, i.e., measuring the operationally tested variables that quantified the behavior of people buying on the Internet and using the services of the CEP industry. In turn, maintaining the reliability of the study was achieved by maintaining due diligence both in the construction and testing of the measurement tool and in the final study. When constructing and testing the correctness of the construction of the measuring tool, the achieved results were compared and it was found that they were similar, which allows us to conclude that the level of test reliability is maintained, even when taking into account random errors.

Women dominated (53.2% of the respondents) compared to men (46.8% of the respondents). Taking into account the age of the respondents, the largest group (36.0%) were people aged 55 and over. The remaining respondents were aged 35–44 (19.3%),

25–34 (16.3%), 45–54 (16.1%), and 16–24 (12.3%). Four out of ten respondents (40.1%) were inhabitants of rural areas, and nearly six out of ten declared themselves inhabitants of cities (59.9%).

To verify the representativeness of the obtained sample in relation to the inhabitants of Poland, a comparative analysis of the existing population and the studied sample in the area of selected comparative characteristics was used. For this purpose, a non-parametric significance test, i.e., a statistical-based compliance test, was used for χ^2,

$$\chi^2 = \sum_{i=1}^{r} \frac{(n_i - np_i)^2}{np_i}$$

where:

p_i—is the probability that the feature X will take a value belonging to the class range "*i*".

np_i—is the number of units that should be in the i-th interval, assuming that the feature has a distribution consistent with the hypothesis.

It is assumed that the statistics have a distribution χ^2 α o k = (r − 1), where k—denotes the number of degrees of freedom; r—is the number of class ranges; and χ^2 is the empirical value of the statistics obtained from the study. The form of the critical set: P ($\chi^2 < \chi^2\alpha$) = α, where $\chi^2\alpha$ is the critical value from the distribution tables χ^2 for k = r − 1 degrees of freedom i p = α. In this approach, two hypotheses were adopted in accordance with the procedure, a null (H0) and alternative (H1) with the following content:

H0: The distributions of the selected variables (sex, age, place of residence) from the sample are consistent with the distributions characterizing the population of Poland aged 16 years and over.

H1: The distributions of the selected variables (sex, age, place of residence) from the sample are not consistent with the distributions characterizing the population of Poland aged 16 years and over.

The analysis of the calculations carried out in the form of the obtained statistical values allowed us to confirm the null hypothesis (H0), which supported the compliance of the distributions of the selected variables (sex, age, place of residence) from the sample with the distributions characterizing the population of Poland aged 16 years and above, meaning that the distribution of variables characterizing the studied sample is consistent with the surveyed population of Poland in terms of sex, age and place of residence (Table 2). However, taking into account the fact that non-random sampling was used in the sampling of units, one cannot unequivocally assess the representativeness of the sample in a statistical sense, though such a result will be the basis for summarizing the entire population of Poland aged 16 years and over, buyers on the Internet, and use of CEP services in Poland for the delivery of last-mile deliveries.

Table 2. Sample representativeness using statistical concordance test χ^2.

Parameters			Value χ^2	Value $\chi^{2\,\alpha}$	Test Realization
	Number	Number	Real	Theoretical	$\chi^2 < \chi^{2\,\alpha}$
Sex					
Female	350	16,722,685	0.103	3.841	concordance
Male	308	15,089,110			
Age					
16–24	81	3,395,513	2.204	12.592	concordance
25–34	107	5,222,883			
35–44	127	6,300,861			
45–54	106	4,975,279			
55–i powyżej	237	11,917,259			

Table 2. *Cont.*

Parameters	Number	Number	Value χ^2 Real	Value $\chi^{2\,\alpha}$ Theoretical	Test Realization $\chi^2 < \chi^{2\,\alpha}$
Place of residence [inhabitants]					
Village	264	15,359,918	4.197	11.07	concordance
city—up to 20,000	70	4,983,795			
city—from 20,000 to 49,000	72	4,237,100			
city—from 50,000 to 99,000	60	3,128,500			
city—from 100,000 to 199,000	63	3,324,500			
city–above 199,000	129	7,231,300			

$^{\alpha}$—confidence level.

After examining the representativeness of the studied sample, an analysis of the answers given by the respondents to the main questions was carried out. The procedure involved the preparation of simple and cross-distributions of the obtained results, and, where it was possible, logical, and statistically significant, the hypotheses on the relationships between the variables were verified. The basis for the cross-comparisons each time was the contingency table, which allowed for the comparison of two features at the same time.

The table consisted of r rows and s columns each time. Each row and column corresponded to particular variants of the X and Y features. The contents of the contingency table consisted of the n and j numbers of sample elements that had the i-th variant of the feature X (i = 1, 2, . . . , R) and j-th variant of the feature Y (j = 1, 2, . . . , s). Each time, such a contingency table was the basis for the verification of the null hypothesis (H_0) of the existence of stochastic independence of the random variables X and Y and the alternative hypothesis (H_1), which was adopted when the null hypothesis (H_0) was rejected. The following formula was used in this analysis:

$$H_0: \; P\{X = x_i \;\wedge\; Y = y_j\} = P\{X = x_i\}\, P\{Y = y_j\}$$
$$H_1: \; P\{X = x_i \;\wedge\; Y = y_j\} \neq P\{X = x_i\}\, P\{Y = y_j\}$$

The basis for the verification of the H_0 hypothesis about the stochastic independence of the variables was the value of the statistics obtained from the formula:

$$\chi^2 = \sum_i^r \sum_j^s \frac{\left(n_{ij} - \widetilde{n}_{ij}\right)^2}{\widetilde{n}_{ij}} : \chi^2_{(r-1)\cdot(s-1)}$$

where:

n_{ij}—are empirical conditional multiplicities resulting from the contingency table,

$\widetilde{n}_{ij}$—are the theoretical conditional counts that would appear in the table if the features were independent. The hypothetical numbers are determined according to the formula:

$$\widetilde{n}_{ij} = \frac{n_{i\cdot} \cdot n_{\cdot j}}{N}$$

In the analysis of the obtained results, the area of rejection of the null hypothesis (H0) is always right-handed. Its size depends on the adopted significance level α. It gets bigger the bigger α is. It is generally assumed that $\alpha \leq 0.05$. Critical values of the χ^2 distribution with $(r - 1) \times (s - 1)$ degrees of freedom. If only χ^2emp > $\chi^2\alpha$, then the null hypothesis (H0) is rejected in favor of the alternative hypothesis (H1), which meant that the pair of selected variables was mutually dependent on each other. Technically, in the case of complex contingency tables, the Cramér V coefficient (or phi Cramér) was used to indicate the level of dependency, which allows us to determine the level of dependence between two variables.

$$\mathcal{V} = \sqrt{\frac{\chi^2}{n \cdot min(r-1, k-1)}}$$

$\mathcal{V}$—is the Cramér V factor between two variables
χ^2— the result of the X^2 test for a pair of variables
n—number of observations
r—number of levels of one variable
k—the number of the second variable
$min\ (r-1, k-1)$—the smaller value of the two, $(r-1)$ or $(k-1)$, is chosen

Using the above methodology, the process for testing the statistical significance of the relationship between the selected variables was carried out. Each time, the verification of statistical significance for the indicated variables consisted of checking whether the value of the asymptotic significance parameter for the χ^2 statistical value of a given pair of analyzed variables was lower than 0.05. If so, the observed relationship between the variables could be considered statistically significant and the obtained results were transferred to the entire population in the inference process. The further part of the article will present the results obtained as a result of the analysis of distributions and cross-compilations of selected variables.

6. Results

After processing, the collected research material was grouped into four thematic areas, with the common denominator of the analysis being indications in the field of smart technologization in logistics.

The introductory layer of the research field is the analysis of the reasons for choosing the digital space of the Internet as a place for shopping before and during the pandemic. In the next step, the respondents' level of knowledge in the field of smart solutions used in logistic customer service at the last-mile stage was verified. The next part of the considerations is the presentation of the implementation of the assumptions of the sustainable development concept by logistics service providers as assessed by the respondents. The final fragment of the considerations refers to the impact of "customer experience" in the time of the COVID-19 pandemic, which may serve as an indication for last-mile logistics recalibration in the field of greening the technology of delivery services.

6.1. Digital Space as a Place of Shopping

The participants of the study indicated that when purchasing products before the COVID-19 pandemic, they used the offers of various purchasing units, both operating in the real and digital world. When deciding to buy tangible goods in the digital reality (Figure 1), the respondents declared that they never bought this way every day. Shopping in the digital reality was usually done occasionally. The respondents indicated that they most often chose the offer of an exclusive online store (61.7%) or an e-store of a traditional network (58.4%). Less frequently, the respondents indicated auction e-services (40.7%) or sales platforms (40.4%). The respondents indicated social networks (26.7%) as places of occasional shopping, which was the least frequently used form of virtual sales given in the questionnaire.

At the time of the COVID-19 pandemic, most of the purchasing related to the selection of sales units did not change (Figure 2). Only the respondents who bought in exclusive online stores during the pandemic mostly admitted that they chose these units for shopping twice as often (51.4%). In the remaining cases, respondents who increased the number of purchases in individual units operating on the Internet during the COVID-19 pandemic were in the minority than those who admitted that their choices remained at the same level. Only every 5th shopper in e-shops of a stationary network (20.7%) and users of e-auction services (20.4%) admitted that they chose remote purchases in such a unit twice as often.

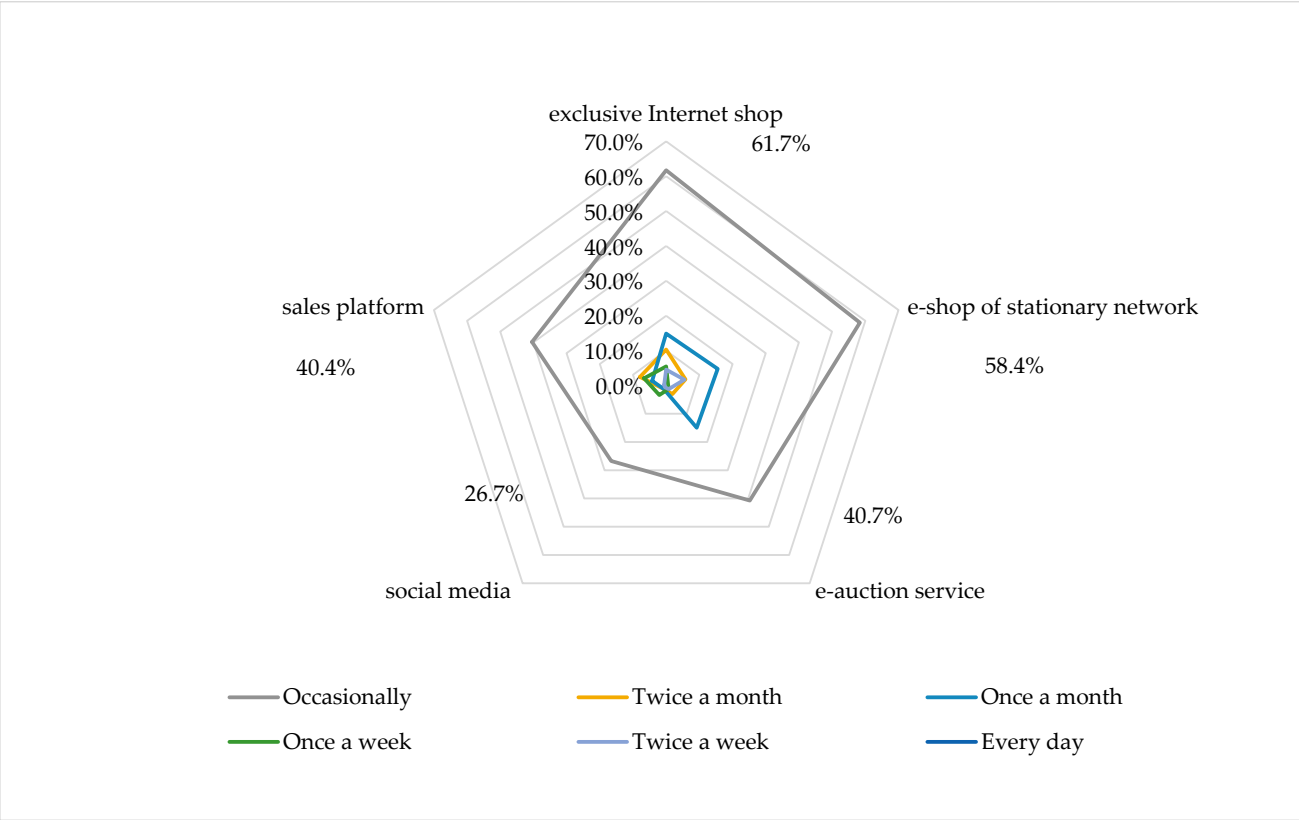

Figure 1. Declarations of the frequency of purchases in selected sales units operating on the Internet before the pandemic COVID-19.

Moreover, every 10th respondent buying on a sales platform (15.8%) or on a social networking site (11.6%) admitted that they made transactions twice as often. However, the majority of respondents who are customers of stationary e-shops (53.2%), and every third sales platform (36.8%), exclusive online store (38.6%) and e-auction service (36.2%), declared that that they made their purchases in selected digital trade formulas at the same level as before the pandemic. Such declarations may prove that customers represent a well-established behavior in the selection of purchasing units operating on the Internet. Only those surveyed who searched for offers from exclusive online stores during the pandemic increased the number of purchases.

The respondents admit that they definitely value the Internet as a shopping destination due to the flexibility and availability of (66.9%), but it is not enough to have a tool and access to the Internet, the ability to save time—a customer does not have to go to the point of sale (56.2%)—and the possibility of comparing offers thanks to price comparison websites (54.7%). In the opinion of the respondents, the broader choice in the form of visual exposure and descriptions appearing in search engines (52.3%), the possibility of verifying information about the offer in the Internet community (44.7%), as well as ecological and financial savings due to the fact that that the customer does not pay for commuting and reduces energy consumption (39.8%) were significant motivators. On the other hand, some of the respondents appreciate online shopping for rationalization, i.e., shopping for what is needed (55.6%).

The advantage of the Internet, which offers the ability to shop anywhere and at any time (7/24/365), was indicated slightly more often by men (72.7%) than women (61.7%), and by rural residents as well (over 77.3%). The breadth of choice is appreciated slightly more often by men (53.2%) than women (51.4%), people up to 34 years of age (75.7%), and people living in the countryside (78.8%). On the other hand, the possibility of comparing offers is more important for men (64.9%) than women (45.7%), people aged 35–44 (63.8%),

and rural residents (77.3%). The factor of shopping rationalization is appreciated more often by men (38.3%) than women (24.0%), younger people between 16–17 years old (54.2%), and city dwellers in cities with over 50,000–999,000 inhabitants (50.0%). In addition, time-saving, as a characteristic of online shopping, was indicated more often by men (65.6%) than women (48.0%), younger people under the age of 34 (70.1%), and people living in cities with 50,000–999,000 inhabitants (93.3%). On the other hand, ecological and financial savings were appreciated slightly more often by women (74.3%) than men (62.3%), people under the age of 34 (47.7%), and city dwellers with 100,000–199,000 inhabitants (65.1%). The existence of the indicated relationships is confirmed by the χ^2 independence test with the strength of the relationship determined by V-Cramer (Table 3).

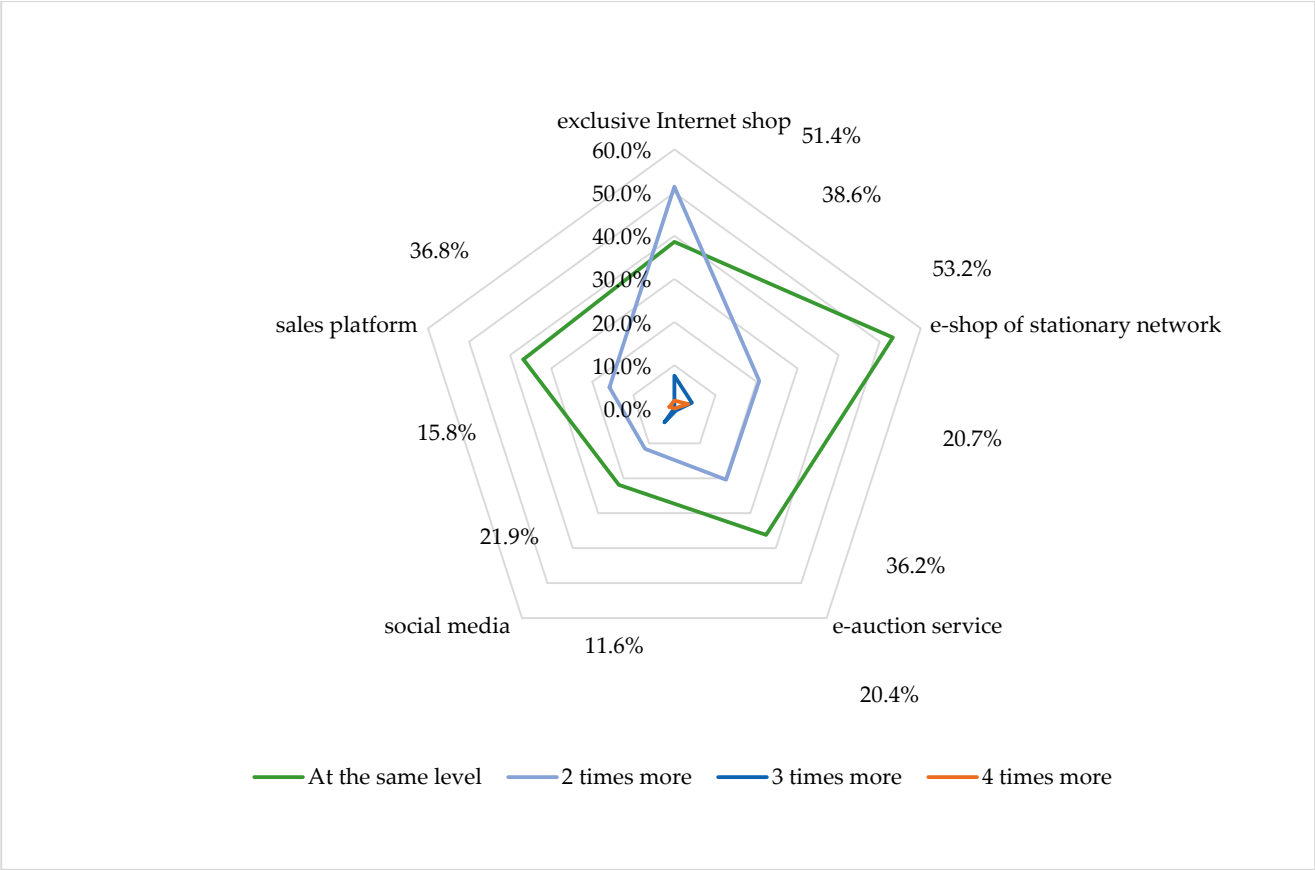

Figure 2. Declarations of the frequency of purchases in selected sales units operating on the Internet during the COVID-19 pandemic.

To sum up, according to the declarations provided by the respondents, shopping on the Internet is a significant alternative to stationary shopping due to the rationality of advantages, such as the availability of purchase opportunities, the breadth of the offer and its comparability and verifiability, as well as saving time, and being financially and ecologically cognizant. Before the pandemic, the Internet buyers were used to shopping and their increased purchasing activity was registered only in the area of online-only stores, and, in the case of other purchasing units such as brick-and-mortar e-shops, e-auction websites, social networks, and sales platforms, the vast majority of purchasing activity remained unchanged. Although there were also respondents who admitted that during the pandemic they more often chose units operating on the Internet as places of purchase, the finalization of the transaction in the form of the delivery of the purchased goods plays an important part in the shopping experience, which may contribute to the consolidation of the trend of choosing the Internet as the place of shopping.

Table 3. Advantages of the Internet as a shopping destination in terms of gender, age, and place of residence as represented through the results of a χ^2 independence test with relationship strength determined by V-Cramer.

Variants	Gender			Age			Place of Residence		
	$\chi^{2\,a}$	P [b]	V [c]	χ^2	P	V	χ^2	P	V
Shopping anywhere, anytime (7/24/365)	42,385	0.001	0.254	27,328	0.073	0.118	190,961	0.001	0.311
Time saving—no need to travel to the point of sale	76,783	0.001	0.342	54,497	0.001	0.166	240,162	0.001	0.349
Ecological and financial savings	21,437	0.001	0.180	66,052	0.001	0.183	251,911	0.001	0.357
The breadth of choice	63,990	0.001	0.312	64,789	0.001	0.222	190,003	0.001	0.380
Possibility to compare offers	52,032	0.001	0.281	59,857	0.001	0.174	230,002	0.001	0.341
Ability to verify information about the offer in the Internet community	15,628	0.001	0.154	69,228	0.001	0.187	313,714	0.001	0.399
Purchase rationalization	69,975	0.001	0.326	36,404	0.006	0.136	144,832	0.001	0.271

[a] χ^2—test value at $\alpha = 0.05$. [b] P—asymptotic significance [c]—relationship strength calculated using V-Cramer.

6.2. Smart Logistics—An Innovative Technological Solution in Customer Service at the Last-Mile Stage

The respondents participating in the survey admit that for most of them, shopping is definitely a pleasure (71.4%). This condition is influenced not only by the functionalities offered by the Internet, but also by the delivery logistics services. The finalization of the transaction is associated with the choice of the company offering the delivery, the form of delivery, as well as the place and time of delivery. Depending on the sales unit, customers can choose the company that provides the delivery service and the form of delivery. In the area of the selection of logistics service providers, respondents indicated that they had the opportunity to use the services of courier companies and deliveries from the out-of-home/out-of-work (OOH) category, which combines pickup at points cooperating with courier companies and from machines.

The vast majority of respondents admitted that they used the services of courier companies, which provide the possibility to send/collect parcels from or to home/work (97.0%). Seven out of ten respondents (71.7%) used delivery logistics services, such as deliveries to the indicated pickup/drop-off point (such as a kiosk/shop/gas station/CEP company branch). In addition to direct contact forms with employees of companies offering delivery logistics services, buyers are more and more willing to use technological solutions. Although fewer respondents admitted that they used machines for sending and receiving parcels in the past, the percentage is still impressive. According to the declarations of the respondents in the past and during the COVID-19 pandemic, 7 out of 10 respondents (68.7%) used it in the past when sending a parcel and 8 out of 10 respondents (79.3%) used it when they picked up a parcel. The option of sending parcels between parcel machines was used by slightly more than half of the respondents (55.0%).

During the COVID-19 pandemic, parcel machines as a form of last-mile logistics service were eagerly chosen by respondents mainly due to factors such as time, flexibility, efficiency, competitiveness, and safety. The respondents, who were asked to assign points from −3 to +3, could indicate both the decisive factor in choosing a parcel locker and the significance of a given factor. Furthermore, most of the positive scores (Figure 3) were obtained by factors such as: flexibility in choosing the place of delivery (98.2%), time-saving ability (94.8%), efficiency of delivery and collection (94.8%), competitive prices of services (91.5%), and security of supply (85.7%). The time-of-service completion (81.8%), anonymity of using the delivery service (77.5%), and communication skills (64.1%) were of

less importance for the respondents. Furthermore, the company's brand (56.8%) and the manner and speed of the complaint (56.5%) were of negligible importance.

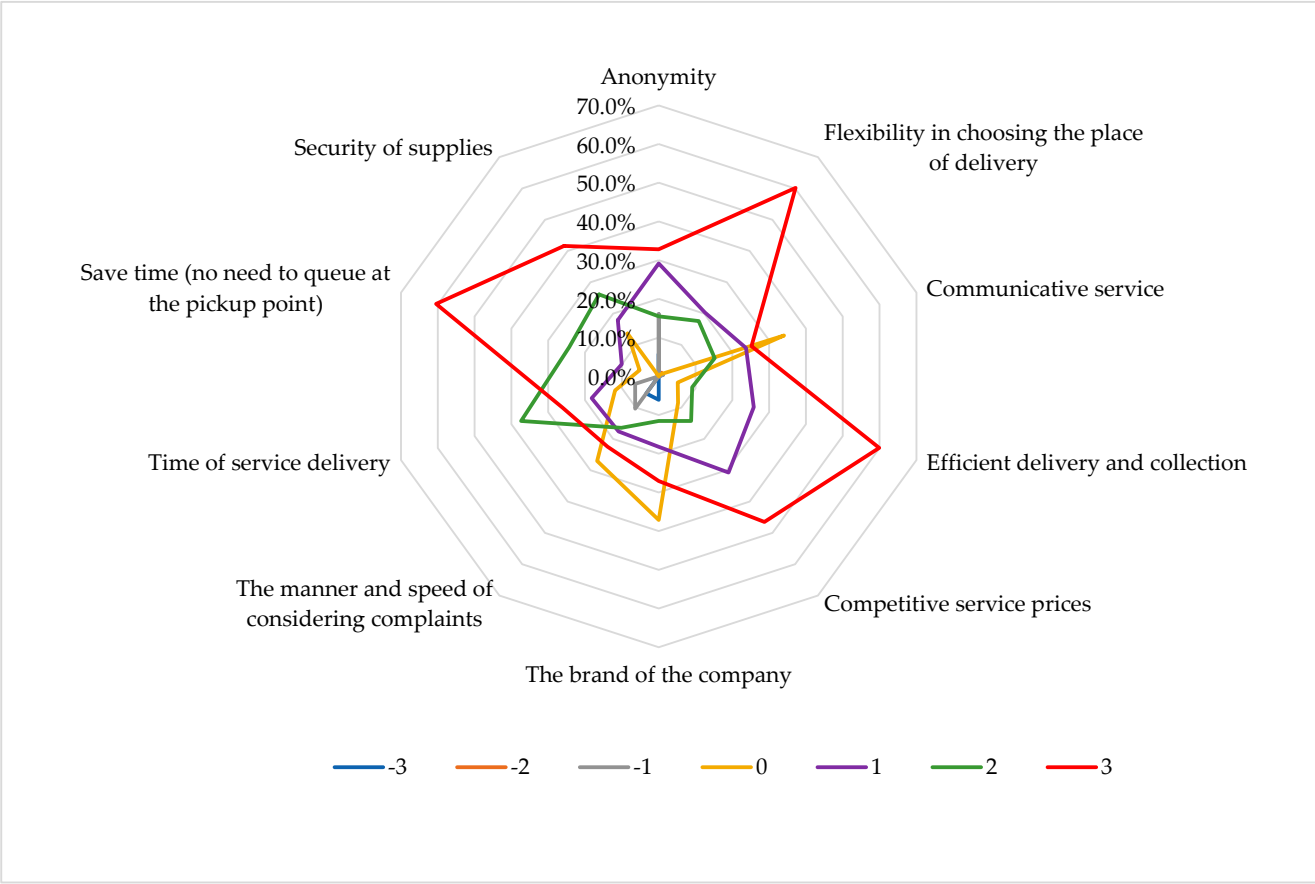

Figure 3. Assessment of the attractiveness of the parcel machines used by the respondents during the COVID-19 pandemic.

Technological solutions for sending parcels are more often used by men (84.4%) than women (54.9%), people aged 45–54 (83.0%), and city residents in cities with 50,000–999,000 people (93.3%). In turn, the collection of parcels from parcel machines is more often preferred by men (93.5%) than women (66.9%), people aged 45–54 (96.2%), and city residents in cities with 100,000–199,000 people (96.8%). On the other hand, sending parcels between parcel machines is more often chosen by men (61.7%) than women (49.1%), people aged 35–44 (59.1%), and city residents in cities with 100,000–199,000 people (74.6%).

The existence of the indicated relationships is confirmed by the χ^2 independence test with the strength of the relationship determined by V-Cramer (Table 4).

It is also worth adding that apart from the parcel machines, which have been in operation for several years and have been studied and tested for several years, there are more and more innovative solutions for the technological support of last-mile logistics. These include refrigerated parcel lockers, deliveries and dispatches by drones, and deliveries using autonomous vehicles. However, the results obtained from the study indicate that few respondents, when sending or receiving parcels, used solutions such as refrigerated parcel lockers (8.2%), drones (4.9%), and/or autonomous vehicles (8.2%). From this, it should be concluded that these solutions are at the stage of introduction and experimenting in applications by customers.

Table 4. Using innovative technological solutions, such as parcel lockers in delivery services at the last-mile stage, in terms of gender, age, and place of residence as represented by the results of a χ^2 independence test with the strength of the relationship determined by V-Cramer.

Variants	Gender			Age			Place of Residence		
	$\chi^{2\,a}$	P [b]	V [c]	χ^2	P	V	χ^2	P	V
Drop off–parcel machine	66,191	0.001	0.318	21,908	0.001	0.182	114,570	0.001	0.417
Pick up–parcel machine	69,343	0.001	0.328	67,078	0.001	0.319	95,406	0.001	0.381
Shipment between parcel machines	9918	0,002	0.126	8070	0.233	0.111	13,614	0.018	0.144

[a] χ^2—test value at $\alpha = 0.05$. [b] P—asymptotic significance [c]—relationship strength calculated using V-Cramer.

6.3. The Applicability of Technological Solutions Identified with the Concept of Sustainable Development by Service Operators

An important issue in the selection of physical products and services, including last-mile logistics services in the process of deliveries carried out as the finalization of e-commerce transactions, is the application of the principles of sustainable development by enterprises, which is consistent with the idea of Society 5.0 and Economy 5.0. Most of the survey participants declare (Figure 4) that they know the term "sustainable development" and understand the meaning of this phrase (46.2%) or are at least familiar with the term "sustainable development" and understand the need to follow its indications (39.8%).

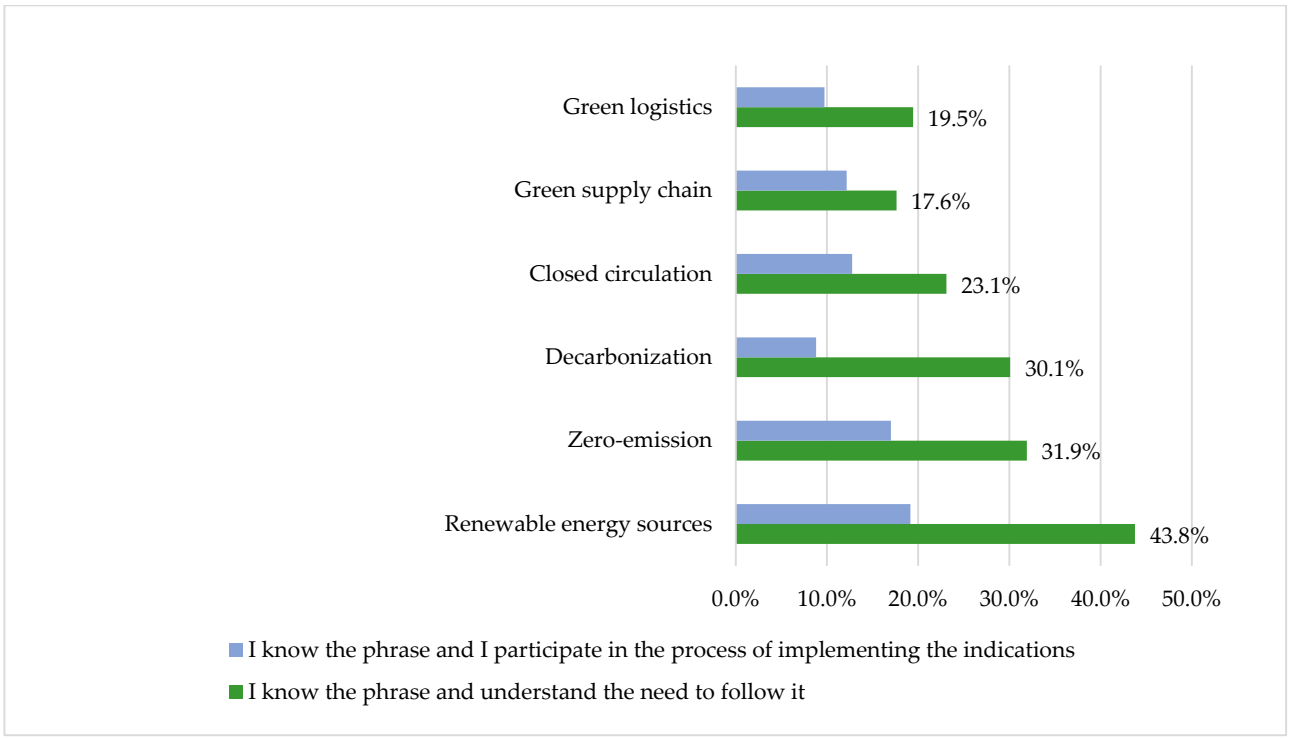

Figure 4. Traceability of the meaning of the term "sustainable development".

Sustainable development is most often identified by respondents as renewable energy sources, where respondents declare that they know the term and understand the need to use it (43.8%), followed by interpretations such as zero-emission (31.9%), decarbonisation (30.1%), closed circulation (23.1%), green logistics (19.5%), and green supply chain (17.6%). The existence of the indicated relationships between the term and its interpretation by the respondents is confirmed by the χ2 independence test with the strength of the relationship determined by V-Cramer (Table 5).

Table 5. Representation of the concept of sustainable development in relation to forms of environmental activities as represented by the results of a χ^2 independence test.

Variants	Sustainable Development		
	$\chi^{2\,a}$	P [b]	V [c]
Green supply chain	422,356	0.001	0.463
Closed circulation	515,648	0.001	0.511
Decarbonisation	593,912	0.001	0.549
Zero-emission	426,262	0.001	0.465
Renewable energy sources	1,002,894	0.001	0.713
Green logistics	230,295	0.001	0.342

[a] χ^2—test value at $\alpha = 0.05$ [b] P—asymptotic significance [c]—Relationship strength calculated using V-Cramer.

According to the respondents, companies offering logistics delivery services in the last-mile area operate in a variety of ways in accordance with the principles of sustainable development.

According to the respondents, the most active enterprises (Figure 5) in terms of meeting the principles of functioning in accordance with the concept of sustainable development are logistics service providers such as InPost (58.7%), DHL (48.0%), DPD (40.7%), and Allegro (40.1%). Another group of equally numerous companies that, according to the respondents, apply the principles of sustainable development are companies such as FedEx (36.5%), Żabka (30.1%), Amazon (26.1%), and AliExpress (25.8%). The least identifiable enterprises servicing the last mile using the principles of sustainable development are enterprises such as: BliskaPaczka.pl (5.2%), Pekaes (7.3%), Geis (7.6%), and Kioski Ruchu (10.6%).

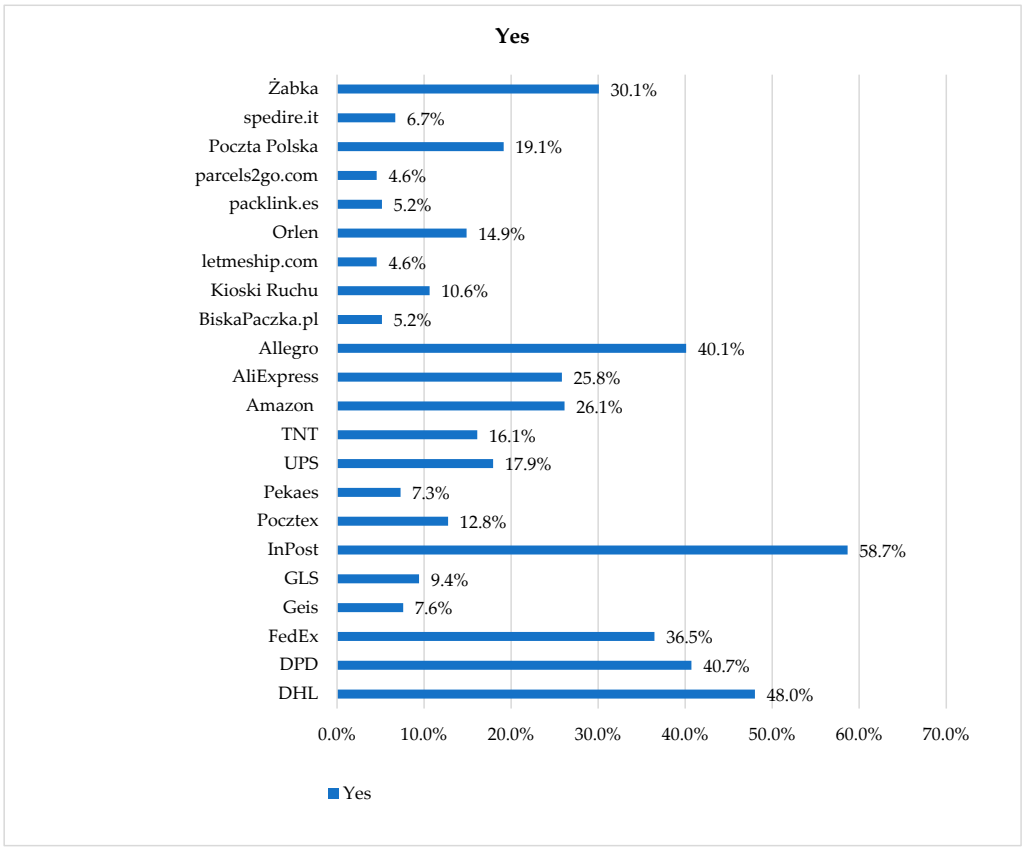

Figure 5. Compliance with the principles of sustainable development by companies offering services of logistics delivery.

The survey of respondents' awareness of specific solutions used by operators of logistics services for deliveries (Table 6) shows the following conclusion: for each of the companies, regardless of the operator, the respondents most often indicated—among the variants of solutions in the area of sustainable development—digitization in communication and documentation, which limits wasting paper as part of the functioning of every enterprise.

Table 6. Identification of solutions used by operators of last-mile logistics services.

	Uses Renewable Energy Sources-Energy Self-Sufficiency	Owns Green Warehouses, Ecological Buildings, and Infrastructure	Conducts Activities for the Benefit of a Closed Circuit-Effectively Manages Waste	Uses Ecological, Reusable Packaging	Reduces CO_2 Emissions—Adjusts the Transport Fleet to the Zero-Emission Guidelines	Reduces Exhaust Emissions through Eco- Driving	Uses Digitization in Communication and Documentation—Reduces Waste of Paper
DHL	18.8%	23.4%	4.9%	18.5%	17.3%	12.8%	53.2%
DPD	16.7%	5.8%	13.7%	20.1%	13.4%	25.8%	42.9%
FedEx	16.4%	12.2%	14.3%	23.1%	18.8%	7.9%	43.8%
Geis	12.5%	7.3%	20.4%	27.7%	11.9%	5.5%	37.4%
GLS	13.1%	12.2%	17.9%	11.6%	28.0%	4.0%	48.0%
InPost	15.5%	25.5%	18.2%	13.1%	23.4%	17.0%	53.2%
Pocztex	11.9%	16.4%	15.5%	19.1%	11.6%	9.7%	41.3%
Pekaes	19.8%	12.2%	18.5%	13.7%	17.0%	3.6%	48.6%
UPS	17.6%	22.8%	11.9%	23.1%	10.3%	9.7%	40.1%
TNT	15.2%	13.4%	14.9%	10.6%	21.3%	7.3%	41.0%
Amazon	18.5%	15.2%	13.4%	21.3%	22.5%	9.1%	39.5%
AliExpress	16.1%	16.7%	17.0%	13.4%	22.2%	10.6%	38.9%
Allegro	13.7%	18.8%	14.3%	20.7%	23.4%	3.6%	38.3%
BiskaPaczka.pl	16.1%	14.9%	17.0%	11.6%	28.0%	13.4%	35.9%
Kioski Ruchu	12.5%	20.4%	18.5%	11.9%	24.3%	7.6%	38.9%
letmeship.com	11.9%	10.9%	21.9%	12.2%	23.1%	16.4%	34.7%
Orlen	12.5%	14.6%	22.5%	13.1%	21.6%	11.6%	35.3%
packlink.es	11.9%	16.7%	21.3%	15.2%	21.9%	12.2%	34.7%
parcels2go.com	15.8%	14.0%	11.2%	21.0%	21.3%	12.2%	35.3%
Poczta Polska	15.2%	14.6%	16.4%	20.4%	17.0%	11.9%	38.3%
spedire.it	12.5%	10.9%	13.1%	13.1%	23.4%	14.9%	34.7%
Żabka	11.9%	14.6%	13.7%	16.1%	21.6%	9.4%	39.5%

In the second place, a solution that was quite often mentioned was the reduction of CO_2 emissions, which allows the adjustment of the transport fleet to zero-emission guidelines, as well as the use of ecological and reusable packaging. A minority of responses included solutions such as the possession of green warehouses, i.e., ecological buildings and infrastructure; the use of renewable energy sources that allow for energy self-sufficiency; and activities for the benefit of a closed loop. On the other hand, the fewest indications from the respondents were in the case of solutions in the field of reducing exhaust emissions through the use of eco-driving.

When analyzing the issue of sustainable development solutions in terms of identifying a given solution with specific companies operating in Poland, the respondents most often attributed the use of new technologies to companies such as: Pekaes (19.8%), DHL (18.8%), and Amazon (18.5%). On the other hand, having green warehouses, i.e., green buildings and infrastructure, was identified by the respondents with companies such as InPost (25.5%), DHL (23.4%), and UPS (22.8%). Conducting activities for the benefit of a closed loop, i.e., effective waste management, was attributed by the respondents to Orlen (22.5%). On the other hand, the use of reusable ecological packaging was associated by the respondents with companies such as Geis (27.7%), FedEx (23.1%), and UPS (23.1%).

The reduction of CO_2 emissions, which allows the adjustment of the transport fleet to zero-emission guidelines, was indicated for the majority of companies. The respondents indicated such companies as GLS (28.0%), BliskaPaczka.pl (28.0%), Kioski Ruchu (24.3%), Inpost (23.4%), Allegro (23.4%), Amazon (22.5%), AliExpress (22.5%), Orlen (21.6%), and Żabka (21.6%). Reducing exhaust emissions through eco-driving was mainly identified with DPD (25.8%), Inpost (17.0%), and DHL (12.8%).

6.4. "Customer Experience" Acquired in the Era of a Pandemic as an Indication for Recalibration of Last-Mile Logistics in the Field of Greening the Technology of Delivery Services

The experience gained in choosing the Internet as a place for purchases and the preferences for the use of new technologies in the provision of last-mile logistics services during a pandemic have been strengthened. Customers more eagerly used modern forms, such as parcel machines, to send and receive parcels. Functional advantages of these solutions, such as flexibility, economy, and efficiency, became the reason why customers eagerly used technological solutions and set requirements at the same time—especially those in the area of sustainable development. Customers are becoming more and more aware that technological development cannot be at the expense of the environment. Therefore, the operators of logistics services should not only increase financial outlays for technologization but should always take into account the environmental aspect by carrying out the process of green recalibration.

Recalibrating, as defined by engineering, is to rebuild a machine to "improve or accommodate a new use and bring it to a desired state." Given this, in accordance with the guidelines of the sustainable development concept, last-mile logistics service operators should invest in infrastructure solutions in the field of green technologies, rebuild processes, and strive for self-sufficiency and the creation of circular solutions.

According to the respondents, in the near future (Figure 6), in line with the concept of sustainable development, operators of last-mile logistics services will use solutions such as full digitization of communication and customer service processes (73.9%) and the widespread use of ecological, reusable packaging (71.4%).

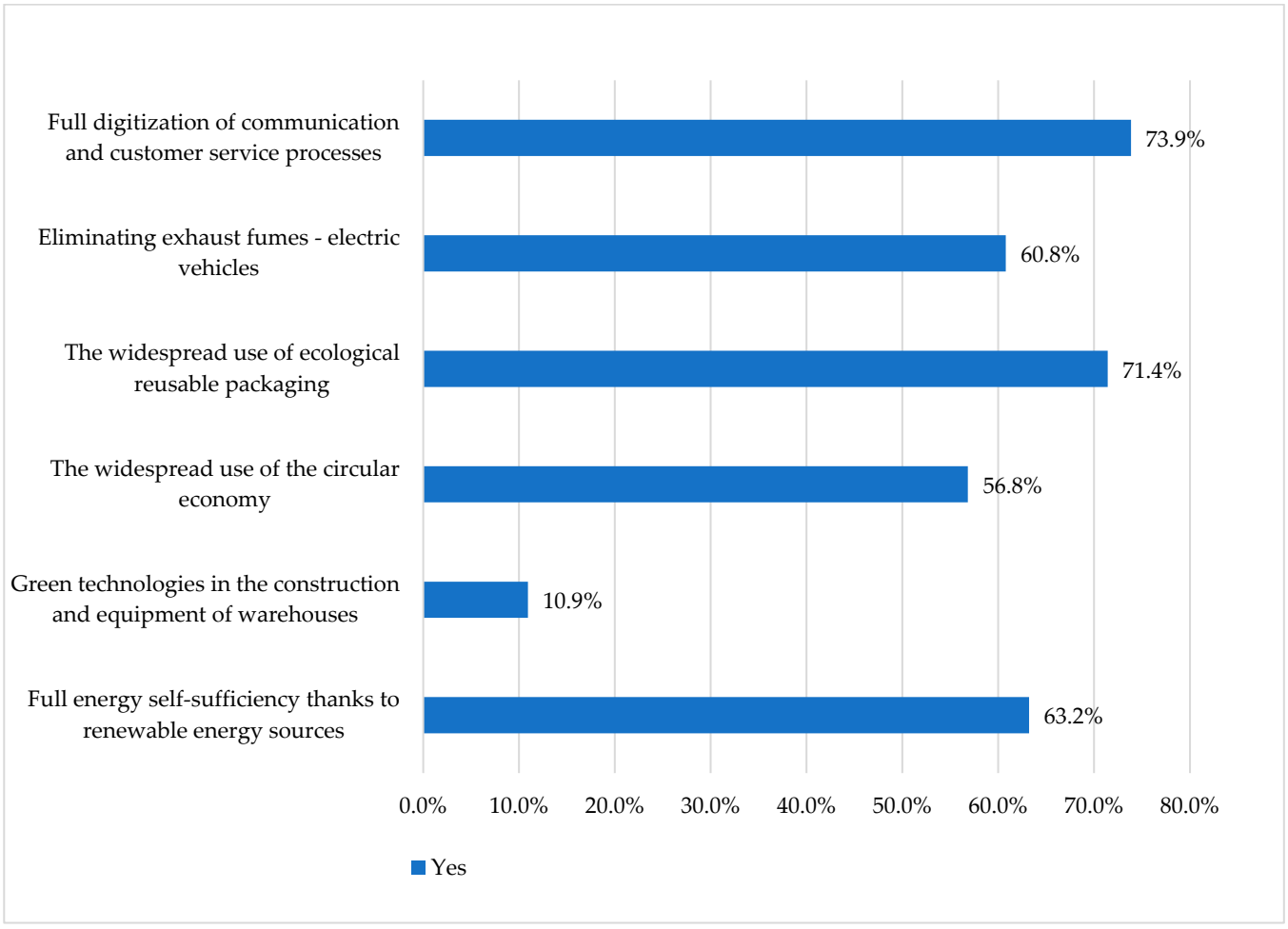

Figure 6. Technological solutions consistent with the concept of sustainable development that will be used by companies offering logistics services in the nearest future.

Full energy self-sufficiency thanks to renewable energy sources (63.2%), the elimination of exhaust fumes thanks to electric vehicles (60.8%), and the popularization of the circular economy (56.8%) will also become quite popular. A small group of respondents indicated green technologies in the construction and equipment of warehouses as those that will be developed in the near future (10.9%).

The respondents were asked to indicate those solutions which, in their opinion, will be the most common in logistic customer service at the last-mile stage in the nearest future—or in ten years.

The most numerous group of respondents indicated reusable packaging in the logistics circuit (78.4%), voice operation of parcel machines (76.0%), drone deliveries (61.4%), and communication bots in customer service (60.5%). Transport electric units (59.0%), extended service deliveries (official documents, equipment repairs) (52.6%), autonomous vehicles as courier units (50.8%), refrigerated parcel lockers (49.8%), and deliveries to cars (48,0%) will also be quite common. The respondents admit that laundry parcel lockers (44.7%), car vending machines, i.e., mobile parcel trucks (43.5%), and autonomous water units (40.1%) may also be common solutions. The indications provided by the respondents should become signposts for company managers to carry out specific solutions that enable the recalibration of enterprises in the trend of greening logistics, ensuring technological development with respect for the natural environment.

7. Summary and Conclusions

The concept of sustainable development is not new, but rather fits into the current business landscape. Currently, many companies in Poland include sustainable development in their business cycle—not on a "nice-to-have" basis, but as a "must-have"—in planning and implementing activities. Furthermore, while Industry 4.0 puts technology at the center of attention, the concept of Industry 5.0 concerns the return of the human dimension (human touch), which is also present in companies operating in the CEP industry. Technological indispensability will accompany economies and businesses, societies, and citizens. It is impossible to escape from what has happened. Certainly, the biggest challenges for the CEP industry in the near future will be digitization, faster and more efficient delivery, and the growing importance of ecological aspects. Considering this, this heralds the further development of the courier services market. As a representation of last-mile logistics, couriers are qualified as a source of potential advantages in the fight for a share in the e-commerce market. It is the final stage of distribution and the point of contact between the customer and the seller that can be a decisive battleground in the fight for customer minds and wallets.

As the research shows, customers choose solutions that are useful, effective, and environmentally friendly. These indications are almost treated as necessary conditions for the implementation of technological solutions, and how they are determined is shown by the acceptance and propagation of the use of parcel machines. Their efficient functioning has a positive impact on the individual functioning of each client, satisfying their needs in terms of flexibility, savings, and efficiency. Moreover, it has had a positive impact on the environment by reducing CO_2 emissions in the field of transport, as well as improving the work of the couriers themselves. The last mile is also optimized by reducing the number of returns or re-trips as a result of the recipient's absence. Vending machines for collecting courier parcels are not only a safe and convenient method, but, above all, it is an ecological way of collecting online purchases. Non-contact devices that are intuitive to configure, do not require connection to electricity, and are operated via a dedicated application, are the future of the entire market—while being in line with green trends—and the respondents appreciate them for that.

Due to the above, it can be stated that the aim of the article was achieved. It can be also said that the thesis set at the beginning of the article was proven to be true. Customers are willing to use parcel lockers and other innovations as it is comfortable to them, and they can also see the environmental impact of those solutions. Deliveries to collection

points, especially parcel machines, should become one of the prevailing last-mile delivery solutions. In order for companies to take full advantage of this type of solution, investments in collection points are necessary. However, in line with the Society 5.0 concept, perhaps it is worth considering the sharing economy idea so that parcel machines are shared by courier companies. This would reduce the environmental impact even further. Moreover, this would require the emergence of a new operator on the market, but the idea could be combined with existing pickup points serving various courier companies.

The research results show that the systems of enterprises should change in terms of customer service policies. Courier companies have to follow both sides of the market. On the one hand, they need to satisfy B2B (*business-to-business*) relations; they have to research the requirements of other companies (like online sellers, manufacturing companies, etc.) who are their clients. However, the research described concerns individual customers and their requirements. What can be said from the research is that policies should concern flexibility in action, efficiency in deliveries, and competitiveness in prices of services. For courier companies, this means building a wide network of sorting plants, parcel collection points—including parcel machines—and increasing the number of couriers. What is more, all of those actions should be taken in terms of sustainable development so there is less harm to the natural environment. As customers equate sustainability primarily with renewable energy, zero emissions, and decarbonisation, these are the issues that need to be addressed. This means that parcel machines should be equipped with photovoltaic panels and energy storage, and courier cars should be electric- or hydrogen-powered. Of course, OOH deliveries are treated as ecological, which is already a good direction chosen by companies. In addition, this also reduces the costs of handling deliveries for courier companies, as they do not require deliveries to individual recipients but only to collection points (fewer kilometers traveled, lower fuel consumption, shorter delivery service time). It can therefore be concluded that if such solutions are implemented, we will be looking at a win–win scenario.

According to the authors, the innovations, if they proved successful at least once, should be permanently implemented to drive socio-economic growth that will be permanent, repeatable, and significant. Therefore, automation and autonomization in the area of customer service at the last-mile stage should take into account such intelligent solutions that will meet the requirement of digitization and technologization, and on the other hand, will not harm the environment. After all, what is important is not so much the "primum non nocere" of creation, but the transition to a higher level of development in accordance with "go smart to the future".

The propagation of absolute thinking technologies that enter many areas of human existence sets billions of devices in motion and creates petabytes of data. The "log in" and "log out" of the digital "multi-generation" customer expecting a personalized experience becomes a marker of this process. The formulated dictum of "glocalization" (anywhere, anytime, anyhow, on any device), reinforced with the requirement of social responsibility, results in the implementation of sustainable and intelligent solutions. A circular economy with the prevalence of ecological reusable packaging, elimination of exhaust gases, energy self-sufficiency, green technologies in construction, and infrastructure supported by communication digitization makes green functional and process recalibration of CEP industry companies possible.

The literature on the subject points to the Industry 4.0 paradigm as the source of the development of the Society 5.0 trend [84–87]. According to Keidanren and Nakanishi, the concept of Society 5.0 sets new trends in the way of solving problems related to the idea of a sustainable society [88,89]. According to the authors, such a smart approach, based on innovation and technological progress with respect for the environment, will be a catalyst for further changes in logistics. In the future, the criteria for smart-eco-techno (*SET*) solutions will be absolute order-qualifiers when selecting companies from the CEP industry as providers of last-mile logistics services.

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