



INNOVATIONS IN LAST MILE LOGISTICS - ANALYSIS OF CUSTOMER SATISFACTION WITH THE SERVICE OF DELIVERY LOGISTICS OPERATORS USING PARCEL MACHINES

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ABSTRACT. Background: The last decade of socio-economic and technological changes has brought a number of transformations in many areas. Digitization results in the transformation of an organization's business activities. Enterprises and customers have appreciated the digital world, but online transactions are not everything. It is also important to complete the transaction, which requires physical support. The CEP industry, especially its innovative solutions in the form of parcel machines, greatly assists with the demand. The aim of the article is to indicate the gradation of the significance of the components of satisfaction with the service of logistics of deliveries at the last mile stage using innovative solutions such as parcel machines on the perception and competitive position of enterprises from the CEP industry.

Methods: The information base consists of secondary and primary sources. The article uses mixed methods in the application of a parallel triangulation strategy: qualitative analysis of the existing publications, participant observation, and a nomothetic study based on the CAWI Internet survey using the Servqual methodology to assess the quality of logistics customer service.

Results: The collected material became the basis for identifying the possibilities of using the potential of customer experience for the development of enterprises, based on the structure of the signpost of the gradation of satisfaction components in the technologization of last mile deliveries in the future. The suggestions proposed by the authors can be used by scientists and managers of enterprises in the CEP industry to redefine business models based on the technology of the logistic customer service process, which should serve to increase the level of customer satisfaction.

Conclusions: The analysis of the material leads to the conclusion that the technology of customer service at the last mile stage may be insufficient in and of itself. Positive adoption, signified by the customer's satisfaction with the value obtained, is still required, i.e., "good service delivery". Such a holistic approach to technological innovation can be the key asset in the fight for customers on the CEP market.

Keywords: last mile, logistics services, technologies, innovations

INTRODUCTION

Our reality is computerized, and it seems that nothing can oppose this trend. The functioning of enterprises in these realities requires the use of modern solutions that will allow enterprises to meet the requirements of customers, but also to achieve the intended goals in relation to the activities of the competition. Moving operations to virtual space allows access to more audiences [Çipi et al. 2023; Mosescu et al. 2022], but also affects the effectiveness of the activities carried out. [Marei et al. 2023; Roman

and Rusu 2022; Markic et al. 2022] In the last decade, special attention has been paid to the new opportunities that resulted from the use of the achievements of Industry 4.0. [Manavalan and Kandasamy 2022] Solutions such as blockchain [Ugochukwu et al. 2022], digital-twin [Zhang et al. 2022], augmented reality [Kettle and Lee 2022], and the Internet-of-Things [Paolone et al. 2022] have become a permanent part of the landscape of entrepreneurship in various industries and areas. They are also used in logistics, which, due to its specific service activity, must meet the requirements of various recipients - from individual consumers, through

small and medium-sized enterprises, to global corporations. The flexibility of logistics activities has been achieved through the implementation of IT systems that currently use the solutions of the fourth industrial revolution, and for which a separate formulation has even appeared - Logistics 4.0. [Khan et al. 2022; Nour 2022]

Logistics activities have changed under the influence of the development of technology, and has also strongly influenced the availability of new technological solutions, using the synergy effect. Currently, it is difficult to imagine that logistics operations would be performed without the use of technology, especially in the global dimension. The experience of recent years (pandemic, war in Ukraine, raw materials crisis) shows that the participation of technology has become necessary to be able to meet the requirements of speed of action, security of people and goods, and resistance to various crises. The flexibility of the challenges taken is no longer extraordinary, because it is necessary to manage operations sustainably, as well as to build a logistics system resilient [Postigo Marcos et al. 2022; Al-Banna et al. 2022] to all the adversities that the world is currently facing in economic, social, or political terms.

A special area of logistics activities are CEP services (courier - express - postal services), which are designed to respond to the needs of business customers (often senders of parcels), as well as recipients (including individual consumers). The organization of such services poses many problems and limitations, and at the same time, one should remember the efficiency of one's own business activity and the costs of the company's operation. That is why the most flexible solutions are increasingly sought, which will reduce the cost of travel, handle the largest possible number of shipments and customers, lower emissions, and shorten customer service time. Hence, OOH (out-of-home) delivery solutions to collection points are becoming more and more popular. They can be divided into two groups: PUDO (pick-up and drop-off) deliveries to various collection points and APM (automated parcel machines) deliveries.

An important element of this system are the requirements and expectations of customers for whom the use of CEP industry services is of key importance in many aspects. The CEP industry, as service providers, must take into account the need to find solutions that will satisfy customers. This is a prerequisite for acquiring and retaining customers. [Sułkowski et al. 2022; Olsson et al. 2023] Interestingly, the research also indicates the need for greater emphasis on the socialization of CEP industry services, as well as in the context of technology and sustainable development. [Lauenstein and Schank 2022; Coffee and Pierański 2021]

Building a logistic customer service system for the CEP industry requires understanding the needs of both business customers and an individual approach to consumers. Of particular importance for the development of the CEP industry was the e-commerce market and customers' delight in online shopping. This challenge has completely changed the approach to creating courier services and customer service. [Hassel and Sieker 2022]

Unfortunately, the customization of services for consumers is associated with increased costs, but it also causes companies from the CEP industry to try to find innovative solutions that will meet the needs of fast order fulfillment, full availability of information, and flexibility when collecting parcels. [Schnieder et al. 2021] More and more often, a sustainable last mile service becomes a challenge, which in the perspective of customer expectations, takes on a completely new meaning. [Otter et al. 2017]

The aim of the article is to indicate the gradation of the significance of the components of satisfaction with the service of logistics of deliveries at the last mile stage using innovative solutions such as parcel machines on the perception and competitive position of enterprises from the CEP industry. The article uses mixed methods in the application of a parallel triangulation strategy: qualitative analysis of the existing publications, participant observation, and a nomothetic study based on the CAWI online survey using the Servqual methodology to assess the quality of logistics customer service.

The collected material was used to create a road map in order to build a logistic customer service system based on solutions using parcel machines. The example of Poland may indicate interesting opportunities for the development of this form of supply, and at the same time constitute a good practice for others.

Technology in logistic customer service in the light of research results

The SARS-CoV-2 pandemic has strengthened the transformation towards digitization with representation, among others, in the form of digitization of documentation circulation and mechanization of customer service processes at the last mile stage, carried out by CEP industry enterprises. The review of the literature and the reported results became the basis for the researchers to design and carry out research at the turn of 2021 and 2022.

The subject of the measurement was the assessment of the use of technological innovations in the implementation of logistics customer service processes at the last mile stage for customer choices as to delivery providers. It was also to specify the necessity of matching enterprises in the CEP industry during the SARS-CoV-2 pandemic. Obtaining the research material was possible thanks to the use of the diagnostic survey method with the "user-centric" CAWI (Computer Assisted Web Interview) Internet survey technique. The research tool was placed on the research platform <https://ebadania.pl>. The questionnaire consisted of 43 basic questions, including 14 questions based on the construction of the Rensis Likert scale and questions on the metrics.

The surveyed population consisted of e-commerce customers from Poland aged 16 and over who made purchases on the Internet in the 3 months preceding the survey. Explanatory research of a descriptive and explanatory nature, classified as fragmentary and deterministic, was carried out on a selected sample with a minimum size determined on the basis of a formula taking into account the distribution of fractions:

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

where:

n_{\min} - is the minimum sample size

NP – the size of the study population

α - confidence level for the results

f – fraction size

e - assumed maximum error

The basis for the calculation of the sample was the study population (NP) of Polish residents who were aged 16 and over on the 31st of December 2020 (according to the Central Statistical Office, this number was 31,811,795 people). Determining the fraction in the value of 0.814 for online buyers and 0.186 for other people was possible thanks to earlier research. [Raport 2020] Moreover, a confidence level of 0.95 and a random error of 5% were assumed. Such assumptions made it possible to perform calculations and specify the minimum sample size at the level of n_{\min} 233 which, as a result of the physical collection of units using the non-random selection of typical units with the snowball technique, was exceeded, resulting in 658 completed questionnaires. The material obtained in this way was anonymized and encoded in the SPSS program (Statistical Package for Social Sciences), as well as verified and validated.

The surveyed sample was dominated by women (53.2% of the respondents) in relation to men (46.8% of the respondents). In terms of age, the smallest group consisted of people aged 16 - 24 (12.3%), and the largest group of respondents were aged 55 and over (36.0%). The dominant group was inhabitants of cities (59.9%) in relation to inhabitants of rural areas (40.1%). The analysis of the representativeness of the sample in relation to the selected characteristics was carried out on the basis of a non-parametric significance test based on the χ^2 statistics in the form:

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

where:

p_i - the probability that the feature X will take a value belonging to the class “i”

np_i - the number of units in the i-th range

The null hypothesis (H0) adopted was that the distributions of selected variables from the sample were consistent with the distributions characterizing the population of Polish residents aged 16 and over, and the alternative hypothesis (H1) was that there was no such consistency.

Table 1. The results of calculations on the compatibility of distributions from the sample to the population - the value of the non-parametric test χ^2 .

Parameter	Sample size n	N population size	The real value of χ^2	Theoretical value of χ^2	Test result $\chi^2 < \chi^2_\alpha$
Gender					
Female	350	16722685	0,103	3,841	Concordance
Male	308	15089110			
Age					
16 - 24	81	3395513	2,204	12,592	concordance
25 - 34	107	5222883			
35 - 44	127	6300861			
45 - 54	106	4975279			
55 - and above	237	11917259			
Place of accommodation					
Village	264	15359918	4,197	11,07	Concordance
City up to 20,000	70	4983795			
City from 20,000 to 49,000	72	4237100			
City from 50,000 to 99,000	60	3128500			
City from 100,000 to 199,000	63	3324500			
City over 199,000	129	7231300			

^a α – confidence level

Source: own research.

After performing the calculations and verifying the values of the statistics, the hypotheses about the compatibility of the distributions of selected variables from the sample with the distributions of the studied population were confirmed (Table 1). In the next step, analyses of the distribution of answers to the main questions were carried out, and where it was possible, logically meaningful, and statistically significant, the hypotheses about the existence of a relationship between the variables from the main questions and the variables of the metric were verified. After verification, the variables and values were compiled in the form

of contingency tables and based on the χ^2 test of independence, verification of the hypotheses about the non-existence (H0) and existence (H1) of the relationship between the variables was carried out:

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

where:

n_{ij} – empirical conditional numbers resulting from the contingency table,

\tilde{n}_{ij} – theoretical conditional counts that would appear in the array if the features were independent.

At the same time, Cramer's V coefficient was used to verify the hypotheses:

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

where:

V – Cramer coefficient between two variables,

χ^2 is the empirical value of the statistic obtained from the study for the pair of variables.

n – number of observations

r – number of levels of one variable

k – the number of levels of the second variable

$\min(r-1, k-1)$ – the smaller of the two (r-1) or (k-1)

In addition to the assessment of customer service using parcel machines as a representation

of innovative last-mile solutions, a comparison of unweighted and weighted values, based on the arithmetic mean for the expected and perceived quality of services offered by last-mile operators, was used in accordance with the Servqual methodology. [Parasuraman, Zeithaml, Berry 1985]

The survey participants admitted that for most of them online shopping is a pleasure (71.4%). This state of affairs is influenced by many factors, especially services related to the logistics of deliveries. For the respondents, apart from the goods themselves, the method of delivery and the possibility of choosing a company offering delivery services are also important. Among the available options for sending/collecting a parcel that the respondents used during the pandemic, couriers prevailed (97%), while the alternative to delivery logistics services were pick-up/drop-off points such as a kiosk/shop/gas station/CEP branch (71.7%). The respondents admitted that, in addition to these methods, they willingly use technological solutions in the logistics of deliveries, such as parcel machines, both when sending a parcel (68.7%) and when collecting it (79.3%). Slightly more than half of the respondents (55.0%) used the option of sending parcels between parcel machines.

Table 2. Calculation results for the use of parcel machines in relation to gender, age, and place of residence - test of independence χ^2 with the strength of the relationship determined by V-Cramer.

Variants	Gender			Age			Place of accommodation		
	χ^2 ^a	p ^b	V ^c	χ^2	P	V	χ^2	p	V
Shipping in parcel machine	66,191	0,001	0,318	21,908	0,001	0,182	114,570	0,001	0,417
Pickup at parcel machine	69,343	0,001	0,328	67,078	0,001	0,319	95,406	0,001	0,381
Sending between parcel machines	9,918	0,002	0,126	8,070	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

Source: own research.

The use of parcel machines to send parcels is the domain of men (84.4%) more than women (54.9%), people aged 45-54 (83.0%), and residents of cities from 50,000 to 999,000 of people (93.3%). Similarly, men (93.5%) more often than women (66.9%) choose collecting a parcel from a parcel machine, people aged 45-54 (96.2%), and residents of cities with a population

of 100,000 to 1,999,000 of people (96.8%). On the other hand, men (61.7%) slightly more often than women (49.1%) choose the option of sending parcels between machines, people aged 35 - 44 (59.1%), and residents of cities from 100 to 1999 thousand people (74.6%). The existence of the indicated relationships is confirmed by the χ^2 test of independence with the strength of the relationship determined by V-Cramer (Table 2.).

Among the operators of services in the field of logistics outside the home—post office, retail outlets, and parcel machines known and used by the respondents—the most frequently mentioned are InPost (88.4%), Allegro (67.5%), DPD (62.6%), Polish Post (48.0%), and Orlen (27.7%). The parcel machines most often used by the respondents are located in the immediate vicinity, i.e., less than 500 meters from the place of residence/work (39.5%) or nearby, i.e., from 0.5 to 1 km (26.4%). Slightly more than one in ten respondents admitted that the distance to the parcel machine was over 5 km (16.4%). The vast majority of respondents go to the parcel machine on foot (62.3%). The alternative is going by car (42.9%). Most of the respondents declare that they can get to the parcel machine in less than 10 minutes (71.4%) or from 11 to 20 minutes (24.3%). In the period of 3 months preceding the survey, the most frequently chosen operator of delivery services using parcel machines was InPost (77.5%).

The respondents were asked to give a detailed assessment of the service of deliveries carried out using parcel machines by last-mile service operators. The questionnaire contained 30 statements appropriately assigned to five areas in accordance with the Servqual customer service quality survey method. The theorems are divided into two blocks. The first block referred to the expectations of the respondents regarding

delivery services provided with the use of parcel machines. The second block referred to the observations of the respondents on the basis of the experience gained as a result of interacting with the service provider.

When choosing a delivery service using parcel machines, the respondents have specific expectations regarding the material dimension of the service, reliability, operator's response to customer expectations, professionalism and responsibility, and empathy, which are subject to verification. Due to the fact that InPost was the most frequently indicated parcel service operator used by the respondents in the 3 months preceding the survey, a detailed analysis was carried out for this company, which resulted in the determination of the unweighted and weighted Servqual index.

When considering individual areas of the quality of delivery services using parcel machines, it turned out that the unweighted Servqual index was (-0.39), which means an unfavorable assessment for InPost. The largest gap between expectations and perceptions resulting from the respondents' experiences is in the area of empathy (-0.53), followed by the material dimension (-0.39) and response to customer expectations (-0.38). The smallest gap level occurs for reliability (-0.33) and for professionalism and responsibility (-0.32).

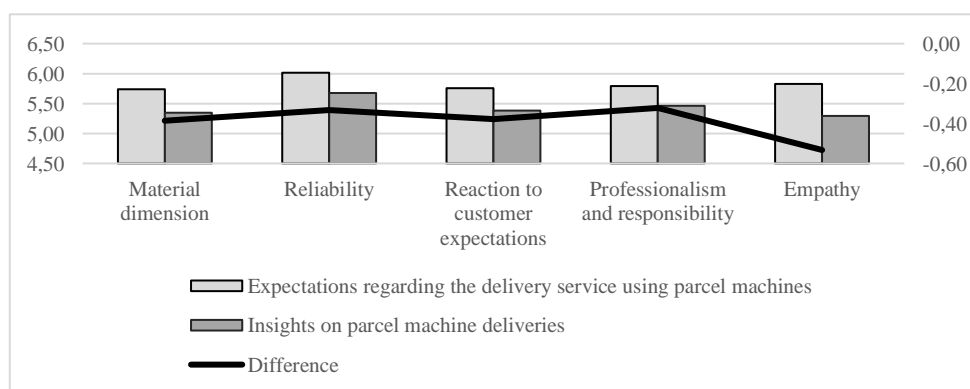


Fig. 1. The results of unweighted areas of the quality of delivery service using parcel machines using the Servqual method - for InPost (n=510). Source: own research.

However, taking into account the component of importance for the respondents of a particular area of the assessment of the quality of the delivery service using parcel machines provided by the InPost company, it turns out that

the weighted Servqual index increased (-0.21). The favorable approach to zero, i.e., the state when the expected values are fully covered by the observations, was influenced by the lower importance of areas such as empathy, professionalism, and responsibility, as well as

reliability in the service offered to the respondents. After adjusting for importance, although the level of vulnerabilities decreased, they are still recorded. The largest gaps were recorded for the material dimension (-0.35) and

the response to customer expectations (-0.30). The next gap areas are empathy (-0.15) and reliability (-0.14). The lowest level of the gap when taking into account weighting was shown for professionalism and responsibility (-0.10).

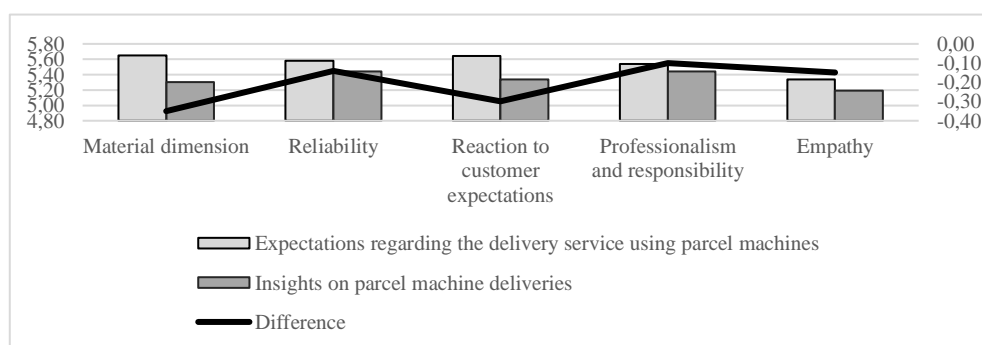


Fig. 2. The results of weighted areas of the quality of delivery service using parcel machines using the Servqual method - for InPost (n=510). Source: own work.

In detail, the InPost company within the material dimension area should work on minimizing gaps by providing lockers for bulky parcels (-0.74), increasing the number of parcel machines so that you do not have to wait for lockers to be released (-0.58), providing lockers for products that require low temperatures (-0.58), and variation in the size/capacity of lockers (-0.46). On the other hand, in the area of reliability, according to the respondents, detailed attention should be paid to the application for sending and receiving parcels, which should be failure-free (-0.66). In the next area of response to customer expectations, according to the

respondents, the gap related to the lack of immediate assistance from the service department, which should be bridged if the customer has problems with the machine (-0.79). In terms of professionalism and responsibility, the respondents indicated gaps related to voice control for the visually impaired (-0.88) and power supply from ecological sources (-0.52), which, in their opinion, should be removed. In turn, in terms of empathy, the respondents point to a dichotomy in terms of the culture of customer service employees (-0.85), helpfulness and competence of the service department (-0.62), responding without delay to customer requests (-0.62), and lack of dedication or sufficient attention to the client (-0.51).

Table 3. The results of indications of expectations and observations in the field of delivery logistics services using parcel machines at the last mile stage.

Area	Expectations regarding the delivery service using parcel machines	Insights on parcel machine deliveries	Difference
Material dimension			
Available location of parcel machines.	6,15	5,97	-0,18
More parcel machines so you don't have to wait for the lockers to be released.	5,47	4,89	-0,58
The exterior of the parcel machine blends in with its surroundings.	5,03	4,75	-0,28
Various sizes/capacity of lockers available.	5,96	5,5	-0,46
Clean and aesthetic appearance of the compartments of the parcel machine.	5,78	5,65	-0,13
Available height of various sizes of lockers for people with difficulties.	5,78	5,65	-0,13
Special compartments for products requiring low temperatures.	5,75	5,17	-0,58

Special lockers for bulky shipments.	5,95	5,21	-0,74
Reliability			
The delivery time to the parcel locker should be in accordance with the information provided by the operator.	6,12	5,98	-0,14
The application for parcel delivery and collection services should provide information about the progress of the service in real time.	5,95	5,78	-0,17
The application for sending and receiving the parcel should be failure-free.	6,09	5,43	-0,66
Parcel machines should not expose the shipment to damage (physical/chemical), leading to the loss of properties of the contents of the shipment.	5,91	5,57	-0,34
Parcel machines should be failure-free.	5,99	5,63	-0,36
Reaction to customer expectations			
Communication with the parcel machine service should be possible using multiple channels (application, telephone, SMS) at every stage: delivery and collection.	5,84	5,61	-0,23
At each stage of the service, the customer has the opportunity to obtain detailed information regarding the delivery by contacting the Customer Service Department.	5,83	5,4	-0,43
In case of problems with the parcel machine, immediate assistance from the service department should be provided.	5,98	5,19	-0,79
From the application level, it should be possible to change the location of the parcel pick-up.	5,53	5,17	-0,36
Delivery to a parcel machine should be shorter than via other forms of delivery.	5,61	5,53	-0,08
Professionalism and responsibility			
The procedure for sending and receiving a parcel should be simple (intuitive).	5,95	5,91	-0,04
The parcel machine should be associated with the application (location, sending, tracking, receiving).	5,91	5,85	-0,06
The parcel machine should be controlled by an application without the need to use a panel placed in the machine.	5,73	5,62	-0,11
The parcel machine should be able to be voice controlled for the visually impaired.	5,82	4,94	-0,88
The parcel machine should be powered by energy from ecological sources.	5,53	5,01	-0,52
Empathy			
Customer support in the form of support should be available 7 days a week / 24 hours, per day.	5,49	5,18	-0,31
The service should react without undue delay after the customer's notification.	5,89	5,27	-0,62
Employees of the customer service department should be characterized by high personal culture.	5,98	5,13	-0,85
Customer support should be knowledgeable and helpful.	5,96	5,34	-0,62
Each customer should be given as much time as they need.	5,85	5,34	-0,51
Customer service employees should be committed to solving the problem reported by the customer.	5,78	5,41	-0,37
Customer service support should be nice and polite.	5,83	5,38	-0,45
^a α – confidence level			

Source: own research.

Despite the imperfections noticed by the respondents in the provision of services on the example of the InPost company, in general, respondents during the SARS-CoV-2 pandemic willingly used parcel machines mainly due to flexibility in choosing the place of delivery (98.2%), saving time (94.8%) and efficiency of delivery and collection (94.8%), competitive

prices of the service (91.5%), and security of supply (85.7%). In addition, respondents believe that parcel deliveries are safe for individual customers, which is reflected in health care (63.8%), care for the shipment itself (70.2%), and payment protection (69.6%) not only during the pandemic.

Due to the experience gained during the pandemic, the diversity of the offer, and the availability of e-commerce formats, the majority of respondents believe that in the future, the demand for online shopping will increase (94.2%) and the interest in shopping in traditional stores will decrease (64.5%). The respondents also believe that in the future, buyers will be more willing to choose deliveries based on innovative last-mile logistics solutions, including parcel machines (74.5%) rather than using other forms (e.g., couriers).

DISCUSSION

The conducted research indicates the significant popularity of parcel machines among customers. Their satisfaction with the use of machines is at a high level. Given the growing popularity of this type of solution, researchers do not often undertake this topic. Most of the research, however, is conducted from the perspective of companies that are trying to find the best algorithm to determine the location of parcel machines. [Schwerdfeger and Boysen 2020; Luo et al. 2022] Other researchers also focused on social aspects, mainly related to the environmental performance of parcel machines. [Moroz and Polkowski 2016; Bonomi et al. 2022] However, looking at one of the few studies conducted in Poland [Lemke et al. 2016], similarities can be found and seems to confirm the thesis that parcel machines will be increasingly chosen by customers, especially when using online stores.

CONCLUDING REMARKS

Summing up, in view of the inertia of technology in all manifestations of human activity, one cannot remain indifferent to what concerns every human being. Each person needs a variety of resources to function. Their offer is increasingly moving from the real world to the virtual one. However, the digitization of the shopping experience finds its finalization in the analog reality. Last mile logistics in the field of deliveries is increasingly carried out using innovative forms, including parcel machines. Delivery logistics services are undergoing transformation.

However, the limitations of the presented study are significant. First, the study concerned customers on the Polish market, and it may be worth considering a comparison with other European countries. In addition, it is also worth repeating the study due to the large impact of the pandemic on customers' purchasing decisions. Thanks to the next edition of the study, it will be possible to check whether these decisions have changed over time.

The analysis of scientific and research achievements indicates the progressive technologicalization of customer service processes. The number of enterprises entering the OOH market is increasing. Reports indicate a growing number of machines. The SARS-CoV-2 pandemic has increased the momentum of the industry's development. Time will tell how long the transformation process will last. It is important to note that the ubiquitous technology should work for the benefit of people—participants of the process. Therefore, enterprises operating on the OOH market should, in the spirit of continuous improvement, take into account the opinions and suggestions of customers. Machine users, although they appreciate the advantages of the autonomy of deliveries, also point to the shortcomings recorded in the form of competence gaps that need to be filled. Without this, it may turn out that admiration for one's own development may contribute to the collapse of the current giants of the CEP industry. The future belongs to the brave and persistent, able to take up challenges and skillfully manage changes, and the current technological innovations in the CEP industry on the OOH market are certainly not the last.

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