

PERSPECTIVE OF FUTURE USE OF AUTONOMOUS ROBOTS IN E-COMMERCE

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Purpose: Identification of the barriers and determinants of the use of autonomous robots in e-commerce.

Design/methodology/approach: The research procedure included a review of Polish and foreign literature and survey research. The paper presents the results of a Delphi study among 25 experts of courier services.

Findings: The use of autonomous robots may be one of the solutions that will contribute to the improvement of the functionality of processes in enterprises. The process of implementing autonomous robots is associated with building a relationship based on trust between the user and technology

Research limitations/implications: Limitations of the conducted research reflects to only one Delphi round.

Practical implications: The results of the study may be helpful for transport companies and courier companies in improving the process of delivering parcels. They can be used for elaboration policy, tools and instrument for the purposes of limitation identified under the study main barriers of the application of autonomous robots in the e-commerce.

Originality/value: The presented research and conclusions provide practical tips for transport and delivery companies on how to use autonomous robots to improve the process of delivering parcels in the e-commerce sector, based on the results obtained from the Delphi study.

Keywords: autonomous robots, logistics, e-commerce, modern technological solutions.

1. Introduction

The field of E-commerce is an integral part of everyone's everyday life. Nowadays, more and more people are shopping online, which is associated with the intensive development of e-commerce (Szymański, 2013). The often-quoted definition is the one that was defined by Central Statistical Office – “E-commerce is the buying or selling of products or services through computer networks, but payment and delivery does not have to be done online” (Central Statistical Office, 2022).

In 2020, during of the global Covid-19 epidemic (SARS-CoV-2), entrepreneurs did not expect such dynamic changes associated with the development of e-commerce. Online retail markets have changed rapidly (Kunnappadeelert et al., 2021). Due to the restrictions and limitations put in place to fight the coronavirus, it caused many more people to start buying online for security reasons (Szpilko et al., 2021). Companies, in order to stay in the market, had to switch from the traditional form of doing business to the electronic one (Batuhan and Taskin, 2020). As a result, e-shopping has become a common form of sales transactions until today (Al-maitah et. al., 2021).

Nowadays, the delivery market for courier services is developing dynamically all over the world (Ejdys and Gulc, 2020). The dynamics of e-commerce development makes global markets able to rely only on selling their products or services online (Sinha and Tanty, 2020). Moreover, the current situation, which prevails in the world as well as in Poland, shows faster digitalization and technological progress. One of the solution which can improve the delivery process in the e-commerce sector are autonomous robots. The definition of autonomous robots was proposed by Bekey – “Autonomous robots are intelligent machines capable of performing tasks in the world by themselves, without explicit human control” (Bekey, 2017). The robot’s function through a preloaded camera system, so they can easily reach the designated locations. Moreover, they are fully disposable, low in maintenance and can bring a quick return on investment.

A McKinsey Report predicted that by 2025 autonomous robots will deliver nearly 100% of parcels from business customers to individual customers (Joerss et al., 2016). Other researchers have also reported that autonomous robots will make 400 million deliveries in Germany by 2030 (Rai et al., 2022). Delivery automation has evolved a lot during the pandemic, as can be seen by the steps taken in Asia or North America. In North America, Nuro tested two driverless vehicles due to a shortage of drivers and for driverless delivery services (Crowe, 2022.05.19). In Asia, Unity Drive Innovation's autonomous vehicles have been used in a variety of cities to transport food to places that have been cut off from supply chains, making over 2,500 rides (Ramey, 2022.05.19).

With the advancement of technology, there is a growing awareness among customers who value their safety in receiving their shipments. According to Pani, Mishra, Golias and Figliozzi, people are willing to use courier services through autonomous delivery (Pani et al., 2020). The aim of this research is to identify perspectives on the use of autonomous robots in the e-commerce in order to understand the state of practice and future potential of autonomous robots for e-delivery.

This article continuous with Section 2, that presented the literature review on autonomous robots and its application in the future in e-commerce. The third section presents a research method. The fourth section presents the results, while the fifth section focusses on discussion. The sixth and final section ends with concluding final conclusions.

2. Literature review

The e-commerce sector requires several IT systems, warehouses, transport companies, couriers, parcel machines, online payment systems, product description specialists, packaging and returns services to enable customers to choose and buy goods conveniently, safely, without moving from home. This powers a whole industry specialising in technologies for e-commerce. Technology trends in e-commerce can be differentiated in terms of three logistics processes: warehousing, transporting and e-selling (Table 1).

Table 1.

Examples of innovative ICT to support e-commerce processes in warehousing, transport and e-sales

Innovative ICT solutions in the process:		
warehousing	transporting	e-sales
<ul style="list-style-type: none"> • electronic RFID tags • warehouse information system (WMS) 	<ul style="list-style-type: none"> • use of autonomous courier robots • using drones to transport shipments • determining routes for couriers using machine learning as part of Business Intelligence 	<ul style="list-style-type: none"> • Perovskite Electronic Shelf Label – electronic price and advertising labels • Mobile applications • Augmented Reality technology • Voice commerce • Freshdesk service • Live Chat service

Source: own study.

Innovative solutions in the field of warehousing make it possible to control stock levels or support the process of placement of goods on shelves. By using a modern IT system it is possible to make the warehouse process more effective and to eliminate errors that occur in the completion of parcels for customers (Borowska and Parakiewicz, 2017). Due to the Covid-19 pandemic, there is a growing need for contactless delivery which has contributed to the development of autonomous drone or robotic transport technology (Kunovjanek and Wankmüller, 2021). Autonomous robots or drones are expected to support drivers in the delivery of parcels and relieve their workload. For many years, experts also have been aiming to revolutionize the e-commerce market using artificial intelligence which can improve the process of picking shipments (Bawack et al., 2022). New technologies are also associated with the support of the e-sales process. In the age of digitization, technologies such as mobile applications or voice commerce make it possible to reach a larger group of customers and sell more goods online (Xiong et.al., 2020). Technologies like livechat or Freshdesk can also be used to improve communication between the customer and the seller (Ding and Zhao, 2021). Augmented Reality technology makes it possible to present a given product in digital space, so consumers will be able to match their purchase preferences and complete the online transaction safely (Pieczarska, 2019). In addition, the breakthrough solution is Perovskite Electronic Shelf Label (PESL) which will help in the digital transformation of commerce.

They will make it possible to effectively sell products with expiry dates (Sauletech, 2022.05.12).

An innovation in the field of transport is the autonomous robot. These robots are programmed to do tasks without human control. According to Fitzgerald and Quasney there are five most important achievements in the field of autonomous robots: artificial intelligence, navigation, cost reductions, sensors and response capabilities, regulatory reform and public policy (Fitzgerald and Quasney, 2017). Due to the advancements in technology, autonomous robots will be more common in human life (Tammvee and Anbarjafari, 2020). Benefits of using autonomous robots include improving safety, productivity, quality of work and include reducing risks of human errors (Kückelhaus & Chung 2018). Companies are looking for solutions to eliminate the human factor in some operations (Tubis and Poturaj, 2021). This is confirmed by research presented by Čámská and Klečka, in which the authors proved that companies can achieve higher profitability by replacing human labor with robots and other new technologies (Čámská and Klečka, 2020).

Investing in autonomous robots should be considered in a high priority in order to reach competitive advantage. Modern technologies are becoming increasingly developed; therefore, many enterprises have opportunity to implement new solutions (Szymańska et al., 2017). It is noted that rapidly changing demands are a precursor to the implementation of new technologies in enterprises (Siderska, 2020).

Nowadays, autonomous robots are used in fields like: industry, agriculture, healthcare, logistics, retail and hospitality, smart cities. Autonomous robots are used on factory floors and in warehouses in many operations such as receiving, shipping and storing (Peyas et al., 2022). In agriculture, autonomous robots are used to support farmers to harvest crops faster and more efficiently. Agricultural robots can assess ripeness, remove leaves or branches from the path and harvest the crop precisely (Beloev et al., 2021). In medicine, autonomous robots are also used to deliver medicines, disinfect surfaces in order to improve the quality of life of patients (Zaouter et al., 2020). In logistics, robots help to deliver goods quickly and efficiently for example in warehouses. They also help to process products, speed up operations and improve accuracy (Zabih and Srikanth, 2021). Furthermore, in retail and hospitality, autonomous robots are being used to automate warehouse processes, to clean various rooms or to assist customers (Bogue, 2019). Moreover, autonomous robots are being used to create smarter and safer cities.

However, there are many concerns about the implementation of autonomous robots. Tammvee and Anbarjafari stated that autonomous robots can only be allowed if they ensure safety for humans (Tammvee and Anbarjafari, 2020). The other research conducted by Dabrowski shows that, the implementation of modern technological solutions is conditioned by the cost. A factor determining the implementation of a new solution is most related with the subsidies for companies (Dąbrowski, 2016). According to Buldeo Rai, Touami and Dablane, the costs associated with investing in autonomous vehicles are keeping companies from investing in autonomous robots (Buldeo Rai et al., 2022). In Poland, from the beginning of

2022, the Ministry of Development and the Ministry of Finance introduced a relief for robotisation, which will allow companies to increase productivity and competitiveness in domestic and international markets (GOV, 2022.05.12). This is an opportunity for many companies to develop, but the implementation of autonomous robots also comply with many legal obligations.

According to Kukielka, the most significant barrier to the development of robots in medicine is distrust of technology especially if this is connected to facilities that are to interact with the human body (Kukielka, 2019). Authors Ejdys and Halicka also stated that the implementation of new technologies depends on cultural factor like trust in technology (Ejdys and Halicka, 2018). Autonomous robots need to be tested and their decisions studied in different scenarios to ensure safety for humans (Sartori, 2019). According to the latest research, robots were shown to have benevolent stated social intentions (Lyons et al., 2022). However, adoption of a new technology requires more researches to explain trust and the public's perception of risk (Baganzi and Lau, 2017). According to report by the Global System for Mobile Association (GSMA), new technology should also create societies that are environmentally balanced (GSMA, 2017).

Considering the current use cases of autonomous robots and the growing interest in this technology, this research focuses on determining the possibilities for the implementation of autonomous robots in the e-commerce delivery sector. All the factors and barriers were the starting point for the development of the Delphi study.

3. Research Method

Data was collected with the help of a survey, which was conducted using the Delphi method. The Delphi method is a type of expert research, in which the opinions of experts are treated as a significant contribution in determining a vision for the future of the research subject (Breńko and Kononiuk, 2021). The Delphi procedure requires respondents to reply to several questionnaire iterations with subsequent rounds containing previous round feedback (Barnette, et al., 1978). The positive aspect of using this method is that the experts can express their opinions without direct interaction (Kowalewska and Głuszyński, 2009).

In this research, one round was carried out using the Delphi method. Due to the risk of obtaining a small number of experts and the time needed to carry out the survey, the second round was not carried out. The detailed research methodology consisted of six steps (Figure 1):

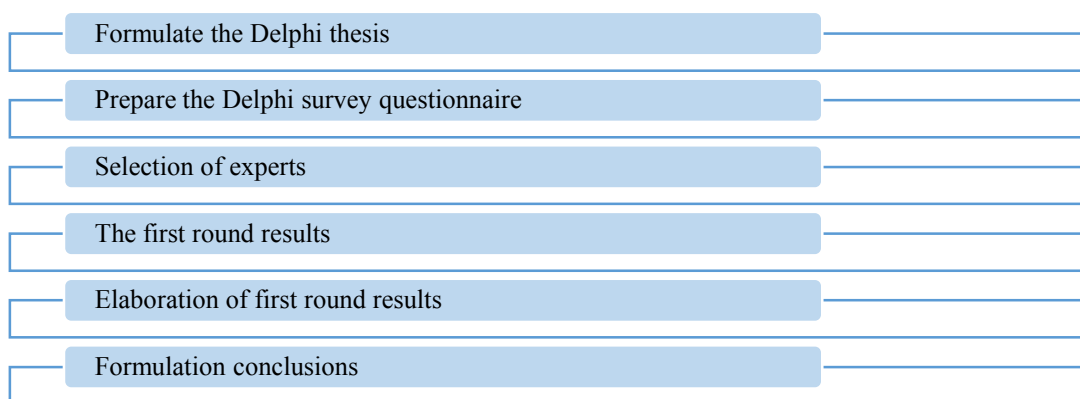


Figure 1. Six steps of the research methodology. Source: own study.

Under the research three theses were considered:

Thesis 1. The dynamics of online shopping will cause a significant increase in the use of robots in courier services.

Thesis 2. Autonomous robots will be the main method of courier delivery.

Thesis 3. Autonomous robots will eliminate human labor in courier enterprises.

For each thesis, the same set of four supporting questions was prepared:

- 1) How do you assess the relevance of the thesis for the development of e-commerce?
- 2) When and how probable do you think the thesis will be realized or when the phenomena/processes described in the thesis will happen?
- 3) To what extent do you think the following factors/activities support the thesis?
- 4) To what extent do you think the following factors/barriers hinder the realization of the thesis?

A link to electronic questionnaires was distributed to individual academic teachers, students and to representatives of courier companies via the university e-mail system. Questionnaires were distributed between February and April of 2021. In total, 25 completed questionnaires were received by: 7 academic teachers – experts in logistics, 3 representatives of courier companies and 15 users of courier services. The structure of the group of experts participating in one round by: education, age, and gender is presented in Table 2.

Table 2.

Structure of the group of experts in the first round of the Delphi research

Specification	First round	
	number	%
Qualification, degree		
Secondary education	3	12
Higher bachelor's or engineering degree	12	48
Higher Master's	3	12
Doctoral degree	7	28
Age		
18-25 years	16	64
26-40 years	2	8
41-60 years	7	28

Cont. table 2.

Gender		
female	16	64
male	9	36

Source: own study.

The most represented group in the Delphi research were experts with higher education of Bachelor's or Engineer's degree (12 experts). All of experts had knowledge of logistics, e-commerce and the development of new technologies. Education with a doctoral degree was represented by 7 respondents, and master's degree and secondary education were represented by 3 respondents in each group. The dominant proportion in the structure of the surveyed experts were people between 18-25 years of age. They accounted for 64% of the respondents. The age of 41-60 years was represented by 28% of the respondents, while the age of 26-40 years was 8%. 16 (64%) of respondents were women, and 9 (36%) were men.

4. Results

The results contain following empirical responses about:

- the relevance of the thesis to e-commerce development,
- the probability of realization of the phenomena described in the theses,
- factors and actions conducive to the realization of theses,
- barriers to the realization of theses.

The first question of the questionnaire concerned the relevance of each thesis to the e-commerce area. All the theses were rated highly in terms of relevance to the e-commerce area as evidenced by the responses of "very relevant", "relevant", and "rather relevant".

In order to determine the relevance of each thesis for e-commerce area, significance indexes (WI) were calculated according to the formula (Ejdys, 2013):

$$W_I = \frac{n_{VR} * 100 + n_R * 75 + n_{RR} * 25 + n_{NR} * 0}{n - n_{NO}} \quad (1)$$

where:

n_{VR} – number of "very relevant" responses,

n_R – number of "relevant" responses,

n_{RR} – number of "rather relevant" responses,

n_{NR} – number of "not relevant" responses,

n_{NO} – number of "I have no opinion" responses,

n – number of all responses.

The indicator is expressed in the range of 0-100. The higher the value of the indicator reflects the greater the significance of the thesis for a particular area (Figure 2).

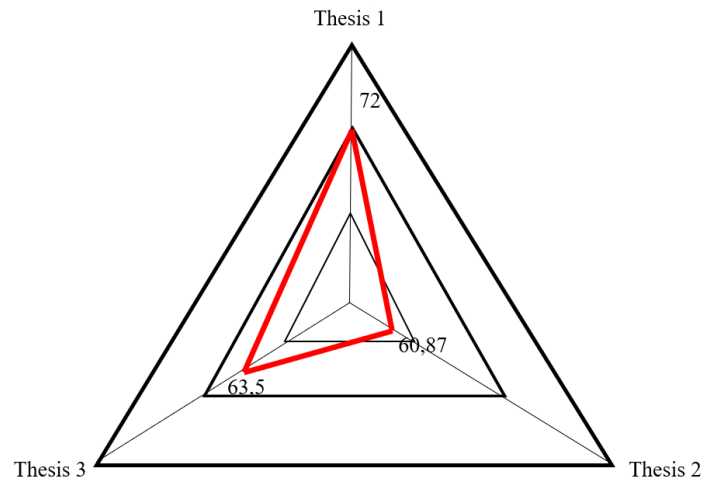


Figure 2. Thesis relevance indicators for the e-commerce sector. Source: own study.

Experts believe that the most relevant is thesis 1, which indicates the relationship between the dynamics of the development of online shopping and the increase in the use of robots in courier services. Less important for the development of e-commerce is thesis 2 and 3, for which the level of the index did not exceed 70. Taking into account the calculated indicators, it can be concluded that thesis 1 is characterized by the highest relevance for the area of e-commerce. The expert assessment of the probability of realization of thesis 1 is presented in Figure 3.

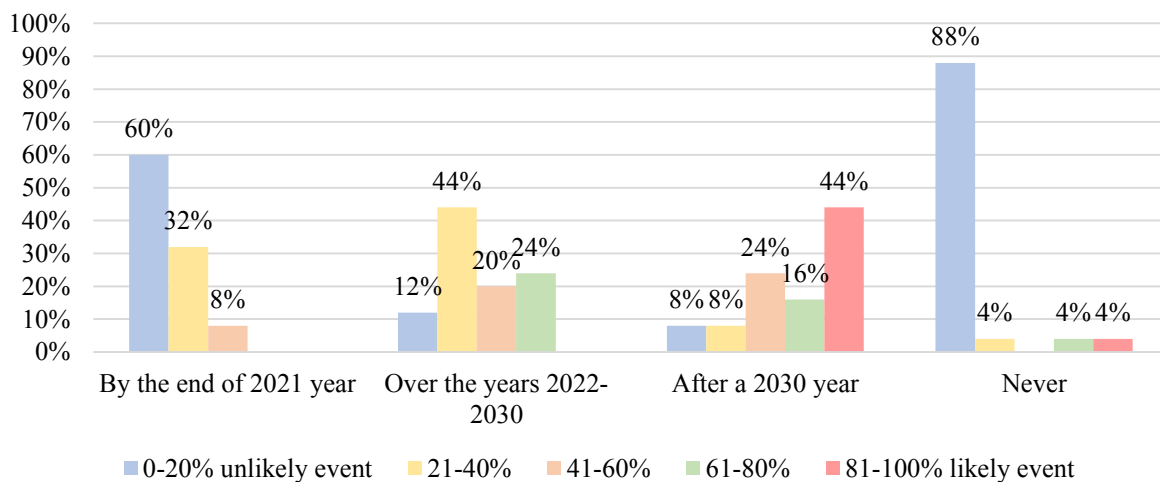


Figure 3. Assessing the probability of thesis 1 for the e-commerce field. Source: own study.

In assessing the probability of realization of thesis one, respondents considered it 60% improbable that this thesis will be realized by the end of 2021. Furthermore, as many as 88% of respondents felt that the thesis would never come true, rating it as an improbable event. Only 8% indicated that the thesis has a medium chance of coming true by the end of 2021. About 44% of the respondents indicated that the thesis has a higher chance of being realized between 2022 and 2030. The farther future, i.e., the time of realization of the thesis after 2030, is indicated by 44% of the respondents with the determination of a certain event. The probability assessment of the realization of thesis two is presented in Figure 4.

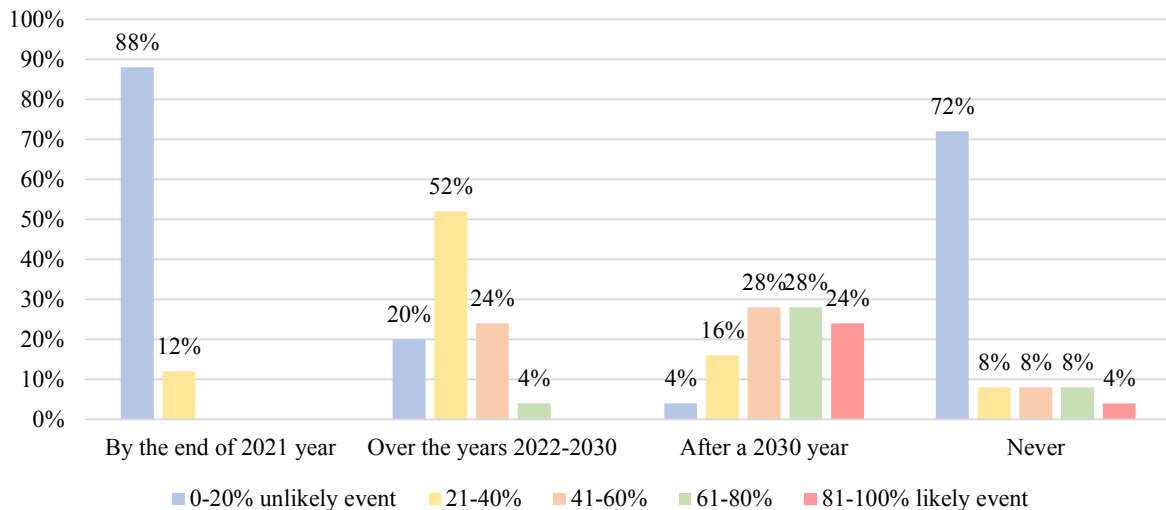


Figure 4. Assessing the probability of thesis 2 for the e-commerce field. Source: own study.

When evaluating the probability of the second thesis being realized, the respondents stated that it is 88% unlikely that the thesis will be realized by the end of 2021. More than half of the people surveyed said that the probability of thesis 2 being realized is possible between 2022 and 2030, while 24% of those surveyed said that this event is certain to occur after 2030. Moreover, as many as 72% of respondents believe that this thesis will be realized in the future. The expert assessment of the probability of thesis 3 coming true is presented in Figure 5.

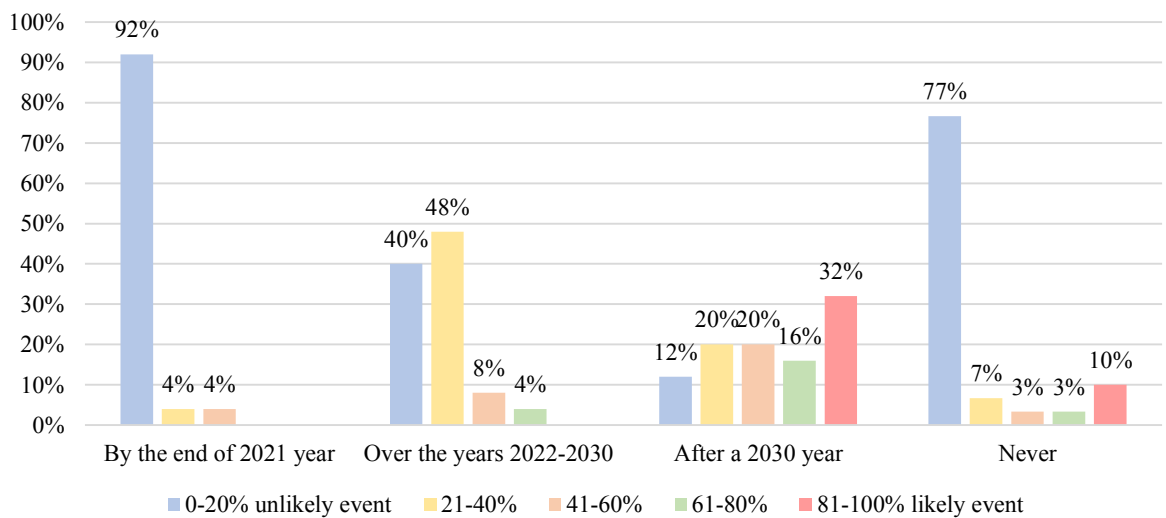


Figure 5. Assessing the probability of thesis 3 for the e-commerce field. Source: own study.

In assessing the probability of the realization of thesis 2, the respondents found that the realization of the thesis by the end of 2021 is 92% improbable. About 48% of the respondents indicate the period after 2030 as the most likely time for the realization of thesis three. Moreover, as many as 77% of the respondents believe that the thesis will come true in the future.

The next issue in the Delphi study was to identify the factors that support the implementation of a particular thesis. For the study, the following five factors were identified from the literature review: opportunity for purchase funding, trust in technology, assurance of

security, regulation, environmental safety associated with the construction of the robot. In order to determine the strength in the operation of the thesis, the favorability index was calculated using the following formula (Ejdys, 2013):

$$W_F = \frac{n_{GE} * 100 + n_{LE} * 75 + n_M * 50 + n_L * 25 + n_{VL} * 0}{n - (n_{NO} + n_{NC})} \quad (2)$$

where:

n_{GE} – number of "to a very great extent" responses,

n_{LE} – number of "to a large extent" responses,

n_M – number of "to a medium degree" responses,

n_L – number of "low degree" responses,

n_{VL} – number of "to a very low degree" responses,

n_{NO} – number of "no opinion" responses,

n_{NC} – number of "the factor has no connection with the thesis" responses,

n – number of all responses.

The indicator is specified in the range from 0 to 100. The closer the numerical value is to 100, the higher the degree of favorability. The degree of favorability of the factors in the realization of these e-commerce area is presented in the table 3. The factors were identified based on a literature review.

Table 3.

The degree of favorability of factors in the implementation of these e-commerce area

Thesis	Factor				
	Opportunity for purchase funding	Trust in technology	Assurance of security	Regulation	Environmental safety associated with the construction of the robot
Thesis 1	61,0	75,0	81,0	58,0	55,2
Thesis 2	60,0	75,0	72,0	61,5	54,3
Thesis 3	59,0	69,0	68,0	65,6	45,6

Source: own study.

According to the opinion of respondents (Table 3), the factors that were the most conducive in the realization of the three theses are ensuring security and trust in technology. Nowadays, man is dependent on technology, but the risks associated with its use, can cause anxiety and fear among users. The basis for building trust in human-machine relationship is functionality, reliability and support system. The factor concerning regulation has a relatively high power of influence on all theses. The other factors concerning the possibility of subsidizing the purchase of an autonomous robot and the environmental safety associated with the construction of the robot have a low strength of favorability.

The experts, while carrying out the research, were also asked to answer to what extent the factors hinder the implementation of the formulated theses. The following five factors – barriers – were identified for the research: ability to subsidize the purchase, trust in technology, security,

legal regulations, environmental safety associated with the construction of the robot. Respondents answered using the same scale as for the factors. The degree of barrier to implementation of the e-commerce area theses is presented in Table 4.

Table 4.

The degree of barrier to implementation of e-commerce area theses

Thesis	Factor				
	Opportunity for purchase funding	Trust in technology	Assurance of security	Regulation	Environmental safety associated with the construction of the robot
Thesis 1	80,0	60,0	62,5	55,2	47,8
Thesis 2	78,0	71,0	65,0	52,0	45,8
Thesis 3	74,0	61,0	68,0	66,0	46,7

Source: own study.

According to the opinion of respondents (Table 4), the barrier that was the most impedes the realization of all theses is: the possibility of subsidizing the purchase. Taking into account all barriers, it can be concluded that the least difficult to realize all these are legal regulations and ecological safety related to the construction of the robot.

5. Discussion

The conducted literature review, as well as the present research, confirmed that the use of autonomous robots in the courier industry is dependent mostly on factors like: the ability to subsidise the purchase, trust in technology and assurance of safety. The survey results confirm that people are aware of the changes taking place in the world. As the most important factor for the realization of the three theses, experts perceive the assurance of safety and trust in technology. The implementation process of autonomous robots involves building a trust relationship between the user and the technology. The research conducted by Tammvee and Anbarjafari confirmed that safety for humans must be ensured when implementing autonomous robots (Tammvee and Anbarjafari, 2020). The research conducted by Ejdys and Halicka confirmed that trust in technology is one of the key aspects when implementing new technology (Ejdys and Halicka, 2018). The most important barriers to the use of autonomous robots in the opinion of the experts are: the possibility of subsidising the purchase and ensuring safety. The research by Dąbrowski confirmed that a factor determining the implementation of a new solution is most related with the subsidies for companies (Dąbrowski, 2016). In Poland, The Ministry of Development and the Ministry of Finance have introduced a robotisation relief, which allows companies to deduct costs associated with the purchase and use of robots (GOV, 2022.05.12). This is a milestone to enable more companies to implement innovative solutions.

The experts highly confirmed the relevance of the first thesis, which points to a correlation between the dynamics of online shopping and the increase in the use of autonomous robots in courier services.

6. Conclusion

The obtained results confirmed that the use of autonomous robots for delivery of packages takes an important role in e-commerce. When evaluating the various statements, the experts paid attention to building a trust-based relationship between the user and the technology. The survey concluded that:

- autonomous robots will be used in the courier sector within a few years,
- safety and trust in technology has the strongest influence on robots implementations,
- if companies receive funding, more companies will buy and use autonomous robots.

The research findings suggest several directions for future efforts. Since there are two parties in the sales process, i.e., companies and customers, it is desirable to research customer acceptance of new solutions and the factors determining the effectiveness of autonomous robots in delivery. As technology develops, there is a growing awareness among customers who value security when receiving parcels. The use of autonomous robots can be one of the solutions that will increase safety and at the same time companies can streamline the delivery process.

The limitations of the conducted research are related to the fact that it was carried out during the Covid-19 pandemic. The conducted research and achieved results will be the starting point for the author to further analysis.

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