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AI AS DECISION SUPPORT IN THE IMPLEMENTATION OF COURIER SERVICES IN SPATIAL TERMS

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ABSTRACT

Purpose: *The purpose of this paper is to present the situation with regard to the use of advanced modern technologies by courier market players and to identify the opportunities offered by AI to courier market players. The paper adopts the following basic research hypothesis: In meeting the emerging challenges in the courier services market, it is essential to identify and implement appropriate AI tools.*

Need for the study: *Decisions to implement state-of-the-art smart mobility solutions can improve productivity, reduce costs and increase efficiency in the operation of the surveyed entities. This article addresses the need to fill the research gap identified in the literature in the area of decision-making regarding the implementation of AI-based tools*

Methodology: *The first part of the article presented a literature review of AI solutions used in the operations of courier operators. This served as the starting point for presenting the results of the study conducted. The survey was conducted in Q1 2024, on a sample of 19 and 21 operators representing the courier services sector. The survey used the expert method, as the issues studied were characterised by the high complexity of the problem, making quantitative measurement impossible. The method used an indirect form of expressions of opinion from experts in the courier services market. The purpose of the article was verified through a CATI survey.*

Findings: *The presented research has shown the differences in the approach to the implementation of AI-based solutions, in the activities of operators operating locally and in the national market. In addition, the authors presented a model solution in the form of a 'roadmap', which will improve the process of introducing AI-based solutions into the day-to-day operations of courier market operators.*

Practical implications: *The research conducted has identified the broad opportunities offered by the implementation of AI solutions, not only for operators operating in the national market, but also locally. The article also provides practical insights in areas such as route optimisation, predictive analysis of customer behaviour and external events, and integration of AI with IoT technologies and robotic process automation (RPA).*

Keywords: postal market, decision-making processes, artificial intelligence, courier services, sustainable development, network markets.

JEL: O32, O14, L87, L14

1. INTRODUCTION

The postal sector, broadly defined, is a pillar of the global ecosystem (Budziewicz-Guźlecka & Drab-Kurowska, 2019). It is important to point out that its role is to cross borders, enabling the communication of societies, businesses and institutions, underpinning e-commerce as well as economic resilience. However, the implementation of these activities encounters a number of barriers and challenges, caused both by independent factors, such as pandemic situations, war conflicts, extreme meteorological phenomena, and as factors related to the change of preferences and behaviours of modern society, which has strongly digitised in the last two decades. Therefore, efficient decision-making by the decision-makers of the market under study is essential in this context.

It should be emphasised that the postal market of the 21st century is an inheritor of many diverse concepts and solutions of the past. It is most evident in the aspect of ways and concepts of postal tasks implementation, the scope of which is systematically increasing, the scale of complexity and dynamism of processes is growing, as well as the scope and manner of use and implementation of more and more developed tools, being the effect of technical and technological development in the sphere of operational, tactical and strategic activities in the local, regional and global aspect. Nowadays, in response to the ongoing changes in the global economy, new determinants are emerging, which now, as well as in the future, will determine the direction of postal enterprises (Drab-Kurowska, 2019; Budziewicz-Guźlecka et al., 2018).

One such determinant is the clearly noticeable development of artificial intelligence (AI) in the context of autonomous and rational decision-making. AI is able to make such a decision, through a self-learning module based on information on the internet or databases (Ilieva, et al., 2024). The reactions of society should be particularly noted here. One is curiosity as to how artificial intelligence has the potential to improve the system that has been in place so far, and how this will affect, through the proposed decision-making proposals, the operating costs of the organisation. On the other hand, one can observe a serious fear of replacing a living human being with artificial intelligence. The changes that are taking place in the postal market determine the reconstruction of operators' internal processes and the gradual implementation of AI in analytical and management processes.

Accordingly, AI is becoming the compass of development for operators of the broader postal market, with a particular focus on the courier market, providing the opportunity not only to implement automation and efficiency processes. The implementation of AI creates a platform for highly efficient operations, resulting in a new era of sustainable growth in the context of the market under review. With decision makers deciding to leverage AI capabilities, global operators around the world have the opportunity to collaborate on an unprecedented scale, sharing data, observations and best solutions. Such collaborative initiatives would be a starting point for addressing disparities in the development of the broader postal services at national and international levels. This would allow economically weaker regions to benefit from the digital revolution and provide innovative solutions for cross-border e-commerce. It should be emphasised that generative artificial intelligence models can support the design of sustainable global postal and logistics systems that are resilient to any negative phenomena occurring both globally (pandemic) but also locally (floods). It should be emphasised that close cooperation between operators, supported by state-of-the-art technologies, could redefine the concept of connectivity (Baláž, et al., 2024).

The development of digital platforms, real-time communication tools and advanced data sharing mechanisms has paved the way for global collaboration. These tools are bridging the barriers of geography and time, allowing close collaboration between multiple operators around the world. It is important to emphasise that the situation for operators over the past decade has been put to a demanding test. Unforeseen events, such as the COVID-19 pandemic or the conflict in Ukraine, have significantly affected operators' operations, changing international transport options and accessibility. It is important to stress that in such a turbulent environment, other unforeseen events may arise, which will in all likelihood put operators' resilience to the test. As already emphasised, the postal market studied in this article, with particular reference to the courier market, is currently undergoing a major transformation and will be further transformed by the development of artificial intelligence. Intelligent solutions have already appeared on the market, streamlining and optimising operational work, and the allocation of deliveries or processes related to cooperation with carriers and customer service are already partly automated to the extent that little manual human intervention is required. The introduction of AI-based

solutions makes it possible to decisively accelerate process optimisation – enabling error analysis and early detection of anomalies in the courier service delivery process. This is particularly important in the context of e-commerce, which is growing at a double-digit rate, as well as increasing customer pressure on delivery times. A major challenge for postal market operators, with a particular focus on courier operators, is the problem of the first and last mile. This is largely due to the involvement of the human factor (collection, picking, decompletion and dispatch). In particular, the final stage of the entire logistics process - delivery to the recipient – is the most costly part of the entire delivery process. State-of-the-art technologies, of which AI is one, should be considered as helpful to courier market players. AI thus allows for the activation of advanced analytical methods that produce measurable results, while leaving space for a human to make the final decision. Thus, being at the same time the quintessence of logistics 5.0.

2. COURIER SERVICES AND MODERN TECHNOLOGY- LITERATURE REVIEW

Postal services, from which courier services originated, have been the foundation of global communication and trade since the dawn of time. In the past, postal services focused on the delivery of letters and parcels, functioning as a critical link between individuals and companies (Kováčiková, et al., 2023; Drab-Kurowska & Drożdż, 2021). It should be noted that the origins of postal services date back to ancient civilisations, where networks based on couriers and messengers were organised to facilitate the exchange of information. These systems then gradually evolved into more structured and reliable postal networks. As a result, they became the backbone of societies and national economies. Today, postal services have evolved strongly, diversifying their activities beyond traditional mail delivery. The dynamic development of modern technology and the Internet has influenced the development of courier services, which now play a key role in the logistics and distribution of goods. The change in society's habits and the development of e-commerce has led to an intensive increase in the volume of shipments, which has been observed over the last decade. This phenomenon has forced courier service providers to adapt to the new rules of the game in the courier services market. It should also be emphasised that technological advances have been a major driver of change in the courier services market area. The implementation of automation systems and digital technologies has revolutionised a number of areas of courier business from sorting and tracking to customer service and delivery (Drobiasiewicz, 2017). Automation has had a significant impact on efficiency and the rapid processing of large volumes of parcels. In addition, advanced tracking systems have been implemented, resulting in increased transparency and reliability, allowing customers to monitor their parcels in real time. IoT, in turn, represents a transformative technology for the courier services industry. IoT devices and sensors can be embedded in parcels, vehicles and infrastructure to provide real-time data on location, status and environmental factors (Novák, et al., 2024). This information gives courier service providers the ability to monitor the status of parcels throughout the delivery process, ensuring that parcels are handled in the right way and will be delivered on time. It is important to emphasise that IoT technology increases transparency and accountability and provides the opportunity to receive delivery status notifications.

The implementation of digital technologies has also transformed customer interactions and service delivery in the postal services industry. Online platforms and mobile applications allow customers to easily access postal services, track parcels and manage deliveries. Digital communication tools such as email and SMS notifications keep customers informed about the status of their parcels. These advances improve the customer experience, increasing convenience and satisfaction. Furthermore, digital technologies enable postal service providers to offer value-added services such as flexible delivery options and secure digital mailboxes.

3. CONTEMPORARY TRENDS AS A BACKDROP FOR SERVICE DELIVERY WITH AI SUPPORT

The changes taking place globally in the context of AI development can be defined as "megatrends" of postal market development (Ludziejewski, 2024; Drab-Kurowska & Kuściński, 2023),

Budziewicz-Guźlecka, 2019). They are the result of changes in the global economy (Garretsen, et al., 2025; Kowalska & Syrda, 2024). Megatrends can be defined as constant economic, social, technological, political and cultural trends, phenomena arising in the process of civilisational development of society, with various conditions affecting humanity beyond national borders and continents, encompassing the entire earth globe and conditioning the main directions and goals of the perspective development of humanity (Bujak, 2016). In the postal context, the concept of a 'megatrend' can be defined as a force that fundamentally changes the way postal entities operate, their way of operating, competing, an important direction, trend or force that emerges globally or locally and is likely to operate in the future. It is important to point out that these megatrends have a significant impact on almost every aspect of the functioning of societies and the economy, and in the view considered in the article, megatrends affecting the development of the postal market, which can be presented in two main groups – social (civilisational) and economic-technological, although this division will be blurred and many elements will interpenetrate and complement each other, generating a kind of feedback loop (Przybylski, 2019; Frias, et al., 2023; Nitsche & Straube, 2023).

It should be pointed out that the current digital economy considered in the context of the postal service envisages further digitisation of postal processes using modern technologies that process a huge amount of information, including the Internet of Things, Big Data Analysis and supporting the provision of postal services through the use of robotics and automation and self-learning systems. It should be pointed out that areas of the postal service where people are supported by modern technology have been developing intensively for a long time. Operators have been using automated sorters or parcel machines for another decade, which on the one hand make work easier and faster and at the same time provide a solution to labour shortages. Despite the emergence of new capabilities to improve the Internet of Things and AI, there are constant concerns about data security and the lack of standards for the postal sector. This is the reason why the postal sector is not exploiting the potential brought by the Internet of Things and AI (Mohammad, et al., 2023; Nawaz, et al., 2023; Sulkowski, et al., 2022).

Further perspective analysis shows that in the third decade of the 21st century, human labour is expected to be gradually replaced by intelligent devices or systems through the use of autonomous vehicles and, to a lesser extent, self-learning systems in intelligent supply chains and drones in the role of couriers, although already occurring in this formula, but not on a large scale.

4. OPPORTUNITIES FOR THE USE OF AI IN THE POSTAL MARKET

The apparent increase in customer demands in the context of reducing lead times is resulting in the search for new solutions and decision-making often based on AI (Wang, et al., 2023; Zhang et al., 2023). Among the disruptive market drivers that will have the most impact on the postal sector is delivery personalisation and multi-channel delivery, which is related to the rapid development of the e-commerce industry. It should be borne in mind that the traditional form of delivery at a time and place specified by the carrier no longer meets the requirements of customers, who expect delivery on demand (on-demand delivery) and therefore at any time and place (Wang & Kern, 2021).

An analysis of market and social trends in the postal sector has shown that in the 21st century, one of the important factors, along with multichannel activity and on-demand delivery, is the concept of the sharing economy (Budziewicz-Guźlecka, 2017). The environmental aspect is also a key trend, especially in the context of oil depletion, which has a negative impact on the postal market (car and air transport). It therefore seems necessary to take measures to intensify investment in 'green' postal logistics, based on renewable energy sources, and to seek innovative concepts for energy collection, storage and distribution and alternative modes of transport. It should be pointed out that more and more often business strategies of logistic postal operators take into account, apart from economic objectives, also ecological actions compliant with the concept of sustainable development.

When analysing market trends, it is important to point out that among the main market drivers that are shaping the courier services sector, personalised production and changes in the retail structure and the rapidly developing e-commerce and e-commerce can be highlighted. Examples of AI applications

include recommendation systems, chatbots, speech and image recognition, autonomous vehicles or data analytics systems.

4.1 Warehouse management systems - RPA - robotic process automation

Robotic Process Automation technology is a form of automation that is becoming increasingly common (Wewerka & Reichert, 2023; Herm, et al., 2023; Farinha, et al., 2024). It is software based on artificial intelligence that automates repetitive and simple business processes. It is most commonly used for data entry, transaction processing and report generation based on predetermined algorithms. This work performed by a bot is much more efficient than performing these activities manually. Applications of RPA in the postal sector can be found when processing orders, eliminating the need for manual data entry thereby speeding up the process and reducing the possibility of error (Nielsen, et al., 2023; Pareek & Tailor, 2023; Rajagopal & Ramamoorthy, 2023). The software can generate a signal, in an automated manner, when the correct stock level drops. RPA also supports the invoicing and billing process with automatically generated documents, as well as the shipping process to specific recipients while monitoring payments. The software also allows data analysis by identifying patterns and trends in large data sets. This makes it possible to generate reports, with information used later to optimise logistics processes.

4.2 Optimisation of routes and delivery schedules - autonomous vehicles

Another state-of-the-art technological solution affecting the delivery of courier services is big data analytics. By analysing large amounts of data collected from various sources, postal service providers can obtain valuable information regarding operational performance, customer behaviour and market trends (Janoskova et al., 2021). This information can be the basis for optimising routes, predicting demand and improving resource allocation. AI algorithms can analyse historical data to predict delivery times, identify patterns and optimise processes. For example, AI-based systems can optimise route planning, taking into account factors such as road conditions, weather and delivery priorities. This allows for faster and more reliable deliveries, reducing fuel consumption and operational costs. In-depth data analysis enables the identification of peak delivery times and areas with high delivery volumes. This knowledge allows for more efficient decision-making in the planning and routing of delivery vehicles. In addition, artificial intelligence can be used to automate customer service interactions, providing immediate responses to common queries and freeing up human agents for more complex issues.

Autonomous vehicles are the result of developments in technology and AI that allow for the highest level of efficiency. An autonomous vehicle uses advanced computer systems, artificial intelligence and a large number of sensors (including cameras, sensors, radars) to analyse the environment and respond efficiently to situations on the road (Gamal, et al., 2023; Dabic-Miletic, 2023). Automating vehicles obviously has a number of advantages, first and foremost being the decoupling of driving time from the driver who needs breaks and recuperation, maintaining an economical driving style, replacing drivers who are becoming fewer and fewer every year, fewer road accidents and increasing the fluidity of the flow of goods. In addition to the positive features, disadvantages can be found, which include: high purchase and repair costs, the need for a well-qualified technical background, system vulnerabilities or hacking attacks. Cargo monitoring and tracking - software visibility

The process of monitoring and transporting cargo is crucial for logistics, the transport industry and trade (Zhao & Lee, J2023). It allows for efficient management of deliveries, optimisation of routes and delivery times which ensures transparency in the supply chain. There are many methods to monitor and track cargo, contemporary technologies include GPS, RFID, barcodes and transport management systems. All of these have increased the efficiency of the logistics sector. Nowadays, these solutions are familiar to everyone and widely used. Monitoring and transport systems provide information on the status and conditions of transport, enabling the indication of quality and safety standards for cargo, especially for sensitive loads. Customers and consignees also benefit from the systems by tracking or monitoring their consignments and are made aware of delivery times. Through a special standard number that is assigned by the logistics or production company, the buyer can enter the number via the company's mobile app or company-owned website and find out

the status of his or her order. There are three different approaches to transport monitoring, including manual, semi-manual and automated monitoring (Lopez-Aguilar, et al., 2023; Cooper, et al., 2023; Sriranga, et al., 2023). The manual monitoring approach is the slowest, least adaptive and most prone to human error. The method uses spreadsheets, emails, faxes or a telephone call. The semi-manual method mainly involves Electronic Data Interchange (EDI), which is based on transferring a large set of supply chain data directly between systems, usually between business partners. Despite its effectiveness, the method does not take full advantage of the capabilities of modern technology. The most effective monitoring method is an automated approach – software that supports real-time monitoring, known as Real-Time Visibility (Kalkha, et al., 2023). Currently, many companies use manual methods of tracking the transportation of supplies and cargo in the conduct of their business. The system has disadvantages such as the creation of delays, errors or increasing customer dissatisfaction. This has led to the development of visibility software, which is designed to monitor the location of loads. It is a collection of functions such as automated workflows, as well as the viewing of quotes and carrier quotes.

5. SURVEY METHODOLOGY

The survey was conducted to obtain the data and information needed to verify the research hypothesis set out in the article. The study was carried out according to the following scenario: 1) Definition of the scope of the study and the target group; 2) Selection and preparation of the survey instrument; 3) Conducting the survey; 4) Summary and analysis of the results; 5) Formulation of conclusions. The survey was conducted in Q1 2024, on a group of 19 and 21 entities representing the courier services sector. The analysis of activity conducted by alternative postal operators indicates that in 2023 62 postal operators indicated that postal activity was conducted exclusively in the courier mail segment. The representatives of the entities taking part in the study are specialists in the application of IT and business solutions. The survey used the expert method, as the issues studied were characterised by a high complexity of the problem, making quantitative measurement impossible. The method used an indirect form of expressing the opinions of experts in the courier services market. The experts were asked to provide answers to questions that were included in a prepared questionnaire containing the issues discussed. It should be pointed out that one of the principles for the selection of experts was their diversity in terms of professional experience. The purpose of the article was verified on the basis of a CATI survey. The choice of this tool was based on the fact that it allowed interviewing the experts, clarifying the questions asked, verifying the answers given, learning about their motivations and identifying other relevant determinants. The selection of experts for the study was carried out by a purposive selection method. The final assessment was carried out by 19 experts representing local actors and 21 experts representing national actors. The specificity of the research problems, which positioned the surveyed entities in a competitive market, required the preservation of confidentiality. The individual indications obtained made it possible to identify indications pointing to the use of advanced IT tools and AI by actors in the courier services market. The questionnaire consisted of 24 questions. When answering each question, experts had the option to choose one answer or provide their own answer. The first group of questions focused on the use of IT tools in the delivery of courier services in the sensitive area of the first and last mile (questions 1-5). The next group of questions attempted to answer questions on the functionality and automation of processes taking place using IT tools in the first and last mile (questions 6-10). The third part (questions 11-16) concerned the use of mobile applications, in the context of effective management of first and last mile processes. In addition, experts were expected to provide information on the scope and context related to their use of mobile applications. In the fourth group of questions (questions 17-24), the questions concerned the degree of interest in the use of AI for the optimisation of sensitive processes at the first and last mile level and the prediction of external phenomena that can significantly affect the courier service delivery process. The aim of the survey was to determine whether the surveyed entities recognise the potential of AI-supported IT tools. Due to limited capacity, the paper presents the answers to the questions of groups one and four.

6. RESULTS OF THE STUDY

Based on the survey, information was obtained on the approach of courier service providers regarding the use of modern technology and AI. During the survey, actors operating at national and local level were identified.

For question 1, the experts indicated (Figure 1) that the organisation uses IT tools in the courier service delivery process, understood as the optimisation, implementation and monitoring of logistics processes especially in the context of the first and last mile. Clear differences can be seen between those operating locally and those operating nationally.

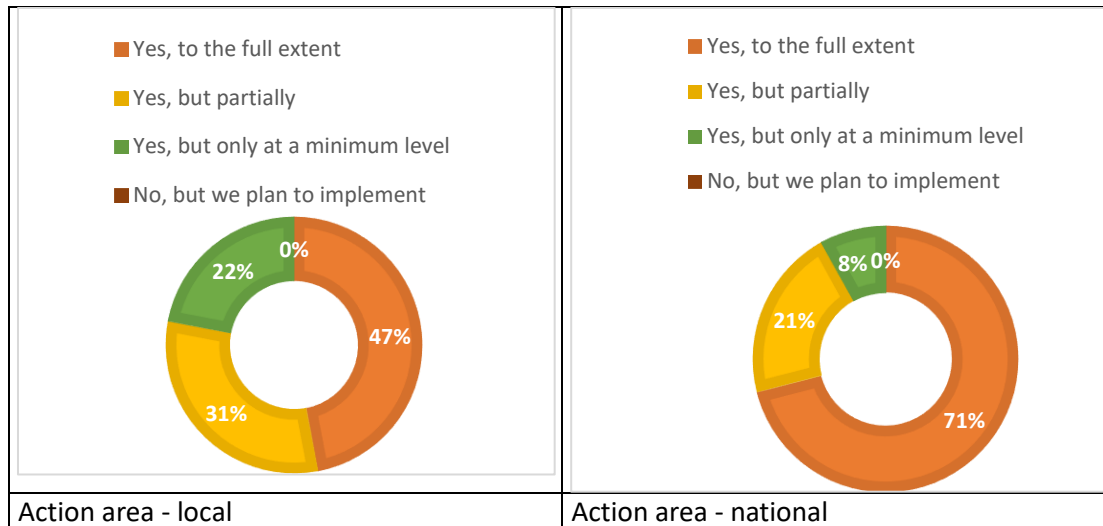


Figure 1. Use of advanced IT tools in the courier service delivery process, understood as optimisation, implementation and monitoring of logistics processes especially in the context of the first and last mile
Source: own elaboration.

It is evident that operators operating at national level use advanced IT tools 24% more often than local operators. For the operators surveyed, operating at a local level, this is only less than half of those surveyed (47%).

Partial use of advanced IT tools in the courier service delivery process is declared by 31% of local operators and 21% of operators at national level. It is worrying that 8% of national operators use advanced IT tools at a minimum level, and the figure is as high as 22% for national operators. This means that the scope of operations has a very strong influence on decision-making regarding the implementation of advanced IT tools. Experts pointed to the lack of need and the cost factor, which at the local level, due to limited economies of scale, would be a burden for the operator.

The next question was about the benefits of using IT tools in the courier service delivery process especially in the context of the first and last mile, as shown in Figure 2. The biggest benefit of using IT tools in the courier service delivery process in the opinion of both local and national operators was the possibility to monitor the route of the parcel (98% of indications of national operators and 97% of indications of local operators).

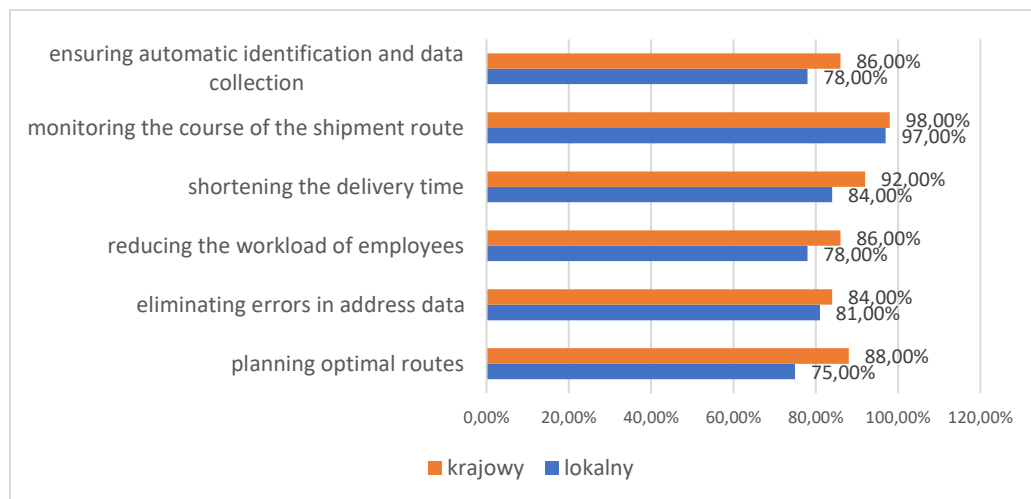


Figure 2. Benefits of using IT tools in the courier service delivery process especially in the context of the first and last mile
Source: own elaboration.

The second benefit indicated by respondents was a reduction in delivery time. For national operators, this benefit was very important (92% of indications). For local operators, it was important to 84% of surveyed operators. The surveyed operators are increasingly paying close attention to optimal routes. This is not solely dictated by economic considerations. It appears that the environmental issue of minimising the carbon footprint is important to them. For 88% of postal operators operating at national level, this is important. In contrast, local operators made an indication of 75%. Another benefit shown by operators was the provision of automatic identification and data collection (86% of indications by national operators and 78% of indications by local operators). The same number of indications was the reduction of clerical workload. Respondents also indicated the benefit of eliminating errors in address data (84% of indications from national operators and 81% of indications from local operators).

Another issue analysed in the study concerned the problems and challenges encountered in the courier service delivery process in the context of the IT tools used, as presented in Figure 3.

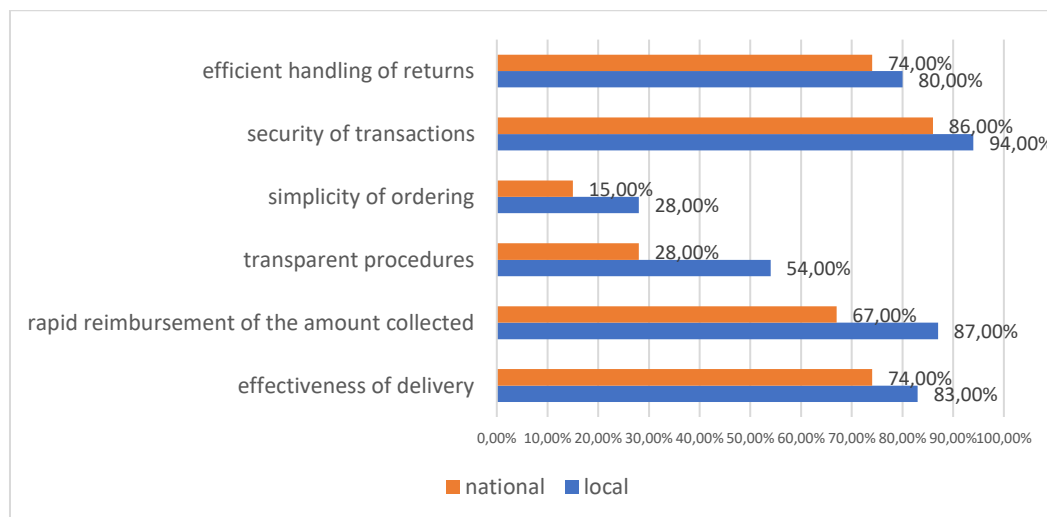


Figure 3. Problems and challenges occur in the process of courier services in the context of the IT tools used
Source: own elaboration.

The biggest problem and challenge, according to the operators surveyed, is the issue of security of the transactions carried out. This issue is prioritized by 94% of local operators and 86% of national operators. A major challenge for operators is also the efficient handling of returns. The parcel return process requires adequate logistics, financing and resources to manage the entire process effectively.

Furthermore, the parcel return process should be as efficient and transparent as possible to ensure a positive customer experience. Operators are aware of this (74% of indications from national operators and 80% of indications from local operators). Next in importance, the surveyed operators indicated issues regarding the return of the collection amount. This is particularly important when paying at the customer's premises (67% of indications from national operators and 87% of indications from local operators). According to operators, a major challenge is the effectiveness of delivery (74% of indications from national operators and 83% of indications from local operators). They expect IT tools to improve efficiency. This is important in terms of timeliness and generating additional costs. IT tools are expected to streamline the process. A less significant challenge in the opinion of operators is the transparency of procedures (28% of indications of national operators and 54% of indications of local operators). These responses show that operators in this area do not need to make major investments. The situation is similar with regard to the simplicity of placing an order for a courier service. According to the operators, customers do not have major problems with this process, which is the result of the high transparency and intuitive layout (15% of indications from national operators and 28% of indications from local operators).

The next question, addressed to the respondents, concerned the plans of the operators, in terms of the implementation of courier services in the perspective of 2 years in the context of the first and last mile, which is presented in Fig. 4. It can be clearly seen that there is a growing awareness of the negative impact on the environment. Operators are looking for solutions that, when implemented, will reduce negative environmental impact and, at the same time, optimise costs. In terms of plans, the answer regarding matching loads to the type of layout vehicle came in first place (98% of indications from national operators and 96% of indications from local operators). In terms of plans for the next 2 years, the surveyed operators indicated two issues. The first was the introduction of the possibility to schedule deliveries in specific time slots, which will increase the effectiveness of deliveries and ultimately reduce the cost of last mile deliveries (87% of indications from national operators and 65% of indications from local operators). The second issue was the simplification of complaint procedures, which will increase customer satisfaction ((87% of indications from national operators and 74% of indications from local operators). Among the plans for the coming years, there is also the very important and relevant issue of reducing fleet costs, which will result from investments in a low-carbon fleet and the use of AI to optimise routes (86% of indications from national operators and 92% of indications from local operators).

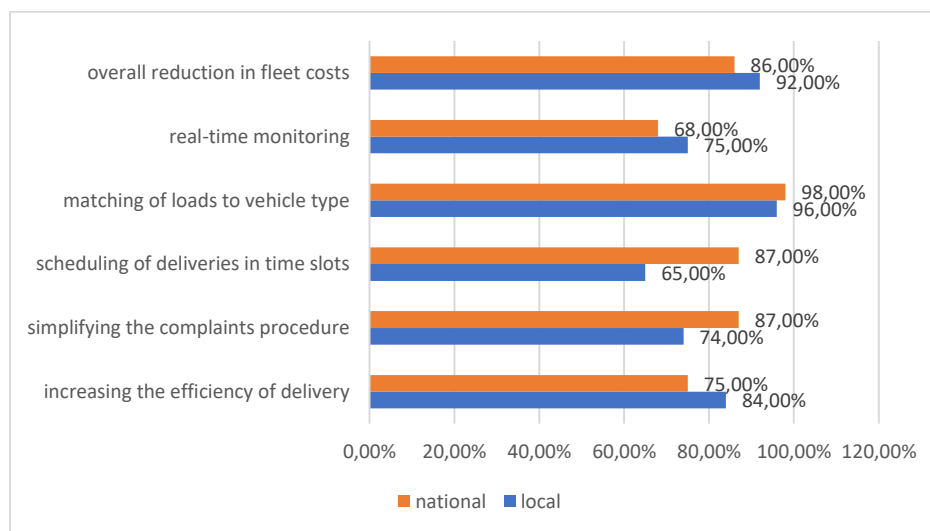


Figure 4. Operators' plans for the delivery of courier services in a 2-year horizon in the context of the first and last mile

Source: own elaboration.

Another group of questions concerned the use of AI in the delivery of courier services. The surveyed entities have high hopes in terms of AI supporting their business (Figure 5).

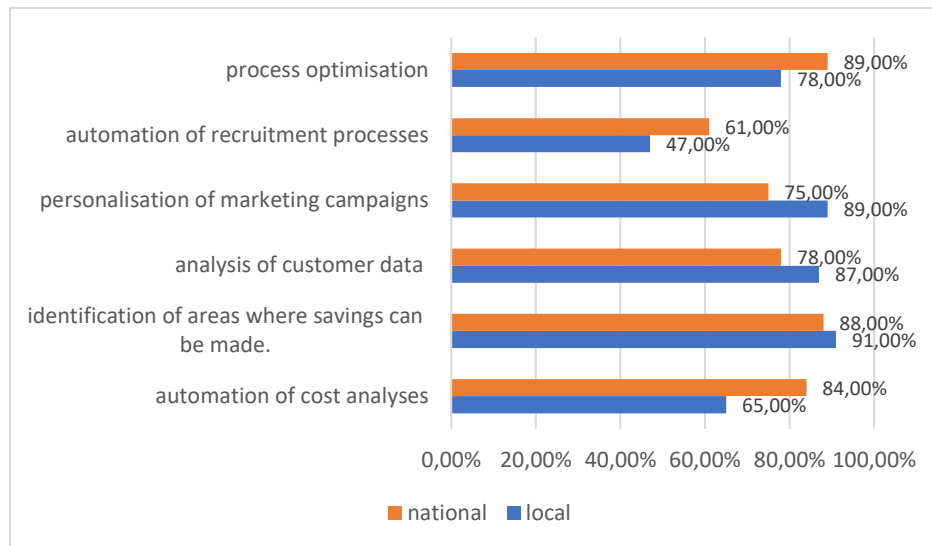


Figure 5. Expectations, in the context of AI solutions, for IT tools supporting the delivery of courier services

Source: own elaboration

An important area that could be supported by AI is the identification of areas where savings could be made. Both national operators (88% of indications) and local operators are strongly interested in this (90%). Operators also point to the possibility of optimising processes within their operations (89% of indications from national operators and 78% of indications from local operators). Closely linked to optimisation and the search for savings is the issue of cost analysis. Operators see the need to automate this process, using AI (84% of indications from national operators and 65% of indications from local operators). According to those surveyed, AI could also serve as a tool to help analyze customer preferences (78% of indications from national operators and 87% of indications from local operators). A better understanding of customer needs and expectations would influence more personalized marketing activities, with the support of AI. It should be noted that there is a high awareness of this among respondents (75% of indications from national operators and 89% of indications from local operators). Human factor issues, i.e. the recruitment process, in the opinion of respondents, could be supported by AI, but only think so (61% of indications of national operators and 47% of indications of local operators).

Subsequently, it was investigated whether actors were using AI to increase operational efficiency, through routing and navigation (Figure 6).

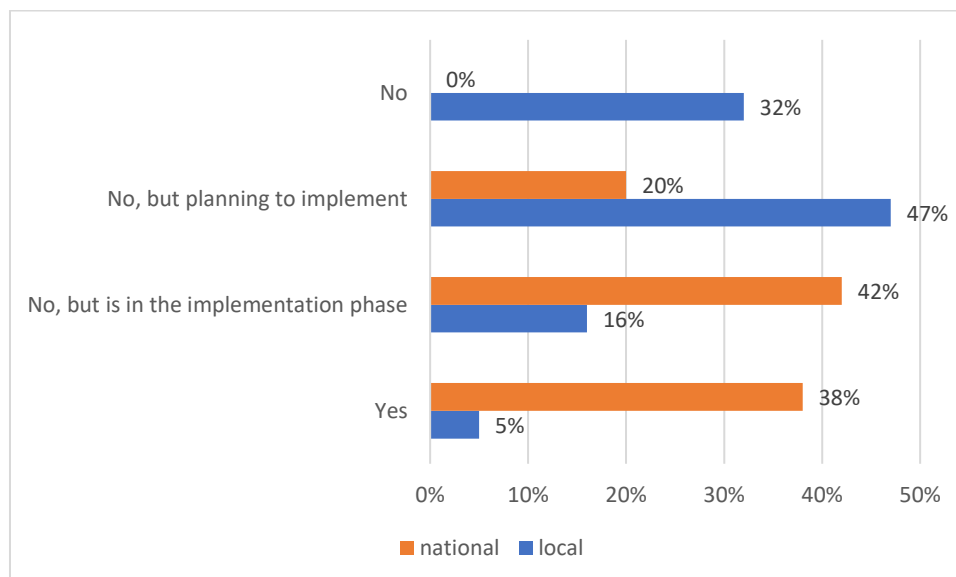


Figure 6. Improving operational efficiency through routing and navigation

Source: own elaboration.

Nearly 40 per cent of national entities have already taken advantage of this tool, 42 per cent are in the process of implementing it and 20 per cent are planning to do so, seeing a number of benefits in the efficient use of both human and physical resources in the entities surveyed, treating it as a strategic element in the entity's digitalisation.

Local operators approach these issues differently. Only 5% support themselves with AI for routing and navigation, and 16% are in the implementation stage. However, seeing the potential of this tool, almost half of the surveyed local entities (47%) are planning such activities in the near future. In contrast, almost a third of the surveyed local entities are not planning such activities.

Another issue that was highlighted in the study was the possibility of using AI to predict external phenomena, such as traffic congestion, unforeseen meteorological phenomena, among others, as shown in Figure 7.

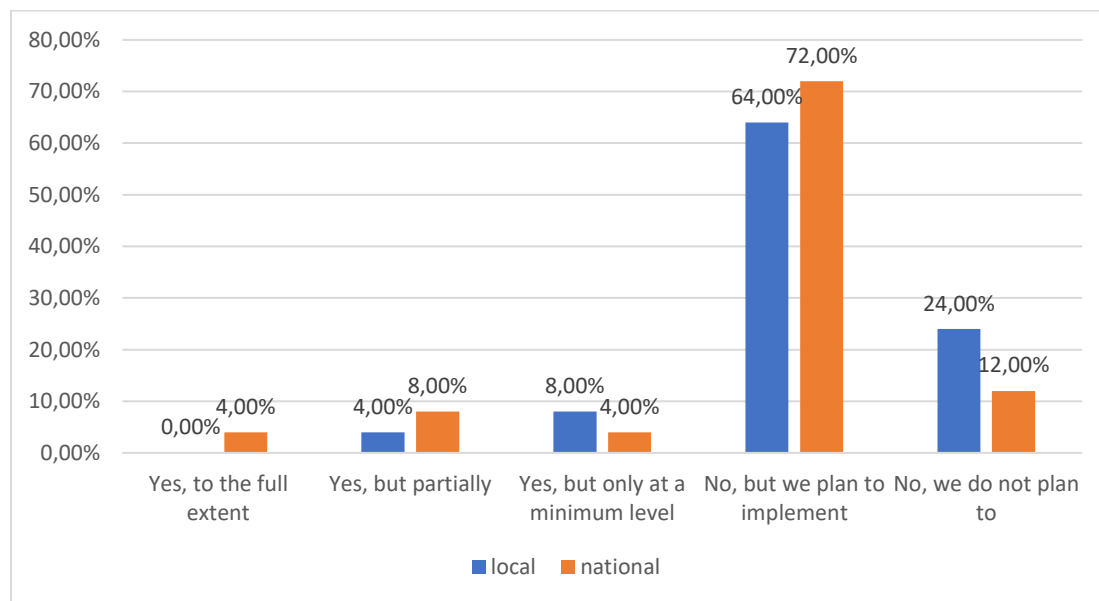


Figure 7. Use of AI to predict external phenomena affecting the delivery of courier services

Source: own elaboration.

It appears that this possibility is only just being recognized by the surveyed operators. Only 4% of the surveyed national operators favour its use to the full extent, 8% partially or minimally. In the case of local operators, none of the surveyed operators have yet used AI to its full extent. 4% of operators indicated that they use it partially or minimally (8% of the surveyed operators' indications). 12% of surveyed national operators and 24% of local operators indicated that they have no plans to do so as of the date of the survey.

However, the growing awareness of AI's potential is reflected in the survey results regarding plans for use. As many as 64% of local operators and 72% of national operators plan to expand the use of AI in the near future to include the prediction of external phenomena negatively affecting the delivery of courier services.

Subsequently, the entities' approach regarding the use of AI to predict customer behavior was verified, as presented in Figure 8.

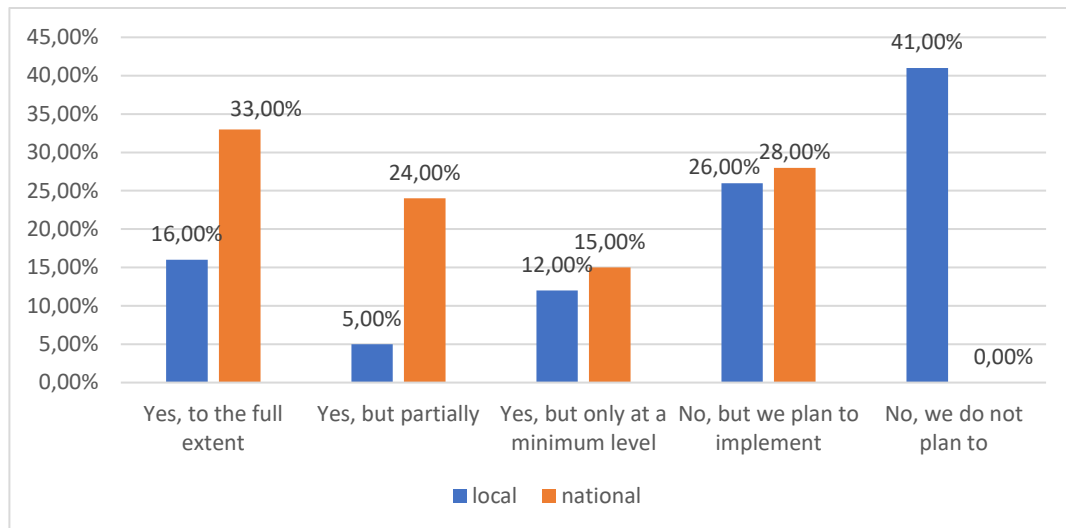


Figure 8. Using AI to predict customer behavior under the influence of external factors
Source: own elaboration.

The results of the survey indicate a high level of awareness regarding customer behavior, hence the need for monitoring. Nearly 70% of the national entities surveyed are using these solutions and the rest are planning to do so. A slightly different approach is presented by local entities. Here, just over 40% of respondents indicated the use of AI to predict customer behavior. There is also a high number of entities, almost 41%, that do not see such a need. This is mainly due to mental barriers, limitations of technological skills and fear of the high costs involved.

The final question explored in this article relates to the need for a 'roadmap', i.e. guidance, guidelines, which would enable the efficient use of advanced modern technologies and AI in managing the entire courier service delivery process (Figure 9).

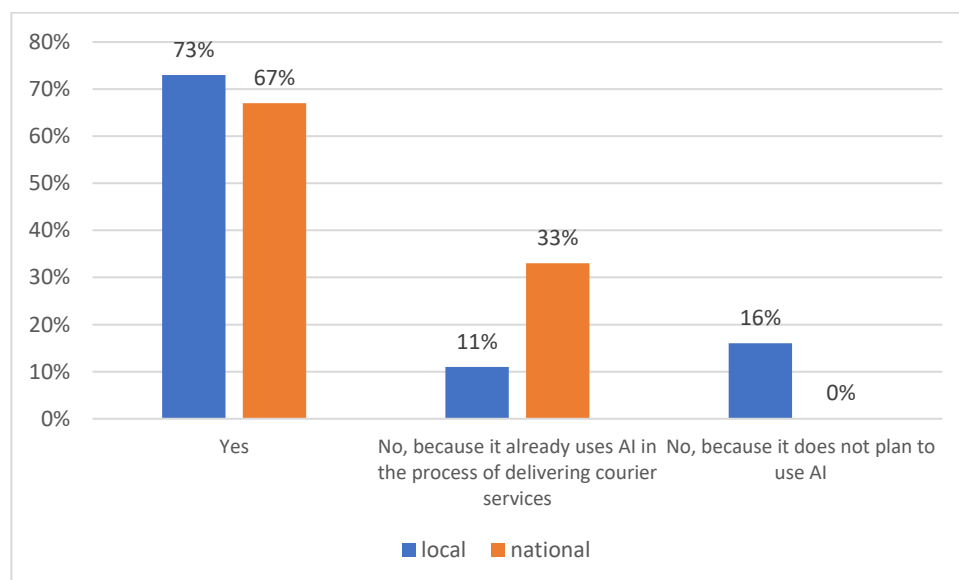


Figure 9. Is there a need for a 'roadmap' in the context of managing the courier service delivery process using advanced modern technology and AI?
Source: own elaboration.

73% of the surveyed local entities declare the need to have such guidelines in place for a smooth implementation of AI. Only 16% have no such need, as they have no plans to use AI. Experts who did not respond positively to this question do not rule out the possibility of using AI to streamline processes, but do not currently find a use for such a solution in their business. This position is influenced by a

number of factors, including the entity's area strategy, the specifics of the AI technologies used and their level of sophistication.

In contrast, for domestic entities, 67% of surveyed domestic entities indicate the need to have a 'roadmap' for AI. This is dictated by the desire to increase the efficiency of the entity's operations. Experts who indicated this course of action indicated that improving the courier service delivery process is a key idea and, at the same time

one of the key activities related to AI.

As with the introduction of any innovation, in the area of the market investigated in the article, AI can carry certain risks - One of these is mistakes made at the implementation and configuration stage of solutions. Incorrect parameters adopted when programming the automatic allocation assumptions, may result in shipments not being sent in the most optimal way, and incorrectly designed response paths, will result in handling bots, instead of reducing the number of contacts, generating more interventions and lowering the level of satisfaction of the end customer. It is therefore crucial to select the right tools and implement them in collaboration with specialists who understand the complexity of logistics processes and have experience in automating them AI is revolutionizing industry after industry, accelerating their technological transformation. However, for the wider postal market, it represents a powerful opportunity to automate and optimise processes. However, it is important to remember that with a highly competitive market, it is important to react to changing trends fast enough. Companies that do not introduce 'smart' solutions in time may lose distance to more technologically advanced competitors.

7. DISCUSSION

Undoubtedly, the incorporation of cost optimisation processes based on artificial intelligence can provide a new approach to optimising cost structures related to the delivery of mail on differentiated routes, especially in the context of the problem of their lengthening. The use of AI will allow to solve the problems related to the efficiency of postal services, which should have an impact on limiting the increase of fees for the services provided. AI's potential for economic efficiency, also comes from determining routes based on their profitability dynamics. AI tools can propose clustering of routes through in-depth analysis based on route profitability models. AI will give the opportunity to apply the right methodology, taking into account the efficient management of routes, by grouping them, taking into account their specific characteristics and operational requirements that ensure the economic sustainability of operators.

As a result, through the use of AI tools, an individual shipment route that might individually appear as unprofitable can become a synergistically aligned element of the network, allowing for economic efficiency. It should also be emphasised that the use of AI makes it possible to identify in advance potential bottlenecks and disruptions occurring in the operator's structures and to propose remedial actions.

AI also improves the sustainability of postal operations (Baláž et al. 2023). Through the use of AI, the reduction of CO2 emissions should be pointed out, in addition to operational efficiency through optimised routes. Effective climate management, in the context of minimising the carbon footprint, should be regarded as a huge challenge for the coordination of operators. Optimisation aimed at reducing CO2 emissions for operator operations is only possible through the use of advanced artificial intelligence algorithms. Furthermore, using the latest IoT solutions, through sensors integrated with AI, operators could access information on CO2 emissions, in real time, at every stage of the delivery process, increasing transparency and environmental awareness. The use of AI can support campaigns highlighting green initiatives, increasing trust and perception of operators. It should also be noted that accurate decarbonization data, validated by AI, can help operators apply for environmental subsidies, which will translate into further investment in green innovation. All the more so as today's institutional customers buying courier services are increasingly paying attention to the eco aspects of their carriers' offerings when finalizing contracts.

Operators using various data aggregation methods and a wide range of data such as, among others, weather forecast, volumes, route times, efficiency, last-mile channels or also geopolitical considerations,

are increasingly interested in engaging AI for estimating risks and recommending management decisions (Zindros, Anagnostopoulou, 2024).

Prediction correlated with operators' operational experience, could definitely reduce problems related to on-time delivery or reduced customer satisfaction.

Another area of impact of AI on operator activity, is the efficient management of resources. In the traditional set-up, many postal operators could use their resource potential (means of transport, warehouses, human resources) inefficiently, which could lead to lower operating efficiency. By using artificial intelligence to forecast demand, operators could more rationally plan the use of resources, adapting them to dynamically changing needs, responding in real time.

8. CONCLUSION

On the basis of the research carried out, it can be indicated that the intended objectives were achieved and the research hypothesis was verified.

In the context of the use of advanced IT tools in the implementation of courier services in the sensitive area of the first and last mile, the entities surveyed are aware of the importance of these tools for the smooth implementation of processes. They largely base it on professional tools. Improving management efficiency and meeting customer expectations are the main benefits of using advanced IT tools.

With regard to the functionality and automation of processes, there is clearly a growing awareness of the continuous modification of processes using IT tools at the first and last mile. The processes of shipment management, quality control and timeliness require continuous adjustment.

In the context of the use of mobile applications, there has been a clear indication of the need to have them, continually modifying and improving them, following ever newer, more user-friendly solutions for end users.

However, the most important issue was to analyse the use of AI to improve the delivery of courier services for the purposes of optimising sensitive processes at first and last mile level and predicting external phenomena that can significantly affect the delivery process. The study showed that the entities surveyed, are attempting to use, whether at a national or local level, routing capabilities, which significantly increases operational efficiency. Another attractive area, strongly emphasised by the surveyed entities, is the possibility of prediction, either of external phenomena affecting the realisation of courier services, or the predictability of customer behaviour, which significantly determine the planning of delivery processes in the courier services market. However, in order to achieve a high level of utilisation of the solutions that AI offers, it is necessary to propose certain solutions, guidelines, which will be a 'roadmap' for the courier services market players surveyed, as shown in Fig.10.

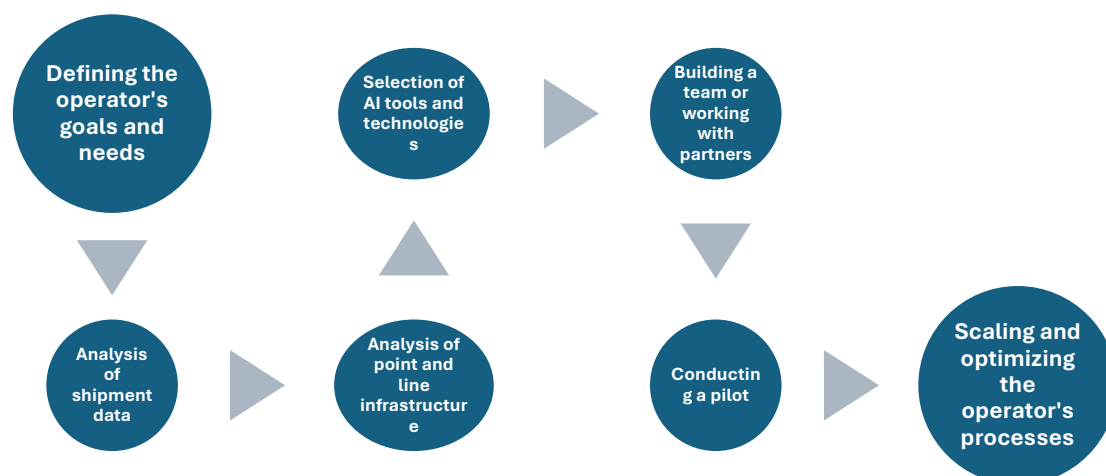


Figure 10. Roadmap for the implementation of AI by courier market players*Source:* own elaboration.

Summarising the results of the survey, the following conclusions can be drawn. The entities of the courier services market are aware of the need to use advanced IT tools. Furthermore, it is important to develop functionalities based on modern technologies. The use of advanced IT tools together with AI tools will allow to gain a strong position in the competitive market of courier services. Additional research is needed into the use of AI by courier market players, indicating which areas need to be developed and which have already reached their optimum.

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