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Machine Learning Application for Improving Customer and Postal Logistics Operator Satisfaction in Urban Areas – A Review

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Review
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ABSTRACT
Machine learning (ML) is a crucial component of artificial intelligence that has recently attracted attention for its application in logistics. ML algorithms are used on large datasets. They create logic correlations among given data and provide predictions of specific values. This research paper aims to conduct a systematic literature review to showcase the potential applications of machine learning in urban logistics systems, specifically focusing on enhancing satisfaction for postal logistics operators and their customers. The authors used various research publication databases in this context (Web of Science, Scopus, Google Scholar etc). The analysis of different models provides insights into diverse aspects, such as predicting product prices and types of cargo, evaluating user satisfaction, forecasting user departures, assessing optimal geographical locations for implementing postal centres, predicting purchase times before online orders, estimating delivery times in the last phase of the logistics chain and more. The significance of this research is highlighted through the identification of shortcomings in existing literature, offering guidelines for future research in developing new machine learning model for optimal operator selection. This model aims to achieve improvements in both customer and operator satisfaction simultaneously.

KEYWORDS
machine learning; urban logistics; postal logistics operator; literature review.

1. INTRODUCTION

The globalisation of economic, political and cultural processes, the emergence and development of new markets and the presence of information technology in almost all areas of life are the main reasons for the growth of all economic flows, primarily including the fields of logistics, transportation and communication. Impacted by these changes, postal and logistics systems have evolved into main actors in shaping market relations in modern business [1].

Scientists and professionals do not have a universal approach to defining the concept of logistics and its associated dimensions [2]. Its content is often identified with the transportation and storage function, which has a two-way orientation from any point in the distribution process [3]. The field of logistics is a broad concept, and as part of the supply chain logistics has a primary purpose – transportation and storage. In this sense, it involves planning, organising and managing the flow of goods, warehousing activities, packaging and addressing, transportation and distribution, replacement or return services and other optional services [4]. Logistics can be divided into:

— Production logistics, which enables raw materials or supplies to move from one phase of transformation to the end product [5].
— Distribution logistics, which is the link between the production function and the sales function in an enterprise [6].

— Warehouse logistics ensures that all merchandise stocks arrive in the company correctly stored and registered [7].
— Integrated logistics involves a range of services from international transportation, customs and forwarding services, warehousing processes, various additional services and packaging and labelling activities to delivery [8].
— Reverse logistics is a subsystem of integrated logistics and includes activities to support the movement of products or materials backward from customers to manufacturers or suppliers [9, 10].
— City/urban logistics is the subject of this research and represents the process of planning, organising, coordinating and controlling the transportation of goods, people and information within urban spatial boundaries [11].

The complex urban logistics system encompasses the collaboration of various participants with their specific needs and activities, including postal logistics (PL) operators, end-users of services, carriers, public institutions and the general population. The focus is on investigating the relationships between end-users, who may act as legal or natural persons in the capacity of senders or recipients, and postal logistic operators. In 2011, 52% of the population lived in cities [12], and this number is expected to increase to 68% by 2050 [13]. The increasing concentration of people in cities raises questions about the housing process and the growing demand for necessities. Considering the diverse user profiles, preferences and demands on one hand, and varied business requirements of operators on the other hand, the question arises how to provide a service that fully satisfies individual user needs while simultaneously ensuring the operator's successful functioning? Postal logistic systems become a critical part of the supply chain and must find an adequate way to cope with these challenges [14]. The design and shaping of customer relationship management heavily depend on the development and application of modern technologies.

Contemporary trends point to an increasingly significant role of artificial intelligence (AI), machine learning and deep learning (DL) in diverse areas, including engineering, business management and customer relationship management. ML is becoming the cornerstone of developing innovative management strategies [15]. While learning, ML systems are capable of recognising patterns and relationships between data, enabling the creation of efficient models for predicting values on new, unseen data [16], providing a foundation for data analysis, and supporting decision-making across various sectors. The selection of ML techniques depends on factors like specific characteristics of the data and the business requirements such as the availability and size of the dataset, the quality of the data and the nature of the prediction task.

The author's motivation for exploring the potential of machine learning in urban logistics is inspired by the guidelines provided in [17] and arises from the pervasive challenges encountered by the postal logistics operator in their operations (growing customer expectations, technological changes and competitive pressures) [14, 18]. The crux of achieving efficient supply chain management lies in the adept fulfilment of customer-defined requirements [19].

The significance of the topic stems from the need for a holistic approach to satisfaction in the postal logistics chain, laying the groundwork for aligning customer expectations with the business needs of the operator. In this context, this paper aims to identify and analyse the latest research focusing on the application of machine learning in urban logistics and provide insights into how this technology can be used to achieve satisfaction for postal logistics operators and their services users.

The papers are systematically organised based on keywords as inclusion criteria, allowing for precise identification and filtering of those relevant to this topic. Another criterion involves structuring according to the applied methods. Given the close association with machine learning, the systematic literature review encompasses models using classification, statistical and survey methods. Survey methods applied for collecting data integrated into machine learning models. On the other hand, statistical methods, such as regression analysis play a crucial role in machine learning by providing tools for data analysis, assessing relationships between variables and making predictions based on patterns. Classification methods enable the categorisation of data into specific classes or groups. The criterion of classifying papers according to machine learning methods and related methods further allows differentiation between models based solely on machine learning methods and those using other associated methods.

The focus of the third criterion for analysis is on the goals achieved by the proposed models/approaches in satisfying customers and/or operators. The identification of relevant papers and precision is significantly contributed to by the fourth criterion related to purpose, i.e. the prediction/assessment that the model enables.

By analysing and comparing research papers based on goal and purpose metrics, it is evident that most of them address the application of machine learning to achieve satisfaction among postal logistics operators.

These models serve various purposes, such as forecasting the type of transported cargo, evaluating customer satisfaction with logistics services, clustering products based on their characteristics, predicting customer churn, forecasting product prices and demand, and more.

Concerning the attainment of satisfaction for customers of postal logistics services, this aspect is treated in only two relevant papers: one predicting the time users start their online shopping process before placing actual orders and another analysing optimal geographic locations for setting up postal centres. Similarly, only two relevant papers were found and addressed the challenge of achieving satisfaction for both parties, focusing on ML models for predicting the competitiveness of a logistics company and estimating the delivery time of packages in the last mile. No papers were found addressing the issue of selecting the optimal operator based on user preferences, which, through predicting user satisfaction, could enhance the satisfaction of postal logistics operators, and, through the selection of the optimal operator, user satisfaction.

In addition to comparing papers based on their goals and purposes, papers are analysed based on the applied methods. In the context of achieving satisfaction for postal logistics operators, the following methods were applied: fuzzy analytical hierarchy process, averaged one-dependence estimators, sequential minimal optimisation, k-nearest neighbours, LogitBoost, repeated incremental pruning to produce error reduction algorithm, logistic model trees, HyperPipes, support vector machine, k-means, gaussian mixture and hierarchical clustering algorithms, among others. Models aiming to achieve customer satisfaction with postal logistics services utilise the genetic algorithm and the K-means method. The authors apply random forest, convolutional neural networks and residual neural networks methods for models to achieve mutual satisfaction.

Despite the observed broad spectrum of machine learning methods and other related methods, there is a noticeable lack of the application of linear regression, random forest and gradient boosting methods in the literature. The analysis of systematised papers underscores the importance of this in addressing identified shortcomings and providing research directions for developing a new model for selecting the optimal operator based on these machine-learning methods to achieve mutual satisfaction.

The "Findings" and "Conclusion" sections delve into the specifics of this paper's contributions.

The structure of the paper comprises six sections. Following the introduction, the second part of the paper is dedicated to outlining the authors' methodological approach to the research, setting objectives and defining the subject of the study. The authors also elaborate on the steps of the systematic literature review. Section 3 delves deeper into the fundamental concepts of urban logistics and stakeholders. After introducing the basic notion of machine learning in Section 4, Section 5 showcases the results of applying machine learning in urban logistics, with an emphasis on ensuring customer and postal logistics operator satisfaction. Concrete examples of models based on various machine learning methods and other related approaches, emphasising the aim of achieving customer and/or operator satisfaction, are considered. Additionally, in this section, special attention in the analysis is given to the purpose of the model/approach in terms of its predictive/evaluative capabilities. Section 6 provides concluding considerations, and suggests future research directions.

2. RESEARCH METHOD

For the evaluation of research questions in the field of machine learning application in city logistics to achieve PL operator and customer satisfaction, the authors chose the systematic literature review (SLR) method. A systematic literature review is a process of collecting, analysing and critically evaluating data published in scientific publications on a particular topic or scientific problem [20] to understand trends and identify existing deficiencies in scientific literature.

2.1 Research objectives

In this paper, the authors conduct a systematic analysis of the application of machine learning in the field of urban logistics. The main objective is to review relevant research in this area, synthesising and identifying trends in the application of machine learning methods to enhance the satisfaction of postal logistics operators their customers. The aim is to create a critical literature review that will serve as a basis for identifying shortcomings, formulating new research questions and providing guidelines for further investigation.

2.2 Research subject

The synthesis of relevant literature on urban logistics, its key participants, and the application of machine learning constitutes the foundation of the research, while the primary focus is directed towards a systematic

review of the application of machine learning models in postal logistic systems within urban areas, aiming to achieve satisfaction for both customers and operators. The research subject is precisely delineated through terms such as machine learning, urban logistics, postal logistics operator and literature review.

2.3 Inclusion criteria

The sources used for this paper consist of scientific peer-reviewed journals, textbooks, doctoral dissertations and peer-reviewed conference proceedings. The search was based on keywords such as machine learning, machine learning algorithm, machine learning model, city logistics, urban logistics, freight transport, logistics operator, postal operator, postal logistics operator, stakeholders, stakeholder satisfaction, customer relationship management, customer satisfaction and operator satisfaction (*Table 1*).

To identify relevant articles that could describe the field of activity, processes and modelling of urban logistics, scientific databases such as Scopus, Springer, Web of Science, Proquest, Emerald, Google Scholar and Science Direct were used. The research process is structured into three phases.

In the first phase, the authors identified relevant literature related to the application of machine learning in urban logistics to achieve satisfaction among customers and postal logistics operators. In this phase, authors reviewed the titles, abstracts and keywords. The search was limited to the use of the terms machine learning, city logistics and stakeholder satisfaction in English and B/C/S languages, from 1 October 2021 to 1 March 2023. The first phase of the research resulted in 116 scientific research papers.

In the second phase, inclusion criteria were established, and keywords were applied to structure and guide the research process. Given that the focus of the study was on the application of machine learning algorithms and models in urban logistics to achieve satisfaction among both customers and postal logistics operators, the initially identified 116 papers were narrowed down based on these keywords as one of the inclusion criteria. The second phase of the research yielded 93 papers. Throughout the research process, no significant keywords were missing.

The third phase resulted in a total of 58 papers, encompassing research limited to books (BO), doctoral theses (DT), scientific peer-reviewed articles (AR), review articles (RE), conference papers (CR) and peer-reviewed conference proceedings (CP), as shown in *Table 1*. The final meta-query for the search had the following formulation:

(TITLE-ABS-KEY ("machine learning" OR "machine learning algorithm" OR "machine learning model")) AND (TITLE-ABS-KEY ("city logistics" OR "urban logistics" OR "freight transport" OR "logistics operator" OR "postal operator" OR "postal – logistics operator")) AND (TITLE-ABS-KEY ("stakeholders" OR "stakeholder satisfaction" OR "customer relationship management" OR "customer satisfaction" OR "operator satisfaction")) AND ((LIMIT-TO (DOCTYPE, "dt") OR LIMIT-TO (DOCTYPE, "bo") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "cr") OR LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND ((LIMIT-TO(LANGUAGE, "English") AND (LIMIT-TO(LANGUAGE, "B/C/S")).

Table 1 – Characteristics of the search query

Keywords 1	Keywords 2	Language	Paper type
Machine learning	Machine learning algorithm	English	Doctoral thesis (DT)
City logistics	Machine learning model	B/C/S	Books (BO)
Stakeholders satisfaction	Urban logistics	-	Conference proceedings (CP)
-	Freight transport	-	Conference reviews (CR)
-	Logistics operator	-	Articles (AR)
-	Postal operator	-	Reviews (RE)
-	Postal logistics operator	-	-
-	Operator satisfaction	-	-
-	Customer relationship management	-	-
-	Customer satisfaction	-	-

The relevant literature was identified through a systematic review, its significance for the research area was assessed, and the results were summarised. *Figure 1* illustrates the results of the systematic literature review, which can be presented through three steps in conducting the research:

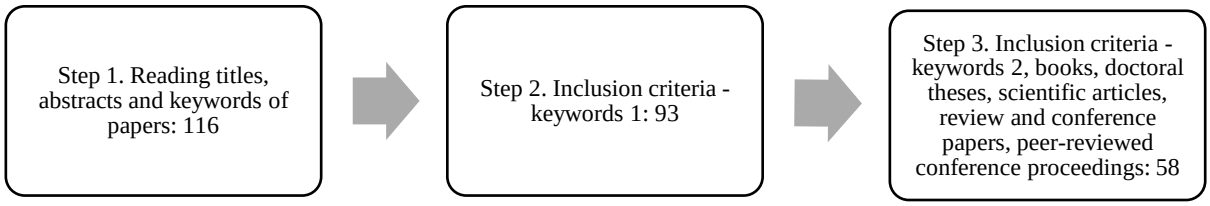

Figure 1 – Selection protocol of the systematic literature review

3. CITY LOGISTICS – KEY STAKEHOLDERS

City logistics encompasses the planning, management and control of transportation and consolidation of goods, services, information and revenue in urban environments [21]. It represents a process of optimising urban logistic activities by the social, ecological, economic, financial and energy impacts of urban freight movement [22] while utilising information and communication systems [23].

The complexity of urban freight traffic involves the participation of various supply and demand actors. These participants have diversified requirements and objectives that they aim for urban logistics. Often, these requirements conflict, but what connects them is a common interest in the transportation of goods and delivery from suppliers to consumers. Taking into account the different segments in the market and their different impact on the domain of urban freight transport [11], the main participants of urban logistics can be divided into general categories:

— Population. People who reside in a specific urban area, when it comes to urban logistics processes, have explicit demands in terms of reducing noise, traffic and environmental congestion [24].
— Public bodies or administrators. Local, regional or international bodies (such as municipalities, transport authorities, administrations etc.) [25] provide approvals for traffic and land use within a spatial urban zone with the adoption of different acts, plans and projects.
— Provider of PL services/PL operator. The logistics operator is a company that manages the movement of various products, goods and materials along the supply chain, offering logistics services to the end customer/user. Some urban logistics operators specialise in specific industries, while others focus on certain types of cargo, such as pallets or containers. Additionally, some concentrate on distinct product categories [26]. According to the authors in [27], a logistics operator encompasses any role facilitating logistics services such as transportation, storage, packaging etc. During the transportation process, the shipper can decide whether to enlist a third party for transport or handle it independently [28]. The different types include 1PL (first party logistics), 2PL (second party logistics), 3PL (third party logistics), 4PL (fourth party logistics), 5PL (fifth party logistics) and 6PL (sixth party logistics). On the other hand, postal operators are categorised as private or public. A public postal operator is predominantly or exclusively state-owned, providing both reserved and unreserved postal services. Private postal operators include any privately owned company holding a license for courier and/or direct mail services. Postal operators offer one or more postal services in terms of reception, dispatch, transportation, arrival and delivery of letter and parcel items, printed matter, newspapers and magazines, postal orders, telegraph messages, registered and value items, cecograms, and direct mail and courier services [29].
— Carrier. A company is responsible for distributing goods (trucking companies, third-party logistics providers, freight forwarders, trucks, drivers etc.) to maximise profit through minimising pickup or delivery costs.
— Customer/end user – sender/receiver. A natural or legal person, institution, wholesaler or retailer who uses the services of a postal logistics operator. Based on the parties involved in the process, customers of the PL sector are divided into six broad categories: business-to-business (B2B), business-to-customer (B2C), customer-to-business (C2B), and customer-to-customer (C2C), as well as business-to-government (B2G) and customer-to-government (C2G). The B2B category represents companies that sell their

products to other companies, such as manufacturers, wholesalers or retailers. The B2B segment excludes direct consumer interaction. B2C consists of companies that do business directly with consumers and sell their products to them. The C2C category includes the sale of goods or services from one consumer to another, where a third party manages these transactions by providing an online platform. C2C usually involves platforms for buying and selling new/used items. C2B represents an individual consumer who services a large corporation and sells its product or services. Consumers create product value and business value in consumer-company relationships, unlike other models [30]. In the B2G category, transactions take place between companies and public bodies or bodies at the local, regional or international levels (municipalities, traffic bodies, administrations etc.). The C2G category involves interaction between individual consumers and public bodies.

4. MACHINE LEARNING – BASIC CONCEPTS

Machine learning is the foundation of artificial intelligence [31] and includes algorithms that enable computers to perform tasks without directly defining rules for how the algorithm should proceed. Applying algorithms to extensive datasets leads to the establishment of logical correlations within the provided data and prediction values [32]. These algorithms utilise mathematical and statistical rules to identify relationships between data based on their attributes [33, 34].

The machine learning process encompasses six key phases. The initial stage involves data collection and preparation from various sources of interest, such as databases and textual documents, to facilitate the effective training of the model. Subsequently, an appropriate machine learning method or algorithm is chosen, taking into consideration the nature of the task, available data and other relevant factors. Following the algorithm selection, the model is trained on the prepared data, thereby learning to recognise patterns and characteristics among the data and predict output values. To assess the overall performance of the model, validation is conducted on unseen data, utilising evaluation metrics such as accuracy, precision and recall. Ultimately, the trained model is utilised to predict new values, providing users with a tool for informed decision-making or forecasting unknown values in real time on unseen data [35].

There are three ML types, namely [36]:

— Type 1 – Supervised learning
— Type 2 – Unsupervised learning
— Type 3 – Reinforcement learning

Various supervised, unsupervised and reinforcement learning methods and algorithms are employed for data modelling and establishing connections among them. The choice of a machine learning method will depend on data availability, sample size, data quality and the nature of the prediction task, as the selection of techniques is based on data characteristics and business requirements [37].

Supervised learning is a technique that is based on labelled data. Input and output variables are represented, where the algorithm maps the input variable to the output variable and thus predicts the result. This includes classification, where the output is categorised into a pre-defined number of classes: anomaly detection for identifying deviations from usual patterns; regression to solve problems with continuous numerical values; and clustering for identifying similar structures in the data [38]. Classification algorithms include naive Bayes, decision trees, logistic regression, k-nearest neighbours and random forest, among others, while regression algorithms encompass simple linear regression, multiple linear regression, polynomial regression, decision tree regression, random forest regression, and more [39]. Support vector machines for evaluating customer satisfaction with logistics services, multiclass decision forest and multiclass logistic regression for predicting product prices and demand are some examples of supervised learning applied in the urban zone postal logistics sector to achieve customer and operator satisfaction.

Unsupervised learning, on the other hand, identifies similar instances or features grouping the data and is used for training on unlabelled data using algorithms such as k-means, Gaussian mixture, hidden Markov, neural networks and others [39]. From the perspective of a postal logistics operator, data clustering is important because it provides the operator with accurate information and enables effective decision-making toward creating methods and plans to improve customer satisfaction. The K-means method of selecting optimal locations and organising the construction of postal centres is an example of unsupervised learning in the urban zone postal logistics sector to achieve customer satisfaction.

Reinforcement learning algorithms involve the interaction of the system with the environment. The agent or system powered by artificial intelligence has an initial and final state and encounters different paths to reach

the final goal. It is a typical scenario where reinforcement learning can solve the problem. Machine learning is a vast scientific field and shows increasing potential for application in urban logistics daily. In the case of applying reinforcement learning to urban logistics, examples include driverless vehicles, self-navigating robots and elevator scheduling.

5. 5. FINDINGS

City logistics implies a systematic approach, where modelling is a key component. Models are used to estimate the effects of various changes in the urban distribution system without actual changes to the system [40].

Despite the differences in the requirements and goals of the participants, the postal logistics operator must understand customer needs and offer adequate services. It is the only way to achieve long-term profitability [41] because customer choice and satisfaction have the greatest impact on a company's revenue and profitability.

Collecting user data and analysing it is an inevitable process for every postal logistics operator operating in a modern environment. By applying machine learning methods and analysing large databases, it is possible to simplify and optimise the processes of a postal logistics operator and predict future opportunities and challenges [42].

The research was prompted by the inadequate understanding of models based on machine learning algorithms applied in urban logistics that provide satisfaction to both customers and operators. Therefore, the authors present in *Table 2* a summary of studies systematised according to key terms such as inclusion criteria, machine learning methods and other applied techniques. The main objective achieved by the model, aiming at customer and postal logistics operator satisfaction in urban zones, as well as the purpose of the model/approach in terms of the prediction/assessment it enables, is delineated.

Table 2 – Overview of papers based on machine learning models in postal logistic systems in urban environments aimed at achieving customer and operator satisfaction

Paper, Year	Inclusion criteria	Methods used		Goal		Purpose of the model/approach
				Satisfaction		
		Machine learning methods	Other methods used	Customer/User (Sender/s, Recipient/s)	Postal logistics operator	
[43], 2020	City logistics, blockchain, customer satisfaction, machine learning.	x	FAHP method.		x	Prediction of customer satisfaction in the context of sustainable urban logistics.
[44], 2016	Retail supply chain, data mining.	x		x*[1]		Prediction of user's shopping start time before ordering online.
[45], 2014	Machine learning, cargo mobility.	x			x	Prediction of the type of transported cargo.
[46], 2005	Logistic distribution, degree of customer satisfaction, model.	x			x	Evaluating the satisfaction of users of logistics services (consumers and suppliers).
[47], 2020	3PL, machine learning, logistics.	x			x	Grouping of products based on their characteristics (weight, size, description, package used).
[48], 2022	Customer analysis, customer relationship management.	x			x	Prediction of customer churn using the example of an e-commerce retail store.
[49], 2021	Machine learning, data mining, data analysis.	x			x	Prediction of product price and demand.

[1] x* (in the function of manufacturer, wholesale and retail)

[50], 2018	Expectations and perceptions of users of postal services, model.		Surveying, statistical and analysis method.		x	Evaluation of postal service user satisfaction
[51], 2021	Logistics company, comprehensive evaluation.	x		x	x	Evaluation of logistics company competitiveness
[24], 2013	City logistics, participants, policy model.		Fuzzy multi-objective programming method.		x	Estimation of the optimal amount of goods to be transported from source to destination.
[52], 2010	Urban movements of goods, freight demand models, choice of customers, retailer's choice.		Classification method.		x	Designing measures for urban freight transportation.
[53], 2021	Last mile, package delivery, predictive modelling, deep learning.	x		x	x	Estimated last kilometre package delivery time.
[54], 2020	B2C model, pickup and delivery of shipments, machine learning.	x		x		Assessment of optimal geographic locations for the implementation of postal centres.
[55], 2013	Customer segmentation, clustering algorithm.		Fuzzy clustering algorithm.		x	Segmentation of logistics company customers
[56], 2021	Logistics service providers, service quality, customer satisfaction.		Survey method.		x	Assessment of customer satisfaction of a logistics operator.
[57], 2022	Customer satisfaction and loyalty, commitment to the customer, quality of services.		Kansei engineering.		x	Assessment of users' perception of the quality of logistics services in the context of the Covid-19 pandemic.
[58], 2020	City logistics, machine learning, social network mining.	x			x	Testing public perception of city logistics.

After the initial selection of papers based on keywords as the starting metric of systematisation, the paper's structure was further shaped through the application of machine learning (ML) methods, statistical analysis, classification approaches, surveys and other techniques related to machine learning. Survey methods and statistical approaches are often used for data collection and analysis from population samples, while classification methods deal with categorising data based on characteristics. These areas are interconnected, where machine learning often employs statistical methods for data analysis, and classification methods are an integral part of a broader set of techniques in machine learning.

The third criterion used for the systematic classification of papers focuses on the goals achieved by the proposed models. It provides a comprehensive overview of models that enable user and/or PL operator satisfaction. Emphasising this criterion as crucial, further analysis of models involves a detailed examination of the methods used in the models and their purpose in prediction and assessment.

The research analysis and comparison according to defined metrics shows the frequency of approaches that deal with the application of machine learning techniques to achieve operator satisfaction in the postal and logistics sector. The mentioned machine learning models in the papers illustrate the possibilities of optimising operations and are further detailed below.

In [43], the authors proposed a customer satisfaction model in the context of city sustainability. It is based on a recurrent neural networks (RNN) machine learning algorithm. The following criteria that affect customer satisfaction in urban logistics were defined: cargo damage rate, on-time delivery rate, cost performance and information transparency. The fuzzy analytical hierarchy process (FAHP) method is used to determine the

weight of each indicator for further evaluation of customer satisfaction with delivery. The model is proposed to provide banks and governments with the ability to assess logistics companies so that they can make better decisions for sustainable urban logistics. The model is also valuable for suppliers, logistics companies, retailers etc. for overall sustainable development.

In [45], researchers analysed waybills apropos documents accompanying the transport goods and made a model proposal based on ML algorithms to predict the type of transported cargo between a given origin and destination. The methods used were: averaged one-dependence estimators (AODE), sequential minimal optimisation (SMO), k-nearest neighbours (k-NN), LogitBoost boosting algorithm, implementation of the popular repeated incremental pruning to produce error reduction (RIPPER) algorithm, logistic model trees (LMT) and HyperPipes. The model will be helpful for logistics companies and public authorities to improve their decision-making.

In [46], the authors presented a model for evaluating customer satisfaction with logistics services. The model used the support vector machine (SVM) algorithm. Through an analysis of suppliers and consumers, five measures evaluating logistics services were defined: safety, time, cost, availability and service quality.

The paper [47] provides an overview of the application of k-means, Gaussian mixture and hierarchical clustering algorithms in the production facility of an automotive industry. The suppliers pack products differently (in different colours, shapes etc.). The ultimate goal is to group products based on their fundamental characteristics as weight, description, size and packaging used. The paper has the potential for application in warehouses.

The focus of research in [48] is the analysis of data from customers of the Brazilian e-commerce retail company Olist. It analysed data on customer orders, reviews and socio-geodemographic information. The aim was to develop a model for predicting customer churn, which showed that customer abandonment depends on the value of payment for the first order, the number of items purchased, delivery costs, category of purchased products, customer demographic environment and their location. The machine learning methods used were logistic regression and extreme gradient boosting (XGBoost).

In [49], the authors applied the following ML methods: multiclass decision forest, multiclass logistic regression and one-vs-all multiclass. They developed a model for predicting product price and demand in the production market by analysing customer purchase history, feedback and business transactions.

In [50], the authors provide insights into the Servqual model and the application of survey methods, descriptive statistics, analysis methods and content analysis to assess customer satisfaction with postal services. They base the assessment of customer satisfaction on the following attributes: tangibles, reliability, responsiveness, assurance and empathy. The Servqual model assists postal operators in advancing their operations and measuring the quality of their services.

The paper [24] presents an analysis of the behavioural parameters of participants in the urban logistics distribution system with a focus on senders, cargo carriers, residents and public bodies. Mathematical formulas were used to represent the objective functions for the participants in urban logistics, including:

— For senders, the total available supply for each source and demand for defined destinations;
— For cargo carriers, the reduction of total transportation costs and delivery time;
— For retailers, the reduction of total transportation and delivery costs;
— For public bodies, the minimisation of complaints and the level of harmful emissions to the environment.

By applying the fuzzy multi-objective programming method, an interactive fuzzy multi-objective linear programming (i-FMOLP) model is proposed to determine the optimal amounts of goods that need to be transported from source to destination. The purpose is to reduce total production and transportation costs, as well as delivery times. The model is a modification of the existing FMOLP model, with the addition of the regular iterative fuzzy control values to achieve customer satisfaction. The authors proposed a conceptual model with development steps.

In [52], the authors investigate the movement of goods in terms of the number of goods and vehicles in urban areas in southern Italy. The paper provides an overview of classifying the main measures for managing and controlling cargo transport, and it defines criteria for analysing previously developed models for simulating urban movement of goods, verifying the ability to assess ex-ante classified measures. The proposed model is

a partial share model and serves urban policymakers to design measures for urban freight traffic more easily and simply.

The authors in [55] propose an algorithm for segmenting customers of a logistics company into multiple segments based on their similar characteristics. They consider a logistics company in Anshun, China, and use a clustering algorithm based on axiomatic fuzzy sets. The hierarchical analysis structure can represent the attributes of each customer according to major and secondary criteria, and then each norm is represented by a linguistic variable. The main goal is to support logistics companies in reducing operational costs and improving customer satisfaction.

The quality of logistics services in the Indian market is discussed in detail in [56]. The study surveyed users of a logistics operator in terms of operational quality, resource quality, information quality, staff contact quality, customisation and innovation quality. The proposed logistics service quality (LSQ) framework is useful for logistics operators in developing strategies to improve service quality. The study identified resource quality and information quality as the most influential factors in LSQ, while less influential factors were customisation, innovation, operational quality and staff contact quality.

In [57], the authors investigate customer satisfaction with logistics services in the context of Covid-19, to provide a realistic picture of the situation and improve the business activities of the logistics operator. In measuring customer satisfaction in the Indonesian market, the authors applied the Kansei engineering method with an open questionnaire with 298 respondents. The study findings emphasise the importance of the following parameters: implementation and adherence to COVID-19 protocols, expertise and friendliness of staff and easily accessible branches.

In [58], the authors analysed the Twitter content of 111.265 tweets related to urban logistics and its users. The goal was to test the public perception of urban logistics using machine learning methods. The research results showed that the public's perception of urban logistics is largely neutral (48%), moderately positive (45%), and negative to a small extent (7%).

When considering achieving customer satisfaction in PL services, this segment has been addressed and examined through only two relevant research papers.

In [44], the authors present an optimisation model based on a genetic algorithm (GA) to predict customer behaviour by predicting the purchase and delivery of products to the nearest distribution centre before the customer places an online order. To achieve the goal of anticipatory delivery, the authors applied predictive analytics, taking into account transportation costs and time, as well as the reliability of the prediction results.

In [54], the authors delved into the B2C segment. To achieve a high level of end-user satisfaction, they addressed the selection of optimal locations and the organisation of postal centre construction. Based on data on the distance between delivery/pickup locations and corresponding postal centres, an approach for organising the postal network is proposed based on the K-means ML method and geoinformation systems for determining the geographic location and the number of postal centres.

Also, only two papers were found and addressed that relate to the issue of achieving satisfaction for both parties [51] and [53].

In [51], the authors present a model for assessing the competitiveness of a logistics company based on ML. They analyse factors such as the developmental environment, related and supporting industries, the government environment and the regional level of informatisation. Predicting competitiveness assists customers in making operator choices, governments and relevant bodies in formulating logistics industry plans, as well as operators in improving their overall competitiveness.

Article [53] presents an analysis and proposal for an application to estimate the delivery times of packages to end users from the warehouse to the destination, based on data provided by Canada Post, the main postal operator in Canada. The database used included data on the source and destination of the package, where routes are not available, and weather conditions for predicting delivery time. For this purpose, the authors applied the random forest (RF) model, convolutional neural networks (CNN), and residual neural networks (ResNet).

By analysing the described models, the application of ML in the context of customer and operator satisfaction can be graphically represented as shown in *Figure 2*.

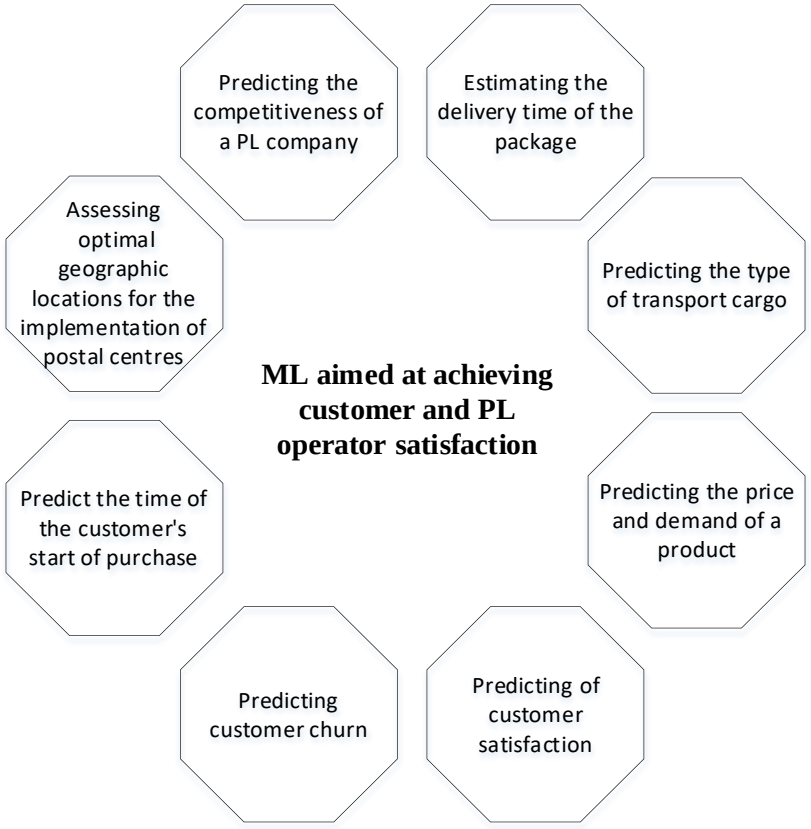

Figure 2 – Machine learning aimed at achieving customer and postal logistics operator satisfaction

A lack of literature was identified regarding the application of ML methods for developing optimal operator selection models based on different user profiles. Notably, there is limited exploration of combined ML methods, such as linear regression, random forest, and gradient boosting, in this area. These methods are particularly applicable and well-suited for developing such models. The research focus should be on predicting how satisfied users will be with the services of different operators. Subsequently, predicted ratings among operators are compared, and the highest predicted ratings are selected.

This allows for the selection of an optimal operator that fly meets the user's wishes and preferences. On the other hand, PL operators can enhance their business activities, create advantages in the market, increase their share and achieve higher profits by making decisions based on predicted user satisfaction ratings.

6. CONCLUSIONS

Contemporary trends in the postal logistics market of urban zones and stricter requirements from customers initiate and generate the application of different business models based on information and communication technologies. The flow of letter, parcel and pallet shipments between postal logistics operators and customers within urban zones creates large databases. It represents the basis for machine learning in postal logistics systems.

This paper highlights the main contributions of machine learning models in postal logistics systems of urban zones to achieve customer and/or operator satisfaction. By examining and analysing, the majority of the researched papers address the issue of applying ML to achieve PL operator satisfaction. When it comes to ML in urban zone PL systems in the context of achieving customer satisfaction, it is concluded that this segment has been addressed and treated through only two scientific research papers. Also, only two papers were found that relate to the issue of achieving satisfaction for both parties – customers and operators.

No paper treats the application of ML methods and algorithms in creating an effective model for selecting PL operators. Such a model would result in the satisfaction of both customers and operators. In this regard, the recommended direction for future research is precisely this area and is explained in more detail in the Findings section.

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Primjena mašinskog učenja u cilju poboljšanja zadovoljstva krajnjih korisnika i poštansko-logističkih operatera gradske zone: Pregled

Sažetak

Mašinsko učenje ključna je komponenta vještačke inteligencije koja u posljednje vrijeme plijeni pažnju svojom primjenom u logistici. Algoritmi mašinskog učenja se koriste na velikim skupovima podataka. Oni stvaraju logične korelacije među zadanim podacima i pružaju predviđanja specifičnih vrijednosti. Cilj ovog istraživačkog rada je provesti sistematski pregled literature kako bi se prikazale potencijalne primjene mašinskog učenja u poštansko-logističkim sistemima gradske zone, s posebnim fokusom na poboljšanje zadovoljstva poštansko-logističkih operatera i korisnika njihovih usluga. Autori su koristili različite baze istraživačkih publikacija u ovom kontekstu (Web of Science, Scopus, Google Scholar, itd). Analiza različitih modela pruža uvid u različite aspekte, poput predviđanja cijena proizvoda i vrsta tereta, evaluacije zadovoljstva korisnika, prognoziranja odlazaka korisnika, ocjenjivanja optimalnih geografskih lokacija za implementaciju poštanskih centara, predviđanja vremena kupovine prije online narudžbi, procjene vremena dostave u posljednjoj fazi logističkog lanca, i mnogo toga. Značaj ovog istraživanja ističe se kroz identifikaciju nedostataka u postojećoj literaturi, nudeći smjernice za buduća istraživanja u razvoju novog modela mašinskog učenja za optimalni odabir operatera. Ovaj model ima za cilj postizanje poboljšanja zadovoljstva kako korisnika tako i operatera istovremeno.

Ključne riječi

mašinsko učenje; city logistika; poštansko-logistički operater; pregled literature.