OVERVIEW OF CRITERIA AND METHODS OF MACHINE LEARNING FOR SUPPLIER SELECTION

Gordana Radivojević [a], Milica Mitrović [a,*], Dražen Popović [a]

[a] University of Belgrade, Faculty of Transport and Traffic Engineering, Serbia

Abstract: *The management and development of relationships with the supplier directly affect the efficiency and profitability of the company's operations. Modern information technologies enable the collection and processing of large amounts of data based on which new information can be created. Consequently, machine learning finds increasing applications in the supply chain. This paper provides an overview of the most common criteria and methods of machine learning in order to select the supplier. The application of machine learning and artificial intelligence can achieve significant optimization of the process in the supply chain.*

Keywords*: supply chain, machine learning, supplier selection, criterion.*

1. INTRODUCTION

Supply chain management is becoming increasingly complex due to the greater competitiveness of companies in the market. In this problem, one of the most important tasks in supply chain management is the problem of supplier selection. Procurement management determines and reviews procurement strategies because the appropriate decision directly depends on the choice of the best supplier among the potential. In the older literature, general criteria for supplier selection can be observed, such as quality, price, delivery, and service. When looking at the newer literature, the authors' concern for the environment is noted, and they are increasingly observing the ecological criteria in selecting a green supplier. Characteristic methods for the supplier selection are the methods of multi-attribute and multi-criteria decision-making, the fuzzy logic, while lately the methods of machine learning are increasingly used.

The aim of this paper is to provide an overview of the criteria and methods of machine learning for selecting the supplier. The paper is organized, in addition to the introduction and conclusion, in four chapters. The second chapter provides an overview of the literature on the criteria and methods of the problem. The third chapter presents the most common criteria, and the fourth chapter describes the most common four machine

* milica.mitrovic@sf.bg.ac.rs

learning methods used to select suppliers, listing the advantages and disadvantages of each. The last chapter contains the conclusion of this review and directions for future research.

2. LITERATURE REVIEW

The methodology for evaluating suppliers consists of conceptual and empirical approaches and modeling techniques (Jayant, 2018). The conceptual approach primarily emphasizes the strategic importance of supplier evaluation according to selected criteria. The empirical approach refers to determining the relative importance of the selected criteria for evaluating suppliers. Modeling techniques, i.e., models used for supplier evaluation, are numerous and can be found in the literature. Most models are used in the final process of selecting suppliers according to a set of defined criteria. In the continuation of the paper, a review of the literature on applied methods and criteria for supplier selection in various industries.

Plebankiewicz and Kubek (2015) conducted a study on the selected supplier of building materials based on AHP (Analytical Hierarchy Process) and FAHP (Fuzzy Analytic Hierarchy Process) methods. The authors took into account a large number of criteria that are subjective, difficult to measure, and in practice can lead to complexity in evaluating suppliers. To avoid problems in assessing the importance of criteria and supplier, the authors proposed the use of the mentioned methods of multi-criteria analysis. The authors classified ten sub-criteria into three groups of criteria: cost, quality, and technical characteristics. According to the defined sub-criteria, they evaluated ten suppliers and determined their ranking. Deshmukh and Sunnapwar (2019) proposed a model, based on the FAHP method, for the selection of a green supplier in the manufacturing industry. Scores of all criteria are given in the form of triangular fuzzy numbers. The FAHP method reduces the inaccuracy in calculating the relative weights assigned to different criteria. The authors evaluated three suppliers. Deshmukh and Vasudevan (2019) state that it is necessary to find the optimal path between industry and the environment. The initial phase is the adequate supplier selection who cares for the environment by reducing waste and using resources that do not pollute the environment. The authors presented the traditional and environmental criteria for evaluating suppliers in the production of plastic products in India. Eight main criteria and forty sub-criteria for supplier selection were used. The results of the model, based on the AHP and FAHP approaches, show that plastics companies focus on cost management, quality, and environmental production. Jayant (2018) proposed a model based on the AHP method for supplier selection in the automotive industry. The author states that procurement managers must periodically evaluate the performance of the supplier to cooperate with the supplier who meets their requirements. The author used four criteria such as quality, cost, flexibility, and reliability, and thirteen sub-criteria to evaluate three suppliers.

Pishchulov et al. (2019) proposed a model for determining the significance of criteria in supplier selection based on a combination of VAHP (Voting Analytic Hierarchy Process) and DEA (Data Envelopment Analysis) methods. The authors defined three groups of criteria for evaluating suppliers in the supply chain, which are: economic, environmental, and social criteria. The authors state that the VAHP method is a tool that helps in the supplier selection and comprehensive monitoring of the development of suppliers, in terms of continuation or termination of cooperation. Çalık (2020) has proposed a model

for selecting a green supplier based on the components of Industry 4.0 by applying the integration of AHP and TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) methods with Pythagorean fuzzy numbers. The author used the Pythagorean FAHP method to determine the weights of the criteria, and the Pythagorean fuzzy TOPSIS method to determine the best supplier. Five suppliers were evaluated in the model.

Jain et al. (2020) created a model based on the Fuzzy Interface System (FIS) and the fuzzy MCDM (Multi-Criteria Decision-Making) approach to assess the sustainability performance of suppliers in the iron and steel industry in India. They used three dimensions of sustainability: economic, environmental, and social. To determine the ranking index of the four suppliers, they created three different FIS models for each dimension of sustainability using the FAHP and fuzzy TOPSIS methods. Omair et al. (2021) proposed a model based on a combined approach of the AHP method and the FIS supplier evaluation system. The AHP method was used to assess the importance of the criteria, and the FIS system was used to determine the ranking index of seven suppliers. Jain and Singh (2019) proposed a model based on the FIS system for supplier selection in the iron and steel industry. The authors used a FIS system that includes a Kano fuzzy model to group the criteria in evaluating supplier performance and selecting the best one. The advantage of the Kano fuzzy model is the identification of the most important sustainability criteria because it makes it easier for decision makers to observe a smaller number of criteria. They defined three groups of criteria for the evaluation of seven suppliers, which are: economic, environmental, and social criteria. Fallahpour et al. (2021) created a hyper-hybrid model based on FDEMATEL (Fuzzy DEcision-MAking Trial and Evaluation Laboratory), FBWM (Fuzzy Best Worst Method), FANP (Fuzzy Analytical Network Process), and FIS system for supplier selection in the palm industry oils in Malaysia. The authors divided 30 criteria for evaluating supplier performance into three groups: general, sustainable, and resilient. Garcia et al. (2018) developed a model based on two evaluation methods for supplier selection. Evaluation methods are the Factor weighting method (FWM) and the FIS system. The results showed the superiority of the FIS system as it allows for better management of inaccuracies and uncertainties in supplier evaluation. The authors used product, price, and delivery criteria to evaluate ten suppliers.

Abdulla et al. (2019) presented an integrated approach to machine learning methods and AHP methods for assessing and selecting the best supplier. The complexity of the supplier selection process is increased by observing a large number of criteria and suppliers. The authors used decision tree algorithms to evaluate the most important criteria, instead of applying the AHP method to a set of all criteria. The results showed that decision tree algorithms can successfully determine the most important subset of supplier selection criteria, thus reducing the complexity of applying the AHP method. Hosseini and Barker (2016) used the Bayesian network to determine the causal relationship between the criteria by which suppliers are evaluated and selected. Primary criteria, green criteria, and resistance criteria were observed. The process of selecting a supplier does not end with finding the desired supplier, but it is a continuous process that aims to monitor and replace existing suppliers with new ones to achieve greater benefits in business. Modern technologies collect, transmit and store information that enables real-time decision-making. It is necessary to identify an effective method for assessing suppliers in today's information society in which everything is shaped by information. In the age of Industry

4.0, efficient results are achieved by processing all collected data using machine learning methods that can analyze large and different datasets (Kiran et al., 2021).

3. CRITERIA FOR SUPPLIER SELECTION

Selected one of several potential suppliers is a strategic decision of the company. There are various criteria in the literature that relates to the performance of the supplier and that the authors present as a rationale in deciding the selection of supplier. Each author proposes several criteria that are evaluated using certain methods and whose analysis results show the importance of the criteria for assessing potential suppliers (Dickson, 1996). Based on the literature review, the criteria and sub-criteria are presented, which are shown in Table 1.

Table 1. Criteria and sub-criteria in the selection of supplier

Criteria	Sub-criteria	References
Quality of delivery	Quality of goods; Delivery timed accuracy; Flexibility; Assortment; Packaging and securing of goods	Taherdoost and Brard, 2019; Fallahpour et al., 2017; Wang et al., 2017; Tirkolaee et al., 2019; Dickson, 1996
Price	The unit price of goods; Terms of payment; Tax; Discount; Costs	Taherdoost and Brard, 2019; Fallahpour et al., 2017; Cengiz et al., 2017; Chen et al., 2018; Dickson, 1996
Location	Geographical distance; Traffic infrastructure; Road speed; Type of transport; Transport conditions and administration	Taherdoost and Brard, 2019; Fallahpour et al., 2017; Cengiz et al., 2017; Dickson, 1996
Reputation	Reliability; Organization; Automation; Financial stability; Environmental and social responsibility	Taherdoost and Brard, 2019; Fallahpour et al., 2017; Wang et al., 2017; Tirkolaee et al., 2019; Chen et al., 2019; Dickson, 1996
Professionalism	Servicing; Providing additional services; Application of information and communication technologies; Responding to disturbance conditions; Compliance with business confidentiality agreements	Taherdoost and Brard, 2019; Cengiz et al., 2017; Dickson, 1996

Delivery can be considered quality when the right goods are delivered, the right quality at the right time. To ensure quality delivery, the supplier must allow flexibility in delivery, a wide assortment of goods, adequate packaging, and security of goods. Flexibility is the adaptability of the supplier in the price of goods, delivery costs, delivery times, etc. Assortment implies the ability of the supplier to provide quality goods to the customer in the right quantity, model, shape, color, etc. To preserve the original quality of the goods, it is necessary to pack the goods and ensure that there is no damage during handling and transport.

Price for the buyer is a very important criterion in selecting the best supplier. The price of the service is influenced by several factors, such as the unit price of goods, payment terms, taxes, discounts, and costs. The unit price of goods means the cost of the product itself. Certain payment terms may facilitate the payment of goods to the supplier by the buyer. Terms of payment for goods are the possibility of cash payment, the possibility of a payment in installments, the possibility of a payment in exchange, and the possibility of a refund. The price of the tax, which affects the price of the provided service, depends on the type and price of the goods, the location of the supplier, etc. The costs include logistics and transport costs, whose reduction contributes to the cost saving of the company or customer.

Location is a criterion that influences the selection of a supplier and can be described by several sub-criteria that can influence the supplier selection process. The first sub-criterion is the geographical distance of the supplier from the customer, which does not have to be a problem if the traffic infrastructure is good in terms of passability and speed of roads. The type of transport implies the possibility of using several types of transport and alternative routes. Increasing attention is being paid to the use of environmentally efficient transport and vehicles. Green transport means that carriers minimize environmental pollution during transport by using environmentally friendly vehicles and green fuels and respecting Euro standards that primarily apply to trucks. Administration refers to customs procedures whose complexity depends on the country in which the supplier is located.

Reputation represents the reputation and position of the supplier in the market that depends on the following six sub-criteria: reliability, organization, automation, financial stability, environmental and social responsibility. The reliability of the supplier is observed based on its work performance, i.e. customer feedback and cooperation with business partners. Organization means efficient decision-making and problem solving. To achieve the most efficient realization of business, it seeks to automate business processes by applying modern technologies. Financial stability refers to the liquidity of suppliers. Environmental and social responsibility means that the supplier uses environmental solutions and smart technologies in the production and transport of goods to minimize emissions and preserve the environment.

Professionalism implies certain competencies or skills of suppliers with which they will consistently fulfill the promised quality. The professionalism of a supplier can be described through the following sub-criteria: servicing, providing additional services, application of information and communication technologies, responding to disturbance conditions, and compliance with confidentiality agreements. The service of servicing goods includes the repair of goods or the possibility of returning damaged goods. The provision of additional services refers to the possibility of processing goods to exceed customer expectations. The technological ability of suppliers is reflected in the use of new technologies and technical resources in business processes. The application of information and communication technologies enables modern business, easy communication, and a simple exchange of information between the supplier and the customer. The use of modern technologies enables monitoring of the realization and visibility of all processes in the supply chain and the possibility of a quick response in the event of a disturbance. Mutual trust and respect for contracts are key to successful long-term cooperation.

Figure 1 shows the procedure for selecting a supplier. The first step is to identify the criteria, and then determine the weight of the criteria. After that, potential suppliers are identified as alternative selections. The next step is to identify methods and develop models in order to select supplier.

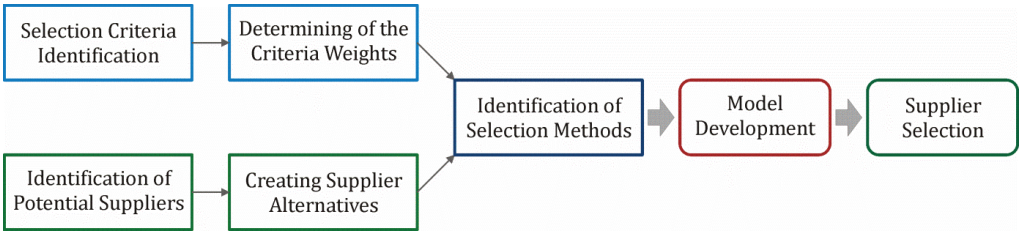

Figure 1. Supplier selection Procedure

4. METHODS FOR SUPPLIER SELECTION

The most common methods in the scientific literature used to select suppliers are (Pal et al., 2013): Methods for prequalification of supplier (e.g. Categorical Methods, DEA, Cluster Analysis), Multi-Attribute Decision Making (e.g. AHP, ANP, TOPSIS, MAUT, Outranking Methods), Mathematical Programming Models (e.g. Linear Programming – LP, Multi-Objective Linear Programming – MOLP, Goal Programming), Artificial Intelligence Methods (e.g. Case Based Reasoning, Artificial Neural Network), Fuzzy logic approaches and combined approaches (e.g. AHP+TOPSIS, AHP+MOLP, MAUT+LP). However, a recent review of the literature noted the use of machine learning methods to select suppliers. Machine learning methods enable work with inaccurate and uncertain data, qualitative and quantitative attributes, and large datasets for model development. Companies use modern technologies that collect large amounts of data in all supply chain processes. Consequently, the use of machine learning methods to make decisions in the supply chain is becoming common practice. The most common methods of machine learning for making decisions about selecting the supplier are (Sepehri, 2020):

- Neural network,
- Bayesian network,
- Support vector machine,
- Decision tree and
- Combined methods.

Neural networks are described as mathematical models for processing information. The development of models based on artificial neural network methods to some extent mimics the way the human brain functions. The processing of information in an artificial neural network is carried out in its elements called neurons. Neural networks are grouped into several layers: the input layer, one or more hidden layers, and the output layer. The input layer consists of nodes called dendrites that correspond to the input variable, and the output layer consists of nodes called axons that correspond to the output variable. The calculation process is performed in the hidden and output layers. That is, hidden nodes receive data from the input layer, combine it with a coefficient or weight that amplifies or minimizes input, and then add the resulting products. Finally, the activation function is applied to the sum to determine the amount of influence of the signal, which traveled

through the network, on the final result (Bousqaoui et al., 2017). Artificial neural networks enable learning from experience, generating and observing important characteristics in input data that often contain irrelevant information. Neural networks can be used for problems of recognition, mapping of input data to output data, grouping, classification, and solving optimization tasks (Teodorović and Šelmić, 2019).

Bayesian networks are a graphical model that helps to judge the presence of uncertainty. That is, Bayesian networks graphically describe networks of patterns and consequences using a set of nodes and a set of causal relationships between variables. The causal relationship between variables can be expressed as a conditional probability. Variables can be based on historical data, expertise, and their combination. Bayesian networks are represented by directed acyclic graphs. In relation to neural networks, there are no hidden nodes in Bayesian network models. Graph nodes represent a set of random variables, and each random variable is an uncertain event. In general, random variables can be discrete or continuous. This method can process both qualitative and quantitative variables (Hosseini and Barker, 2016; Dohale et al., 2021).

The method of support vectors is based on finding a hyperplane that separates data according to different classes to maximize the margin between classes. The margin represents the width of the distance between the two classes that need to be maximized. Supporting vectors represent the data closest to the margin and contribute the most to successful classification. Also, this method based on hyperplane creates a model that predicts which of the classes to the new instance belongs. The idea of this method is that in a vector space using hyperplanes, all data from the same class are on the same side of the plane. The method of supporting vectors is a method of supervised learning that is used for classification and regression analysis (Vujinović, 2019; Nedeljković, 2015).

Decision trees are graphs of decisions and their possible consequences. Each node in the decision tree contains a question that relates to a specific attribute. According to the answer to the question asked, i.e. according to the value of a certain attribute for each individual sample, the set of defined nodes is divided into two subsets and forms two new nodes. The task of this method is to find the optimal question based on which the separation of nodes will be carried out by going through a set of potential questions to make the nodes cleaner after each question asked. The purity of a particular node is expressed in the dominance of one of the classes in the set. The criterion for cessation of branching may be the achievement of an absolutely clean node or a limitation in terms of the maximum number of samples in the last node or the maximum depth of the tree. Nodes that do not have subsets are called leaf nodes. Decision trees are used to develop classification and regression models. In the regression model, the value of the output variable usually represents the average value of the samples in the last node, and in the classification models, it is usually determined as the class that dominates among the samples in the last node (Nosek et al., 2020).

These four methods of machine learning for supplier selection have some advantages and disadvantages among themselves. In Table 2, the first column on the left represents the name of the method, the second column the advantages of the method, and the third column shows the disadvantages.

Table 2. Advantages and disadvantages of four machine learning methods (Du et al., 2019; Ray, 2019)

Method name	Advantages	Disadvantages
Neural network	Nonlinear adjustment; Simple learning rules; Strong robustness; Independent learning; Spreading the error backward; Good parallelism	Inability to judge the process; Unsuitable for a small dataset; Sensitive to initial values
Bayesian network	Good for small datasets; Applicable to multi-classification; Easy implementation; Working with continuous and discrete data	Requiring an assumption for the uncertainty condition leads to less accuracy; Poor performance classification
Support vector machine	Suitable for nonlinear classification; Applicable to classification and regression problems; Easy to understand; Minor errors in generalization	Sensitive to functions and parameters; Performance declines with a large dataset; Long training time
Decision tree	Easy calculation and handling of missing value attributes; Evaluates different attribute characteristics; Strong interpretability	Problem overfitting; Unstable tree size control; Local optimal solution

5. CONCLUSION

Based on the literature review, it can be concluded that the most common criteria for evaluation and supplier selection are quality of delivery, price, geographical distance, reputation, and professionalism. In the literature, in addition to traditional methods for selecting suppliers, machine learning methods are increasingly used. Modern technologies collect large amounts of data that can be processed in an "intelligent" manner by methods of machine learning and therefore make business decisions. Each method has disadvantages and advantages, in terms of compatibility in applying to a particular dataset and problems.

In future research, a combined model based on traditional and machine learning methods can be created to evaluate and select criteria and suppliers in the supply chain. Machine learning enables the processing of large amounts of data and contributes to the decision-making process.

ACKNOWLEDGMENT

This work was supported by the Ministry of Education and Science of the Government of the Republic of Serbia through the projects TR 36005 and TR 36006 for the period 2011-2022.

REFERENCES

[1] Abdulla, A., Baryannis, G., Badi, I., (2019). Weighting the key features affecting supplier selection using machine learning techniques. The seventh international

conference transport and logistics, University of Niš faculty of mechanical engineering.
[2] Bousqaoui, H., Achchab, S., Tikito, K., (2017). Machine Learning applications in supply chains An emphasis on neural network applications. International Conference of Cloud Computing Technologies and Applications. IEEE.
[3] Çalık, A., (2020). A novel Pythagorean fuzzy AHP and fuzzy TOPSIS methodology for green supplier selection in the Industry 4.0 era. Soft Computing 25(3), 1-13.
[4] Cengiz, A.E., Aytekin, O., Ozdemir, I., Kusan, H., Cabuk, A., (2017). A Multi-Criteria Decision Model for Construction Material Supplier selection. Procedia Engineering, 196, 294-301.
[5] Chen, Y., Wang, S., Yao, J., Li, Y., Yang, S., (2018). Socially responsible supplier selection and sustainable supply chain development: A combined approach of total interpretive structural modeling and fuzzy analytic network process. Business Strategy and the Environment 27(8), 1-12.
[6] Deshmukh, A.J., Vasudevan, H., (2019). Supplier selection in Plastic Products Manufacturing MSMEs Using a Combined Traditional and Green Criteria Based on AHP and Fuzzy AHP. , Proceedings of International Conference on Intelligent Manufacturing and Automation, 593-600.
[7] Deshmukh, S., Sunnapwar, V., (2019). Fuzzy Analytic Hierarchy Process (FAHP) for Green Supplier selection in Indian Industries. Proceedings of International Conference on Intelligent Manufacturing and Automation, 679-687.
[8] Dickson, G.W., (1996). An Analysis Of Vendor Selection Systems And Decisions. Journal of Purchasing, 2, 5-17.
[9] Dohale, V., Gunasekaran, A., Akarte, M, Verma, P., (2021). An integrated Delphi-MCDM-Bayesian Network framework for production system selection. International Journal of Production Economics, 242.
[10] Du, N., Xiao, Z., Lim, M.K., (2019). A systematic review of the research trends of machine learning in supply chain management. International Journal of Machine Learning and Cybernetics, 7, 1-20.
[11] Fallahpour, A., Nayeri, S., Sheikhalishahi, M., Wong, K.Y.,Tian, G., Fathollahi-Fard, A.,M., (2021). A hyper-hybrid fuzzy decision-making framework for the sustainable-resilient supplier selection problem: a case study of Malaysian Palm oil industry. Environmental Science and Pollution Research, 1-21.
[12] Fallahpour, A., Olugu, E.U., Musa, S.N., Wong, K.Y., Noori, S., (2017). A decision support model for sustainable supplier selection in sustainable supply chain management. Computers & Industrial Engineering. 105, 391-410.
[13] Garcia, N., Puente, J., Fernandez, I., Priore, P., (2018). Suitability of a Consensual Fuzzy Inference System to Evaluate Supplier of Strategic Products. Symmetry, 10(1), 1-20.
[14] Hosseini, S., Barker, K., (2016). A Bayesian Network Model for Resilience-Based Supplier selection. International Journal of Production Economics, 180, 68-87.
[15] Jain, N., Singh, A.R., (2019). Sustainable supplier selection under must-be criteria through Fuzzy inference system. Journal of Cleaner Production, 248(1), 1-20.
[16] Jain, N., Singh, A.R., Upadhyay, R.K., (2020). Sustainable supplier selection under attractive criteria through FIS and integrated fuzzy MCDM techniques. International Journal of Sustainable Engineering, 1-22.
[17] Jayant, A., (2018). An Analytical Hierarchy Process (AHP) Based Approach for Supplier selection: An Automotive Industry Case Study. International Journal of

Latest Technology in Engineering, Management & Applied Science (IJLTEMAS), 7(1), 102-114.
[18] Kiran, M.S., Eşme, E., Torğul, B., Paksoy, T., (2021). Supplier selection with Machine Learning Algorithms. Taylor & Francis. 103-125.
[19] Nedeljković, A., (2015). Implementation and evaluation of machine learning algorithms for spam filtering. Master paper. University of Belgrade, Faculty of Mathematics.
[20] Nosek, T., Brkljač, B., Despotović, D., Sečujski, M., Lončar-Turukalo, T., (2020). Machine learning practicum. University of Novi Sad, Faculty of Technical Sciences.
[21] Omair, M., Noor, S., Tayyab, M., Maqsood, S., Ahmed, W., Sarkar, B., Habib, M.S., (2021). The Selection of the Sustainable Supplier by the Development of a Decision Support Framework Based on Analytical Hierarchical Process and Fuzzy Inference System. International Journal of Fuzzy Systems, 23(7), 1-18.
[22] Pal, O., Gupta, A.K., Garg, R.K., (2013). Supplier selection Criteria and Methods in Supply Chains: A Review. International Journal of Economics and Management Engineering, 7(10), 2667-2673.
[23] Pishchulov, G., Trautrims, A., Chesney, T., Gold, S., Schwab, L., (2019). The Voting Analytic Hierarchy Process revisited: A revised method with application to sustainable supplier selection. International Journal of Production Economics, 166-179.
[24] Plebankiewicz, E., Kubek, D., (2015). Multicriteria Selection of the Building Material Supplier Using AHP and Fuzzy AHP. Journal of Construction Engineering and Management, 142(1), 2-7.
[25] Ray, S., (2019). A Quick Review of Machine Learning Algorithms. International Conference on Machine Learning, Big Data, Cloud and Parallel Computing. IEEE, 35-39.
[26] Sepehri, S., (2020). Supplier selection and Relationship Management: An Application of Machine Learning Techniques. Master of Science in Management (Operations and Information Systems), Faculty of Business, Brock University St. Catharines, Ontario.
[27] Taherdoost, H., Brard, A., (2019). Analyzing the Process of Supplier selection Criteria and Methods. Procedia Manufacturing, 32, 1024-1034.
[28] Teodorović, D., Šelmić, M., (2019). Computer intelligence in traffic. University of Belgrade, Faculty of Transport and Traffic Engineering.
[29] Tirkolaee, B.E., Mardani, A., Dashtian, Z., Soltani, M., Weber, G.W., (2019). A Novel Hybrid Method Using Fuzzy Decision Making and Multi-Objective Programming for Sustainable-Reliable Supplier selection in Two-Echelon Supply Chain Design. Journal of Cleaner Production, 1-56.
[30] Vujinović, O., (2019). Search for axions on the ATLAS experiment using machine learning methods. Master paper. University of Novi Sad, Faculty of natural sciences.
[31] Wang, T.K., Zhang, Q., Chong, H.Y., Wang, X., (2017). Integrated Supplier selection Framework in a Resilient Construction Supply Chain: An Approach via Analytic Hierarchy Process (AHP) and Grey Relational Analysis (GRA). Sustainability, 9, 1-26.