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Classification of Vehicle Routing Problems as a Concept of a Decision-Making Tool in Distribution Logistics

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Abstract

The article follows an extensive investigation of individual variants of Vehicle Routing Problems (VRP) in distribution logistics. The paper aims to use the existing research and the developed VRP classification to design a new concept of decision tool. The research methods are analysis, synthesis, induction, deduction, comparison, and expert interviews. The tool will be able to provide quick information to the professional public and users without prior knowledge based on a created and easily accessible decision-making environment. In this article, user-flexible and fully or partially free options including the structure of concept of decision tool are presented. They will enable developers to prepare an efficient solution that guides the user through the VRP database using the form.

Keywords

Classification; Vehicle routing problem; Decision-making environment; Data filtering.

Introduction

Distribution logistics is a vast and dynamically changing field. In this connection the vehicle routing problem (hereinafter VRP) was chosen for deeper study due to its variety and diversity. The key elements of VRP are capacity, time windows, demand variability, cost efficiency, and overall flexibility. However, the main challenge is to optimize the vehicle's route, which must serve the customer according to his requirements and minimize the total transportation cost while satisfying the constraining conditions. It is, therefore, necessary to plan the route to meet the capacity constraints of the vehicles; respect the (specific) time windows in which customers can be served; adapt the circuit to different amounts of demand; minimize the total cost of operation - fuel, wages, or vehicle maintenance. Thus, flexibility refers to responding quickly to changes or unplanned events. (Tan & Yeh, 2021)

VRP is mainly used to distribute goods, collect waste, deliver food, courier services, supply shops, and perform maintenance and service. Effective VRP solutions ensure cost efficiency, customer satisfaction, and high service quality. These are critical factors for successful logistics operations. Specific impacts of VRP on overall costs include reduced fuel costs, reduced or better utilization of working hours, reduced wear and tear and subsequent repairs of vehicles, optimization of vehicle capacity, reduction in the number of vehicles, minimization of delays and potential fines, improved quality of service and finally reduction of emissions and environmental costs (Tan & Yeh, 2021). Moreover, implementing an efficient VRP leads to significant financial savings. For example, efficient route planning for supplying the business community will reduce transport costs by up to 10-20%. Optimized routes for waste collection and recycling will reduce fuel and labor costs by 15-25%, as reported in (Puri, 2023). Besides, courier companies achieve a 10-15% reduction in overall costs with better route planning (Kant et al., 2008).

In the real world, distribution companies combine intuitive approaches with exact methods because purely algorithmic or expert systems may not always fully cover all aspects of their complex operations. They must be very flexible and react to changes in demand or unexpected situations. This may involve ad hoc decision-making and reallocating resources based on the current situation, rather than strict adherence to predetermined plans. Examples show (Salas et al., 2010) that while distribution companies use technology and expert systems, hands-on experience, intuition, and manual intervention are still a key part of their day-to-day operations. Consequently, managers in distribution companies often use their years of experience and intuition to make decisions supported by data analytics. For example, they can apply their knowledge of historical sales trends when planning seasonal inventory while using forecasting models to validate their estimates.

The author's original intention was to subdivide the VRP offered by the contribution of Plevný (2013). During the analysis, the overview of the essential eight VRPs was supplemented by the periodic VRP, which has experienced a significant expansion in recent years (Gutiérrez-Sánchez & Rocha-Medina, 2022). The often-mentioned environmental restrictions should also be better explained. The uniqueness of this article is explained by the fact that the data collected by the author in the research did not reveal any correspondence with the studies presented before (Tan & Yeh, 2021).

This article explores the development of VRP classification and aims to propose a new decision-making concept. The results of a systematic review of literature related to the topic from 1970 to 2022 are introduced in Subsection 1. The research methodology, including analysis, synthesis, induction, and deduction of theoretical approaches and expert interviews, can be found in Section 2. Section 3 focuses on artificial intelligence applications that aim to assist developers and users in identifying specific VRP variants. It proposes a VRP classification concept structured around three pillars for use in distribution logistics. Finally, this is followed by a discussion (see Section 4) and a conclusion emphasizing the uniqueness of the decision-making tool proposed in the field.

1 Literature Review

Currently, the general public does not have a tool to make it easier to select the type of VRP they seek. Expert systems have this tool, but it is difficult for the general public to access due to the purchase price. For example, **Freight Management Systems** (FMS) allow for the real-time monitoring and management of transport operations. A charming comparison is offered by Škabić et al. (2018), who analyzed three types of FMS – Mobilises, CVS Mobile, and My GPS. Distribution companies use simulation software for traffic modeling. These can be PTV Vistro or VISUM. PTV Vistro is the software mentioned in transportation modeling by Yulianto et al. (2018). Programming languages such as **Python**, mentioned in Benítez-Hidalgo et al. (2019), MATLAB in Farizal et al. (2023), and C++, mentioned in Koguma (2024) have been successfully used directly for solving VRPs. They can find the optimal route and minimize transport costs or transport times.

Specialized tools may be unaffordable for the general public or students. Several cheaper options and approaches may be more affordable for individuals. For example, open-source solutions are available for route optimization (Stančić et al., 2023). These are software tools with the **OptaPlanner** project (Jubé et al., 2023) that can provide comprehensive optimization and planning functions but not for selecting a suitable VRP option based on known model parameters. The primary programming language used in OptaPlanner is Java. Thanks to its interoperability, it is also possible to use the Kotlin programming language. Finally, there are opportunities to contact university departments of transport engineering that can provide computational resources or software for research purposes.

All acquisition-intensive and more affordable simulation, optimization, and planning options are mentioned. Even the more cost-effective alternatives provide some functionality for route optimization and VRP design (Sun et al., 2022; Jena, 2024). However, none of them will allow the general public, without prior knowledge, to access a decision environment where the type of VRP can be easily and freely determined. Thus, this affluent area of distribution logistics is introduced without the need for users to have prior knowledge of VRP issues or to operate the decision environment.

2 Methodology

2.1 Classification of Vehicle Routing Problems

The author has applied the analysis, synthesis, induction, and deduction in this article.

In this case, **analysis** means determining the basic areas of the VRP into individual components and examining to what extent the parts are elaborated and published. It also means examining their interrelation or identifying deviations and differences, i.e., exploring. The analysis was to relate the research work to the literature.

Synthesis required a thorough understanding of the general divisions and the appropriate assembly of the parts into a comprehensive whole. It was also necessary to describe the organizing principles that guided the overall concept to the individual parts.

Induction was used to generalize the data and in the systematic search associated with the VRP concept. The result is the identification of a specific breakdown of VRP types and their grouping according to related features. In addition, the following two methods of inquiry were necessary: **qualitative interviewing** and **expert interview**.

Deduction was used to determine the key specifics of each method. The theory identified so far from the research was applied, and the comparison method was used to assess and compare the relationships between the secondary data obtained from the literature searches and the partially obtained primary data from interviews with subject matter experts.

Moreover, synthesis and induction/deduction were carried out simultaneously or in some sequence. Using synthetic methods, new research areas could be derived for further elaboration by induction and deduction.

To get a comprehensive idea of the area discussed, articles and contributions, both domestic and foreign, were mapped. Duplications were removed from the searched contributions, and relevant outputs were processed into an overview summarizing the issue. For the target classification, subject databases needed to be limited and divided according to the structure of mathematical models and specifications.

The classification is based on nearly 300 articles published from the 1970s to 2022. The first phase of the research was completed in 2022, and the second phase is working on the real use of the VRP classification as a decision-making tool concept. New findings from 2023-2025 will be processed after the second phase is completed and incorporated directly into the existing tool's database. In terms of the review articles themselves, Braekers et al. (2016) are worth mentioning as they presented a taxonomic review of the literature on VRP published between 2009 and June 2015. Dynamic VRP is addressed in Psaraftis's review paper

(Psaraftis , 1995). The paper presents a comprehensive review of the VRP literature for 2015-2021, focusing on applications and solution methods. In the case of robust VRPs (RRVRPs), Min et al. (1998) aim to provide a comprehensive and relevant taxonomy for literature and propose a refined definition of RVRPs.

During the search, VRP has grown considerably in recent years. This is a periodic VRP (referred to as PVRP). Therefore, the division's original intention is extended by modifying this problem according to Gutiérrez-Sánchez & Rocha-Medina (2022) and supplemented with new findings. The basic VRP variants are Capacitated VRP, VRP with time windows, VRP with pick-up and delivery, periodic VRP according to Gribkovskaia et al. (2008), multiply depot VRP, split delivery VRP, stochastic, dynamic and open VRP. The listed types of VRP were further divided into further subclasses. This is a breakdown of the VRP classes listed according to the publications available in the databases of professional articles. For the decision-making process, which includes the mentioned concept, considerable knowledge of VRP variants is necessary, achieved during the creation of the classification itself.

2.2 The Use of Artificial Intelligence

Due to the large number of individual VRP variants, artificial intelligence services are possible. They offer the user several options.

General Artificial Intelligence (GAI) is usually defined as an artificial intelligence capable of performing any intellectual task that a human can. Unlike **narrow AI** systems designed for specific tasks, GAI has broad capabilities and flexibility. However, in the context of distribution logistics and the vehicle routing problem (VRP), GAI will not be foreseen soon.

Another variant is **Machine Learning** (ML) algorithms, used for demand forecasting, inventory optimization, and traffic conditions prediction. These algorithms use historical data and models to learn and improve their predictions (Bai et al., 2023), which can help in VRP decision-making. **Deep Learning** (DL) is a more advanced form of machine learning that uses neural networks with many layers. **Natural Language Processing** (NLP) technologies analyze text data, process customer requests, and automate communications (Chin et al., 2024). In the context of VRP, NLP can help analyze customer reviews, predict demand, and improve customer support.

GAI/Language Processors are also used in VRP classification. For example, large language models such as GPT-4 can help process and analyze large amounts of textual data such as customer orders, feedback, and logistics documents. Decision Support in AI systems can provide recommendations based on historical data and current conditions (Canoy et al., 2023). NLP technologies can interact with customers via chatbots, improving customer service and quickly responding to delivery queries. Further, AI tools can automatically generate and monitor key performance indicators (KPIs) such as delivery cost, delivery time, and customer satisfaction (Klabusayová, 2013). As a concept, GAI is not envisioned for VRP soon, but current AI tools and language processors (NLP) provide significant advantages. They help with data processing, decision support, customer interaction, KPI monitoring, and algorithm optimization. The results of these tools need to be expertly assessed to ensure their reliability and effectiveness in specific logistics scenarios.

Although the possibilities of using **Large Language Models** (LLM) in distribution logistics and solving Circular Transportation Problems (CTP) are still limited compared to specialized optimization tools, several promising directions remain. LLMs can help with pre-processing and structuring textual data relevant to VRP. LLMs can be used as part of a broader decision framework where they prepare data or parameters for optimization algorithms (Tupayachi et al., 2024). LLMs help generate summaries or explanations of complex optimization results

(Ackerman et al., 2024). Overall, LLMs today do not provide a direct VRP solution (they do not perform optimization independently at the level of mathematics and heuristics). However, they can significantly support pre- and post-optimization phases, simplify communication, data, and result interpretation, and make decision-making based on VRP solutions more understandable and flexible.

2.3 Classification of Vehicle Routing Problems as a Decision-Making Tool

Classification represents a significant number of vehicle routing problems that distribution logistics offers. There has also been a significant increase in other modifications of these problems in recent years. The mentioned trend can be expected in the future as well. The professional public or distribution companies are well-informed in this area. In their case, detecting or determining the type of VRP is easy. However, the general public can encounter many pitfalls when making decisions. If the circuit is not correctly set and solved, getting a relevant solution is impossible. Artificial intelligence can be a specific tool. Here, however, it is necessary to recall the necessity of control based on knowledge in the given area.

The goal of the concept is to enable a standard user without prior knowledge to identify the current situation and use the offered solution easily. It will offer rooting of the problem and identify approaches and results for the professional public. It will help to compare one's research with already published works. After a deeper analysis, it will be possible to discover a theoretically unworked problem and work on its formulation further. The article describes the creation of a decision tool concept. Acquisition of knowledge is essential for the mentioned form of creation. They are based on VRP classification and elaborate on it further.

Two options were considered for the correct form of the concept. The first option was to design the work according to the VRP taxonomy of type designations (variants). The second option involved thinking of the problem as a complex group of restrictions and requirements that must be set correctly according to the original classification to select in the next step.

In the case of VRPs, no common standardized system would guarantee an accurate classification in terms of taxonomy. No uniform notation convention is used. In literature, it is common to find a problem whose mathematical model exactly corresponds to another published problem, but the notation is different. During the literature survey, some publications were found, the content of which was very detailed but only at the level of basic types of VRP (Eksioglu et al., 2009) or, in contrast, complex but narrowly specialized (Vidal et al., 2013). Designation of VRP variants by prefixes or suffixes that indicate the presence of restrictions is used mainly for basic types. Identifying other levels is often very difficult, so some variants are given with unambiguous phrases even in the classification. We can find various approaches (Psaraftis, 1995; Min et al., 1998). A very successful proposal for recording problems is presented in the publication (Cherif-Khettaf et al., 2015). The work mentioned proposes a formal notation of problems that would unify and simplify the identification. However, the use in theoretical practice is quite different. Therefore, moving in the direction of decision-making based on the VRP designation proved challenging to implement.

The draft concept is not intended to resolve the taxonomy of VRPs. The comparison of the different types of designations was outlined mainly because it was one of the options for designing the structure of the concept. However, due to the inconsistent notation, it cannot be taken as a classification system. All would have to use taxonomy uniformly. The above-mentioned publications help this. However, if this way of writing is not normatively addressed, the labeling is still different. The concept of three pillars, where the attributes of the VRPs are clearly defined, and sorting occurs based on these attributes, proved to be better.

The second direction is based on the correct distribution of system requirements, the structure of the given problem, and related requirements or optimization goals. Based on the parameters set in this way, a concept was created that includes all the mentioned areas.

The concept is divided into three fundamental pillars that are characteristic of VRP. The first pillar is basic system requirements and resources. The second pillar is the structure of the problem; the third pillar consists of constraints and optimization goals. The concept presented is not a tool for route optimization itself, nor does it explore using optimization methods and models as contributions. This supports an effective search and recognition of the type of VRP or a deeper analysis. Jablonský (2014) addresses a similar issue.

The classification itself serves as a framework for creating the concept's structure. Based on it, three pillars have been developed that contain the basic attributes for defining a VRP variant. A given problem is placed in each category, which, by its very nature, captures the essence of the VRP. Some VRPs are placed in several categories/sub-categories, while other specific VRPs are placed in only one category.

```
from ortools.constraint_solver import pywrapcp

def create_data_model():
    data = {
        'distance_matrix': [...],
        'demands': [...],
        'vehicle_capacities': [...],
        'num_vehicles': ...,
        'depot': 0
    }
    return data

def create_vrp_model(data):
    manager = pywrapcp.RoutingIndexManager(len(data['distance_matrix']),
                                           data['num_vehicles'],
                                           data['depot'])
    routing = pywrapcp.RoutingModel(manager)

    # Adding limitations and rules
def demand_callback(from_index):
        return data['demands'][manager.IndexToNode(from_index)]
    routing.AddDimensionWithVehicleCapacity(
        demand_callback,
        0,  # no capacity
        data['vehicle_capacities'],  # vehicle capacities
        True,  # start cumul to zero
        'Capacity')

return routing
```

Source: Own

Fig. 1: *Example of source code in Python programming language*

The first version is indeed intended for the already existing VRP variants according to the developed classification. The general approach to the extension includes requirements analysis, selection of a suitable open-source tool, implementation of the new type of VRP using available APIs and tools, definition of the new data structure, variables, and constraints, and testing and validation to ensure correctness and efficiency. In the case of this developed concept, the subsequent combination of new species and their integration into the concept structure will follow the following scenario:

1. Definition of categories/sub-categories representing new VRP types, for example, new types of vehicles or customers with new attributes.
2. Definition of the model using Python; new constraints and rules can be added using the API. The general Python code notation is shown in Figure 1.
3. Customizing constraints will require using annotations and custom rules to define new constraints and rules for optimization. For example, new constraints can be added for time windows, vehicle capacities, or special customer requirements.

When creating a concept, an important factor is identifying the target group for which the given tool is chosen. If the form is aimed at the professional public, the wording of the questions will not be understandable for students and the public. It is necessary to find such terms that it will not be necessary for an ordinary user to search for a long time or to get help from experts. The material created has a motivational, informative, and, finally, educational character. The form includes notes and explanations to ensure comprehensibility and overview, which may help understand the question correctly and assign the corresponding requirement or restriction.

Therefore, the tool will fulfill an educational function simultaneously. Due to the need to connect the theory and practice of using the tool, it is necessary to determine the target group to which the created tool can be presented and allowed to be tested. Furthermore, the tool will be subjected to a review to ensure a higher quality of the material created. After incorporating comments, an evaluation of the tool's contribution to theory and practice will take place.

3 Results

3.1 The Concept Structure

The advantage of the concept is the follow-up to the extensive research of VRP variants. The classification shows greater detail, as evidenced by the many sublevel series of VRP variants. The work provides enough information for the intended concept. The VRP variants are divided according to the characters into three main pillars. The listed pillars are processed into components at four levels of categories and subcategories so that each VRP can be included in at least one component. The branching of pillar categories is shown in Figure 2. The processing of information and decision-making materials can take many forms. The electronic version appears promising, considering the purpose of use, content, and importance for further use. In addition to ease of use, this version will ensure future updates.

1. System Requirements and Resources	2. Structure of the Problem	3. Specific Limitations and Objectives
1.1 Capacity	**2.1 Vehicles**	**3.1 Unserved customers**
1.1.1 exceed	2.1.1 one vehicle	3.1.1 one and more
1.1.2 not exceed	2.1.2 more than one vehicle	3.1.2 not exceed
1.2 Time windows	2.1.2.1 homogenous fleet	**3.2 Traffic conditions**
1.2.1 VRP without time windows	2.1.2.2 heterogeneous fleet	3.2.1 stochastic
1.2.2 VRP with time windows	2.1.3 non-specific number	3.2.2 dynamic
1.2.2.1 fixed delivery time	**2.2 Demand**	**3.3 Decision-making authority**
1.2.2.2 simple time windows	2.2.1 number of product types	3.3.1 driver
1.2.2.3 soft time windows	2.2.2 one commodity	3.3.2 dispatcher
1.2.2.4 multiple time windows	2.2.3 more different products	**3.4 Network level**
1.3 Pick-up/Delivery	2.2.4 location	3.4.1 single level
1.3.1 delivery only	2.2.4.1 on nodes (VRP)	3.4.2 two levels
1.3.2 pick-up and delivery	2.2.4.2 on edges (ARP)	3.4.3 three levels
1.4 Period	2.2.4.3 combination	3.4.4 multi-level
1.4.1 one day	**2.3 Cost of service**	
1.4.2 more days	2.3.1 time at the customer	
1.5 Warehouse type	2.3.2 loading/unloading	
1.5.1 depot	2.3.3 fixed costs	
1.5.2 warehouse	2.3.4 costs proportional to the size of the load	
1.5.2.1 backhaul	**2.4 Transportation costs**	
1.5.2.2 cross-dock	2.4.1 proportional distance	
1.5.2.3 combination	2.4.2 proportional to the transport time	
1.6 Stochasticity	2.4.3 another case	
1.6.1 known requirements	**2.5 Reverse logistics**	
1.6.2 random requirements	2.5.1 return services	
1.7 Circuit options	2.5.2 environmental improvement	
1.7.1 closed circuit	2.5.3 local dependency	
1.7.2 open circuit	2.5.4 service	
1.8 Specific requirements		
1.8.1 asymmetry		
1.8.2 priority		

Source: Own

Fig. 2: *The concept structure*

3.1.1 The First Pillar: System Requirements and Resources

The first pillar specifies the basic requirements of the VRP, which is one of the nine main types of VRP offered to the user.

Capacity – The default data for this requirement are the cases where the vehicle capacity is and is not exceeded.

Time windows – In this case, the problem can be solved with and without time windows, and the subsequent specification of the time windows includes a choice of simple time windows and costs that we add to the depot and individual customers, as well as time windows with a fixed delivery time, with a more significant number of time windows, and with soft time windows. The latter requirement allows for a slight discrepancy with the schedule.

Pick-up/Delivery lists two options: whether or not it is possible to return/store the commodity at the customer's place at the same time.

Periodicity – The type of route planning for one day or an extension for several days is considered here.

Warehouse – This is the definition of deliveries from one or more warehouses. Clarification is needed within the terminology. The depot indicates the starting depot from which the circuit is made and to which the vehicle is returned. By warehouse, it meant any warehouse, i.e., especially those located directly on the vehicle's route. As the next level of the Warehouse item, the type will be backhaul, cross-dock, or a combination thereof. The mentioned terms must be concerning their English names explained in the form.

Stochasticity within VRP is characterized by the presence of random data. For effective decision-making, known requirements are offered at the beginning of the process, and a variant is when all requirements are not known at the beginning. So, it is assumed that they will change during delivery.

Circuit options offer a closed circuit when the vehicle returns to the starting depot and an open circuit when it does not return to the starting depot after the end of delivery.

Specific requirements – In this category, VRP prerequisites that do not fall into the previous requirements but clearly define a specific type of VRP were included. This is the VRP asymmetry or customer priority order.

3.1.2 The Second Pillar: Structure of the Problem

The second pillar specifies the next level of the basic VRP selected in the first pillar in more detail based on the problem's structure. This is a classification in the second or third level of classification.

Vehicles must be specified in terms of number: one vehicle, a fixed number higher than one, and an unspecified greater number of vehicles. Furthermore, it is necessary to determine the type of fleet, whether it is homogeneous or heterogeneous.

Demand is represented by four subcategories. The number of product types (1) can be the transport of one commodity or several different products. The location of requests (2) can be on nodes (VRP), edges (ARP), or a combination of both. Service costs (3) can be equal when the vehicle stops at the customer's place, or they can be loaded/unloaded. Costs can be fixed or directly proportional to the size of the load. Transport costs (4) can be proportional to the distance and transport time, or it is negotiated in another case.

Reverse logistics considers the possibility of standard problems with time windows, local dependencies, problems involving service, and a multi-warehouse variant of the problem. The prerogative of reverse logistics is primarily the area of return services and issues related to improving the environment.

3.1.3 The Third Pillar: Constraints and Optimization Objectives

The formulation of specific limitations and objectives characterizes the third pillar. It generally leads to a narrow circle of problems that are privileged or unusual due to their mathematical model.

The number of unserved customers represents a selective limitation of the problem (Cherif-Khettaf et al., 2015). In this variant, not all customers are necessarily served, as the capacity of the vehicles does not allow this.

Traffic conditions must be specified, especially if they are stochastic or dynamic. Default problems do not consider traffic conditions.

Decision-making authority may be a vehicle driver on the route or an experienced dispatcher responding to stochastically or dynamically changing customer requirements.

Number of network levels – Most VRPs consider single-level networks (Cherif-Khettaf et al., 2015). Some variants enable multi-level networks within the management of supplier-customer chains. Intermediate warehouses usually handle this variant.

3.2 Decision-Making Environment

In the first phase, it was important to find the environment where the decision-making process would occur. Software programs have two fundamental disadvantages. The first one is a significant financial requirement. Another disadvantage is the dependence on the development company in case of any system change. Therefore, searching for a freely available environment directly guides users to download a program or application for free. However, this environment must meet the requirements set for it by the author of this publication. There is the option of a decision-making program or application, a web interface, or an environment like an e-shop where users can filter VRP according to various parameters.

3.2.1 Decision-Making Programs and Applications

The first variant is classic processing using **Excel/Google Sheets**, which offers a familiar environment where it is possible to create a table with products and various parameters and then use the filtering and sorting functions in Excel or Google Sheets. The given environment is readily available and, with the help of the other applications, allows for various multi-criteria decision-making options, as reported by Jablonský (2014). With the Excel **Solver add-in** and possibly the **Sanna** application, it is possible to perform multi-criteria evaluation of alternatives.

OpenRefine is open-source software for data editing and cleaning. Suppose the creator of the decision-making environment has programming knowledge in **program R** (Wickham & Grolemund, 2023). It is possible to create an interactive decision-making environment using packages such as **Shiny** (Chilimoniuk et al., 2024), which allows the creation of interactive web applications.

The **Python** programming language offers, as in the case of R, the creation of an interactive decision-making application using libraries such as **Pandas** for data manipulation and **Dash** (Jin et al., 2023) or **Streamlit** for creating interactive web applications.

Likewise the open-source **Anaconda** platform in R or Python (Kadiyala & Kumar, 2017) the **Airtable** platform offers data management options. It combines the properties of spreadsheet systems with database functionality and options for filtering and sorting data according to various parameters.

When creating an environment for deciding and filtering products online, it is possible to use **WordPress** together with the **WooCommerce plugin**, as seen in (O'Riordan et al., 2023). WooCommerce allows easy website management, including filtering products according to various parameters. WordPress is free, but WooCommerce often has hosting costs and plugin payments. With the increasing demands for Android smartphones and apps, this environment is very advantageous from a user perspective and a processing perspective, especially when converting a web interface to an equivalent mobile application (Dehghani & Kolahdouz-Rahimi, 2019).

The above-mentioned variants can offer the creator a space suitable for preparing a decision-making environment according to his needs and preferences. This will enable the creation of a decision-making module for users who will be able to filter individual VRPs according to various parameters.

3.2.2 Web Interfaces

The web interface is currently easily accessible. It offers the user an environment in which he is used to working and having fun, which is very promising. When placing the decision-making environment on a website, one can consider one of the many options offered.

A custom website with its code is the easiest option. VRP filtering is implemented on the web page using **HTML**, **CSS**, or **JavaScript**. This option will provide maximum flexibility but requires knowledge of web development.

Many **Content Management Systems** (CMS) with a plugin or extension allow you to create an environment for product decision-making and filtering. These are, for example, the aforementioned **WordPress**, **Joomla**, or **Drupal**. External services or APIs (services that are directly part of programming applications) provide data filtering and sorting functions integrated into custom web pages.

Creators' choice options are limited by knowledge and budget. Specific solutions can also be obtained by combining the various approaches mentioned. For example, a CMS with a plugin and custom code for further modifications is offered.

3.3 Database of Variants

A database is a table or list of data that allows for recording information and further work with it as needed. The given data must be related. By data, we mean data that specifies a given attribute. An attribute is a property monitored for a given VRP and must be recorded to distinguish it from other types. As a rule, they form table columns; they can take on different (predetermined) values or be of different data types. In this case, especially the verbal description. The primary key that identifies a record is the table row. This is a taxonomic designation or unambiguous phrase that indicates the type of VRP according to the previous classification.

The classification itself is created as a hierarchical data model. Data is organized into a tree structure. Each record represents a variant of the VRP in a tree structure, and the mutual relationship between the records is at several levels of breakdown. Finding data in a hierarchical database requires searching through the basic variant of VRP towards lower levels and back and to the sides to further lower levels. This entails a more complex operation of inserting and deleting records and a higher demand for data organization. The data stored in it must be consistent with the given rules. To effectively use the list, it is necessary to create a table (list) uniformly for all VRP variants. When creating the list, it is necessary to determine what information will be monitored. In the case of a list, these are items with a large amount of information, so the unity of the record is necessary for subsequent filtering. An empty entry cell indicates the selection of all values. Only data that meets the primarily defined criteria can be entered. It is necessary to respect the limitations of admissible information, or the data typeset for the value column. The previously defined three pillars and the subsequent description of the individual pillars' attributes will ensure integrity.

3.4 The Form

The form is a questionnaire that guides the user objectively through the fundamental division of VRP with simple questions. It then clearly specifies the classification of the problem using the questions of the second pillar. If further specification is needed to find the VRP variant, the queries of the third pillar, which brings with it the latest supplementary information, will serve. The form makes it easy for creators to display one whole line that does not fit on one screen. It is thus suitable for both filtering and data entry without having to scroll through many columns. Everything is presented in one dialog window. It also allows a quick entry form for updating databases and the like. Forms are used to work with data listed in the database.

In addition to text fields, forms can contain control elements such as checkboxes, selection lists, selector switches. The arrangement of individual elements in the form must correspond to the practical purpose of the search. A catalogue search engine option is offered when placing the form on the website – it acts with manually sorted lists of links organized into categories according to the type of link. The advantage is the fixed categories according to which the sorting takes place.

3.5 Data Filtering and Record Display

Data filtering is a helpful way to display only the data wanted or data that meets a particular condition or string of conditions. In this case, it will select an entry in the list that meets the criteria specified by the user. In the case of the concept, it will be extended filtering according to the criteria table of categories and subcategories. By selecting the criteria in the individual fields of the form, we specify the resulting condition for the filter.

A table is an area of criteria or conditions. Each record of the table is evaluated based on the given criteria. The record is filtered and displayed to the user if it meets the condition. The user-defined filter itself will not change or delete any of the records.

After filling out the form, the user will be shown possible VRP variants that meet the string of criteria he entered. At the same time, several relevant publications for the given type of VRP and possibly useful links are also displayed, further guiding the user to the selected type. It is also possible to insert a comment with explanatory information.

4 Discussion

Due to the vast number of VRPs and the variety of requirements, constraints, and optimization goals, it is difficult for the general public to specify or pinpoint exactly what problem they are looking for in their needs. For users without previous expertise, this topic is very complex. The trend of recent years is the use of artificial intelligence. The results presented by artificial intelligence need to be properly and professionally evaluated.

The article aims to present a quality elaboration of the concept of a tool for the decision-making process in determining the appropriate VRP variant based on the elaboration of the classification of individual variants of distribution problems. The classification is intended in the first stage to create the structure of the concept. In this phase, its role is crucial. In addition to populating the database with given VRPs, it is also a valuable source of search and supplementary information. As an additional use within the decision tool, it appears to be used to check the novelty of VRPs and classify new VRPs into the concept structure.

The first step is to correctly choose the decision-making environment that will be offered to the user. There are many options. The decisive aspect is user-friendly and simple processing and, of course, the creator's level of technical knowledge.

The working version is on the website created for the plan's layout. From the point of view of the knowledge of the processor, the decision-making environment will be created on the WordPress web interface, which has proven to be the most efficient, especially concerning the considerable number of templates.

Once the database is populated with the VRPs, the final task is to create a form for the user to search across the VRP categories and subcategories. The final step will be to present the user environment to a select group of students in Operations Research I and II courses and then to the public. Any inconsistencies or comments identified will be incorporated to improve the overall quality of the concept.

The concept can serve students to clarify the diverse field of operational research, researchers for deeper analysis and comparison of their research with materials published so far, and also the general public to create an idea. The concept will be freely accessible on the net and guide the user through a simple decision-making process based on the form. Fixed links or terms used directly in the English translation will be defined as notes or explanations. If the tool is intended to be usable by the general public, it is impossible to search for the translation or meaning of the mentioned phrases. With this step, the function of the concept will be upgraded from searching to education. This material can be used to support access to knowledge of distribution logistics and will offer an effective teaching tool. The user can look for connections between concepts in an environment close to him. Digital technology is an integral part of the work process for teachers, students, and researchers. Free web applications offer an efficient way to ensure and improve the quality of teaching.

Similar studies (Chen et al., 2024; Sun et al., 2022; Jena, 2024) have examined VRP classification and decision-making tools and emphasized the role of artificial intelligence in logistics optimization. However, in contrast to their approaches, the approach presented in this paper focuses on creating an accessible, user-friendly tool designed especially for people with no prior expertise.

The limitation of this study lies in its focus on a simplified decision-making process that may not fully account for complex real-world scenarios in which multiple conflicting constraints exist. A solution could be to use classification trees or neural networks instead of filtering.

Conclusion

The presented work is a logical outcome of the previous research on the classification of VRP and offers it as part of the decision tool concept. This is not a tool that optimizes VRP. The concept offers support in formulating the type of problem. Using simple questions, it evaluates the type of VRP and places it in the mentioned classification. It will also offer the user other options that could be the problem. Each result includes a general description and a small amount of research on the identified topic.

The benefit of such a decision-making environment is undoubtedly its educational function. It will offer the public, with no prior knowledge of a broad area of distribution logistics, only the segment that is suitable for the user based on their answers in the form. Thus, there is no need for a lengthy examination and comparison of the different VRP options. In addition to the selected range of VRP, the user will receive information on publications and other useful links related to the topic. This is another tool for students to check their practice in creating a qualification thesis.

The novelty of the research is mainly because it brings a complex topic closer to all those who will need the information, not only to the professional public who are well acquainted with the issue. For the aforementioned field of researchers, it can be beneficial in their own research as an easily accessible and multi-purpose supporting tool.

Fuzzy logic is being considered by the author in the future, which will make it possible to offer more types of VRP that meet the conditions specified by the user and variants with the probability of the correct choice. The user can then evaluate the percentage of his correctly determined problem.

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KLASIFIKACE OKRUŽNÍCH DOPRAVNÍCH PROBLÉMŮ JAKO KONCEPT NÁSTROJE ROZHODOVÁNÍ V DISTRIBUČNÍ LOGISTICE

Článek navazuje na rozsáhlé zkoumání jednotlivých variant okružních dopravních problémů (VRP) v distribuční logistice. Cílem článku je využít dosavadní výzkum a vytvořenou klasifikaci VRP k návrhu nové koncepce rozhodovacího nástroje. Metodami výzkumu jsou analýza, syntéza, indukce, dedukce, komparace a expertní rozhovory. Nástroj bude schopen poskytnout rychlé informace odborné veřejnosti a uživatelům bez předchozích znalostí na základě vytvořeného a snadno dostupného rozhodovacího prostředí. V tomto článku jsou představeny uživatelsky flexibilní a zcela nebo částečně volné možnosti včetně struktury koncepce rozhodovacího nástroje. Umožní vývojářům připravit efektivní řešení, které uživatele provede databází VRP pomocí formuláře.

KLASSIFIZIERUNG VON TOURENPLANUNGSPROBLEMEN ALS KONZEPT FÜR EIN ENTSCHEIDUNGSINSTRUMENT IN DER DISTRIBUTIONSLOGISTIK

Der Artikel folgt einer umfangreichen Untersuchung der einzelnen Varianten von Vehicle Routing Problems (VRP) in der Distributionslogistik. Ziel des Artikels ist es, die vorhandenen Forschungsergebnisse und die entwickelte VRP-Klassifikation zu nutzen, um ein neues Konzept für ein Entscheidungsinstrument zu entwickeln. Die Forschungsmethoden sind Analyse, Synthese, Induktion, Deduktion, Vergleich und Experteninterviews. Das Tool wird in der Lage sein, der Fachöffentlichkeit und den Nutzern ohne Vorkenntnisse schnelle Informationen auf der Grundlage einer geschaffenen und leicht zugänglichen Entscheidungsumgebung zu liefern. In diesem Artikel werden benutzerflexible und ganz oder teilweise freie Optionen vorgestellt, die auch die Struktur des Konzepts des Entscheidungswerkzeugs umfassen. Sie ermöglichen es den Entwicklern, eine effiziente Lösung vorzubereiten, die den Benutzer mit Hilfe des Formulars durch die VRP-Datenbank führt.

KLASYFIKACJA PROBLEMÓW TRANSPORTU OKRĘŻNEGO JAKO KONCEPCJA NARZĘDZIA DECYZYJNEGO W LOGISTYCE DYSTRYBUCJI

Niniejszy artykuł opiera się na szeroko zakrojonych badaniach nad różnymi wariantami problemu transportu okrężnego (CTP) w logistyce dystrybucji. Artykuł ma na celu wykorzystanie istniejących badań i opracowanej klasyfikacji VRP do zaprojektowania nowej koncepcji narzędzia decyzyjnego. Metody badawcze to analiza, synteza, indukcja, dedukcja, porównanie i wywiady eksperckie. Narzędzie będzie w stanie dostarczyć szybkich informacji profesjonalistom i użytkownikom bez wcześniejszej wiedzy w oparciu o stworzone i łatwo dostępne środowisko decyzyjne. W tym artykule przedstawiono elastyczne dla użytkownika i w pełni lub częściowo bezpłatne opcje, w tym strukturę koncepcji narzędzia decyzyjnego. Umożliwią one programistom przygotowanie wydajnego rozwiązania, które poprowadzi użytkownika przez bazę danych VRP za pomocą formularza.