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A METHODOLOGY FOR EVALUATING AND IMPLEMENTING LOCATION SELECTION APPROACHES: A CASE OF CITY FREIGHT HUB

Keywords
Location selection
City freight hub
Methodology

Abstract
Currently, more than half of the world's population lives in cities, whose population has doubled in the last five decades. What has long been a problem is that the mobility of the majority of the urban population and the logistics flows in the city depend on cars and other motorized vehicles. Traffic congestion, insufficient number of parking places, increasing energy consumption, and air pollution are just some of the problems people face. City hubs are one way to partially solve these problems by consolidating goods from different suppliers in a hub and cooperating in last mile delivery. The idea of integrating micromobility initiatives as innovative urban transport solutions can enhance the effectiveness of city hubs even further. However, due to the limited urban space available, finding a suitable location for such a hub is a major challenge. Numerous location selection models can be found in literature, reflecting the ongoing relevance of this logistics challenge. Continuously, new models emerge, often as variations of existing ones. Hence, the primary objective of this research is to present a pragmatic approach for assessing existing models regarding their applicability to a specific location selection case. The potential practicability of the developed methodology was demonstrated through its application in the case of identification of the city freight hub's location in Novi Sad.

1. INTRODUCTION

There is a need to boost the efficiency and effectiveness of logistics operations in cities since global trends indicate a rising demand for commodities in urban areas [1]. City logistics refers to activities involved in the delivery of goods within urban areas, and according to [2] represents one of the subgroups of green logistics.

The fundamental objective of the European Commission's White Paper on Transport is to achieve carbon dioxide (CO_2)-free city logistics in major urban centers by 2030. In addition, the increasing urbanization and rising urban freight transport volumes necessitate radical changes in current patterns of urban freight transport. This is crucial because, according to [3], urban freight distribution accounts for an impressive 20% of all motor traffic in metropolitan areas.

Urban environments are particularly negatively affected by the movement of commodities by a certain type of freight vehicle. The movement of freight vehicles in cities creates additional problems compared to nonurban driving. For instance, traffic jams, visual encroachment ([4], [5]) and kerbside space occupation [6] are all examples. Unfortunately, if current patterns continue, the negative effects will undoubtedly get worse over time. As confirmation of this are the following two trends. Firstly, according to United Nations research from 2014, nearly all population expansion is anticipated to occur in metropolitan areas, which will raise demand for commodities. Secondly, the demand for faster delivery is growing, forcing logistics service providers (LSPs) to transport items more quickly using smaller or less-loaded vehicles ([7], [2]). Both trends will likely lead to an increase in the number of freight trucks delivering goods in cities.

Using urban consolidation centers or city hubs with a two-stage urban delivery method is a viable answer to these issues [8]. Delivering items from outside the city to the hub within the city limits constitutes the first stage. A combined last mile distribution of commodities to the end recipients is part of the second stage. Thus, by better utilizing freight vehicle capacities, the number of vehicles entering the urban area can be decreased. Air pollution and noise levels can be reduced much further if the second stage is completed by electric or other low-emission cars [9].

Discovering suitable transshipment facilities in urban regions, which already have a shortage of urban space, is a notable challenge problem. One of the primary and potentially most crucial steps in addressing this issue involves definition, assessment, and evaluation of the criteria on which the decision on the location of such a hub depends. Numerous location selection models can be found in literature, reflecting the ongoing relevance of this logistics challenge. Continuously, new models emerge, often as variations of existing ones. Therefore, the main motivation of this paper is not to reinvent the wheel but to provide a practical methodological approach for applying an existing model to a specific problem. That is, the primary objective of this research is to present a pragmatic approach for assessing existing models regarding their applicability to a specific location selection case. The potential practicability of the developed methodology was demonstrated through its application in the case of identification of the city freight hub’s location in Novi Sad.

2. STATE OF THE ART

When designing any kind of city hub, the hub's location is a key factor. Costs and the availability of transportation are frequently deciding considerations in this decision. Standards for the environment and society might be taken into consideration in addition to these economic ones to meet all dimensions of sustainability [10]. Traditionally, choosing a hub location involves reducing costs and/or time [11]. In light of this, common techniques for choosing a location tend to be quantitative in nature and range from company-driven and pure utility-based assessments to optimization-based facility location and hub location problems [12] and [13]. In these optimization issues, often only one objective is addressed. However, by converting them into expenses, qualitative criteria can also be easily included in such a model [14]. However, multi-objective optimization can also be utilized to address several objectives [15]. Paper [16] conducted a thorough literature analysis on facility location issues related to choosing a city hub location.

In [9] the authors elaborate in detail about the concept of city hubs or urban consolidation centers (UCC), which are located close to the end delivery area to minimize the last-leg trips and to boost responsiveness. Typically, these centers are utilized to consolidate the flow of people and goods into the city [17]. It is typically referred to as a micro-hub or micro-consolidation center, particularly if such a center aspires to carry goods within its close proximity using emission-free vehicles like cargo bikes [18] and [19]. An interface between outbound and inbound freight transports, a UCC can be described as a logistics facility that serves an entire city or portions of it. According to several studies [20] and [21], UCC is also one of the most researched municipal logistics programs. The advantages of city hubs can be separated into two categories: benefits aimed at various stakeholders and benefits related to reducing the negative consequences of distribution of goods. First, fewer freight cars may be required by consolidating commodities near to the city [17]. This is done by achieving a high load factor on the freight vehicles approaching the city. The damaging environmental and social repercussions brought on by freight vehicles can be lessened with fewer of them. Additionally, UCCs allow for the switch to smaller, more environmentally friendly cars due to shorter delivery distances [22] and [23] also remark that energy usage can be decreased. By introducing and expanding the concept micromobility, it is possible to alleviate the existing problems of city logistics. That is why micromobility solutions are increasingly being considered in the analysis of city freight hub location.

3. METHODOLOGICAL APPROACH

The evaluation process for an existing site selection model will concentrate on multiple levels of analysis to identify strategic and operational possibilities for potential implementation. This approach is tailored to the notion that distinct location criteria hold relevance in various specific cases. To apply an existing location selection model effectively in a specific situation, the following steps need to be followed:

- *Understand the location selection method being considered*: study the methodology, steps, and requirements of the given approach in detail. Ensure a clear understanding of how the method works and what data inputs it requires.
- *Define objectives and criteria*: clearly define the objectives of location selection process that is the subject of investigation. Determination of the specific criteria and their potential adjustments to the specifics of the location selection being resolved.
- *Gather data*: collection of the necessary data for the location selection process and ensure their accuracy and comprehensiveness.
- *Adapt the existing method to the specific case*: customize the existing method to suit the specifics of case in question. Adjust the weights or scores assigned to different criteria based on the specific project's requirements.
- *Application and analysis of data*: application of the adapted method and assessment of the suitability of each of proposed locations. Interpretation of the results of analysis and proposing top-ranked locations.
- *Decide about potential implementation of the analyzed method*: based on the analysis and interpretation of the results a decision regarding suitability of the explored method should be made.
- *Implement and monitor*: development of implementation plan for the application of chosen method.

By following these steps, an existing method for location selection can be assessed and implemented in a specific case. It should be noted that adaptation of the method to suit the unique requirements and circumstances of the specific case and ensuring data accuracy and consistency is of extremely importance.

4. APPLICATION EXAMPLE OF THE DEVELOPED APPROACH

In this section, the feasibility of implementing the developed methodology will be examined using the case of evaluating the location for a city freight hub in Novi Sad. It is important to emphasize that this particular example will focus solely on the application of the initial three phases of the developed approach. Therefore, an analysis of the location selection model proposed in the paper [10] was carried out. This model is based on the Analytic Hierarchy Process (AHP) and was used for the hub location selection problem in Vienna. The reason behind selecting this type of location selection model is widespread utilization of the AHP method, which proves to be practical among existing models. Consequently, accomplishing the first step (*Understanding the location selection method)*, becomes straightforward by understanding the steps and requirements of the AHP methodology and comprehending its underlying logic.

The analyzed model [10] defines three main types of criteria that can be used in the case of Novi Sad. These are: costs, environmental and social aspects and location-specific characteristics and features. The outcomes of implementing steps two (*Define criteria*) and three (*Gather data*) of the developed methodology, involving the

definition of criteria and collection of the necessary data, are displayed in Table 1. Therefore, the focus is on the proposed criteria and their adoption in the case of the hub location in Novi Sad, as well as identification of sources and availability of the necessary data.

Table 1. The location criteria and its characteristics

Criteria	Adoption to the case of Novi Sad	Availability of data source
Costs		
Real estate costs	Real estate costs are increasing and thus very important factor in Serbia (fully applicable)	Information obtained from municipal planners; market analysis
Costs of local logistics companies	Most costs have risen suddenly in the last couple of years, among others due to the complex geopolitical situation in Eastern Europe and the inflation rate typical of most countries in the world (fully applicable)	Information obtained from logistics companies; market analysis
Environmental and social aspects		
Number of nearby E-charging stations	Unfortunately, there are still very few, not only in the city of Novi Sad, but in the entire country (limited applicability)	Planning documentation; aerial photos
Bike lanes	At the national level is at the forefront, but still lags behind developed countries (fully applicable)	Existing planning documentation, aerial photos
Air-quality	There is space for development. Especially in the winter months the air is polluted, and the region is often among the most polluted regions (fully applicable)	Regional scan of available regional and city data sets
Population density	Is constantly increasing. It has been a trend in the country for residents to more from the villages to the cities, so the city's population is constantly growing, new apartment blocks are constantly being built ((fully applicable)	Existing planning documents; municipal information
Location-specific characteristics and features		
Number of traffic accidents	There is a decreasing trend over the years due to increased regulations and police supervision as well as tightening of fines and penalties (fully applicable)	Existing publicly available data
Access to the highways	International highway A1 (E-75) passes directly by Novi Sad (fully applicable)	Strategic road network; planning documents
Access to the rail	The section of the railway network is currently under renovation, but when it is completed, it will form a section of the international railway network, which will facilitate traffic and freight transport between neighboring countries (fully applicable)	Strategic rail network; planning documents

5. CONCLUSIONS

The hub's location is important when designing any kind of city hub. Choosing a hub location typically entails saving money and/or time. In urban areas where there is already a shortage of urban space, finding suitable transshipment facilities is a significant challenge.
This paper introduces a methodology for assessing the suitability of existing models for specific location selection cases. The practical feasibility of the developed approach was demonstrated by applying it to the criteria selection process for selection the city freight hub's location in Novi Sad.

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