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The Influence of Local Conditions on the Use of Cargo Bikes for Last Mile Delivery

A. Seidlová[1], M. Ledvinová[2]

[1]*University of Pardubice, Studentská 95, 53210, Pardubice, Czech Republic, E-mail: andrea.seidlova@upce.cz*
[2]*University of Pardubice, Studentská 95, 53210, Pardubice, Czech Republic, E-mail: michaela.ledvinova@upce.cz*

Abstract

Cargo bikes are transport means with specific operating demands. Factors that may not be important to other transport means may be critical to the use of cargo bikes. The use of cargo bikes for the last mile delivery is therefore not universally applicable.
Cargo bikes are currently operated in many cities with diverse geomorphologic, weather, and urbanistic conditions. Also, the infrastructure and its quality may vary. The article analyzes how local conditions can affect operation of cargo bikes for last mile delivery. In response to this analysis, the conditions in selected cities in the Czech Republic are evaluated and compared.
KEY WORDS: *cargo bike, last mile delivery*

1. Introduction

Although the history of cargo bikes is almost as old as the bike itself, in Europe and the United States, modern cargo bikes have become to be used more widely only few years ago. [6,3]. Cargo bikes can be used in various ways from commercial transport in courier, post and delivery services to personal logistics. [8,13]. Last mile delivery service is supposed to be quick enough and efficient. A cargo bike can fulfill these requirements if the conditions in the city are suitable. Cargo bikes are environmentally friendly transport modes. Conventional motor vehicles in last mile delivery systems produce large amounts of CO_2 [7], which can be reduced by supplementing the part of total number of motor vehicles with the cargo bikes [17].

This article focuses on the analysis of predetermined conditions such as climate and terrain, characteristics and condition of the transport infrastructure and legislative measures. The cargo bike operator is supposed to adapt to these conditions, eg by selecting the suitable bike, the appropriate operating technology, the business model, etc…Demanding climatic and terrain conditions can place high demands on the physical condition of the bicycle driver. Unlike the private journeys, the courier cannot decide not to ride in bad weather. These conditions can result in lack of cargo bike drivers or in high turnover of bicycle drivers. Better conditions can be partially ensured by a suitable bicycle construction - from bikes with simple rain top covers [14] to fully covered electric multi-wheels bikes. The condition of the transport infrastructure and its characteristics can affect the speed and reliability of the delivery service. Narrow cargo bikes are more suitable for traffic in narrow streets in historic city centers, but they have a smaller loading capacity. [1,2,12] Local regulations and legislative measures can also affect the operation of cargo bikes. E.g. cargo bikes can gain an advantage of unrestricted entry in locations with limited motor traffic. Legislation in different countries may define e-bike within categories of road vehicles in different ways [12].

2. Analysis of terrain and climate conditions

We analyzed local conditions in 126 cities with cargo bikes systems from 20 European countries. The map in Figure 1 shows both smaller cities and large urban areas with different terrain conditions. The cities with population over 100000 represent the majority with total of 73%. Only 16 cities (12%) are in the category up to 50,000 inhabitants. Larger cities with a large group of potential customers are more suitable for the use of cargo bikes.

Cargo bikes are most used in the United Kingdom (21 cities). In another six countries, cargo bikes are operated in more than 10 cities (Spain, Belgium, Italy, the Netherlands, Germany, and France). These countries belong to area with mild climate within Europe. A large part of the territory is flat and bicycle transport has a long tradition in these countries. Approximately 50% of the analyzed cities is located mainly in flat areas, only approximately 10% are cities with mostly hilly terrain in mountainous or foothill areas. Electric bikes are more suitable for areas with more demanding terrain conditions.

Climatic conditions are important especially in terms of the possibility of year-round cargo bike use. The following climatic factors were assessed in the analyzed cities:

- • average temperatures in January,
- • average temperatures in July,
- • annual total precipitation.

Fig. 1 Selection of European cities with cargo bike delivery service [5,15,16]

Figures 2 and 3 show the number of cities according to the average temperatures in January and July. The year-round use of cargo bike in Europe can be influenced by weather fluctuations during the year. In winter, temperatures can drop below freezing point, it can be windy with snowfall. High temperatures in summer can also be a problem. Such conditions place high demands on the physical condition of the bicycle driver. The analyzed data show that in cities with cargo bikes, the average January temperatures are most often in the range of 0.5-5°C and the average July temperatures are in the range of 17-20.5°C. The average annual precipitation in the analyzed cities varies between 300 mm (Murcia) and 1738 mm (Donostia/San Sebastian).

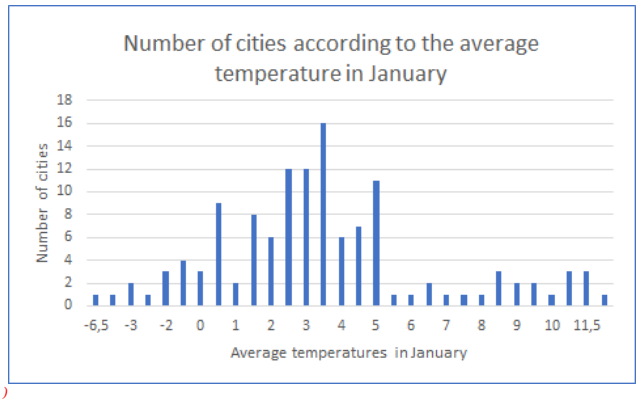

Fig. 1 Number of cities according to average temperatures in January

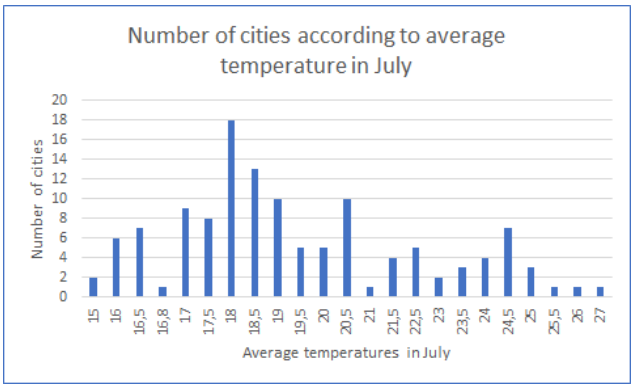

Fig. 2 Number of cities according to average temperatures in July

However, even in the case of less favorable conditions, it is possible to implement a successful system by choosing a suitable business model and the right type of bike. This is proved by examples from Sweden (Umea with January temperatures around -6.5 ° C) or Spain (Seville with very hot and dry summers).

The Czech Republic does not have typical conditions for the operation of cargo bicycles. The country is relatively mountainous with lower average January temperatures than in countries where cargo bikes are most common. However, there are cities where bicycle transport has a long tradition and local conditions are favorable.

3. Analysis of transport infrastructure and legislation

The condition of the infrastructure and the traffic associated with it are important factors influencing the choice of transport means for the collection and distribution of small consignments. The road traffic rules in the Czech Republic are regulated by Act No. 361/2000 Sb. Technical standards and technical terms regulate the infrastructure parameters. Specifically, the infrastructure in the Czech Republic is regulated mainly by CSN 73 6101 Design of roads and motorways, ČSN 73 6102 Design of crossings on roads, ČSN 73 6110 Design of local roads.

3.1 Cargo bikes in relation to transport infrastructure and legislation

Cargo bicycles that fulfill the terms of a bicycle can also use the infrastructure for cyclists, which is regulated by TP 179 Design of roads for cyclists [10]. Technical terms TP 179 define other related legal regulations, technical standards and technical regulations related to this issue.

But the question is: “When can a cargo bike be considered to be a (standard) bicycle?”. The concept of a bicycle,

or e-bike is not directly defined in the legal regulations of the Czech Republic. However, the Decree No. 341/2014 Sb., determines the technical requirements for bicycles (specifically in Annex No. 12 letter C - Technical requirements for the equipment of bicycles, cover vehicles and handcarts). If the vehicle (electric bicycle) fulfills all the requirements for fitting an auxiliary engine defined in section 8 of this Annex. and in the cases described in sections 9 and 10, it is still considered a bicycle with all consequences that relate to road traffic rules, especially resulting from Act No. 361/2000 Sb. Requirements for fitting an auxiliary engine determine that the load-bearing parts of the engine have not been tampered with and the auxiliary engine can be removed again at any time.

Other versions of vehicles referred to as e-bikes, which do not fulfill the terms defined in the above Decree (especially the auxiliary engine - the engine is already mounted directly from the manufacturer, so there is interference with the load-bearing parts, engine power exceeds 1 kW, max design speed exceeds 25 km/h, etc.), are assessed for classification according to Regulation No. 168/2013 of the European Parliament and of the Council on the approval of two- or three-wheel vehicles and quadricycles and market surveillance of these vehicles.

Technical terms TP 179 - Design of roads for cyclists summarize the rules and principles for the design of roads so that they are safe and comfortable for the use of bicycles:

- The scope of the scale is from the level of the basic spatial-operational concept to the detail of the measure.
- They apply to all roads, especially local roads.
- They specify in the detail the individual measures of the cycling infrastructure and the principles of their use.
- They specify the requirements of road solutions from the point of view of bicycle traffic.
- They are intended primarily for designers and other professions related to the process of assignment, preparation, approval and implementation of roads and public spaces in general.

Many cities have already learned to apply measures to support cycling. These measures include both building and transport organizational elements and measures that help to use bicycles safer and more comfortably. Roads for cyclists are being created in the main and associated traffic areas. However, these measures support "passenger" bicycle transport, and therefore the parameters of the roads correspond to the driving profile for single-track bicycles, or bicycles with a two-track trailer (especially for children).

For this reason, such an infrastructure may not always to fulfill the requirements of cargo bicycles, which have a wider riding profile due to their dimensions.

The operational-spatial character of the road should be "timeless" according to (TP 179), it determines the basic principles of access to this road, defines appropriate transport and organizational measures and ultimately defines the quality standard for users. Regarding the above mentioned, it is necessary to include the whole concept in the planning phase.

3.2 Cargo bikes in relation to sustainable mobility

Currently, larger cities in the Czech Republic (population approximately of over 40,000) are preparing sustainable mobility plans. These plans are a strategic tool for sustainable mobility planning. They are not only focused on the issue of transport, but they should also provide a framework and support for solving the urban mobility and meeting their needs. It is not only about the mobility of residents and visitors in the city, but also about the mobility of services and goods. It is also important to address the issue of city logistics already during the preparation of these plans. In the initial analysis, it is necessary to choose the users of the system and to invite their representatives as partners to the creative team. The analysis itself must target to supply and demand, the possibilities of transport space for the preference of cargo bicycles, etc. Specific measures should be reflected both in the design part and in the part of the action plan. After implementation, it is necessary to use the information obtained from the monitoring feedback in the evaluation of the entire plan. Unfortunately, the Methodology for the Preparation of Sustainable Mobility Plans for the Cities of the Czech Republic (X) deals with bicycle transport only as passenger transport.

As a part of urban mobility planning, cargo bicycles should be the preferred means of transport within city logistics. The adaptation of urban infrastructure should be the active preference. It is not possible to full use of the existing cycling infrastructure due to the wider driving profile of cargo bike, which depends on the size and design of the cargo space. Even so, their advantage in terms of size and environmental friendliness should be used to the full, as it is in the case of passenger cycling. The parameters of roads for cyclists should be based on the dimensions of the so-called standard vehicle, ie the largest bicycle for which it is proposed.

Significant roads, the so-called integrated corridors, should be accessible to cargo bikes through integration measures. These roads tend to be more congested with car traffic and public transport, but are inherently attractive in their straightforwardness, speed, and reliability. They also have an important transport function in addition to the service function (they can also contain sources and destinations for cargo bikes). The measures on these roads should be directed mainly to the main traffic area (e.g. different types of reserved lanes).

Quiet and calm roads and zones that are used for movement within the transport service area should also be accessible to cargo bikes. There is usually no need to create special measures on these roads. Measures for bicycle transport are applied as additional measures to ensure clarity and safety of the area. However, it is important to be aware of the wider passage profile in these cases so that the permeability is maintained also for cargo bikes (e.g. measures for two-way roads for bicycles).

The permeability of the cargo bike area should be maintained within the framework of protected cycling routes and connections. The parameters of roads for cyclists must be adjusted so as not to endanger the safety of movement of

pedestrians using the associated traffic area (separation of pedestrians and cyclists, adjustment of construction parameters, etc.).

4. Comparison of selected cities in the Czech Republic

Cargo bicycles are currently operated in the Czech Republic in Prague and České Budějovice. Courier services with standard and cargo bicycles are operated in Prague as part of a larger system of municipal courier services [9,11]. Prague is the largest city in the Czech Republic with a relatively hilly terrain and intensive traffic in the center. The main advantage here is the existing wide number of potential customers, the operability of bicycles in normal traffic and the contribution of this system to environment in the city center. The city of České Budějovice belongs to the top ten largest cities in the Czech Republic according to the number of inhabitants. The terrain in the inner city is mostly flat, the climate is colder than in Prague. One cargo bike is operated here by a large delivery company [4,11]. The city of Pardubice is also one of the top ten largest cities, the terrain here is mostly flat, the climate is mild. Cargo bikes are not currently operated here. Table 1 summarizes the observed factors for the above three cities.

Table 1

Local conditions in selected cities in the Czech Republic

City	Population	Average January temperature	Average July temperature	Average year precipitation	Terrain
Prague	1324277	-2°C	17,6°C	542 mm	partly hilly
České Budějovice	94463	-3,8°C	13,1°C	629 mm	mostly flat
Pardubice	91727	-3,9°C	15,3°C	599 mm	flat

We performed an analysis based on all the monitored factors from Chapters 1 and 2 for the city of Pardubice, where cargo bikes are not currently operated (Table 2).

Table 2

Analysis of local conditions in the city of Pardubice

Strengths	Weaknesses
- flat terrain - favorable temperatures and distribution of precipitation throughout the year - compact city - good transport accessibility of all city districts - distribution of individual transport modes within the modal split (representation of bicycle transport 14%) - connection of surrounding villages by means of cycle paths	- traffic intensity in the city center - insufficient parameters of the cycling infrastructure for cargo bikes - lack of (insufficient) measures to restrict car entrances to the city center - absence of internal and external bypasses (routes for internal transit through the city center)
Opportunities	**Threads**
- existence of unused commercial space in the center - a growing range of bicycle types suitable for last mile delivery - support of bicycle transport by the city authorities (solution of city logistics within the emerging SUMP) / region	- insufficient set of end customers - operation of bicycles together with other modes of transport - natural obstacles in the development of infrastructure (Elbe, Chrudimka)

The city of Pardubice is currently preparing a SUMP, within the action plans concerning the city logistics are also created. Not only experts in spatial planning, traffic engineers, etc. are involved in the creation of this strategic document, but also representatives of companies, enterprises, and services in the city. This can be very important for the creation of own concept of logistics.

The city of Pardubice has very favorable terrain and climatic conditions, the parameters of the transport infrastructure are here the problem factor. Although Pardubice is a city of cyclists and has a good infrastructure for cyclists, which continues to develop, this infrastructure is not always suitable for cargo bikes. Especially larger cargo bikes could have a problem moving in the associated space due to their wider driving profile. Congestion, which arises, among other things, due to inappropriate internal transit tracing, will prevent smooth movement in the main traffic area together with other vehicles during peak periods. Unfortunately, the routes currently lead through the city center. The city has not got a bypass, which would also connect the individual parts of the city. The development of transport infrastructure is limited by the flow of two rivers, which must be crossed, and by the very limited size of available areas in the city center. In practice, it is therefore possible, especially in the city center, only to redistribute the area for the benefit of individual users. However, this cannot be done without compromise and a change in the thinking of all

involved subjects.

Recently, the local authorities efforts to reduce the traffic load on the city center, especially the private motor vehicle transport (new parking policy, the realization of the first P+R parking lot on the south side of the city, etc.) have begun to emerge. It will be possible to further develop these efforts also thanks to the analyzes that arise within the activities for SUMP, and thus to guide the personal mobility of residents and visitors to the city. This also creates scope for "managing" freight mobility and the use of more environmentally friendly modes of transport here as well. The cargo bikes can be one of the ways. Right now, the city has the opportunity to use the cooperation of individual subjects and thus create a system for the delivery of small consignments using the type of transport, which has been proving itself in passenger transport in Pardubice for many decades.

5. Conclusions

The decision to use a cargo bike system for last mile delivery depends to a large extent on external factors, which are predetermined. Unlike conventional modes of transport, the importance of these factors can be crucial in decision-making. A detailed analysis of climatic conditions, terrain, infrastructure, and legislation can help the cargo bicycle operator in deciding on the operation model. It can be the basis for creating a suitable business model and for choosing the right type of bike. At present, regional authorities place great emphasis on sustainable mobility within urban agglomerations, which also includes the organization of city logistics processes. Cargo bicycle is an ecological and flexible means of transport that can complement the conventional last mile delivery systems in cities with suitable conditions.

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