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SYSTEMATIC APPROACH FOR DETERMINING AVAILABILITY OF LOGISTICS URBAN INFRASTRUCTURE FOR PEOPLE WITH DISABILITIES

The article describes the availability of urban infrastructure for people with limited mobility. Propositions are given to improve the existing logistics systems for increasing the accessibility.
Keywords: *people with limited mobility; accessibility; logistic system; passenger transportation.*

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МЕТОДИЧНИЙ ПІДХІД ДО ВИЗНАЧЕННЯ ЛОГІСТИЧНОЇ ДОСТУПНОСТІ ОБ'ЄКТІВ МІСЬКОЇ ІНФРАСТРУКТУРИ ДЛЯ МАЛОМОБІЛЬНИХ ГРУП НАСЕЛЕННЯ

У статті розглянуто основні поняття, що визначають доступність об'єктів міської інфраструктури для маломобільних груп населення. Запропоновано варіанти поліпшення існуючих логістичних систем з метою підвищення критерію доступності.
Ключові слова: *маломобільні групи населення; доступність; логістична система; пасажирські перевезення.*
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МЕТОДИЧЕСКИЙ ПОДХОД К ОПРЕДЕЛЕНИЮ ЛОГИСТИЧЕСКОЙ ДОСТУПНОСТИ ОБЪЕКТОВ ГОРОДСКОЙ ИНФРАСТРУКТУРЫ ДЛЯ МАЛОМОБИЛЬНЫХ ГРУПП НАСЕЛЕНИЯ

В статье рассмотрены основные понятия, определяющие доступность объектов городской инфраструктуры для маломобильных групп населения. Предложены варианты по улучшению существующих логистических систем с целью повышения критерия доступности.
Ключевые слова: *маломобильные группы населения; доступность; логистическая система; пассажирские перевозки.*

Problem setting. The current public transport does not fully satisfy the needs of all residents and visitors in many cities. For example, the complicated transport service for people with disabilities (PWD), which include people with limited mobility, children, passengers with prams, pregnant women, the elderly, temporarily restricted mobility of people moving around with crutches, canes etc. For their transport special conditions must be created.

Recent research and publications analysis. Tasks and problems in the logistic availability of urban infrastructure were discussed by J.J. Coyle et al. (2003), P. Conroy (2004), R. Johnston (2005), T. Rickert (2007). However, the issues of available urban infrastructure is poorly studied, particularly in China.

The purpose of this research is to develop guidelines for the formation and evaluation of logistic accessibility for people with limited mobility in today's conditions.

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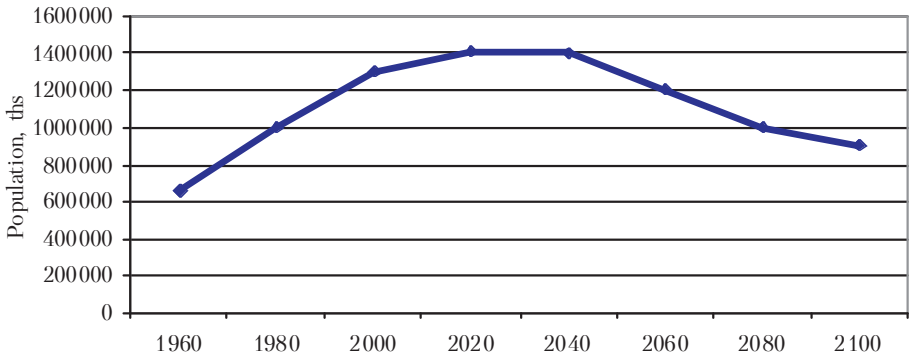
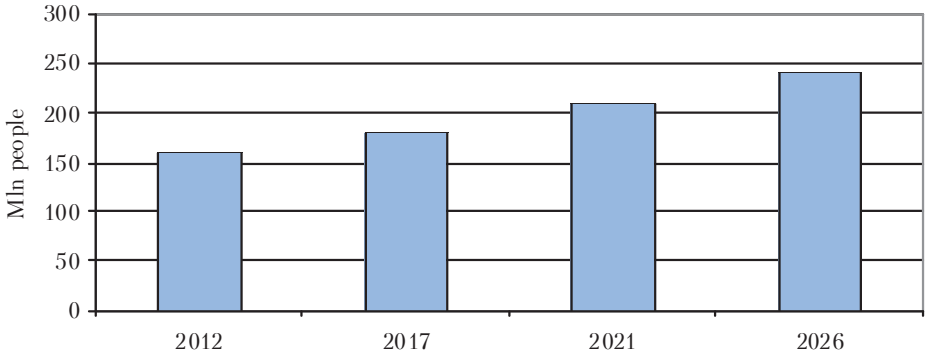
Key research findings. The Republic of China (ROC) is the largest populated country in the world. In January 2013, Chinese government released the data showing that the population of China, excluding Taiwan, Hong Kong and Macao is 1,354 bln people. By September 2013, this figure increased to 1,363 bln. Figure 1 shows the population dynamics in the ROC. According to Chinese government forecasts, this figure should reach the peak in 2026 and then decline. The reason for the decrease is the enactment of the policy of "One Child" that controls the birth rate and population growth in the country (China Disabled Persons Federation, 2013).



Source: China Disabled Persons Federation.

Figure 1. **Dynamics of population in China**

According to demographic predictions, at the time of the population peak in 2026, the number of people aged over 65 years will be approximately 240 mln people (16% of the total population) (Figure 2).



Source: China Disabled Persons Federation.

Figure 2. **Forecast of the number of people over 65 years for the period until 2026 in China**

China has other demographic problems: for example, due to historically dominated male fertility, together with the existing policy of "one child" nowadays the fertility ratio is 120 boys per 100 girls.

Over the past 20 years, the ROC government has adopted a number of important legislative proposals that would significantly affect the quality of life of the persons with disabilities in the country. These are primarily:

1. Medical Rehabilitation Education Plan (1992), which contains provisions on training and education of doctors and rehabilitation therapists, physiotherapists and occupational therapists.

2. Regulations on the Education of Persons with Disabilities (1994). It guarantees the right of persons with disabilities to receive education.

3. Temporary provisions of qualification system for prosthesis (1997), aimed at improving the production of prostheses, assistive devices, wheelchairs and canes. Particular attention is paid to standardization of production (Law on the Protection of Persons with Disabilities, 2008).

4. Law on the Promotion of Employment of People with disabilities (PWD) (2007), prohibiting discrimination against persons with disabilities.

5. Position on the construction of accessible environment (2012), which obliges local authorities to build necessary public facilities for PWD (Infrastructure, EBRD, 2004).

Particular attention is focused on this problem by the ROC government. For example, in Beijing only 100000 disabled are provided with basic social guarantees. Tens of thousands of persons with disabilities have found work with the state help. In order to improve the conditions of movement for persons with disabilities in recent years Beijing has allocated over 600 mln yuan (Halifax, 2011).

The scheme of the logistics chain for PWD includes the following units:

- exiting the building (construction, residential building, organization etc.);
- approach from the departure point to the location of a vehicle (parking lot, bus stop);
- waiting for the rolling stock equipped for a safe, comfortable trip of PWD;
- entrance to a building (construction, residential building, organization).

Providing logistical accessibility of urban infrastructure for people with limited mobility requires manifold elements constituting these supply chain units of PWD movement from dispatch to destination:

1. Excite entrance (to) the building (construction, residential building, organization):

- Compliance with the width of walkways and doorways;
- Equipment of lifts and elevators;
- Availability of ramps, appropriate safe exit;
- Path colour pointers for PWD.

2. Approach (departure) to (from) the location of a vehicle (car, public transport):

- Colour (yellow) path indices for persons with disabilities;
- Availability of lifts and ramps in underground, aerial crossings;
- Availability of parallel and perpendicular to sidewalk ramps to cross the carriageway.

3. Waiting for rolling stock:

- Equipment of parking places for the disabled;
- The presence of handrails and fences;
- Equipment for a comfortable seats and waiting transplant.

4. Boarding (landing), transfer in (out) the vehicle:

- Automatic rolling equipment (lifts) or manual (reclining platforms) boarding (landing) means;
- The presence of yellow identification bands on the doors, handrails and vehicle lighting;
- Guarantee free up space in the rolling stock for wheelchair users or prams;
- Use the buzzer that tells the visually impaired where doors are.

Situations with the availability and forecasting the development of urban infrastructure are offered for operational monitoring and detecting of violations to ensure the accessibility of facilities and improvement of the easy-access system to expect availability of the logistics chain for PWD movement from origin to destination.

The availability of transportation logistics chain for i-species of PWD is proposed to be calculated by the formula:

$$D_i = \sum_{i=1}^{u} D_l, \quad (1)$$

where $l = 1, ..., u$ – links of the supply chain movement of PWD; D_l – the availability of l-th link in the logistics chain movement of PWD.

The accessibility of objects is determined by the formula:

$$D_{object_l} = \sum_{i=1}^{n} D_l, \quad (2)$$

where $i = 1, .., n$ – variety of PWD; D_l – the availability of l-th link of the logistics chain movement of PWD.

Table 1 shows an example of calculations of the proposed logistic accessibility evaluation facilities for people with limited mobility.

Table 1. **Example of calculation of logistic accessibility evaluation facilities for reduced mobility,** *author'*

Links of the logistics chain from origin to destination		People with limited mobility				Availability, facilities, %
		Disabled on a wheelchair, people with prams	Disabled with lesions of the musculoskeletal system, temporarily-disabled, moving with crutches, canes	Disabilities related to hearing	Disabilities related to eye vision	
Object of origin	Equipment at the facility, the available output of the neighborhood	+	+	+	+	100
Provision of transport	Possibility to stop traffic	-+	-+	+	-+	62,5
	Stopping point	-+	-+	+	-	50
	Vehicle	-	-	+	+	50
	Stopping point	-	-	+	-	25
	Way traffic to stop	-	+	+	+	75
Destination	Equipment at the facility, accessible entrance, neighborhood	-	-	+	-	25
Availability, facilities, %		28,6	35.7	100	50	

+ available - + partially available - not available.

The analysis of available maps helps to identify the main advantages of individual schemes of movement and offer recommendations for the development of cards that will carry the most significant information for PWD:

- the use of icons of different colours to indicate the degree of accessibility of the object – green, yellow, red or grey. Green labelled completely barrier-free objects. Yellow – partially barrier-free object. Red indicates that a building or facility is not suitable for wheelchair users. Grey – the lack of information on the object;

- implementation of an integrated interaction with maps of other settlements and regions to create opportunities and provide information accessibility of movement maps within China, as well as opportunities to transfer this data to foreign sites, such as the German "Wheel map", reflecting the world map, which contains the data on accessibility in London, New York and other cities for international trips of PWD and extensive development of tourist trips for PWD;

- assessment of the accessibility degree for different groups of persons with disabilities and general accessibility of facilities, but using logistic approach;

Creating a simple, straightforward, user-friendly, maximum informative accessibility maps for people with limited mobility will attract the attention of society, business and government to the comfort level of urban infrastructure for PWD.

Conclusions. In practice, for solving the basic problems of availability of transport services for PWD using logistic approach is possible for specific conditions, depending on the level of funding and a certain level of quality of transport provision to determine:

- the optimal ratio forms of transport services for PWD;
- the minimum number for disabled persons vehicles;
- the criteria for evaluating the transport system for people with limited mobility;
- measures to improve the management of urban passenger transport to ensure transportation for PWD.

The research helps to develop and validate the guidelines for assessing logistic availability of urban infrastructure for people with limited mobility, and develop the guidelines for improving the conditions for the transport of PWD in the logistic system of urban passenger transportation in China.

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