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Using of Regionalization Techniques to Select Optimal Routes Based on Criteria of Road Features

Tatiana Menukhova [a]*, Alexandra Vyushkova [b]

Saint Petersburg Mining University, 2 21st Line, Saint Petersburg, 199106, Russia

Abstract

The article describes a technique of solving one of the main problems when organizing the transportation, i.e. selection of an optimal route with a focus on the traffic safety (TS) factor.

The authors substantiate a possibility to use regionalization techniques to select an optimal scheme of cargo delivery and passenger transportation taking into account various traffic conditions.

The article presents calculation results for various routes using the specified techniques; results testifying to a possibility of using regionalization techniques for achievement of an optimal solution of the multi-criterion problem of transportation route selection are obtained.

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Keywords: traffic safety; multi-criterion problem; regionalization technique; intelligent transport system; motor transport; cargo transportation; passenger transportation

1. Introduction

As of today, the influence of traffic safety factors has a dominant significance for all processes connected with transportations, therefore, their assessment is also important at such stage as selection of an optimal route. Besides, inclusion of traffic safety criteria in the category of the determinants, when organizing transportations, enables to make the schemes of deliveries more reliable and exert a positive impact on the company reputation.

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: men-ta@yandex.ru[a] *, alexw2210@ya.ru [b]

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In practice, mainly such indicators as distance or time spent on transportation are considered to be the determining criteria for selection of optimal routes. Such approach represents one-criterion assessment. However, when organizing transportations, it is necessary to take into account criteria related to traffic safety as well, such as traffic density, accident rate, road surface quality, etc. It is necessary to make multi-criterion assessment in the case under study.

The authors have chosen the comparison of techniques for determination of optimal transportation schemes, existing today, as the objective of their study and suggest using regionalization techniques for solution of similar problems, which confirmed their effectiveness based on the results of the study.

2. Main text

2.1. Investigation of various techniques to determine optimal transportation schemes

Currently, such techniques as a technique of linear convolution (ranking method), technique of specific weights determination ("weights system of Fishburne") are used to select transportation routes. Another approach to solution of this problem is application of case analysis criteria under conditions of uncertainty or risk. Wald's "maximin" criterion, the principle of insufficient reason (Laplace's criterion), Savage criterion and Hurwitz pessimism-optimism criterion are distinguished among them [Bogoyavlenskiy (2014), Gmurman (2003)].

Let us consider a situation when it is necessary to select an optimal route. The value of the relative en-route accident rate coefficient, cost of provision of en-route traffic based on tariff rates, average value of the driving speed of en-route traffic flow have been singled out as the main parameters analyzed when making a decision [Babkov (1993)]. The data are summarized in Table 1.

Table 1. Delivery criteria.

Route No.	Value of the relative en-route accident rate coefficient	Cost of provision of en-route traffic, monetary units	Average en-route speed, km/h
1	0.2	5	35
2	0.3	12	45
3	0.1	20	50
4	0.6	8	20

It is necessary to determine an optimal route taking into account the indicated criteria. The minimization of the value of the relative en-route accident rate coefficient, minimization of the cost parameter, and maximization of the en-route driving speed are specified as requirements.

The problem belongs to the multi-criterion category since it is necessary to select a route with the optimal ratio of the presented criteria [Gmurman (2003)].

Matrix of initial data A_{ij}, where i — route number (i=1…m, m=4), j — delivery criterion number (j=1…n, n=3), is represented as follows:

$$A = \begin{pmatrix} 0.2 & 5 & 35 \\ 0.3 & 12 & 45 \\ 0.1 & 20 & 50 \\ 0.6 & 8 & 20 \end{pmatrix}$$

Let us reduce the initial data to the effectiveness matrix of routes criteria B_{ij} calculated according to formula (1) if j-parameter is minimized, and according to formula (2) if it is maximized:

$$b_{ij} = \frac{min_j(a_{ij})}{a_{ij}} \quad (1)$$

$$b_{ij} = \frac{a_{ij}}{max_j(a_{ij})} \quad (2)$$