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Innovative Methods of Regional Availability Analysis as a Factor of Competitiveness

Abstract

Regional competitiveness is strongly dependent on the accessibility of a region. Innovative tools are sought for analysis and prediction. The precedent analysis is one of these tools[1]. Through this analysis we can compare disparate variables. We can describe and analyse stocks and flows too. This way we can compare transport infrastructure changes and economic variables changes. There is a possibility to describe the evolution and impact on the environment. By using the first precedence of this analysis we can find the frequency of observed changes in the area. The range (distance) changes of selected variables in the area we find by using multiple precedence. The article demonstrates the method on the example of road access to regions of the Czech Republic. Comparing different types of region´s roads were created directions border flows. These flows were described by binary precedence matrices. Square precedence matrices have been calculated for all regions and groups of roads. Thus were made multiple precedencies. Those precedencies are recorded by matrices, charts and maps. By using the criteria there can be set a boundary threshold. For the basic research the threshold is set around the average values. To determine the direction of flow of the individual variables can be used multicriteria threshold. For the demonstration of the method there is applied the difference of observed variables averages. Referred method allows comparing the increases and decreases in the values of selected road network. The article compares the percentage ratios of the sums given for regions and sums given for road types. For the basic understanding and for demonstration of the method there have been compared the precedence in two categories by quality. Comparison is done on the highway and motorway and from the first to third class local roads. Above mentioned method is further extended for example by the monitoring of border flows or cyclical events. Binary matrices are use for research of the precedence existence. By using of numeric precedence matrices there can be defined the frequency of precedence.

Key Words

precedence, incidence matrix, region, Czech Republic, infrastructure, road network

JEL Classification: O18, C65

Introduction

Competitiveness is basic precondition for development. Standard methods of economic analysis provide equal opportunities to all subjects for market analysis. Substandard

[1] For inclusion, see [1], [2], [8], [11], [12]

approach to used methods can bring new and previously unknown results. We need innovative methods to analyze and compare flows, disparate and state variables regardless of the enviroment. Such a method can be precedence analysis. Principles are based on the graph theory and system analysis and there exists relatively developed mathematical apparatus [2]. In several research projects at the Silesian University in Opava[1] have been carried out analysis of economic variables and their reciprocal comparison. Within this research are identical factors and trends searched. An undeniable factor that affects the development of regions is transport accessibility. Therefore, the research is focused on the comparing changes in transport and changes in the economy. Due to the location of the Czech Republic, is also important factor relationship with European corridors and infrastructure. The presence of European transport infrastructures is not always benefical for regions. There are many other factors, such as backbone links of European moves at national and regional level. Absence of links (motorway feeder, logistics centers, multimodality, etc.) may lead to environmental stress, the lose of workforce, traffic accidents or other negative phenomena[2] at all. From the above mentioned artice results that it is necessery to analyze variol large and complex systems. It is necessery to be able to quantify and use these variol links as kriteria. As stated earlier, it is important to analyze flow variables and states variables. Last but not least, it is necessary to find a comparative mechanism for comparison of asymmetric variables. The tool that meets these criteria is the case analysis. The basic idea is based on the philosophy that the individual economic variables are not compared, but their impact on the enviroment. A measurable variable, in this case is increase or decrease, respectively to the rate of increase or decrease of the quantities at some point (increase the value of the attribute element) to the vicinity of this point. These procedures were successfully used for example in the European structures in the analysis of immigration flows[3], evaluation of education and unemployment[4], in the Czech Republic in the analysis of accessibility[5] and the unemployment rate in the Moravian-Silesian region in the analysis of municipalities with extended powers[6]. The principle was successfully used to analyze the impact of the crisis[7]. The whole method is very flexible and essentially independent of the environment. The model can be applied to any real object by changing resolution levels, selecting elements and definition of links. The links in the system are based on the methods of structural analysis, when the spatial criteria is established for the existence of structure (such as adjacency of regions, physical crossing of roads, etc.[8]). The quantification of the binding parameters (orientation, frequency, robustness, etc.) is

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[1] SGS – 24/2010 Use of BI and BPM to support effective management, 23/2010 Fiscal policy in the context of the global crisis and its impact on business, SGS 5/2013 Precendence Analysis of Selected Parameters Influencing Interaction Between Traffic Infrastructructure and Regional Expansion, CZ. 1.07/2.4.00/12.0097 „AGENT"

[2] For more information, see [3]

[3] For more information, see [9]

[4] For more information, see [5], [6]

[5] For more information, see [10]

[6] For more information, see [6], [7]

[7] For more information, see [4]

[8] For more information, see [3], [10]

mostly expressed as the difference among the relevant values of the variables among elements with defined binding, but it can be calculated on the basis of multi-criteria evaluation. The advantage of this method is considerable flexibility in the definition of the links and easy recording method. If we want to analyze other relationships, such as relationships among all regions, not just among adjacent, then we simply write the links to the incidence matrix to the places of the required bonds. Last but not least it is necessery mention the advantage of the method is sufficiency of standard spreadsheet (MS Excel) and conventional matrix operations that we simply modify to the binary operations and it is easy to algorithmic.

1. The definition of the system and the data

To demonstrate the method in this article was created model based on the regions of the Czech Republic. Individual region forms element of the system. The links are defined when the the regions adjacent or the regions adjacent with the enviroment.

Fig. 1 Percentage calculation for creation of Precedence

	percent of roads - total					percent of regions - total				
regions	Motorways	Highways	Road I. class	Road II. class	Road III. class	Motorways	Highways	Road I. class	Road II. class	Road III. class
Praha	12,694611	40,239521	11,616766	35,449102	0	1,4443385	7,9564291	0,1663152	0,2022576	0
Středočeský	2,0151499	1,578292	6,8610563	24,625921	64,918543	26,461371	36,017049	11,336865	16,216142	18,331253
Jihočeský	0,2512727	0,1207414	10,666036	26,820911	62,142671	2,0983785	1,7523088	11,208271	11,232132	11,159555
Plzeňský	2,12907	0	8,206278	29,245467	60,417235	14,879411	0	7,216707	10,249542	9,0797747
Karlovarský	0	1,3292434	10,161652	22,928231	65,580874	0	6,4645986	3,5783482	3,2176729	3,9465434
Ústecký	1,2513977	0,2926272	11,424357	21,564009	65,467609	7,167189	2,9126214	8,2334585	6,1934567	8,0630322
Liberecký	0	0,9153507	12,79017	20,063497	66,226859	0	5,2569264	5,3186564	3,3249515	4,7063167
Královéhradecký	0,4452808	0	11,776087	23,666145	64,115137	2,2891402	0	7,6179209	6,1012108	7,087897
Pardubický	0,2443291	0,0860705	12,67457	25,332482	61,659772	1,1990734	0,7340753	7,8271008	6,2344549	6,5071524
Vysočina	1,8138678	0	8,3810495	32,14958	57,655502	12,603897	0	7,3281553	11,20275	8,6150619
Jihomoravský	3,0021651	0,57588	9,3926475	32,901051	54,128256	18,326748	6,1094009	7,2149924	10,071883	7,1054775
Olomoucký	0,9310413	2,5379287	9,6497378	25,906503	60,974789	4,5237771	21,430263	5,8999023	6,3123514	6,370903
Zlínský	0,5841121	0,7476636	15,985981	26,757009	55,920561	1,7032293	3,7887758	5,8656105	3,9125919	3,5064433
Moravskoslezský	1,5592213	0,9326183	19,016671	23,577757	54,913733	7,2898215	7,5775515	11,187696	5,5279198	5,5208828

Note: The names of regions in the Czech language

Source: own, initial data: www.rsd.cz

The links among elements are expressed by incidence matrix. Based on the data of Directorate of roads and highways and length of relevant roads categories[1] there were calculated percentage ratios for each category (Figure 1). These percentage calculations were calculated in relation to the total length of the respective category in all regions and to the total length of the roads of all categories in the region.Finally the two qualitatively different groups were compared, the sum of motorways and highways (expressways) (M+H) and roads for the sum I. to III. category. Orientation of the links in the system was designed for these groups by comparing the percent of adjacent regions. Orientation of the links to the enviroment has been set for this post exhaustively based on the average percentage changes in the group. In total there were analyzed four different groups. For each group the Incidence matrix was transferred to the Precedence

[1] Reports from the information system of road and highway network, the Czech Republic, modified date 2011 to January 1, 2013, http://www.rsd.cz/Silnicni-a-dalnicni-sit/Delky-a-dalsi-data-komunikaci, online 1. 4. 2013

matrix (Figure 2). During the transfer of the precedence matrix, there was controled the corectness of the system.

Fig. 2 Precedence determination based on percent

Region	% Roads in the region	Incidencies													Precedencies												
Praha	52,93413174		1																								
Středočeský	3,593441943	1		1	1		1	1	1	1	1					1											
Jihočeský	0,372014097		1		1						1	1			1		1		1					1	1			1
Plzeňský	2,129069994		1	1		1	1								1		1											1
Karlovarský	1,329243354				1		1								1				1		1							1
Ústecký	1,544024933		1		1	1		1							1		1		1									1
Liberecký	0,915350678		1				1		1						1		1				1							1
Královéhradecký	0,445280818		1					1		1					1		1					1						1
Pardubický	0,330399534		1						1		1	1	1		1		1						1		1	1	1		1
Vysočina	1,813867754		1	1						1		1					1								1				
Jihomoravský	3,578045133			1						1	1		1	1	1													1
Olomoucký	3,468969966									1		1		1	1										1			1
Zlínský	1,331775701											1	1		1										1	1		1	1
Moravskoslezský	2,49183959												1	1		1										1			1
Surroundings	5,448389659			1	1	1	1	1	1	1		1	1	1	1														

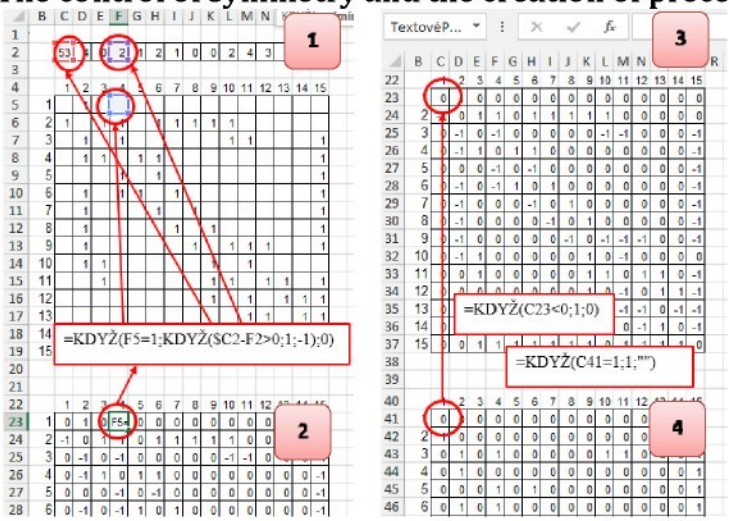
Note: The names of regions in the Czech language

Source: own

2. The precedence of the matrix, creation of precedence matrix

Based on the mentioned values were progressively found differences in the length of the various categories of roads among regions. By comparing the values in each region were determined directions of subsidence values among individual regions.

Fig. 3 The control of symmetry and the creation of precedence



Source: own, using MS Excel (Czech localization)

The direction is assignemnt to the linkage among the links. The element, which in the direction of the session precedes another element, is referred as the precedent (the predecessor). Setting guidelines enables the construction of directed graphs and creation of precedence matrix [7].

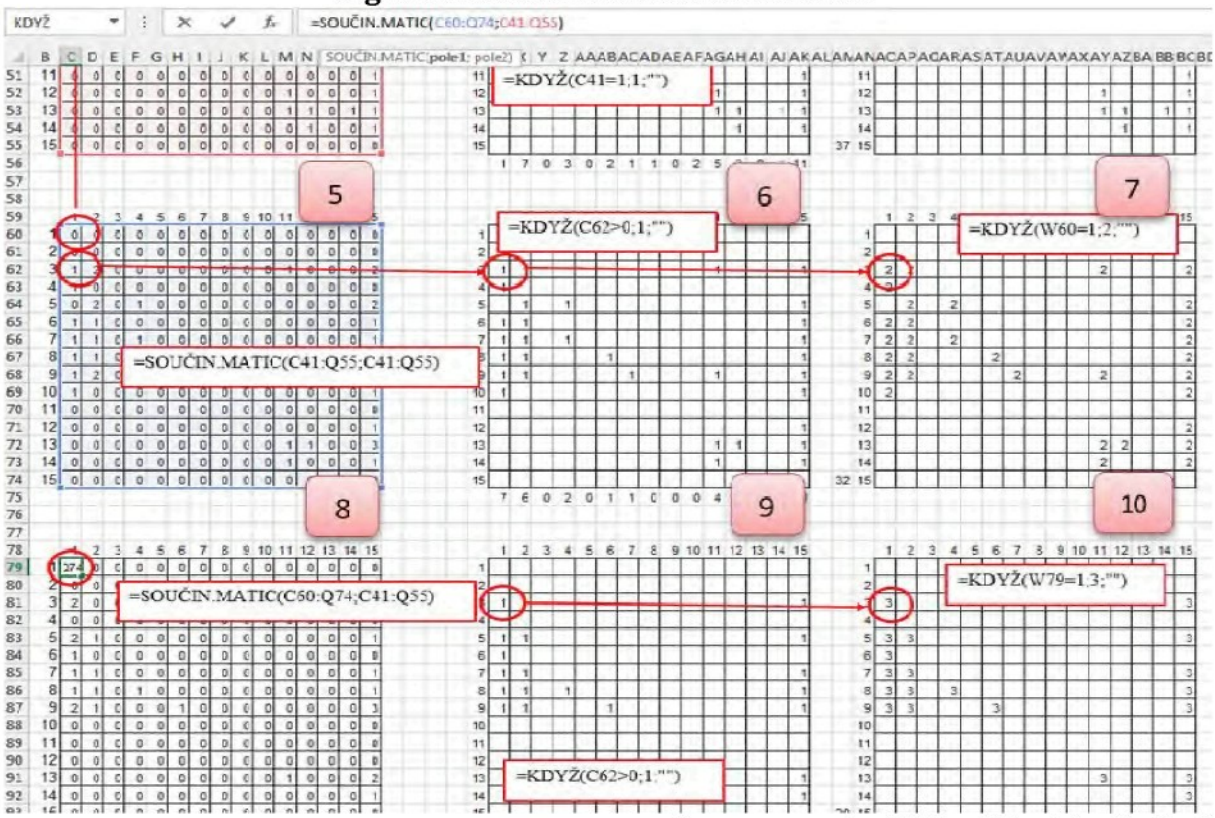
The matrix group shows the process of creating precedence in MS Excel (Figure 3). Based on the vector with proportional values and incidence matrix (matrix 1) was performed the symmetry control and there was created the matrix of which the decrease and increase in percent among adjacent objects was expressed by the value "1" or "-1" (matrix 2). This matrix was transferred for further calculations of matrix patterns to the matrix of values (matrix 3) and after supervision of the symmetry was eliminated negative component. This led to creation of the precedence matrix for selected group of data. The precedence is recorded by using the precedence matrix (matrix P). Precedence matrix has the number of rows and columns given by the number of elements, among which we monitor the precedence. When inline element passes column element, then the precedence is written to the line and column. In this article, the matrices have size 15x15, fourteen lines (1 – 14] and columns are made up of the region and one row and column (15) indicates the surroundings.

3. Calculation of the multiple precedence

The relationships captured by precedence are successively analyzed by using pVR of the matrixes. Based on the pVRs there is detected a sequence of regions where is no decrease respectively non-growing values varions of monitored communications. The precedens of vary length are monitored and there is found maximal precedence. Thus we can define multiple precedence so-called precedence of different lengths. Multiple precedence shall be entered (or calculated) using by the pVRs precedence.

There was successively calculated pVRs precedence matrices to each monitored variables and investigated the number of the precedence appropriate length. To calculate the pVRs precedence matrix is normally used binary multiplication, where the columns of the resulting matrix are created by the unification operation. This operation is performed above the set of the vectors of the precedence matrix, which are successively selected by selection of the vectors. The selected vectors are used successively as each column of precedence matrix or the pVRs [2]. In MS Excel, it is possible modify the operation of binary multiplication by using two steps. In the first step, it is necesary to do classical multiplication operation (matrix 5, matrix 8, etc.)), in the second step it is important to convert this matrix to bingy matrix using "= IF (value_aij> 0, 1, 0)". Classical precedence matrix is able to obtain by eliminating zero values (Figure 4, matrix 6, matrix 8, etc.). For each matrices pVRs were created auxiliary numerical matrices (matrix 7, matrix 10, etc.) in which is indicated precedence and its duration.

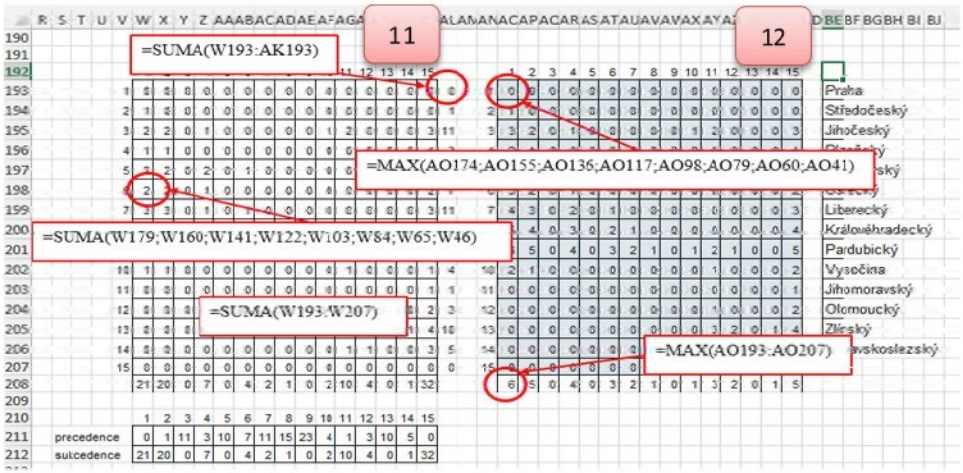
Fig. 4 Calculation of matrix elements



Source: own, using MS Excel (Czech localization)

By summarization of the precedence matrices and their pVRs were calculated the total number of precedencies and consequent for all regions and surroundings (Figure 5, matrix 11). By finding the maxima of the other numerical matrices for individual matrix elements there were obtained multiple precedence matrixes for each region. The overall analysis involves the creation of the common incidence matrix, three matrixes for setting the first precedence and symmetry control data and three matrices for the calculation of each pVRs and its summarization. According to the system size and the number of non-zero pVRs of the matrices, the number of the matrices of acyclic systems ranges for this type of analysis around (3k +1) for each investigated value, where „k" is the number of nodes in the system, in this particular example it is about 120 matrices. The advantage is possible algorithm that reduces the number of basic operations to 3. Those are the calculation of the first precedence, the multiplication of matrices and the transfer of pVRs of matrices to binary matrix. The resulting figures show the rate of change of the individual categories of communications among individual regions. The more precedence individual region consists, the greater is relative increase (or smaller decrease) of values of the quantity due to the surrounding regions. The following figure (Figure 6) shows the difference precedent matrices describing the precedence of I. to III. classes.

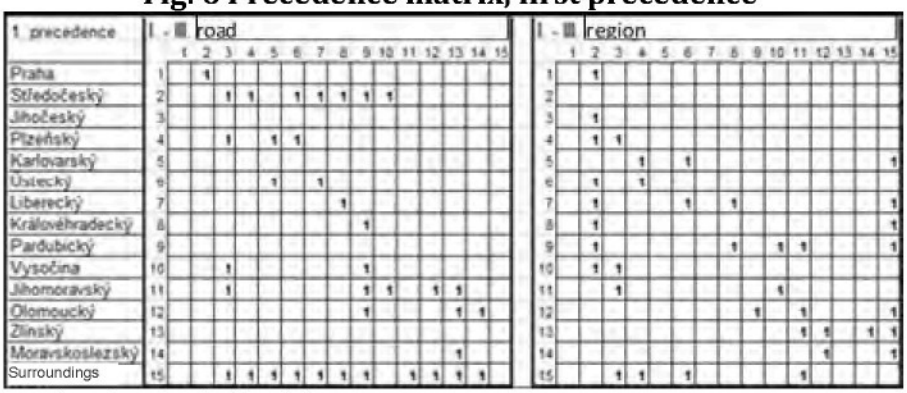
Fig. 5 summarization of Precedence



Source: own, using MS Excel (Czech localization)

According to the number of precedencies of the element we can examine the "strength" of impact of the value to the immediate enviroment (the more have the element first precedencies the more is "dominant" in the selected are). Multiple precedencies shows system paths among the elements with increasing (decreasing) value of studied variable. In other words, we can determine the distance of variable which has impact around its surroundigs.

Fig. 6 Precedence matrix, first precedence



Note: The names of regions in the Czech language

Source: own

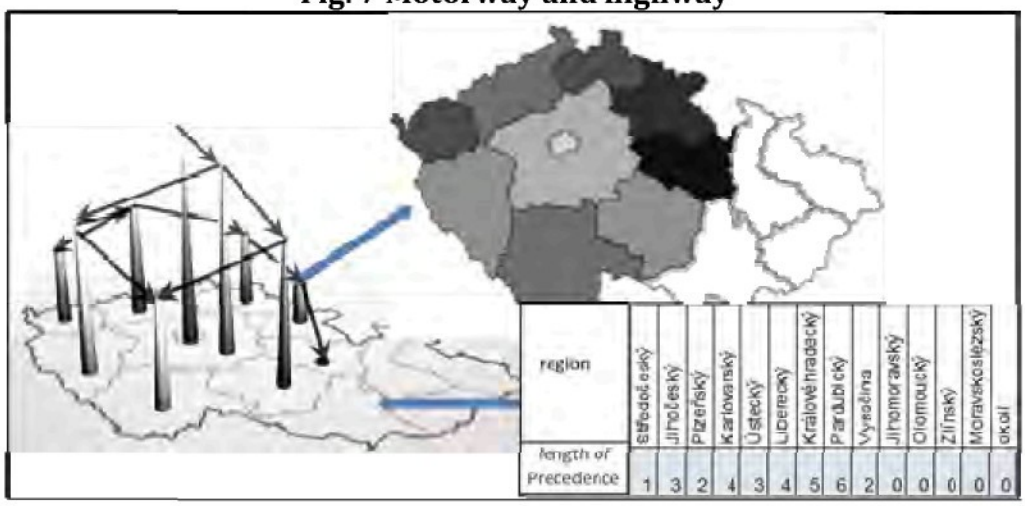
To demonstrate the results of the methods were appropriate precedence displayed by using maps. In the maps the shades express precedence of different lengths, each lighter shade means less precedence. That the region is precedent for another, means it has smaller percentage of that type of communication shown in the map.

4. Evaluation of analysis

Analysis results are fairly widely applicable to different areas of practice, both in terms of availability analysis for example same in terms of coverage of the regions by individual types of communication or tracing still unclear links in the infrastructure.

Based on the documents from precedece matrices were created 56 maps. For each of the county (14) there are 4 maps. The meaning of those maps is the combination of two qualitative parametrs (M+H, I. – III.) and two quantified parameters (percent of assets for the county, the sum of percentages for communication). Into the individual maps were entered routes where is the decreasing value of qualitative parameters of the quantifiable parameter. The following figure graphically shows the precedence of the county of Prague.

Fig. 7 Motorway and highway



Note: Prague, Percent of the length of all roads in Prague, the names of the regions are in Czech

Source: own

The calculated multipled precedence was recorded by using the graph. In the chart for clarity has been a modified precedence value as follows. Maximum precedence was assigned to pursue region (Prague). Regions with precedence were assigned a value of "max (existing_predence) – precedence (region)". In this graph it can clearly trace the paths with decreasing number of the precedence. In practice, these paths show the way to a steady decline in the communications according to the criteria. On the basis of these graphs were created maps, in which marked decreases have progressively darker shades.

Among quite interesting findings include, for example, that Prague has a curl around the Central Czech region, which has all types of communications higher values, thus it acts as a barrier. Exception is the length of M+H in relation to the total length of roads in the region. In this case, the Central Bohemian region has lower value so it is precedent. This allows the passage of others, multiple precedencies. Figure 7 show that the second precedencies copy major highways (Brno, Pilsen). An interesting finding is the fact that the scope of precedence is at M+H focused solely on the Czech regions and it does not

overlap among the Moravian regions. In general, from maps it is possible to trace a strong dominance of the Central and Southern Czech regions in all types of analyzes. This dominance is quite strictly segmented to the southeast of the Republic of South Moravian region (Figure 8, Map 1) and the Central Bohemia region (Figure 8, Map 2), where the precedencies M+H are due to the length of roads in the regions.

Fig. 8 Dominance of the regions

Source: own

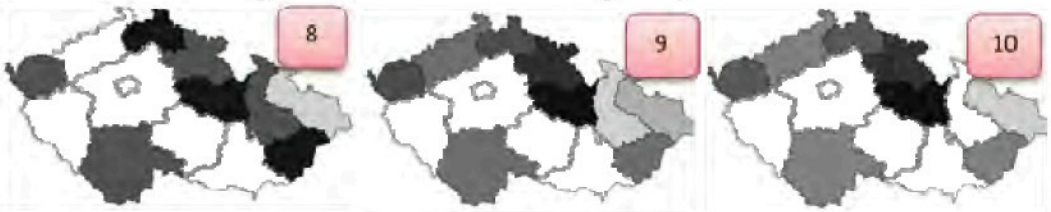
Dominance of the Central Bohemian region is also evident in other comparisons. For example the analysis of I. – III. categories in proportion to the total length of roads in the country, it is clear routing of precedence in Moravian regions and it is seen unflattering situation of Moravian and Zlín regions (darkest color is the longest precedence).

Fig. 9 Similarities in the precedence

Source: own

The comparison of I. to III. class to the total length of roads in the region contains the regions Královehradecko (Figure 9, map 4) and Pardubice region (map 5) comparable by heading of precedence to the Czech regions with precedence Prague – Central Bohemian region – Pilsen region – Ústí region – Liberec region. If we evaluate class I to III. class to the total length of the type of communications in the country, then the region Královehradecko (map 6) is more akin to the region of Vysočina (map 7) routing to precedence of Moravian-Silesian regions.

Fig. 10 precedence and highway corridor



Source: own

In the analysis of highways´ lenght due to the length of the whole country is Moravian-Silesian region predecessor of Olomouc region (map 8), however, if we add to highways

speed routes, then the situation is reversed (Map 9 and 10). Dominance of D1 and D5 (Figure 10, lack of precedence) is obvious.

These comparisons are made to demonstrate the methods and overall evaluation is beyond the scope of this article. The results will be published in a separate monograph[1].

Conclusion

The article shows the possibility of precedence analysis. It is obvious that this method of analysis can be used to monitor the intensity and extent of the changes of a quantity. Intensity is measured by the number of precedencies; the extent is measured by the degree of precedence. The method works with binary matricesa and resulting operations are binary matrices. Precedence matrices for multiplication are defined operations that specify the same length among the same elements of precedence existence, not frequency. The Method shows the existence of the precedence (not the frequency of precedence of the same length among the two regions). Therefore, in practice it is appropriate expand the method to detection of the frequency of precedence which can be achieved by the classical (non-binary) matrix multiplication precedence.This contribution shows the possibility of matrix case analysis in the analysis of regional transport infrastructure. It shows relatively large variation of the method, in particular the ability how to easily define the system, change links in the system by simply binding transcription incidence matrix, analyze various large systems, define the sensitivity of the enviroment, etc. The variability is dictated by the choice of links, where the method can be easily modified, whether the linkage is defined by boundary, border crossing or physical connection to the type of communication, etc. The method is focused on examining two types of tasks, we can analyze the intensity ofchanges of the variables in the immediate vicinity or scope of the changes in distant surroundings. Precedence analysis has more options which were not mentioned due to small space, such as the analysis of flow in loops in detecting cycles in a system or detection boundary flows, etc. [8]

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[1] SGS 5/2013 OPF SU

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