On some spatial aspects of sustainable development: focused on transport infrastructure in the Czech Republic

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Abstract: - There are several themes related to links between transport infrastructure on one hand and sustainable development on the other. This article is focused on some spatial aspects in this regard. First, the relationship between transport infrastructure and spatial development at the level of Czech counties is surveyed. Second, spatial inequalities of Czech counties in road accessibility are evaluated. Our conclusions point at some signs of a positive impact of transport infrastructure on spatial development. However, there is no universal conclusion in this regard and the case-by-case approach to identify the main development barriers of Czech counties is recommended. Third, two spatial clusters of Czech counties were identified as lagging in their road accessibility. It is recommended to focus new highway construction just on these regions.

Key-Words: - sustainable development, transport, accessibility, spatial competitiveness, spatial equity, unemployment, Czech Republic

1 Introduction
Sustainable development belongs to the leading concepts of modern society (see e.g. [14]). There are various definitions of sustainable development. Traditionally, the balance of economic, social and ecological interest is stressed (see e.g. [16]). Naturally, a number of conflicts between the three interests may be identified. Transport is no exception in this regard.

There are several themes related to links between transport on one hand and sustainable development on the other. Gudmundsson and Höjer mention four themes of this kind [7]:

- preserving natural resources for future generations,
- preserving the option value of human and man-made capital for future generations,
- improving quality of life for individuals,
- ensuring a fair distribution of life-quality.

Various issues are relevant for these four themes. They include the themes like transport dependence on non-renewable resources, loss of biodiversity, pollution, transport costs, accessibility and mobility, safety, or equity. Litman and Burwell summarize the transport impacts on sustainability, using a typology based on the three traditional dimensions of sustainable development (see table 1).

<table>
<thead>
<tr>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic congestion</td>
<td>Inequity of impacts</td>
<td>Air and water pollution</td>
</tr>
<tr>
<td>Mobility barriers</td>
<td>Mobility disadvantaged</td>
<td>Habitat loss</td>
</tr>
<tr>
<td>Accident damages</td>
<td>Human health impacts</td>
<td>Hydrologic impacts</td>
</tr>
<tr>
<td>Depletion of non-renewable resources</td>
<td>Community interaction</td>
<td>Depletion of non-renewable resources</td>
</tr>
<tr>
<td>Facility costs</td>
<td>Community liveability</td>
<td></td>
</tr>
<tr>
<td>Consumer costs</td>
<td>Aesthetics</td>
<td></td>
</tr>
</tbody>
</table>

Source: [10]

Altogether, sustainable transport may be defined as the type of transport which supports increasing economic competitiveness and accessibility. Simultaneously, the principles of human and ecosystem health protection, and protection of natural resources are considered (e.g. [1], [9], and [13]). Moreover, some spatial aspects are closely related to the sustainable transport concept. These
aspects are traditionally discussed considering the goals of spatial competitiveness and spatial equity. And just these spatial aspects of sustainable transport are the subject of our interest. The Czech Republic was chosen as the model area for our research.

There is a rather extensive literature on relations between transport infrastructure and spatial development now. Although conclusions are not straightforward there is a consensus that transport infrastructure is a necessary but not sufficient prerequisite of spatial development (see e.g. [5], or [6]). In this article, we deal with the relationship between transport infrastructure and spatial development at the level of Czech counties. The relationship between market accessibility by roads as the indicator of transport infrastructure and unemployment as the indicator of spatial development is surveyed. We hypothesise that the better the market accessibility the lower unemployment (spatial competitiveness).

Subsequently, the map of time-distance accessibility at the county level in the Czech Republic is analyzed to identify lagging regions. On this basis, some recommendations how to increase the balance of accessibility between Czech counties are formulated (spatial equity).

The article is structured as follows. The second chapter discusses some theoretical backgrounds of this article. The third chapter defines problems of our interest, and the methodology. The fourth chapter summarizes the main results of our analysis and the fifth chapter concludes.

2 Theoretical Background

There is a long history of the research on relations between transport infrastructure and spatial development. Transport costs belong to the cornerstones of the classical location theories from the 19th and the first half of the 20th century (see e.g. [18]). However, the knowledge on the relationship between transport infrastructure on one hand and spatial development on the other is not without ambiguities (see e.g. [8]). First, there are the following arguments for the positive relationship between transport infrastructure and spatial development (e.g. [6], or [17]):

- Transport infrastructure development reduces transport costs, increases labour productivity, and consequently spatial competitiveness.
- Transport infrastructure development improves access to markets, and consequently increases labour productivity and spatial competitiveness.

It is noteworthy that EU Transport Policy is based just on these two arguments. It is assumed that transport infrastructure development is a tool how to increase not only EU competitiveness but also how to reinforce balanced spatial development ([17]).

Balanced spatial (regional) development belongs to the leitmotifs of the ambitious European integration project. Its importance has been increasing especially since the first reform of EU primary legislation at the turn of the 1980s and 1990s (see e.g. [3]). The concept of the so called territorial cohesion is now firmly positioned as one of the main goals of the Treaty of Lisbon. Thus, it is not surprising that the debate on European spatial development policy tends to be intensified in the last twenty years or so.

At the end of the first decade of the 21st century two key documents related to the concept of territorial cohesion were published ([15]):

- the Green Paper on Territorial Cohesion – Turning territorial diversity into strength in 2008,
- the influential Barca’s Report introducing the so called place-based approach to development ([2]).

Subsequently, the Territorial Agenda of the European Union 2020 (only TA 2020 hereafter) was agreed at the meeting of Ministers responsible for spatial planning and territorial development in 2011. These steps further confirmed the importance of the territorial cohesion concept. But, what is the meaning of this concept?

TA 2020 defines six territorial priorities related to the concept of territorial cohesion:

- Promote polycentric and balanced territorial development
- Encouraging integrated development in cities, rural and specific regions
- Territorial integration in cross-border and transnational functional regions
- Ensuring global competitiveness of the regions based on strong local economies
- Improving territorial connectivity for individuals, communities and enterprises
- Managing and connecting ecological, landscape and cultural values of regions
For the purpose of this article, it is essential that TA 2020 connects this set of principles with harmonious, balanced, efficient, and sustainable territorial development. Thus, a spatial framework of sustainable development arises. It is noteworthy that the Czech Strategic Framework for Sustainable Development gives the same rationale (e.g. [12]).

Transport infrastructure is a natural glue of the abovementioned TA 2020 priorities – sustainable territorial development. Transport infrastructure promotes polycentric and balanced territorial development, enables integration of cities and their hinterland. Thus, the research on the relationship between transport infrastructure and spatial development is essential. This relationship was the subject of interest in several surveys (e.g. [4], [11] and others). Findings from these surveys show that transport infrastructure is a necessary but not sufficient prerequisite of spatial development (e.g. [5], [6], or [17]).

The Czech Republic is characteristic by a dense transport network. However, the quality of this network is rather low. In addition, some regions of the Czech Republic are disadvantaged in this regard because of the incompleteness of the highway and railway corridor networks. Therefore, the research on the relationship between transport infrastructure and spatial development in the Czech Republic is substantiated. Such a research may confirm the importance of transport infrastructure for the development of Czech regions, may identify the lagging regions, and on this basis may recommend spatial orientation of new transport infrastructure construction. This article deals with these issues.

3 Problem Formulation

The main goal of this article is to assess some spatial aspects of the relationship between transport infrastructure on one hand and spatial development on the other. Two partial problems are formulated in this regard:

- The first problem deals directly with the relationship between transport infrastructure and spatial development. We chose market accessibility by roads as the indicator of transport infrastructure and unemployment as the indicator of spatial development. Czech counties are the spatial level of our interest. Note that the choice of the indicators was determined also by the availability of data. We hypothesise that a better market accessibility is connected with a lower unemployment.
- The second problem identifies lagging spatial units with respect to road accessibility. Czech counties are the spatial level of our interest once again. The accessibility of a county is measured by the highest speed to reach all other Czech counties. We regard this indicator as a suitable one for determining the lagging counties when considering transport infrastructure endowment. In addition, recommendations for further road infrastructure construction may be given.

3.1 Methodology

The methodology of this article is based on a rather straightforward approach. There are 77 counties in the Czech Republic. These counties were chosen as the spatial unit for our analysis. However, five counties in the surrounding of three large cities (the Cities of Prague, Brno, and Pilsen) were united with the corresponding city-counties. Thus, data on 72 counties were compiled.

Our first research problem was focused on the relationship between market accessibility by roads as the indicator of transport infrastructure and unemployment as the indicator of spatial development. The following approach was applied to create the market accessibility index:

- First, a matrix of time distances between each pair of counties was compiled. The time distance was calculated as the fastest travel between the most important cities of the counties by car. GPS systems were used for this purpose. The year 2012 is relevant.
- Second, a vector of number of inhabitants of the analyzed counties was constructed. We used the data of Czech Statistical Bureau for the year 2011.
- Third, for each county, the market accessibility index was calculated as the sum of time distances to all other counties multiplied by the corresponding number of inhabitants. In this way, the market potential expressed by the number of inhabitants is considered.
- Fourth, the values of the market accessibility index were standardized by subtracting the average value and dividing by standard deviation of all values.

Unemployment was calculated as the average value for unemployment figures of the years 2009, 2010 and 2011. In this way, one year deviations were eliminated. The Czech Ministry of Labour and Social Affairs is the source of data. Note that the
same data standardization as for the market accessibility index was applied.

The relationship between market accessibility by roads and unemployment was evaluated by bivariate correlations. Thus, Pearson’s correlation coefficient and Spearman’s rho were computed. Moreover, statistical significance was considered. In addition, a typology of counties was suggested.

The second research problem was focused on lagging Czech counties with respect to road accessibility. The accessibility of a county was measured by the highest speed to reach all other Czech counties. The following approach was used:

- First, the matrix of time distances was used once again.
- Second, a matrix of distances in kilometres between each pair of counties was compiled. The distance was based on the fastest travel between the most important cities of the counties by car. GPS systems were used for this purpose. The year 2012 is relevant.
- Third, for each county, the time distances and distances in kilometres were summed. These sums were divided subsequently.

The counties with low values of this indicator were understood as the lagging ones. Spatial pattern was analyzed using cartographic visualization. On this basis, some recommendations were formulated.

4 Problem Solution

Our first research problem is focused on the relationship between market accessibility by roads as the indicator of transport infrastructure and unemployment as the indicator of spatial development. We suppose a direct relationship between these two indicators.

Figure 1 shows some initial findings using the scatterplot of Czech counties. Thus, the expected relationship seems to be prevailing. A better market accessibility tends to be connected with a lower unemployment. The relevance of this assertion we verified on the basis of Pearson’s correlation coefficient and Spearman’s rho. Table 2 gives the results. There is a moderate strong relationship between market accessibility by roads and unemployment. Moreover, this relationship is significant at the 0.01 level.

Figure 1 and table 2 showed a direct and statistically significant relationship between market accessibility by roads and unemployment. However, figure 1 points at the existence of counties with a relatively better market accessibility but higher unemployment figures on one hand and with a relatively worse market accessibility but lower unemployment figures on the other. What is the spatial pattern of these types of counties?

Fig. 1 – Relationship between market accessibility by roads and unemployment – Czech counties (N=72)

Source: own calculations based on GPS systems and data of Czech Ministry of Labour and Social Affairs

Tab. 2 – Relationship between market accessibility by roads and unemployment – Pearson Correlation and Spearman’s rho

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Significance</th>
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<tbody>
<tr>
<td>Pearson Correlation</td>
<td>0.416</td>
<td>0.000**</td>
</tr>
<tr>
<td>Spearman’s rho</td>
<td>0.395</td>
<td>0.001**</td>
</tr>
</tbody>
</table>

Correlation is significant at the 0.01 level (2-tailed)

Source: own calculations based on GPS systems and data of Czech Ministry of Labour and Social Affairs

Fig. 2 – Relationship between market accessibility by roads and unemployment – typology of Czech counties

Source: own elaboration based on GPS systems and data of Czech Ministry of Labour and Social Affairs

To answer the abovementioned question, we construct a simple typology of counties based on the both indicators. Figure 1 is the starting point of the
typology. The zero axes divide counties into four quadrants. Each quadrant forms one type of counties in our typology. Figure 2 shows the spatial pattern of our typology.

There are four types of counties which may be characterized as follows:

- The counties with relatively better market accessibility and lower unemployment are depicted by the lightest colour. Two clusters of counties may be identified. Their common feature is their proximity to the largest agglomerations in the Czech Republic – Prague and Brno. In addition, the impact of the capital city of Prague seems to be much stronger.
- There are several peripheral counties with a relatively worse market accessibility but with a relatively lower unemployment figures. And on the contrary, there are several counties with a relatively better market accessibility but with a relatively higher unemployment figures. Thus, no universal conclusion on the relationship between market accessibility and unemployment may be formulated.
- The counties with relatively worse market accessibility and higher unemployment are depicted by the darkest colour. Two clusters of counties may be identified once again. They generally correspond to the so called structurally affected regions in the Czech Republic. Thus, their relatively worse market accessibility seems to be another piece to the mosaic on their worse performance in unemployment. However, it must be stressed that no cross-border relations are considered in this article.

Our second research problem is focused on lagging Czech counties with respect to road accessibility. The highest speed to reach all other Czech counties was chosen for our analysis. Figure 3 shows our results in a cartographic form.

Some findings are noteworthy in this regard:

- There is a rather good accessibility in the both clusters of counties which were categorized as counties with relatively worse market accessibility and higher unemployment. Thus, other tools than transport infrastructure should be searched to solve the problem of unemployment.
- The highest potential how to improve road accessibility is connected with the northern and southern parts of the Czech Republic (the darkest colour in figure 3). These parts of the Czech Republic are characterized by underdevelopment of their highway network. However, there is a bit ambiguous political attitude especially towards the highway in the Central Moravia – North Bohemia direction. Such a stance does not seem to be in accord with the sustainable development principle – ensuring a fair distribution of life-quality.

5 Conclusion

There are close links between sustainable development and transport infrastructure. Spatial aspects related to the competitiveness and equity development goals belong to them. This article dealt just with these aspects. Czech counties were chosen for our analysis. Our main conclusions may be summarized as follows:

- First, we identified a moderate strong relationship between market accessibility by roads on one hand and unemployment on the other. In accord with other surveys, there seems to be a sign of a positive impact of transport infrastructure on spatial development (competitiveness) of Czech counties.
- Second, there is no universal conclusion on the relationship between market accessibility by roads and unemployment. Thus, the case-by-case approach must be chosen to identify the main development barriers of Czech counties.
- Third, the situation of Czech structurally affected counties confirms the idea that transport infrastructure is not a sufficient prerequisite of spatial development. There is a rather good road accessibility of these regions now. However, unemployment remains high. Thus, other tools how to solve the problem of unemployment must be searched.

Fig. 3 – Road accessibility of Czech counties – the highest speed to reach all other Czech counties

Source: own elaboration based on GPS systems
• Fourth, two spatial clusters of Czech counties were identified as lagging in their road accessibility. If following the spatial equity goal, in accord with the sustainable development principles, new highway construction should be focused just on these two regions.

The abovementioned conclusions evoke also some themes for further research. These themes include, among others, spatial evaluation of new highway projects in the Czech Republic or cross-border extensions of our analysis.

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