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The conceptualization of the costs projections of metropolis' space dysfunctionality

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Abstract

Aim/purpose – The conceptualization of the estimation of spatial dysfunctionality costs.
Design/methodology/approach – An innovative method of estimating costs due to spatial dysfunctionality was proposed, including costs directly incurred and the time lost.
Findings – A modern system of integrated planning requires costs projections that justify the necessary changes in space and convince the public and competently independent territorial authorities in the metropolis to take them accordingly. The dysfunctionality of space exposes a society to high costs. On the example of the Cracow Metropolitan Area, costs only from commuting to work amount to PLN 114.7 billion (2018-2030).
Research implications/limitations – The results of research indicate the geographical directions in which the investments of public authorities operating in the metropolitan area should concentrate. For the accuracy of the projections presented, it would be essential to increase the frequency and scope of Central Statistical Office research on commuting to work.
Originality/value/contribution – The presented study is part of a few Polish studies in the field of estimating the costs of spatial phenomena – especially in terms of mobility costs. The proposed method of the research attempts to fill the gap in estimating the costs of commuting by taking into account the costs of car amortization. Thus far, research in the field of travel costs has focused merely on fuel costs.

Keywords: costs, predictions, commuting, households, Cracow Metropolitan Area.
JEL Classification: R31, R32.

1. Introduction

Recognizing the future is an important stage in the preparation of all types of activities, including the activities of public authorities (Kleinberg, Ludwig, Mullainathan, & Obermeyer, 2015). Recognition of the future acquires a special meaning in the strategic spatial planning system because it enables earlier anticipatory adaptation to various processes taking place in space. Effective planning therefore requires, among others, to take into account a link, the role which would be to determine future operating conditions and the effects of spatial processes (Cieślak, 2002). Nowadays, the spatial process in Polish metropolises is urban sprawl, the effects of which are to be anticipated on the basis of the analogy of western countries. It is pointed out that the urban sprawl process has a negative impact on the functional level of space and the economy (Lisowski & Grochowski 2007). Chaotic space structure limits the possibilities of transport accessibility within the metropolitan area. At the same time, it should be noted that internal transport accessibility is a factor of socio-economic and spatial development, as it affects productivity, employment, vitality of the area, and the quality of life (Śleszyński, 2017; Metz, 2008; Van Ommeren, Rietveld, & Nijkamp, 1999). Thus, the challenge for entities will be to identify areas that require transport improvements and justify the need to act on them. This justification will be socially and economically acceptable when, apart from its descriptive character, it will present long-term effects obtainable in monetary values, i.e., profits or losses (Lityński & Hołuj, 2017; Kleinberg at al., 2015). In Polish research on the costs of spatial dysfunctionality, the first attempts of estimates appear. Śleszyński (2017) diagnoses the availability of cities in the light of car travel costs. However, in Polish studies there is a lack of analysis of the costs of social mobility (i.e., actual movement) in metropolitan areas, and what is more, there is a lack of projections in this respect.

The aim of the article is to conceptualize the estimation of the costs in the dysfunctionality of space, which in the future may affect the society of the metropolitan area. The aim was accomplished by selecting transport function as representing spatial dysfunctionality, while the implementation of costs projections was prepared for the Cracow Metropolitan Area (CMA). The structure of the article includes: section 2, which presents the need and state of research in the field; section 3 is an original proposition for predicting costs due to dysfunctionality. The exemplification of the method is set out in section 4. Sections 5 and 6 cover the discussion and conclusions.

2. Literature review

The prospective studies play an important role in the planning process. In Poland, forecasting has a long theoretical and empirical tradition, but in recent years less and less perceptive analyzes in spatial management have been observed, especially when it comes to strategic spatial plans. Forecasting is the stage of the projection of the future, which gives the basis for choosing and justifying the directions, time sequence and deadlines for the implementation of a number of projects in space (Cieślak, 2002). This enables the assessment of several planning variants, the selection of financial instruments and the selection of those that ensure the achievement of the goal at the lowest cost and in the shortest possible amount of time. This way, forecasting allows a rational choice of the best course of action in the future period (Grabiński, Wydymus, & Zeliaś, 1982). Nevertheless, in many cases of strategic spatial planning, the forecasting process is not active or even considered.

However, the elements of recognizing the future in the public sector are present at lower levels of space management – in point the implementation of plans in the form of investment projects. In Poland, as well as in developing and developed countries, in the assessment of public sector investment projects, a cost-benefit analysis is applied (Drobniak, 2002; Livermore, Glusman, & Moyano, 2013). An element of analysis is the forecast of investment efficiency including essential – from the point of view of spatial economy – external effects. Despite the extensive Cost-Benefit Analysis (CBA) methodology, it is not implemented at the level of strategic space management, which comprehensively covers socio-economic and spatial issues. This is due to the weaknesses of the CBA in relation to comprehensive assessments of spatial phenomena (Foltyn-Zaryhta, 2008).

Turning to the problem of the functionality of space, it should be pointed out that it is defined as the degree or scope of the expected functions in space, e.g., residential, economic, transport, cultural, leisure, etc. Domański (2004) indicates that between the functions and structure of space there are interdependent relationships, but they do not have a linear or unambiguous character. Developing functions over time do not fit into existing structures creating new ones. Domański (2004) concludes that the functional and spatial interdependencies are not synchronized with each other in time and result in disturbances in spatial order. These observations are currently particular in relation to metropolitan areas in which disruptions occur in the implementation of the housing function

resulting in the spontaneous suburbanization processes. If these disturbances are long-term, unplanned and uncontrolled, then we can agree with Bober et al. (2013) that spatial dysfunctionality is the disordered and uncontrolled development of space, leading to the pathological formation of spatial relations. Due to the spatial separation of various types of places (residence, work, services, etc.), their transport accessibility still determines not only the quality of life but also economic development (Gibbons, Lyytikäinen, Overman, & Sanchis-Guarner, 2012). At the same time, one of the more widely recognized spatial dysfunctions in metropolitan areas is the limited transport accessibility, affecting the lengthening of travel times (Śleszyński, 2017; Lityński & Hołuj, 2017; Metz, 2008; Van Ommeren et al., 1999).

The issues related to spatial accessibility is one of the most important research subjects of the impact of urban areas. Śleszyński (2017) summarizes the research and empirical achievements related to the problem in question, indicating that the analysis are most often focused on time availability, and to a lesser extent on the cost perspective. These, in turn, are up-to-date research topics in western countries (El-Geneidy, Levinson, Diab, Boisjoly, Verbich, & Loong, 2016; Ford, Barr, Dawson, & James, 2015; Mouter & Chorus, 2016; Ojeda-Cabral & Chorus, 2016). Meanwhile, in Poland, the research challenge still remains in the organization of socio-territorial systems in the national specifics, consisting of spontaneous suburbanization processes, scattering of buildings, or the increasing costs of transport services (Kowalewski, Mordasewicz, Osiatyński, Regulski, Stępień, & Śleszyński, 2014). In addition, it should be noted that financial estimates play an important role in the decision-making process both in the areas of settlements' deconcentration as well as in areas of depopulation (Śleszyński, 2017). Hence, in Polish economic and geographic studies, there are still issues that need to be developed, also from the methodological side. Which is why the conceptualization and operationalization of research into the economic accessibility of cities in cost aspects is just beginning. An example of this is the publication of Śleszyński (2017) examining the economic accessibility of voivodship cities in the light of the costs of commuting by car. This study adopts a research scheme taking into account: road specificity, number of inhabitants in the vicinity of the road, diversification of terrain, car fuel costs, motorway charges, hourly pay based on the average remuneration.

In studies on spatial accessibility two close synonymous terms should be distinguished: accessibility and mobility. Accessibility is a chance to take advantage of certain functions or a chance of spatial interaction. Mobility, on the other

hand, is an actual displacement in space in order to achieve a specific goal (Guzik, 2016). In Polish literature research, there are no common studies on the costs of mobility, especially inside metropolitan areas. It relates not only to flows from the suburbs to the core city but also between the municipalities of the metropolitan area. Thus, while the accessibility costs indicate potential expenses related to mobility, the costs of mobility reflect the actual expenditure incurred.

The problems of functionality or dysfunctionality of space are still to be resolved against the background of costs. It should be noted that one of the basic features of space is resistance. From the economic point of view, overcoming the resistance of space requires the involvement of financial expenditures. It is not as issue here for necessary financial expenditures to overcome it, but additional costs or losses being the difference between the necessary and additional expenses. Thus, from an economic perspective, space will be dysfunctional when it will impose additional costs on its users rather than if it were organized in an optimal way. In foreign economic studies on losses related to pathological spatial structures in metropolitan areas, it is specified that over-normative costs should be defined as: losses, net costs or marginal costs (Brueckner, 2000; Wassmer, 2002). Summing up, spatial dysfunctionality captured through the prism of transport mobility can be described as a spatial structure that generates losses in transit for its users.

3. Research methodology

The concept of research on spatial dysfunctionality will refer to transport mobility and will take into account six basic assumptions. First, the costs associated with dysfunctionality are defined as additional expenditures that would not exist under ideal conditions. Secondly, the costs will be expressed in monetary values, i.e., in current gross prices. Thirdly, the projection will concern both the expenses incurred directly and the value of the time lost. Fourthly, it was assumed that the costs will be calculated for commuters returning from work in all municipalities of the metropolis – the CMA. Fifth, the estimation will be carried out for the period 2018-2030 as a cumulative value (projection). The last sixth assumption is the assumed projection function, which can be described as research.

In the proposed projection method, up to year 2030 losses due to transport mobility, it was assumed that the first step is to recognize current costs. The point being an estimation of the financial amounts currently incurred by society. The second research stage is a projection that uses current values as the starting point for estimates.

The current value of the direct costs due to transport mobility is given by the formula 1:

$$DC_i = 2 * \sum_{i=1}^{n} pc_{ij}[(sd_{ij} - pd_{ij}) * a_m * wd_t] \quad (1)$$

where:

DC_i – direct costs in commuting (and returns) to the i-th commune from all other communes of the metropolitan area in PLN,

pc_{ij} – number of people commuting to work to the i-th commune from j-th commune,

sd_{ij} – actual distance (streets) between the i-th and j-th commune in km,

pd_{ij} – potential distance (in a straight line, bypassing barriers) between the i-th and j-th commune in km,

a_m – amortization rate for a vehicle with an engine capacity of 900 cm^3 = 0.8358 PLN/km,

wd_t – number of working days in t-this year,

n – the number of communes in the metropolitan area.

It should be explained that the presented model (DC) includes commuting to work and returns between all municipalities of the metropolitan area. For this purpose, the statistics of the Central Statistical Office were used in the scope of commuting to work (Główny Urząd Statystyczny [Central Statistical Office, CSO], 2014). This value was referred to the estimated cost in the distance (km) generated by the spatial structure of the metropolitan area. As a cost, the difference between the real distance between municipalities following the roads and streets using Google Maps and the potential distance was assumed. The potential distance was defined as the distance between municipalities in a straight line, bypassing significant spatial barriers (e.g., water reservoir, landscape or national park, airport, etc.). The presentation of losses in commuting in monetary terms required the adoption of a specific financial multiplier. As mentioned above, the costs of fuel consumption are often assumed by Polish researchers. Depreciation of cars is ignored due to problems in its estimation (Śleszyński, 2017). Indeed, the calculation of vehicle depreciation due to the number of vehicle operating components can be problematic. In general, we know the cost of fuel consumption per 100 km, however, it is less common to know the costs of car component depreciation, e.g., tires at this distance. There are many such car components, e.g., brake pads and discs, shock absorbers, oils and filters, etc. These calculations should also include other expenses related to car maintenance, e.g., insurance (depending on the reported annual distance, insurance is calculated differ-

ently) but also the loss of value of the car itself along with increasing mileage. The above examples illustrate the problems with estimating the car's depreciation costs, but on the other hand they do not allow to downplay these expenses, which may reach an amount comparable to the costs of fuel consumption. Therefore, for the estimates in question, The regulation of the Minister of Transport on the reimbursement of the costs… (Rozporządzenie Ministra Transportu z dnia 23 października 2007 r.) has been used, which sets the amortization rate for a vehicle with an engine capacity of over. 900 cm^3 at the level of 0.8358 PLN/km. This amount should protect the car's depreciation along with the fuel costs.

Moving to the projection until 2030 in terms of costs due to transport mobility, it should be noted that it accepts direct costs (DC) as the starting value. The direct costs projection is expressed by the formula 2:

$$PDC_{it} = \sum_{i=1}^{n} (DC_{it} * CPI_t) + cp \quad (2)$$

where:

PDC_{it} – projection of direct costs in commuting (and return) to work to i-th municipality from all other municipalities of the metropolitan area in PLN,

DC_{it} – direct costs in commuting (and return) to i-th municipality in a year in PLN,

CPI_t – an indicator of the projected dynamics of prices of consumer goods and services in the t-th year %,

cp – expenditure on the purchase of an additional car in PLN; 1 car in the horizon of the forecast; base amount of PLN 25,000 PLN (PV); *cp* was calculated based on:

$$FV_t = PV * (1 + CPI_t)^t,$$

t – number of years.

Direct costs in each subsequent year of projection are chain-linked to the indicator of the forecasted growth of prices of consumer goods and services in a given year (CPI). The indicator of the forecasted growth of prices of consumer goods and services (CPI) was taken from the current guidelines of the Ministry of Finance for municipalities in the field of financial forecasts (Ministerstwo Rozwoju i Finansów [Ministry of Development and Finance], 2017). In addition, it was assumed that commuting between municipalities in a longer time horizon forced users to exchange vehicles more frequently, mainly due to a quicker amortization use. At the same time, neither the amortization rate included in the diagnosis (DC) nor the CPI does not include expenses for an additional vehicle.

It should be noted that the price of cars is growing faster than CPI, mainly due to the use of additional, more and more modern solutions in cars. In the light of CMA research in the field of household expenditure, it is pointed out that the expenses on the purchase of a car amount to an average of PLN 50k and it is a car from a so-called 'second hand' (Lityński & Hołuj, 2015). The projection assumed the basic amount of PLN 25k resulting from the difference in the purchase of another car and the sale of the previous one. The base amount was the present value (PV), and the future value (FV) was used to calculate the forecast.

According to the adopted assumptions, the projections also include the value of the time lost. Also in this case, the first step is to estimate the current value of the time lost, which is expressed by the formula 3:

$$TL_i = 2 * \sum_{i=1}^{n} pc_{ij}[(st_{ij} - pt_{ij}) * hs_i * wd_t] \quad (3)$$

where:

TL_i – value of time lost due to travel (and return) to work to i-th commune from all other communes of the metropolis in PLN,

st_{ij} – travel time by roads between the i-th commune and j-th commune in the peak hours in min,

pt_{ij} – time of potential trip, in a line with the speed of 50 km/h, between the i-th and j-th commune in min,

hs_i – the average hourly gross wage in the county in which the i-th commune is located in PLN.

Calculation of the value of current time lost (TL) includes: commuting to and return between all municipalities of the metropolitan area; number of people going to work for a given commune CMA from other communes of the CMA (CSO, 2014). In the case of this calculation costs are expressed in units of time [min]. As a cost, the difference in the real time of car travel was treated during peak hours 7:30-8:45 and 16:30-18:00 (Hołuj & Frączek, 2015) between municipalities (Google Maps) and the potential time of commuting. Potential time is the time needed to overcome the distance between municipalities in a straight line, avoiding significant spatial barriers with an average speed of 50 km/h. As a financial multiplier, CSO statistics were used to calculate the average hourly gross wage in the county in which the municipality to which commuting is calculated.

Projections in the cost of value of lost time from commuting to work are expressed by the following formula 4:

$$PTL_{it} = \sum_{i=1}^{n} (TL_{it} * WPI_{t}) \quad (4)$$

where:

PTL_{it} – projection of the value of time lost due to commuting (and return) to work to i-th municipality in PLN,

TL_{it} – the value of time lost from commuting to work to the i-th municipality in t-th year in PLN,

WPI_t – indicator of forecasted dynamics of wage changes in t-this year in %.

Projections up to 2030 in the value of time lost will take into account previously calculated time lost value (TL). Current losses in each subsequent year of projection are chain-linked to the indicator of forecasted dynamics of remuneration changes in a given year (WPI), the basis for counting TL was the average remuneration in the county. The indicator of projected dynamics of changes in salaries (WPI) was taken from the guidelines of the Ministry of Finance (2017).

4. Research results

Table1 presents the basic statistical measures for the loss projections in CMA due to commuting to work and Figure 1 presents the projection of the costs directly incurred in commuting and returning from work in the municipalities of the CMA. It should be explained that the values assigned to a municipality reflect the costs incurred by employees of other municipality of CMA commuting to the given municipality. The values assigned to the municipality are accumulated costs in the period 2018-2030.

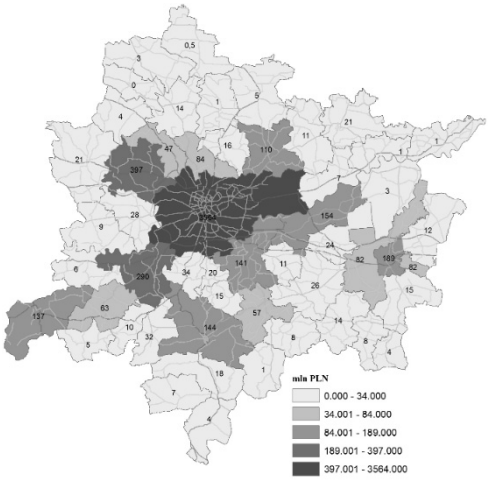
Table 1. Basic statistical measures describing the cost projection in CMA due to commuting to work (and returning), 2018-2030

Statistical measures	Direct costs in PLN million [PDC]	The value of time lost in PLN million [PTL]	Total costs and lost value of time [PDC + PTL] in PLN million
sum	5,877.17	5,588.90	11,466.07
average	115.24	109.59	224.83
min	0.00	0.00	0.00
max	3,563.59	4,249.42	7,813.01
Q1	5.49	2.24	9.07
Q2 (median)	15.21	5.69	21.10
Q3	51.72	26.03	88.53

Source: Author's own study.

Transport dysfunctionality in the CMA, measured directly by costs incurred on commuting to work, can be valued at PLN 5.9 billion. Focusing on municipalities external to this city, it should be noted that the highest transport dysfunction can be attributed to the municipalities located to the west and south of Cracow. These are primarily Zabierzów (PLN 397 million), Skawina (PLN 290 million). The Bochnia area should also be classified as dysfunctional in this regard, as costs in commuting to the city of Bochnia can reach up to PLN 189 million, and to the country side of Bochnia PLN 82 million annually.

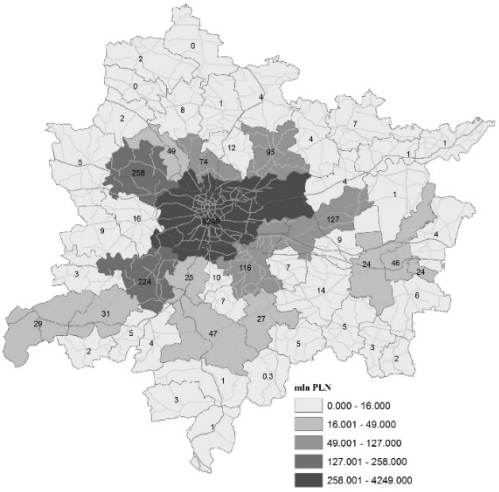
Figure 1. The projection of direct costs in the CMA for commuting to work [PDC] – values in PLN million cumulated for the period 2018-2030



Source: Author's own study.

Analyzing transport dysfunctionality measured by the value of time lost (Figure 2), also draws attention to high losses as previously analyzed costs incurred directly. It predicts the phenomenon of large losses due to congestion. The sum of lost time value in commuting to work in CMA amounts to PLN 5.6 billion. Also in this case, the largest costs are attributed to municipalities to the west of Cracow, i.e. Zabierzów (PLN 258 million), Skawina (PLN 224 million).

Figure 2. Projection of the value of time lost in the CMA for commuting to work [PTL] – values in PLN million cumulated for the period 2018-2030



Source: Author's own study.

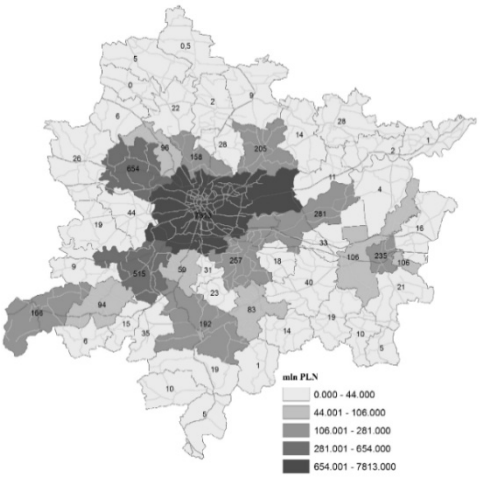
Adding the costs directly incurred and the value of the time lost and trying to forecast total social costs (Figure 3), the annual total cost in the CMA is close to PLN 11.5 billion. The largest costs are visible from the western part of Cracow, i.e., Zabierzów (PLN 654 million) and Skawina (PLN 515 million). It can be concluded that this area from the point of view of the interest of the CMA community is the most justified for carrying out communication investments.

Table 2. Basic statistical measures describing the costs projection of CMA residents due to commuting to work to Cracow (and returning), 2018-2030

Statistical measures	Direct costs in PLN million [PDC]	The value of time lost in PLN million [PTL]	Total costs and lost value of time [PDC + PTL] in PLN million
sum	3,563.59	4,249.42	7,813.01
average	71.27	84.99	156.26
min	14.83	6.39	21.62
max	338.79	490.23	829.02
Q1	25.90	20.35	50.95
Q2 (median)	59.28	39.49	101.51
Q3	85.80	116.51	210.87

Source: Author's own study.

Figure 3. Projection of direct costs and values of time lost in the CMA for commuting to work [PDC + PTL] – values in PLN million cumulated for 2018-2030



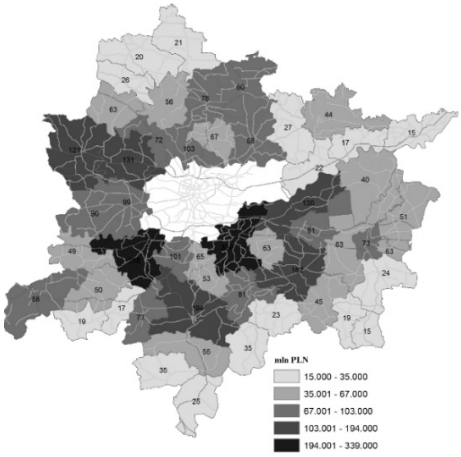
Source: Author's own study.

The presented analysis is additionally extended with discussion regarding the direction of road investments, i.e., with which areas the municipalities should be communicated. The proposed methodology allows this approach. Due to the conceptual nature of the study, it was assumed that such estimates will be presented for Cracow. Thus, Table 2 presents the basic statistical measures for the cost projections in CMA due to commuting to work in Cracow.

As can be seen from Figure 3, the costs of residents of CMA commuting to work in Cracow in 2018-2030 may exceed PLN 7.8 billion (the sum of costs directly incurred and the value of time lost), which accounts for 68% of social costs of all metropolitan areas. These values encourage reflection on the necessary directions of communication improvements. Therefore, Figure 4 presents the forecasted losses in commuting to work in Cracow, i.e., the values assigned to the municipality reflect the costs incurred by the residents of this municipality due to commuting to work in Cracow in the period 2018-2030 (summed up).

Potential transport dysfunctionality of CMA in the period 2018-2030 measured by costs incurred directly on commuting to work to Cracow may exceed PLN 3.5 billion. The highest transport dysfunctionality can be attributed to the road connections of Cracow with Wieliczka and Skawina. The value of directly incurred costs amounts to PLN 339 million and PLN 258 million, respectively. But also the residents of other municipalities, those located to the south of Cracow suffer significant costs, e.g., Myślenice (PLN 197 million), Gdów (PLN 162 million).

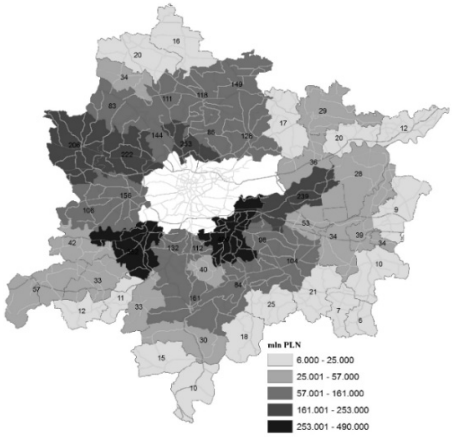
Figure 4. Projection of direct costs from commuting to work to Cracow from municipalities of CMA [PDC] – values in PLN million cumulated for 2018-2030



Source: Author's own study.

Transport dysfunctionality, measured with the value of time lost (Figure 5), draws attention to slightly higher losses (by 20%) than costs incurred directly. Such a difference can announce a congestion, and because it concerns municipalities neighboring with Cracow in practice, it threatens the lack of traffic permeability at the entrance to the core city. The sum of time lost per year may exceed PLN 4.2 billion. The greatest losses are faced by residents of the municipalities neighboring Kraków: Wieliczka (PLN 490 million) and Skawina (PLN 352 million), Zielonki (PLN 253 million).

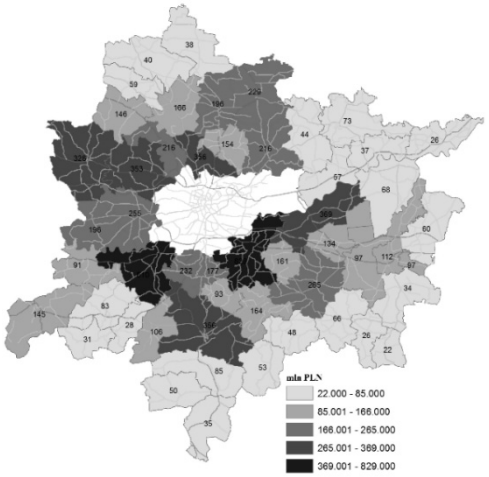
Figure 5. Projection of the value of time lost from commuting to Cracow from municipalities of CMA [PTL] – values in PLN million cumulated for 2018-2030



Source: Author's own study.

Aggregating the projection of costs directly incurred and the value of time lost (Figure 6), the potential costs of the society of the external zone of the CMA in the scope of commuting to work to Cracow may exceed PLN 7.8 billion. The most probable losses are from the southern part of Cracow, i.e., Wieliczka (PLN 829 million) and Skawina (PLN 610 million). This area from the point of view of the social interest of KOM is the most justified for carrying out communication investments – investments diversifying the current functioning road connections.

Figure 6. Projection of direct costs and value of time lost from commuting to work to Cracow from municipalities of CMA [PDC + PTL] – values in PLN million cumulated for the period 2018-2030



Source: Author's own study.

5. Discussion

The consequences of spatial dysfunctionality can be significant. Projections of costs in commuting to the core city – e.g., Cracow – in the 13 years may reach PLN 7.8 billion. This value can be interpreted as a loss in transport dysfunctionality but also as a cost of urban sprawl. However, losses in journeys to work in the Cracow Metropolitan Area generated solely by its residents amounted to PLN 114.7 billion within thirteen years.

The results of the projection for the Cracow Metropolitan Area indicate that the highest costs are characteristic for, of course, the core city, but also for external municipalities, which are considered economically developed, i.e., Zabierzów

and Skawina. In these communes there are Special Economic Zones with tax concessions for companies. The economic strength, and thus the developed labor market, justifies the travel of metropolitan employees to these municipalities (also from the core). However, the archaic road system surrounded by these municipalities results in road congestion and high financial losses of the metropolitan population. These municipalities do not always suffer from a deficit of basic roads and rapid traffic – on the contrary: both Skawina and Zabierzów are characterized by the availability of the A4 road, which has the parameters of the highway (Cracow-Silesia) and the expressway (southern bypass of Cracow). The archaic road system is understood here more as a post-agricultural system of primary (communal) roads, which does not satisfy metropolitan needs, as demonstrated by high financial losses. In relation to the A4 road mentioned, it should be noted that due to the limited number of entries to the road and crossings to the other side of the road. Many years ago, the number of entries and crossings was sufficient, but nowadays the road is an important spatial barrier that makes communication in the metropolitan area unusually difficult. The indicated costs may be the basis for reflection of public authorities on the construction of additional entries for the road and trips across (bridges, tunnels).

6. Conclusions

6.1. Research contribution

The presented study is part of a few Polish studies in the field of estimating the costs of spatial phenomena – especially in terms of accessibility costs and transport mobility. As in the state of research, the proposed methodology indicates the direct costs incurred and the value of actual time lost. However, the proposed conceptualization of the research attempts to fill the gap in estimating the costs of commuting by taking into account the costs of car amortization. So far, research in the field of travel costs has focused mainly on the costs of fuel consumption, and the time was calculated as a potential one. The research also uses Google Maps function that displays not only the actual distance, but also the actual travel time on a given day. This approach has not been applied thus far.

A very important contribution to the research in Poland is also the fact that – in contrast to the current research, which focuses on expenditures – the proposed methodology indicates losses. Loss in research was defined as a cost, i.e., the

difference between expenditures currently incurred and expenditures incurred in an ideal situation. This allows the valuation of space dysfunctionality; and in other words, if the space were optimally organized, the values of the proposed estimates would equivocate to zero. In addition, a unique approach to the projected losses was proposed, including a necessity of a purchase of an additional car, and forecasted inflation and changes in wages. Equally important, the methodology proposal includes sources of data that are widely available, which do not require specialist knowledge and software (GUS, Google Maps, ministerial regulations).

6.2. Researchers implications

Polish science, and especially practice, must develop a system of diagnosing and projecting the value of spatial phenomena. From the theoretical side, the role of forecasts is known: to develop an image of the future. Therefore, spatial forecasting is important not only from the point of view of planners involved in the preparation of spatial plans of different levels, but also from the point of view of economic development. It is also important from the point of view of making strategic investment decisions.

Based on the obtained results of the proposed calculations, decisions about the spatial distribution of strategic investments in metropolis should be made, creating the optimal path of socio-economic development. Projections justify the need to undertake specific actions in space on the one side, and on the other, they convince the public and independent local authorities in the metropolis in their necessity. In this way, the projections pave the way for a modern system of integrated planning, creating with it an increasingly integrating whole system of forecasting, planning and managing the metropolis development process.

6.3. Researchers limitations and future work

The possibility of enriching the methodology is noticeable. However, it requires the development of research in Poland on commuting to work. Increasing their frequency and scope of such research carried out by the Central Statistical Office, e.g., once every two-three years, including the statistics: distance and frequency of the weekdays in trips to/from work. In addition, the study used the current car amortization rate specified by the ministerial regulation, which was

set in 2007. It seems that the development of motorization (richer standard equipment, higher car purchase prices and operating parts) would require the Ministry to update amortization rates. At the same time, the usefulness and up--to-datedness of the Ministry of Finance's studies regarding the indicators applicable in the proposed methodology as well as the Google Maps were noticed.

As the research focused only on the cost side of spatial dysfunctionality, further development of the concept could go towards a wider use of the CBA. This is not a matter of direct application of this analysis, since it has limitations, but the use of the framework and some research techniques. This will allow a wider assessment including the benefit side.

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