PRICE DISPARITIES ON THE HOUSING MARKET VS. TRANSPORTATION COSTS FOR HOUSEHOLDS. A CASE STUDY OF REAL ESTATE DEVELOPMENT PROJECTS IN SZCZECIN

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ABSTRACT

Motives: Land situated on the outskirts of cities and even outside their borders is being seized for urban development, as well as for housing purposes. Properties in such locations are usually significantly cheaper than those located in the city centers. However, living in a suburban location often entails higher commuting, education, and entertainment costs. Therefore, the following question arises from a property buyer's point of view: is it more economically advantageous to purchase more expensive property in a downtown district or a cheaper one located peripherally and incur higher transportation costs?

Aim: The purpose of the study was to compare the transportation costs incurred by households in peripheral locations with the property price differentials between suburban and central city districts.

Results: The study covered the city of Szczecin. Data for the study were obtained from public sources and analyzed with tools such as the payback period, simple rate of return, net present value (NPV) for 10 and 20 years, and internal rate of return (IRR) for 10 and 20 years. The results indicate that in certain cases, very high commuting costs might encourage potential buyers to consider the purchase of more expensive property in a central city location where these costs are significantly lower or not necessary.

Keywords: housing prices, transportation costs, Szczecin, Poland

INTRODUCTION

Since prehistoric times, human settlements have increased in size through the development of outer areas. These processes were limited by the distance that could be traveled on foot within reasonable time. Urban spread accelerated significantly with the arrival of public transportation, and the growing popularity of individual transportation subsequently led to uncontrolled mass settlement. In Western Europe, the construction of modernist settlements outside the inner city intensified after World War II, and this trend gained speed in Poland in the 1980s-1990s (Małek, 2011). Currently, suburbanization is a process that affects most European cities, including Poland (Głuszak & Marona, 2013). Various aspects of suburbanization, which is defined as the effect of civilizational changes accompanied by decentralization and urban growth, have received much attention in the scientific literature (Champion, 2001; Ciok & Leśniak, 2015; Gałka & Warych-Juras, 2020; Gnat & Bas, 2013; Harasimowicz, 2018; Hirt, 2008; Hollow,

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2011; Jackson, 1985; Jadach-Sepioło & Legutko-Kobus, 2021; Kokot, 2006; Korwel-Lejkowska, 2022; Kuzara & Szmytkie, 2022; Mantey & Sudra, 2019; Szmytkie, 2021; Wojewnik-Filipkowska & Koszarek-Cyra, 2022). The most obvious effect of suburbanization is the increase in population density in suburbs and the relocation of social and business activities from the city center to the suburbs. However, suburbanization affects many of these activities, including the real estate market, particularly the land market and the housing market. The effect of suburbanization on price differentiation on the housing market has been rarely analyzed. In particular, it is difficult to find studies on housing price differentiation in the context of higher costs associated with travel from peripheral locations to the inner city, where social and economic functions are concentrated. In contrast, the time and cost of commuting have been extensively researched in the context of typical transportation problems (Manaugh et al., 2015; Nguyen, 2022; Rakowska, 2014; Schéele & Andersson, 2017; Sen et al., 2019; Sen et al., 2021; Ubbels & Verhoef, 2007). Several studies have investigated the impact of commuting time on the residents' health and households' ability to satisfy their life needs (Bergstad et. al., 2011; Choi et al., 2013; Hilbrecht et al., 2014; Simón et al., 2020). A substantial part of the research on commuting costs focuses on the problems related to the choice of transportation mode. In this regard, the research findings indicate that commuting time significantly affects the choice of transportation mode. Above all, commuters tend to opt for private cars if they have to change transportation modes or walk longer distances (Ha et al., 2020; Kerr et al., 2009). Other factors that influence the choice of transportation mode include the work and residence environment and the family model (Maat & Timmermans, 2009). The impact of socially motivated factors on the propensity to work in locations far from home was also examined in the literature. The household income is one of such factors because low-paying, unskilled jobs are available in geographically diverse areas (Axisa et al., 2012). Low-income workers are not willing to bear the costs of longer travel. In contrast, high-income workers travel farther and pay more for transportation, but still prefer to live in remote and attractive locations (Rouwendal & Nijkamp, 2004). In reality, the problem is more complex, and different trends can be observed in certain professional environments. Research has shown that in Shanghai and Melbourne, affluent people live in expensive inner-city areas that are close to their workplace, whereas low-income workers tend to live on the outskirts of the suburbs and travel longer (Berry, 2006; Li, 2010).

Notwithstanding the above, housing prices in various locations and the related factors have been extensively examined (Cellmer et al., 2021; Kuryj--Wysocka & Osiecka, 2014; Wang et al., 2017; Wiliński et al., 2017; Xifilidou et al., 2012), but there is a general scarcity of research analyzing the influence of transportation costs on property prices.

The aim of the study was to compare the transportation costs incurred by households in peripheral locations with the property price differentials between suburban and central city districts. The study compared the costs associated with daily commuting to downtown districts from peripheral locations with the average difference between the prices of typical downtown and suburban properties. The following research hypothesis was formulated: the purchase price of a more expensive property in a downtown district is compensated by the absence of costs associated with commuting to downtown areas where most jobs, education and entertainment are located. In other words, the study was undertaken to determine whether buyers of cheaper, but peripherally located property actually save money, or whether these are illusory savings that would be later absorbed by higher commuting costs. From this point of view, the purchase of more expensive property can be regarded as an investment that pays for itself through lower transportation costs.

It should be noted that the present calculations are general in nature and correspond strictly to the described case. In reality, transportation costs vary between individuals and households and depend on where they work, whether they can work remotely, how often they commute, what lifestyle they prefer,

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whether they have children and how they organize children's activities, the number of cars in the household, the type of vehicles (type of fuel, fuel consumption, and other operating costs). The results are also heavily influenced by factors relating to the analyzed properties. Residential properties may also differ significantly in terms of size and price. The differences in housing prices do not result solely from travel costs, and can be significantly associated with pure market factors, in particular the attractiveness of the neighborhood, the availability of services and infrastructure, and the popularity of certain locations on local real estate markets. In the present study, higher transportation costs incurred by peripheral households are associated with location, rather than with lower housing prices. The study was not undertaken to identify the causes of differences in housing prices, but to examine differences in the cost of commuting to the inner city as one of the consequences of differences in location. The residential properties selected for the study were similar in structural design and the offered standard. The compared apartments were also selected by ensuring that the price per square meter was not affected by differences in floor area. Therefore, the obtained results constitute a benchmark for comparing properties that are most similar to those analyzed in the study.

The study focused exclusively on private car transport. The analyzed properties are located in the city of Szczecin, where private cars dominate and, despite the indicated objective impediments, continue to be the fastest mode of transport. In the surveyed locations, buses are the only type of public transportation which is as affected by rush-hour traffic as cars, and they run relatively infrequently – every 40–60 minutes. Bus services often have "down times" due to staff absences. As a result, public transportation is chosen only by people who do not own cars. The above is frequently observed in rapidly expanding medium-sized cities (with a population of 100,000 to 500,000) which do not have and probably will never have a subway system. For this reason, the results of this study cannot be directly related to cities with

different social and transportation logistics, such as Berlin or Amsterdam. At present, only one Polish city has a designated zone where car traffic is limited. The offsetting of public transportation costs with differences in housing prices is an important consideration, but it is beyond the scope of this study because it requires other, specially formulated research assumptions, and therefore may be the subject of a separate study and publication. The study did not consider rental costs due to the perishable nature of such contracts. Rental agreements are usually concluded for 1 year, rarely for longer. Within this time horizon, rentals cannot be regarded as a substitute for property investments, and the differences in rents cannot be directly confronted with transportation costs. The study demonstrated that when buying an apartment, such differences can be large and offset for years.

MATERIALS AND METHODS

The survey was conducted in February 2023 based on current information for the Polish city of Szczecin. Data for the analysis was obtained from public sources, in particular:

– websites of real estate development companies, including the offered properties, prices and location;
– telephone conversations with real estate developers (to obtain information that was not available online);
– Google Maps to calculate travel times and distances;
– legal acts concerning remuneration rates and reimbursement rates for the use of vehicles that are not owned by the employer, but are used by the employees for business purposes (mileage).

To determine the boundaries of Szczecin's downtown district, the author relied on expert knowledge as well as own knowledge about the area and the operational conditions of the urban road network. Up-to-date information on fuel prices and other data were also obtained from the websites referenced in the text.

The study was divided into the following research steps:
1. The downtown district, defined as a typical area where the local community's professional activity

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is concentrated, was designated. Development projects with residential property available for purchase were identified.

2. The available property was analyzed to determine its feasibility for the study.

3. Travel times and distances from individual development projects to the boundary of the downtown district were measured.

4. Assumptions were made about the number of vehicles and the frequency of trips.

5. The procedure of calculating the cost of commuting from selected suburban locations to the district boundary was selected. Three approaches were considered:
   – based on the rate applied by employers to reimburse the cost of traveling to work in a private vehicle (mileage);
   – based on the sum of the above reimbursement rate and driving time;
   – based on travel cost parameters established by experts.

6. Data analyses.

The analyses involved the following measurements and calculations:

1. Measurement and calculation of daily and annual input parameters for trip costing, i.e. travel times, distances, travel time costs, fuel consumption, mileage.

2. Calculation of travel costs according to the three approaches.

3. Calculation of capitalized and discounted 10-year travel costs from suburban locations to the boundaries of the central district according to the three approaches.

4. Calculation of payback periods and simple rates of return on investments in higher-priced housing in the downtown district according to three approaches.

5. Calculation of the capitalization rate and the discount rate for further analysis.

6. Calculation of 10-year and 20-year discounted net cash flows (net present value – NPV).

7. Calculation of 10-year and 20-year internal rates of return (IRR).

Therefore, the study relied on parameters that are commonly used in cost-effectiveness analyses of investments because the examined problem was also viewed as an investment in more expensive property, where the associated cost is recouped through lower spending on travel.

The research assumptions and the results of the calculations are presented and discussed in detail in the following section describing individual research steps.

RESULTS

The downtown district, defined as a typical area where the local community's professional activities are concentrated, was mapped in the first step of the study. This was done based on expert knowledge, as well as the author's familiarity with the area under study. The designated downtown district in Szczecin is demarcated by the following streets: Ku Słońcu, Santocka, Traugutta, Wojska Polskiego, Zaleskiego, Słowackiego, Wyzwolenia, Staszica, Emilii Plater, Gontyny, Matejki, Trasa Zamkowa, Kolumba, Dąbrowskiego, and Bohaterów Warszawy (Fig. 1).

In the next stage of the study, the available housing offers were identified and residential properties were selected for the analysis based on the following assumptions:

1. Properties available on the primary market, excluding renovated properties in the existing buildings.

2. Apartments with a floor area of 40–50 m^2.

3. Typical residential properties outside the luxury market segment; top locations (Old Town, Boulevards, etc.) were excluded from the analysis.

The selected residential estates that met the above specifications and fetched prices typical of apartments with a floor area of 40–50m^2 are summarized in Table 1.

Two residential estates are located in the designated downtown district (Osiedle Pomorzany and 34 Malczewskiego Street), and four are located outside the downtown district in areas that can be accessed on foot within 20 minutes from the nearest
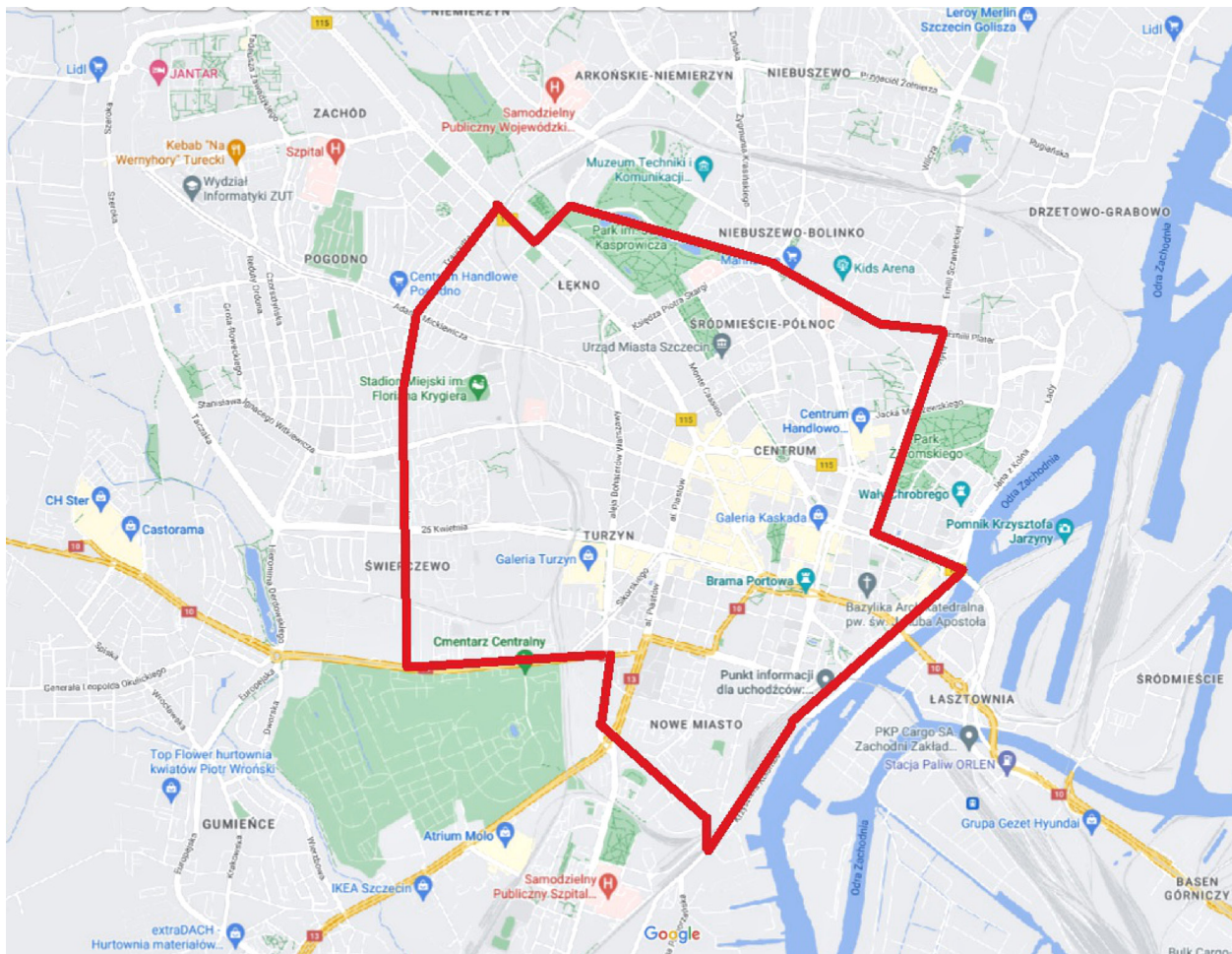
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Fig. 1. Downtown district in Szczecin mapped for the purpose of the study
Source: Google Maps (07.03.2023).

district boundary (times measured in Google Maps). These include:

1. EP7 – 9-minute walk to the intersection of E. Plater and Gontyny streets.
2. OKIDOKI – 12-minute walk to the intersection of E. Plater and Gontyny streets.
3. Kutrzeby 12- to 20-minute walk to the intersection of Mickiewicza and Traugutta streets.
4. Pogodno Gardenia – 17-minute walk to the intersection of Traugutta and al. Wojska Polskiego streets.

The remaining four estates (Nowa Północ, Jaśminowe Wzgórza, Nowe Warzymice and Osiedle Jarzębinowe) are located outside the downtown

district, relatively far from its boundaries. Three of these were selected for further analysis because two estates are adjacent to each other (Nowa Północ and Jaśminowe Wzgórza).

The differences in the prices of a 45 m² apartment located in the downtown district and in suburban locations were calculated on the assumption that the typical unit price of property in the central district was PLN 9,500 per m² (calculated as the average price of two apartments in the downtown district) (Table 2).

Only apartments in implemented residential projects were selected for the analysis. All investments implemented in Szczecin and its vicinity were identified for the needs of the study. It should be

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Table 1. Selected residential estates that met research specifications and fetched prices typical of apartments with a floor area of 40–50 m^2

Residential estate, location	Developer	Unit price [PLN/m^2]
EP7, Miedziana Street, Szczecin	Sowińskiego 72 sp. z o.o.	11,700
OKIDOKI, Nocznickiego/Firlika streets, Szczecin	Vastbouw Polska sp. z o.o.	11,500
Kutrzeby 12, Kutrzeby Street, Szczecin	Vastbouw Polska sp. z o.o.	11,550
Pogodno Gardenia, Unii Lubelskiej/Zakładowa Streets, Szczecin	Gardenia Developer, A&M-PROJEKT Spółka z ograniczoną odpowiedzialnością Spółka komandytowa	11,400
Osiedle Pomorzany, 29 Powstańców Wielkopolskich Street, Szczecin	Zakład Budowlany SIEMASZKO sp. z o.o	9,400
34 Malczewskiego street, Szczecin	Zakład Budowlany SIEMASZKO sp. z o.o	9,600
Nowa Północ, 2. Sobola Street, Szczecin	Ronson Development Management sp. z o.o.	8,400
Jasminowe Wzgórza, Sobola Street, Szczecin	Tomaszewicz Development sp. z o.o.	8,100
Nowe Warzymice, 1 Spacerowa Street, Rajkowo	Ronson Development Management sp. z o.o.	8,100
Os. Jarzębinowe, Wejherowska Street	Murbud Developer Spółka Jawna	8,200

Source: own elaboration based on data from: https://ep7.pl, https://vastbouw.pl/inwestycje/nowe-mieszkania-domy-szczecin/nowe-mieszkania-firlika-oki-doki/cennik/, https://vastbouw.pl/inwestycje/nowe-mieszkania-domy-szczecin/nowe-mieszkania-kutrzeby-12/, https://gardenia-deweloper.pl, https://siemaszko.pl, https://ronson.pl/nowa-polnoc, www.tomaszewicz.pl/jasminowe-wzgorze, https://ronson.pl/nowe-warzymice, https://murbud-invest.pl/osiedle-jarzebinowe (14.02.2023) and own research.

Table 2. Unit prices of apartments and price differentials

Price of a downtown apartment	Residential estate	Price of an apartment in the residential estate	Difference
427,500	Jaśminowe Wzgórze	364,500	63,000
	Nowe Warzymice	364,500	63,000
	Os. Jarzębinowe	369,000	58,500

Source: own elaboration based on data from: https://tomaszewicz.pl/jasminowe-wzgorze, https://ronson.pl/nowe-warzymice, https://murbud-invest.pl/osiedle-jarzebinowe (14.02.2023) and own research.

noted that a limited number of such investments is implemented at any given time. All investments meeting the established criteria were included in the study. The analyzed apartment prices reflected the state of the market at the time of the study, as well as the prospective buyers' decision-making strategy.

Car travel time to the nearest district boundary in the morning peak traffic and from the district boundary in the afternoon peak traffic hours was examined for each apartment. Commuting times was analyzed on the following assumptions:

1. Popular commuting routes were mapped. In some cases, longer alternative routes appeared to be faster during rush hours. The shortest routes, i.e. routes that were also fastest outside peak hours, were chosen.

2. Commuting time to the boundary of the downtown district was measured as the part of the journey between peripheral locations and downtown Szczecin that was the source of greatest inconvenience. In fact, the commuting time from home to the city center is longer, but traffic conditions along the district border are the same for the residents of the downtown district and the residents of other areas. This assumption cancels out the difference in travel times to specific downtown locations from points within the central district and from suburban locations.

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3. Travel times to the central district were measured on 27 February, 28 February, 1 March and 7 March 2023 with the Google Maps traffic measurement tool. The weather was fair without precipitation on the first three dates. On the last day of the measurements, the streets were covered by a thin layer of snow in the morning, and strong wind (30 km/h according to the Interia weather service) with occasional hail showers were noted at midday. The measurements were performed during the morning (6:40–8:20 AM) and afternoon (3:00–5:00 PM) rush hours at 10-minute intervals. The average of the longest commuting times recorded on each day was used for the analysis. This approach is justified by the fact that the residents of peripheral districts must account for maximum travel times to the workplace in their daily routines. The results were rounded up to the nearest minute. The calculated times and the route lengths determined based on Google Maps are shown in Table 3.

Travel routes and travel times measured from each location are shown in Figures 2–4.

In the next step, prospective property buyers (households) were characterized based on the following assumptions:

1. The household has 1 car.
2. One trip to and from the downtown district is made on each working day. Other trips are undertaken sporadically. A representative household makes such trips back and forth 300 times a year.

It seems that the way a household operates is the most differentiating factor affecting the actual cost of living in a peripheral location. These costs can increase in households that own more than one vehicle. Similarly, a higher number of trips, for example to transport children to kindergartens, schools or extracurricular activities, significantly affects the transportation costs incurred by a family. In contrast, remote working or simply working from home or close to home significantly reduces these costs. Therefore, the present results are relevant only for households that meet the adopted, typical assumptions, and they constitute a reference point for other situations.

The last assumption was related to the method of calculating the cost of commuting from selected peripheral locations to the boundaries of the downtown district. These costs were calculated with the use of three approaches.

The first approach was based on the reimbursement rate for the use of vehicles that are not owned by the employer, but are used by the employees for business purposes (mileage). At the time of the study, the reimbursement rate was PLN 1.15 per kilometer for a car with an engine capacity of more than 900 cc. The reimbursement rate is stipulated by the Regulation of the Minister of Infrastructure of 25 March 2002 on the conditions for determining and the manner of reimbursing the costs associated with passenger cars, motorcycles and mopeds that are not owned by the employer, but are used for business purposes (Journal of Laws of 2002 No. 27 item 271, as amended). According to the legislator, this reimbursement rate covers the costs of fuel and vehicle operation. The advantage of this approach is that it is based on official, presumably objectively calculated costs of operating a typical vehicle, and the simplicity of the calculation. The main limitation is that this approach does not account for commuting time.

In the second approach, the cost of commuting time was added to the values calculated in the first approach. The cost of commuting time was calculated

Table 3. Commute times and route lengths from each location to the boundaries of the downtown district

Residential estate	Travel time to the downtown district in the morning (minutes)	Travel time from the downtown district in the afternoon (minutes)	Route length (km)
Jaśminowe Wzgórza, Szczecin, Sobola Street	26	22	7.1
Nowe Warzymice, Rajkowo, 1 Spacerowa Street	22	15	5.0
Os. Jarzębinowe, Wejherowska Street	20	19	10.7

Source: data from Google Maps (07.03.2023).
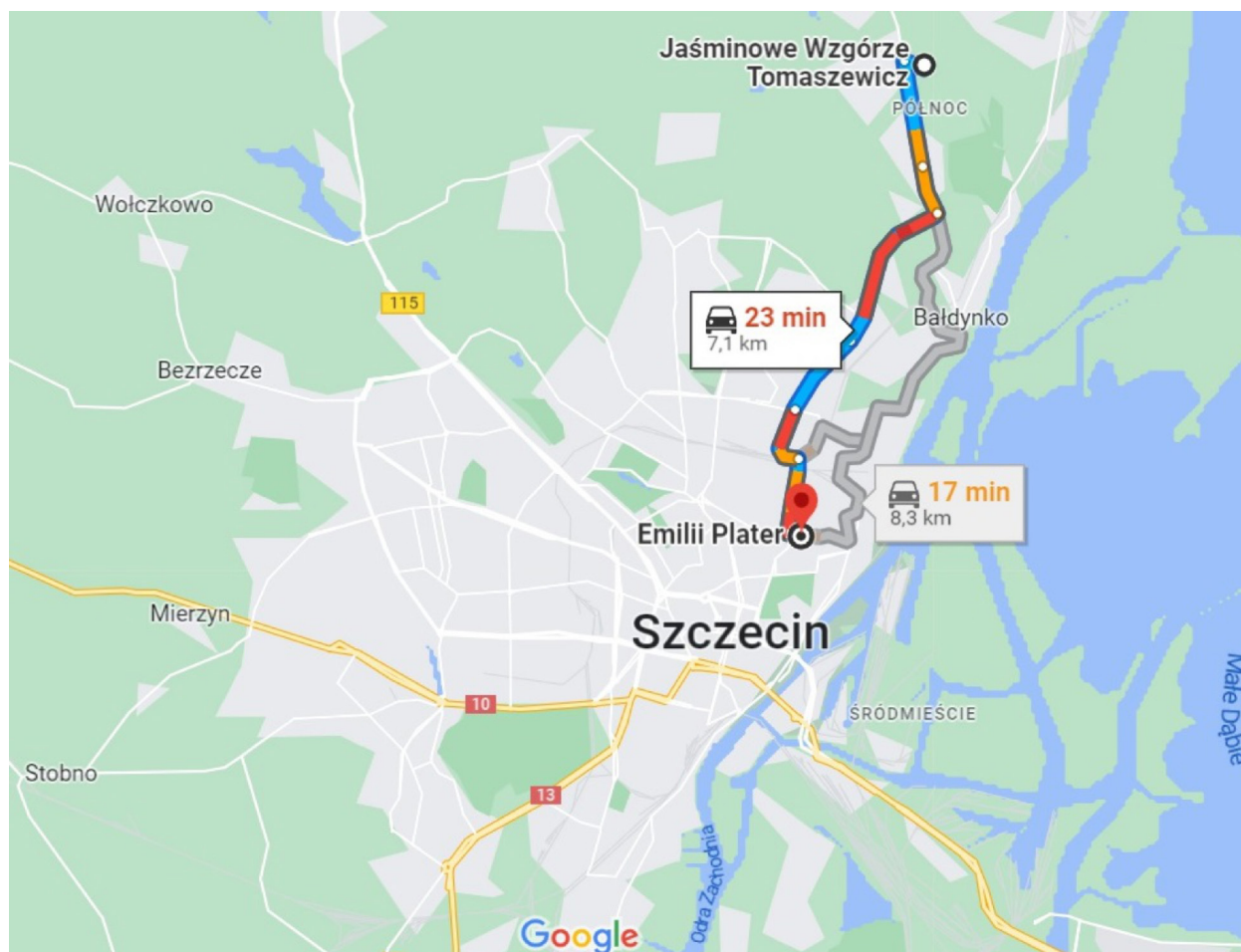
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Fig. 2. Travel routes and travel times measured from Jaśminowe Wzgórze estate
Source: Google Maps (07.03.2023).

based on an hourly rate corresponding to the lowest net hourly wage stipulated by a Regulation of the Council of Ministers of 13 September 2022 on the minimum wage and the minimum hourly rate in 2023 (Journal of Laws of 2022, item 1952) which was set at PLN 17.75 per hour (PLN 22.80 per hour gross).

In the third approach, the calculations were performed based on the parameters determined by experts:

1. Fuel consumption and prices: typical fuel consumption was set at 10 L/100 km and fuel price per liter was set at PLN 7.
2. Cost of travel time – calculated based on the second approach.

3. The remaining vehicle operating costs consisted of maintenance, repairs, and insurance. These costs were determined at PLN 3,000/year. This amount may seem low, but it should be borne in mind that the costs of operating a vehicle for commuting from a peripheral location to the place of professional and non-professional activities in the downtown district should correspond only to the portion of the actual operating costs incurred, since vehicles are also used by households for other purposes. According to mubi.pl, the average annual mileage of a car in Poland is 8607 kilometers. In the examined scenario, the owner of a car resides in a peripheral district of a large city; therefore, it seems reasonable to assume that the distance covered each year

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is twice higher, where commuting to downtown locations accounts for only around 30% of that distance based on the adopted assumptions (3000–6420 km, depending on the location). In turn, according to the wygodnie.pl service, in 2022 the average annual total cost of operating a car without purchase and fuel costs ranged from PLN 3042 to 7378. Thirty percent of the higher of these figures gives PLN 2459. Non-fuel related costs of operating a vehicle were adjusted for high inflation (16.1% in March 2023 according to *Statistics Poland*), and rounded to PLN 3000/year.

None of the above approaches accounts for vehicle depreciation. Cars lose value with age and mileage. Vehicle depreciation was disregarded in the analysis on the assumption that a typical homeowner would own a vehicle regardless of their place of residence. Therefore, age-related depreciation seems irrelevant in the examined scenario. Moreover, depreciation caused by intensive vehicle use (greater mileage) and differences in depreciation were not taken into account because such estimates depend on the make, model and age of a car, as well as the owners' propensity to care for their vehicles. It should be noted, however, that depreciation caused by wear and tear is a real cost that reveals itself periodically when the vehicle is sold and replaced, and it may additionally increase the cost of living in a suburban area.

The last consideration in the process of estimating the cost of daily commuting from peripheral locations to the boundaries of the central district is the capitalization rate and the discount rate
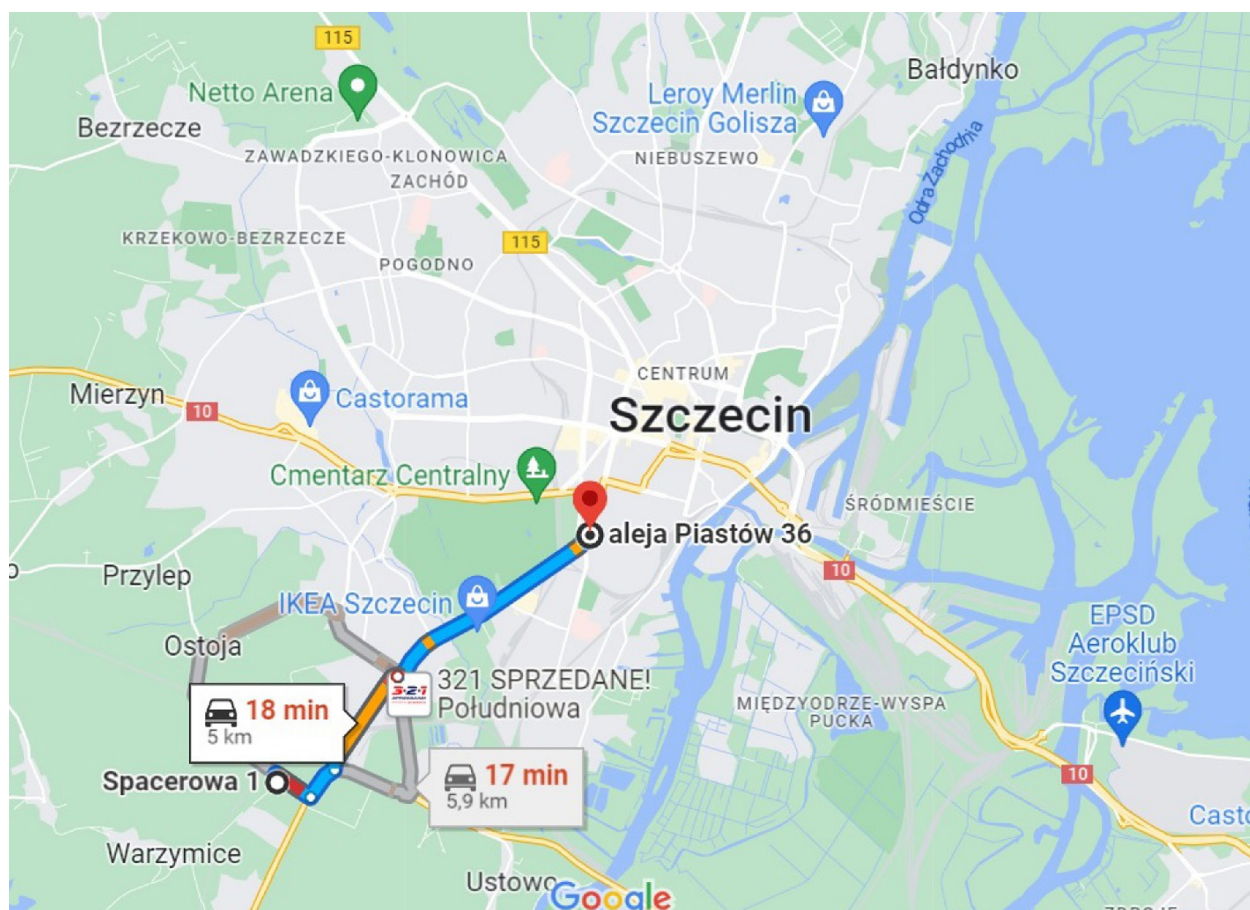

Fig. 3. Travel routes and travel times measured from Nowe Warzymice estate
Source: Google Maps (07.03.2023).
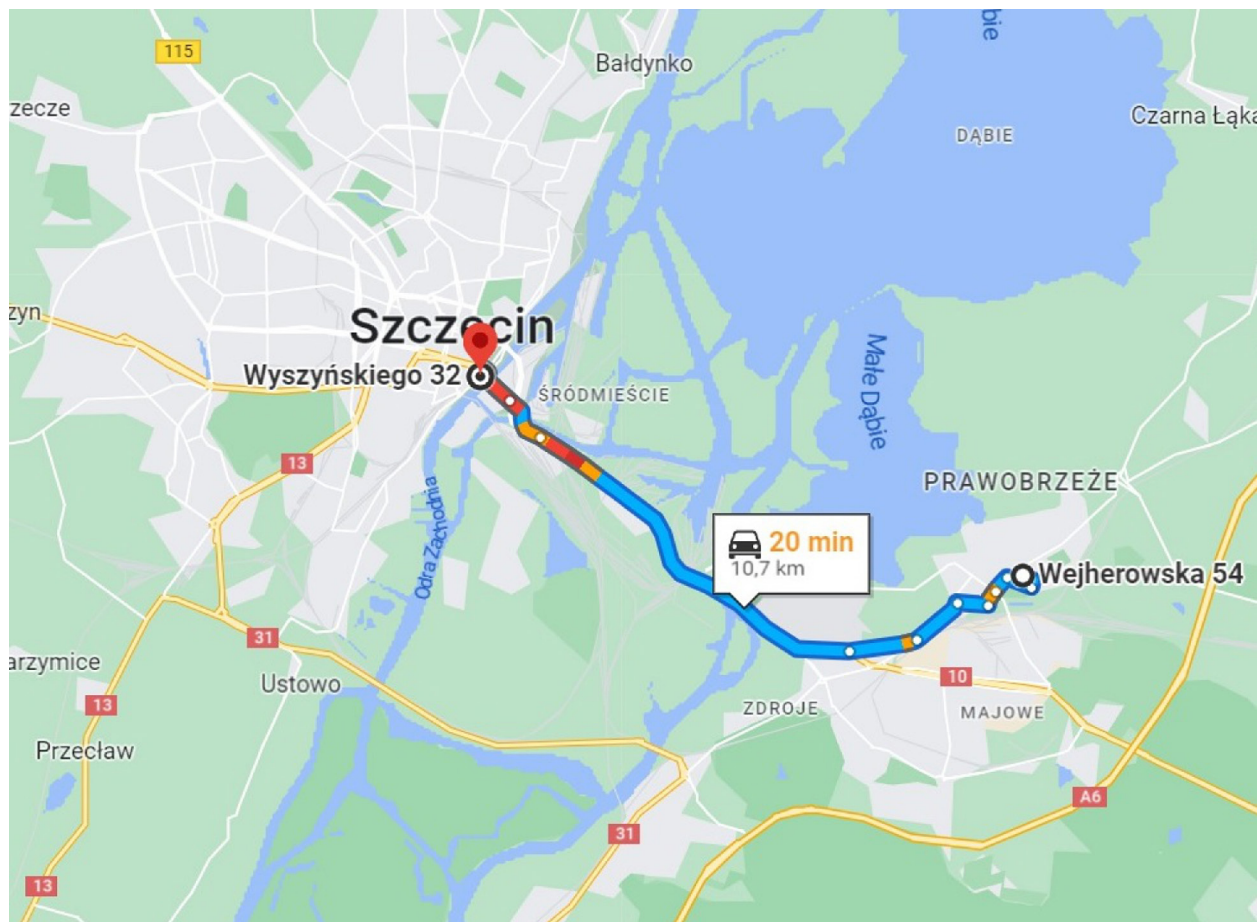
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Fig. 4. Travel route and travel time measured from Os. Jarzębinowe estate
Source: Google Maps (07.03.2023).

used in some of the travel costing methods. It was assumed that travel costs would be incurred over a long, indefinite period of time; therefore, capitalized costs were estimated and compared with differences in housing prices in the downtown district and in peripheral locations. A capitalization rate of 4% was adopted because it corresponds to the typical mortgage rates under normal economic conditions. At present, mortgage rates are significantly higher, but the expected long-term average rate was used for the purpose of the analysis. A capitalization rate that corresponds to mortgage rates was selected because a buyer of a property in a peripheral district could potentially consider buying a more expensive property in the suburbs by financing the difference in price with a mortgage credit. The capitalization

of costs carries with it the assumption that they will be incurred over an infinitely long period of time. In practice, we usually operate on a shorter time horizon. Therefore, in this study, discounted travel costs were also calculated for a 10-year period on the assumption that they would be constant throughout the analyzed period, and the discount rate was also set at 4%.

The resulting input parameters for calculating commuting costs with the use of the presented approaches are shown in Table 4 (daily parameters) and Table 5 (annual parameters).

The annual travel costs calculated in each of the presented approaches based on the data shown in Table 5 are presented in Table 6.

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Table 4. Daily input parameters for calculating commuting costs

Residential estate	Travel time (h)	Distance (km)	Cost of travel time (PLN)	Fuel consumption (L)	Fuel cost (PLN)	Cost of travel in terms of mileage (PLN)
Jaśminowe Wzgórze	0.80	14.20	14.20	1.42	9.94	16.33
Nowe Warzymice	0.62	10.00	10.95	1.00	7	11.5
Os. Jarzębinowe	0.65	21.40	11.54	2.14	14.98	24.61

Source: own study.

Table 5. Annual (300-day) input parameters for calculating commuting costs

Residential estate	Travel time (h)	Distance (km)	Cost of travel time (PLN)	Fuel consumption (L)	Fuel cost (PLN)	Cost of travel in terms of mileage (PLN)
Jaśminowe Wzgórze	240	4260	4260	2982	2982	4899
Nowe Warzymice	185	3000	3284	2100	2100	3450
Os. Jarzębinowe	195	6420	3461	4494	4494	7383

Source: own study.

Table 6. Annual costs of commuting from suburban locations to the boundaries of the central district calculated according to three approaches

Residential estate	Travel costs (PLN)		
	Approach I	Approach II	Approach III
Jaśminowe Wzgórze	4899	9159	10242
Nowe Warzymice	3450	6734	8384
Os. Jarzębinowe	7383	10844	10955

Source: own study.

The travel costs calculated with the use of the second and third approach are similar, but the estimated costs are higher for properties located relatively far from the border of the downtown district due to the greater distance. The travel costs estimated in the first approach are clearly lower, mainly because the cost of travel time was not considered. Thus, already in this stage of the study, it could be concluded that travel costs are strongly influenced by how people value their time, in particular whether they regard the time spent commuting as a specific cost, or whether they believe that their time costs nothing. Such assessments are always highly subjective. At this stage of the study, it can also be seen that the cost of travel is not negligible, but, depending on the adopted approach and the location of the property, accounts for 1.3 to more than 4 times the net minimum monthly salary (according to the referenced regulation, PLN 3490 gross, i.e. around PLN 2709 net) and from 0.7 to 2.1 of the average net salary (according to the announcement of the President of *Statistics Poland*, in February 2023, the average monthly salary in the enterprise sector was PLN 7065.56 gross, i.e. around PLN 5145 net). Therefore, given the salary levels in Poland, these amounts should be considered significant.

The capitalized and discounted 10-year annualized travel costs in each of the three approaches, calculated based on the data in Table 6, are presented in Table 7.

Capitalized travel costs denote the present value of future transportation expenditures on the assumption that these costs will be incurred forever and that the portion corresponding to the assumed capitalization rate, rather than its nominal amount, should be subtracted from the present value of an expense that will be incurred in a year's time. In mathematical

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Table 7. Capitalized commuting costs and discounted 10-year commuting costs from suburban locations to the boundaries of the central district calculated according to three approaches

Residential estate	Capitalized travel costs (PLN)			Discounted 10-year travel costs (PLN)		
	Approach I	Approach II	Approach III	Approach I	Approach II	Approach III
Jaśminowe Wzgórze	122475	228975	256050	39735	74288	83072
Nowe Warzymice	86250	168344	209593,8	27983	54617	68000
Os. Jarzębinowe	184575	271106	273881,3	59883	87957	88857

Source: own study.

terms, these discounts are introduced on the assumption that transportation costs will be incurred for an infinite number of years. Therefore, capitalized costs have informative rather than real value. Nevertheless, it can be seen that these amounts are significant, ranging from 23.7% to as much as 75.1% of the amount paid for property outside the downtown area. From a practical point of view, these amounts can be regarded as higher valued discounted 10-year commuting costs, since this is the typical and realistic time horizon that investors consider when purchasing property. In the examined case, depending on the investment and the adopted approach, travel costs are determined in the range of PLN 39,735–88,857, which means that they account for 7.6–24.4% of the property price. Hence, if property is purchased in a peripheral district under the adopted assumptions, the resulting additional costs must inevitably be paid over 10 subsequent years, which can be equated with higher property purchasing costs.

The estimated commuting costs (Table 7) and the differences in housing prices (Table 2) were used to evaluate investments in more expensive property in the downtown district and to recover the difference between the prices of property within and outside the central district from the amount saved due to the absence of commuting costs. This amount can be regarded as an investment in the "housing price differential" because the buyer of a downtown property is initially charged with higher costs due to the difference in price between this property and an alternative property in a peripheral location. These costs are subsequently recovered because the owners of downtown property save on commuting costs. The following indicators were used to assess such investments:

1. Payback period, calculated as the difference in housing price divided by the annual cost of travel.
2. A simple rate of return, namely the inverse of the payback period which is calculated as the annual cost of travel divided by the difference in property price.

These indicators were calculated with the use of all three approaches to estimating travel costs, and the results are presented in Table 8.

The results in Table 8 indicate that in the first approach, where the cost of travel is disregarded, the investment will pay off nominally over a period of 8.5 (Osiedle Jarzębinowe) to more than 18 years (Nowe Warzymice), which means the rate of return ranges from 5.48% to 11.72%. Based on the current interest rates on bank deposits, these return rates should be rated as typical to highly favorable. These investments compare even more favorably when the cost of travel

Table 8. Payback periods and simple rates of return on investments in more expensive property in a downtown district

Residential estate	Payback period (years)			Simple rate of return (%)		
	Approach I	Approach II	Approach III	Approach I	Approach II	Approach III
Jaśminowe Wzgórze	12.86	6.88	6.15	7.78	14.54	16.26
Nowe Warzymice	18.26	9.36	7.51	5.48	10.69	13.31
Os. Jarzębinowe	8.53	5.81	5.75	11.72	17.21	17.39

Source: own study.

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time is included in the calculations (Approaches II and III). In this case, the maximum payback period is less than 10 years, and the return rates range from 10.69% to even 17.39%.

The above indicators for assessing the profitability of investments belong to a group of static indicators that do not account for the fact that the present value of a future expense is below its nominal value. This phenomenon is captured by dynamic methods. In the first method, the profitability of an investment is determined by calculating the sum of discounted cash flows (NPV). As previously mentioned, the study was conducted on the assumption that a buyer of a downtown property is initially charged with higher costs that are partly recovered due to the absence of costs associated with commuting from a suburban location to the downtown district. These calculations are based on the assumption that the current nominal values represent, from the present perspective, real amounts in future periods (thus eliminating the impact of inflation). This discount rate was adopted in the calculations based on the premise that, in the long term, the mortgage rate will reach 4% in real terms. The calculations were performed for 10- and 20-year periods, and the results are shown in Table 9.

The NPV values obtained under the adopted assumptions indicate that the purchase of property in a peripheral district, which is associated with higher commuting costs, may be advantageous in a 10-year perspective for buyers who do not regard commuting time as a cost. This is evidenced by the negative NPV values in Approach I. The NPVs for the New Warzymice estate, which is closest to the downtown district and entails the shortest travel time (even allowing for the cost of travel time), suggest

that this location is a viable alternative to downtown locations relative to other residential estates. An increase in the time horizon to 20 years significantly affects the NPV. In this case, only property in the New Warzymice estate can be regarded as profitable, provided that the cost of travel time is not included in the calculations. The choice of location should also be guided by the buyer's planned length of residence. A suburban property appears to be a better choice if an investor expects to live in a particular location for a limited period of time (for example, until starting a family) and then buy a larger property. However, locations that do not generate regular travel costs should be considered if the property is meant to be a place of residence for a long, unspecified period of time, Depending on the investment and the method of calculating transit costs, the present value of expenses to be incurred over 20 years can exceed PLN 80,000, which is evidently higher than the difference between the price of a downtown property and a suburban property.

The IRR offers yet another approach to assessing the cost-effectiveness of a property investment by analyzing changes in the value of money over time. The IRR is calculated on the assumption that the sum of discounted capital expenditures and the investment income incurred in different years is equal to 0. An investment project is profitable when the IRR is equal to or greater than the cap rate (for example, the interest rate on a loan). The higher the IRR, the higher the profitability of an investment project. The IRR is widely used to evaluate the cost-effectiveness of investment projects, usually in combination with NPV, despite the fact that the results may be difficult to interpret in some situations (Wawrzyszuk, 2004). The IRR was used as an alternative approach

Table 9. 10-year and 20-year net present value at r = 4%

Residential estate	10-year NPV (PLN)			20-year NPV (PLN)		
	Approach I	Approach II	Approach III	Approach I	Approach II	Approach III
Jaśminowe Wzgórze	-22370	10854	19300	3441	59109	73261
Nowe Warzymice	-33670	-8059	4809	-15494	27420	48982
Os. Jarzębinowe	1329	28321	29187	40228	85455	86906

Source: own study.

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Table 10. 10-year and 20-year internal rates of return

Residential estate	10-year IRR (%)			20-year IRR (%)		
	Approach I	Approach II	Approach III	Approach I	Approach II	Approach III
Jaśminowe Wzgórze	-4.33	7.45	9.98	4.63	13.35	15.32
Nowe Warzymice	-9.68	1.23	5.56	0.88	8.66	11.90
Os. Jarzębinowe	4.47	13.15	13.40	11.08	17.84	18.05

Source: own study.

to interpreting the results obtained in this study. Similarly to NPV, the IRR was calculated for 10 and 20 years. The IRRs on hypothetical investments in more expensive property, i.e. investments in the price differential between favorably and less favorably located properties, including the cost of travel, are presented in Table 10.

To a certain extent, the calculated values of IRR confirm the conclusions drawn from the NPV analysis. In the first approach, negative values of 10-year IRR were obtained for Jaśminowe Wzgórze and Nowe Warzymice residential estates. Such values merely indicate that the investment is not profitable. As a rule, investments with an IRR higher than the expected minimum rate of return should be regarded as worthwhile. If the IRR is 4% and the considered payback period is 10 years, a downtown property appears to be more profitable than a property in Osiedle Jarzębinowe, regardless of the cost of travel time, and, in the second approach, more profitable than properties in the remaining residential estates. If the payback period is extended to 20 years, only the purchase of a property in the downtown district instead of New Warzymice may not yield a satisfactory return.

CONCLUSIONS

The results of this study indicate that the purchase of residential property in the downtown district of Szczecin is more profitable than properties in peripheral locations when travel costs are included in the calculations in each of the presented approaches. The resulting benefits are least pronounced when the cost of travel time is not included in the calculation of transit costs. In this case, discounted 10-year travel costs are even less than the difference in the price of property located in the downtown district relative to a peripheral location. However, travel costs begin to approximate the price differential when transit times are included in the calculations. If travel costs are to be incurred indefinitely, the purchase of property in the downtown district will generate profits due to the absence of regular commuting costs that significantly exceed the price differential. The purchase of property in a peripheral district is a worthwhile alternative only if the buyer does not regard his free time as an economic good, or if his professional and non-professional activities do not require daily travel whose cost and duration are similar to the assumptions made in the analysis.

The present calculations apply strictly to the analyzed case study. The results of similar calculations may be interpreted differently in other cities, other residential estates, or in different periods of time. However, the research findings indicate that such assessments should be carried out because they can deliver measurable benefits in specific cases. The knowledge and application of basic indicators for assessing the profitability of an investment can and should be taken into account by prospective buyers when considering the purchase of property in alternative locations. To assess the profitability of various investments, the input parameters should be modified and adapted to specific scenarios, and the buyer's lifestyle should be taken into consideration to calculate the actual costs of travel, including the estimated annual number of trips and the cost of travel time. For the needs of this study, properties were selected from all residential projects currently under way in Szczecin based on objective criteria. The obtained results, including the rates of return, payback periods, NPV and IRR refer to a specific

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place and time, which can be largely attributed to the specific characteristics of this type of research. The present results also support the formulation of practical conclusions, albeit less precise. The study demonstrated that transportation costs should be taken into account as one of the factors that affect the choice of property location in the context of differences in housing prices in various locations. However, these observations cannot be directly translated to other European cities. Thus, further studies should be carried out on other local real estate markets to expand our knowledge of such phenomena. However, such studies should rely on assumptions that are adapted to the unique characteristics of the examined area. In this context, the present results constitute benchmarks that could be applied in the search for similar phenomena on other local real estate markets.

The present calculations do not account for potential changes in housing prices in different locations. It was assumed that the prices of attractively located properties are less sensitive to market turbulence and are more likely to increase.

It should also be noted that the present study refers only to costs in financial terms. However, long commutes to places of work and education, especially by means of private transportation, also generates non-financial costs for households, including:
– environmental pollution caused by exhaust emissions and consumption of various materials such as tires, oil, automotive fluids, or car parts;
– cost of stress and health hazards;
– social costs associated with the erosion of family ties.

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