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Important drivers influencing the transport mode choice for leisure activities – a study from Warsaw and Berlin

The goal for most urban areas within the European Union is the transition to sustainable mobility, achieving CO_2 neutrality by 2035, at least in the inner-city areas. The research field of transport behaviour has already been investigated in literature from various perspectives. However, both in science and in practical implementation, there is a shortage of research in the area of transport mode choice for leisure activities, with a concentration on Poland and Germany. The aim of this article is to identify underlying behaviour attitudes, which impact the transport mode choice for leisure activities in Warsaw and Berlin, where mobility is becoming increasingly important alongside daily commuting. Besides a comprehensive literature and internet research, a survey was conducted to obtain new insights from the data analysis. The focus is on generations Z, Y and X and thus includes survey participants aged 18 to 56. Based on descriptive statistics, a bivariate preliminary analysis was executed to find out significant potential predictors. The final specified exploratory model comprises a binary logistic regression analysis to identify influencing factors for the transport mode choice for leisure time activities. The analysis shows that the core influencing factors are the availability of a car, income, and satisfaction with access to public transport. Although future expectations suggest that alternative modes of transportation for recreation have to be improved, the car remains dominant because it represents a high degree of freedom and perceived comfort. Secondary data shows that congestion and burdens from air pollution are increasing and require a more holistic implementation of a sustainable mobility approach focusing on environmental factors and the quality of life of urban citizens. Based on data collection from a structured survey, new insights were gained on important drivers influencing the choice of transport for leisure activities with reference to the cities of Warsaw and Berlin. In addition, it provides guidance and ideas of how the transport services could be improved and how to incentivise more sustainable mobility behaviour among urban citizens.

Keywords: sustainable urban mobility, leisure time activities, mobility behaviour, transport mode choice

JEL classification: R11

Introduction

Despite some efforts toward greater sustainability, the world's exponentially growing population is causing increasing emissions of pollutants and putting pressure on the land and water environment at various levels. Especially the rising population of urban areas worldwide [World Bank, 2018] bears new challenges which require new concepts of urban planning. The cityscape is still mostly characterized by motorized means of transport with an internal combustion engine such as the car, which on the one hand leads to a high volume of traffic, especially during rush hours, but also high noise and pollutant emissions [Kaleniuk et al., 2021]. This in turn has enormous negative consequences on the mental and physical health of urban citizens [Brazier, 2016; Matz et al., 2019; Salvi, Salim, 2019].

Nevertheless, many city dwellers drive their own car because there is a lack of alternative means of transport. In addition, even short distances are often not covered with alternative transport modes such as the bicycle because, for example, the bike paths are not well developed and thus lead to a lack of perceived safety, which is unfortunately also confirmed by many accident statistics in practice [Nuyttens, 2020; Schimek, 2017].

In the scope of a smart city, well-developed urban mobility is one of the core elements of a well-functioning, connected and vibrant city. It provides the basis for the social interactions of its citizens and thus contributes significantly to a good quality of life. A high level of leisure satisfaction includes short commute times, active transportation, such as walking and cycling, and general physical activities [Mouratidis, 2019]. With regard to the structure of a city, it can be observed that compact architecture and more restrictive traffic policies for car traffic can have a positive effect on travel satisfaction [Mouratidis et al., 2019]. Lifestyle also has an influence on leisure activities [Scheiner, 2010]. Together with the spatial environment of the place of residence and its availability and quality of mobility offers, the mobility behaviour of urban residents is significantly influenced. In addition, many crucial factors such as the quality of the urban transport infrastructure, cultural characteristics, and the expectations of society, as well as the economic purchasing power, play an important role in determining the mobility behaviour and thus the preferred choice of transport mode of everyone.

The main objective of this study is, based on literature research, to explore the question of which essential influencing drivers play a role in the choice of transport mode for leisure activities – such as shopping or pursuing hobbies and meeting up with friends.

1. Literature review

The decision-making process on which mode of transportation is best for an individual depends on various factors. There are different trip types, such as the daily commute to work or education facility, trips to leisure activities such as meeting friends, shopping and going to the cinema, and a trip for a vacation. In addition, the place of residence, whether in a rural or urban area, and the associated mobility options also play a decisive role [Berg, Ihlström, 2019]. In the present study, a basic distinction is made between two categories (1) the daily commute to work or education facility and (2) all trips made during leisure time, whether after work or at weekends.

Even though alternative means of transportation are increasingly being developed, cars still dominate the cityscape in most cities in Europe, but also worldwide. The reasons why urban citizens prefer their own car are, for example, the availability and convenience of being able to travel individually at any time, determining their own travel time, or minimizing their own effort. Underlying this motive is often a desire for control [Gardner, Abraham, 2007]. Habits are strong influencers of the mode of transportation choice regardless of the purpose of travel [Ramos et al., 2020]. In addition, car use in particular shows that symbolic and affective motives are decisive for the transport mode choice [Steg, 2005]. Gartman [2004] defines the car as individualized mobility, expressing the ultimate compensatory consumption.

Various reasons such as higher time investment, lack of infrastructure (inconvenient transfer connections, too far distance to the next stop), a perception of insufficient safety in public transport, lack of comfort, lack of flexibility and dependence on the often not tightly existing frequency are major reasons for not using public transport [Suder, Pfaffenbach, 2021]. Thus, there is a gap between the required and desired efficiency, reliability, flexibility, and the price-performance-ratio for public transportation. In addition, particularly in poorer countries or those where the gap between rich and poor is very wide, public transport is considered the primary mode of transport for low-income users [Maia et al., 2020]. Thus, members of the middle or upper class might even avoid it for status reasons.

In addition to a "green mobility transition" of the vehicle fleet, an increased use of public transport and focus on active means of transportation (e.g., bicycles and walking) are essential for a sustainable transition in transport with the goal of CO_2-neutrality [Biernat et al., 2018]. Several behavioural influencing factors, such as availability (e.g. proximity to the next stop, frequency), personal safety and comfort, service, and atmosphere (cleanliness, pleasant climate, service personnel, entertainment and information, etc.), especially travel time, and actual cost [Chen,

Li, 2017], have to be addressed when implementing for the betterment of public transport.

People who tend to rate alternative means of transport poorly also currently use them less and rarely feel the need to change this [Fan, Chen, 2020]. The study shows that walking has a positive effect on the use of public transport. Another study shows that especially for distances up to 5 kilometres, the bicycle is a competitive means of transport in terms of satisfaction of the urban citizens. The satisfaction degree is influenced by functional suitability, agreement on symbolic suitability, and agreement with supporting environmentally friendly principles through bicycling [Hamidi, Zhao, 2020]. The study also shows that people with a higher level of environmental awareness are more likely to use public transportation or bicycles.

Moreover, socio-economic, and socio-demographic factors play a role in the choice of transport mode. Women tend to behave in a more environmentally and health-conscious manner than men, which is also reflected in their choice of more sustainable means of transport [Saigal et al., 2021a]. Research shows that low-income households are less likely to use polluting modes of transport [Saigal et al., 2021b]. The extent to which this is related to the fact that such social groups generally travel less and simply cannot afford a car, however, requires further investigation. Other studies show that, in general, an improvement in public transport also leads to its greater use also by higher-income households, although not quite as much as for lower-income households [Cui et al., 2020]. Besides income, and travel time, other socio-demographic factors such as the age group, education level and lifestyle play a role with regard to the transport mode choice [Verhoeven et al., 2007].

2. Urban mobility in Warsaw and Berlin

By consideration of the demographic factors of the capitals of Poland and Germany, it can be observed that the total population in Berlin is more than twice as high as in Warsaw. The total area is 70% bigger in Berlin and thus the population density is effectively 22% higher than in Warsaw. The average age of city residents is higher in Warsaw (46.7), which may give an indication of the more dynamic influx of young people in Berlin (42.6). In Warsaw, more residents have paid jobs in percentage terms, which also has a corresponding effect on the lower unemployment rate (Table 1).

Table 1. Warsaw vs Berlin: Basic numbers of demographics

	Measure	Warsaw	Berlin	Unit
Demographics	population	1,794	3,777	thousands
	area size	517.24	891.68	km^2
	population density	3,469	4,228	inhabitants/km^2
	average age	46.7	42.6	years
	people in paid work	60.2	47.5	%
	unemployment rate	2.0	7.6	%

Source: Own elaboration based on, e.g., statistics offices in Poland and Germany; for source and details of the different measurement indicators, see Appendix A.

When analysing the key traffic figures, one value emerges that is highly different between the two cities (Table 2). The percentage of car use in Warsaw is more than twice as high as in Berlin. Other traffic values also show that Warsaw citizens are much more likely to be stuck in traffic jams and must put up with correspondingly greater time delays than in Berlin. The coverage of the urban area that is connected to public transport is almost identical in both cities (Warsaw: 77%, Berlin: 75%). However, Berlin has a much higher frequency and effectively faster public transport connections.

Table 2. Warsaw vs Berlin: Key mobility indicators

	Measure	Warsaw	Berlin	Unit
Key mobility indicators	car use	76.4	37.4	% of the population
	relative fuel costs	32nd	24th	ranking of 38 cities
	traffic congestion index	4.7	4.0	out of 10
	congested roads	8.72	2.58	% of road network
	time delay in traffic	29	23	mins per 100 km
	public transport frequency	189	442	trips per stop per day
	public transport expense	2.82	3.92	% of monthly income
	public transport coverage	77	75	% of city area
	Green spaces	8.7	27.0	% of city area
	public transport vs car speed	24th	15th	ranking of 38 cities

Source: Own elaboration based on, e.g., statistics offices in Poland and Germany; for source and details of the different measurement indicators, see Appendix A.

The relative cost of petrol is higher in Warsaw and the cost of public transportation is even cheaper than in Berlin, yet car use dominates. The proportion of green space is more than three times higher in Berlin than in Warsaw, which is an

important factor for the local recreation of the urban citizens. In addition, it makes an important contribution to the air quality in the city [Krajnik et al., 2019; Nieuwenhuijsen et al., 2017].

The car driver ratio in Berlin is relatively low in comparison to Warsaw. In Warsaw and Berlin new concepts are being tested, leading to constant changes in the field of urban mobility. In recent years, the Berlin Senate has been pursuing a change from a city dominated by combustion engines to an intermodal use of transport with a focus on public transport and the expansion of bicycle lanes. In addition, buses with internal combustion engines are also gradually being replaced by electric and hydrogen propulsion ones. Different projects are being coordinated in the various areas of pedestrian traffic, bicycle traffic, buses and trains, and local transportation plans. The goal is to achieve CO_2-neutrality in the inner part of the city (S-Bahn ring) by 2030. To achieve this, no more vehicles with combustion engines are to be allowed to enter the city area by then. Currently 74% of trips in the city of Berlin are made by bicycle, buses, trains, or on foot [Senate Department for Environment, 2021].

Initial measures have also been adopted in Warsaw based on EU funding for a Sustainable Urban Mobility Plan (SUMP). These include an increase in public transport coverage. However, a report also shows that there is a lack of a concrete implementation plan for the strategies. For example, there are no specific targets in terms of the modal share [European Court of Auditors, 2020]. In addition, only 37% of Warsaw's urban area is covered by spatial plans, which limits the effectiveness of the urbanization design for urban mobility.

In guiding further urban development actions towards a sustainable and healthy environment for urban citizens, the reasons that lead to a particular mode of transport choice should also be explored as input variables to be assessed.

3. Survey structure, sampling method and descriptive statistics of the data analysis

To collect primary data, an online survey was conducted in June 2021 among citizens of Warsaw and Berlin. The target age group (from 18 to 56 years) was derived based on the generations to be considered. The sample was selected based on the inclusion criteria for generations Z, Y and X and their place of residence, i.e. it is a semi-random sampling. Since no under-age participants could be interviewed in the survey, Generation Z was only surveyed from the age of 18.

To obtain a corresponding representation of the generational and gender distribution, the data collected through the survey was weighted based on relevant

structural characteristics of generation and gender obtained from secondary data [Federal Statistical Office; Statistical Information Centre][1]. Since Berlin and Warsaw differ in this respect, the two cities were also weighted separately and taken into account accordingly in the data analysis with SPPS.

The target generations were surveyed using a quantitative questionnaire to express their opinions on several statements related to urban mobility and its development prospects. In addition, the typical use of different modes of transport was considered. The questions were divided into four different areas: (1) personal values of different generations, (2) urban mobility and travel behaviour, (3) future living in a smart city, and (4) general information about socio-economic and socio-demographic factors.

For the most part, closed questions based on a 5-point Likert scale were used. Thus, the characterization of the variables was mostly categorial (ordinal). Other variables such as gender and having a driving license can be classified as binary data. Other questions where the survey participants had the possibility to choose one or more options were scaled nominally. Some of the data collected in the survey (e.g. questions with a 5-point-Likert-scale) were transformed into continuous numbers, which are better suitable to statistical analysis. Details about the applied variables can be found in Appendix B.

For this paper, the overall sample has 537 valid answers, obtained from the participants among the three selected generations (Z, Y and X) from Warsaw and Berlin. The distribution indicates that there were slightly more survey participants in Berlin (54.2%) than in Warsaw (45.8%). The size of the overall sample, but also the distribution between the two cities, is sufficient to derive a statistical significance [Memon et al., 2020]. Depending on the question, the significance of the results, and the field of expertise, however, samples can vary in terms of their informative content [Malterud et al., 2016]. The informative value of the present sample will be examined in the further course [Boddy, 2016].

Table 3 shows basic socio-demographic statistics.

The generation and gender distribution are interpolated on the basis of real figures to ensure representativeness. It also shows that the number of those who live in their own property is much higher in Warsaw (69.3%) than in Berlin (28.8%).

Table 4, on the other hand, shows the specific essential mobility parameters.

[1] For Warsaw, the data were interpolated based on the age population numbers for urban areas for the Masovia Province (all data processed according to age groups).

Table 3. Socio-economic parameters of the research sample for GEN Z, GEN Y and GEN X

Factor	Values
overall participants	Warsaw: 45.8% (246), Berlin: 54.2% (292)
distribution generation Warsaw	GEN Z: 15.0% (37), GEN Y: 52.8% (130), GEN X: 32.1% (79)
distribution generation Berlin	GEN Z: 15.8% (46), GEN Y: 41.8% (122), GEN X: 42.5% (124)
sex Warsaw	female: 48.4% (119); male: 51.6% (127)
sex Berlin	female: 50.0% (146); male: 50.0% (146)
living situation Warsaw	home rented: 68.3% (168); home owned: 31.7% (78)
living situation Berlin	home rented: 28.8% (84); home owned: 71.2% (208)
education level Warsaw*	ISCED-level 1–2: 2.9% (7), ISCED-level 3–4: 24.4% (60); ISCED-level 5–6: 16.7% (41); ISCED-level 7–8: 56.1% (138)
education level Berlin	ISCED-level 1–2: 5.5% (16), ISCED-level 3–4: 22.4% (65); ISCED-level 5–6: 19.3% (56); ISCED-level 7–8: 52.8% (153)
monthly disposable income per person Warsaw**	low-income: 15.4% (38); middle-income – lower range: 10.2% (25); middle-income – upper range: 44.7% (110); high-income: 29.7% (73)
monthly disposable income per person Berlin	low-income: 19.9% (58); middle-income – lower range: 8.2% (24); middle-income – upper range: 26.5% (77); high-income: 45.4% (132)

Notes: Calculations by the author. The sum of the rows may not add up to 100 because the values are rounded.

* ISCED-level 1–2: Completion of elementary school (lower secondary school, usually 8 or 9th grade + Secondary school diploma; ISCED-level 3–4: Vocational education / technical school and Upper secondary school (high school or similar); ISCED-level 5–6: Bachelor's degree or equivalent; ISCED-level 7–8: Master's degree or equivalent and doctoral degree.

** Normalization based of Purchasing Power Parity (PPP).

Source: Own survey conducted between end of May and end of June 2021.

Table 4. Main mobility parameters of the research sample of GEN Z, GEN Y and GEN X

Category	Value
car driving license Warsaw	yes: 84.0% (207); no: 16.0% (39)
car driving license Berlin	yes: 94.2% (275); no: 5.8% (17)
access to a car in household Warsaw	yes: 78.9% (194); no: 21.1% (52)
access to a car in household Berlin	yes: 70.4% (206); no: 29.6% (86)
average travelled kilometres on a weekend day / day off from work	below 5 km: 14.5% (78): 5 to 10 km: 25.1% (135); 10 to 20 km: 30.8% /165); 20 to 30 km: 19.3% (104); 30 to 50 km: 6.1% (33); more than 50 km: 4.2% (23); mean value for Warsaw: 16.3 km; mean value for Berlin: 19.4 km
transport choice for free time activities Warsaw	own car / taxi / car sharing: 53.9% (133); public transport: 33.1% (81); Active commute: 12.9% (31)
transport choice for free time activities Berlin	own car / taxi / car sharing: 47.7% (139); public transport: 25.2% (74); active commute: 27.1% (79)
dominant transport mode Warsaw	car: 53.9%; green transport: 46.0%
dominant transport mode Berlin	car: 47.7%; green transport: 52.3%

Notes: Calculations by the author. The sum of the rows may not add up to 100 because the values are rounded.

Source: Own survey conducted between end of May and end of June 2021.

Almost 90% of respondents have a driver's license and around 74% have access to a car in the household. For leisure activities such as going to the cinema or museum, but also for visits to friends etc., a good half of those surveyed prefer to use the car.

The largest share (56%) covers a daily distance of between 5 and 20 kilometres. In the last line, the variable dominant transport mode (DMT) is set as the primary basis for the ensuing research approach. Thus, all transport modes other than the car are defined as "green transport" (GT), assuming them to be either CO_2 neutral or at least low-CO_2-emitting[2].

4. Data analysis

The survey asked the following question regarding transportation choices for leisure activities: "Based on a typical week, what mode of transportation do you use most often for your leisure activities such as meeting with friends and family, shopping, sports activities, etc.?". Different means of transportation could be selected as an answer. In the focus consideration, the car (own car, car sharing, taxi) is examined with the other means of transport such as public transport, bicycle as well as walking (GT). Therefore, binary logistic regression is used for the statistical analysis, which is a classic model of discrete decision theory that, as its name implies, requires a binary code. The binary categorization takes place with the variable name "trans_typ_leis_dmt", which is defined as the dependent variable, by coding the car with "0" and GT with "1" nominally scaled.

To identify significant variables influencing the choice of transport in leisure time, a bivariate preliminary analysis was conducted to preselect the significant potential predictors. Depending on the scaling of the variables (nominal, ordinal or metric / quasi-metric), different tests were used (Pearson chi-square, Kruskal–Wallis test, and ANOVA). Then a subject-specific logical model was built up, and significant input variables were determined step by step with a binary logistic regression. This also prevents an increased consideration of strongly correlated predictors (independent variables) in a regression analysis and thus reduces undesirable multicollinearity. The aim was to find those variables that have a high correlation with the dependent variable "trans_typ_leis_dmt" (criterion / dependent variable).

The established hierarchical model selection approach with a stepwise performing of a logistic regression was conducted as follows.

[2] This assumption is made to simplify the comparison, since in Warsaw, but also in Berlin, the proportion of alternative and CO_2-free drive systems is still quite low compared to internal combustion engines in private motorized transport.

Table 5. Stepwise procedure model for the analysis of factors influencing the choice of transport mode during leisure time

Step	Description focus area
primary main influencing variables	average distance travelled on a weekend day / non-working day, access to a car and bicycle in own household, holding of a monthly public transport ticket
future expectations regarding urban mobility	questions regarding urban mobility and future living in a smart city in the areas of: measures for improvement of the transport infrastructure; perceived importance of smart city areas such as mobility, health, security, cultural and informational offering, citizen participation, technological innovation and mobile apps, sustainable urban planning, car infrastructure and public transport
satisfaction of living environment	satisfaction with the living environment, e.g. proximity to facilities for daily needs, family and friends, work; but with the quality of the living environment, the quality / cost of the apartment / house and access to public transport.
personality characteristics	selected clustered variables based on a factor analysis for the questionnaire part "personal values of different generations" - questions about values and attitudes and how these are manifested in the various areas of life, both professional and private
socio-economic factors	supplementing of the demographic and socio-economic factors

Source: Own elaboration based on the established methodological approach.

In Berlin, the correlation between the distance travelled at the weekend and car use is more pronounced than in Warsaw (cf. Figure 1). This shows that cars are

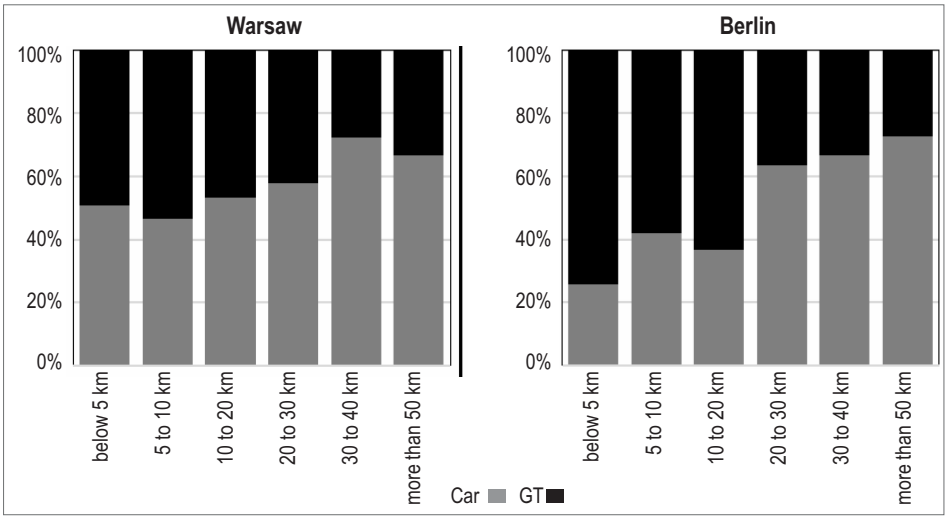

Figure 1. Warsaw vs Berlin: Car use for leisure time activities in correlation with the distance

Source: Own elaboration based on the descriptive statistics obtained from the survey.

especially used for longer journeys. In Warsaw, this tendency is only very slightly pronounced. This means that shorter distances are also travelled frequently by car.

Comfort is cited as the main reason for using one's own car for Warsaw and Berlin alike. For the use of alternative means of transport, primarily the health aspects play an important role. The reasons for not using a car differ significantly between Berlin and Warsaw. Berlin tends to have an even distribution of reasons. Compared to Warsaw, however, sustainability is cited as a key reason. In Warsaw, costs are much more dominant in this respect (Figure 2).

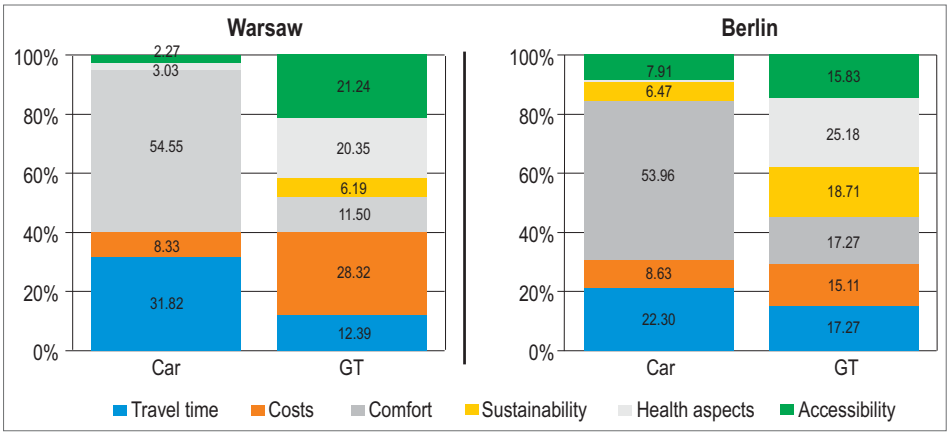

Figure 2. Warsaw vs Berlin: Reason for transport mode choice for leisure time activities

Notes: Values below 1% are not depicted.

Source: Own illustration based on the descriptive statistics obtained from the survey.

After conducting a binary regression model based on the established stepwise approach as depicted in Table 5, the following R^2 and delta R^2 values for the significance of the model according to Nagelkerke are shown (cf. Table 6). In addition, the selected variables based on the analysis for each step are depicted.

To analyse the reliability and significance of the model in addition to the Nagelkerke R^2, an omnibus test, and a Hosmer–Lemeshow goodness-of-fit test, were applied. As the descriptive statistics show, 49.4% of the survey participants prefer transport modes other than the car for leisure time activities, and the classification cut-off of 0.49 is set. The aiming value of the variable "trans_typ_leis_dmt" (depend variable) is GT.

A Nagelkerke-R^2 of 0.469 for the final model as a quality measure for the statistical explanatory power of the estimated logit model is a good variance resolution (medium effect) of Nagelkerkes $R^2 = 0.469$ according to the recommendation of Backhaus et al. [2016]. After execution of the Omnibus test, it shows that the binomial logistic regression model is statistically significant, $\chi^2(10) = 232.99$, $p < 0.001$.

The Hosmer–Lemeshow test indicates a good model fit, χ^2 (8) = 11.00, p > 0.05 with an p-value of 0.202 (confirmation of a null hypothesis).

Table 6. R^2 and delta R^2 values

Step	Description	R^2 (in %)	delta R^2 (in %)	Selected variables*
1	primary main influencing variables	31.5	–	trans_km_leis_x, ress_car, ress_lic
2	travel behaviour and future expectations urban mobility	40.1	8.6	urb_live_traffic_free, imp_lc_secure, imp_ul_pt, tp_car_freedom
3	satisfaction of living environment	42.4	1.3	sat_access_pt
4	personality characteristics	44.1	1.7	wol_city
5	socio-economic factors	46.9	2.8	soz_income
Final	overall model	46.9	–	trans_km_leis_x, ress_car, ress_lic, ress_pt_tick, urb_live_traffic_free, imp_lc_secure, imp_ul_pt, sat_access_pt, wol_city, soz_howner, soz_income

* For detailed variable definition, see Appendix B.

Source: Own elaboration based on the established methodological approach.

After each step, the not significant variables were dismissed. The final overall model results are shown in Table 7.

Table 7. Final model

Variable	B	SE	Wald	P-value	Odds ratio
ress_car	–1.588	0.308	26.518	0.001	0.204
soz_income	–0.499	0.107	21.758	0.001	0.607
sat_access_pt	0.021	0.005	15.301	0.001	1.021
tp_car_freedom	–0.015	0.005	11.201	0.001	0.985
imp_ul_pt	0.736	0.222	10.972	0.001	2.087
ress_lic	–1.301	0.447	8.460	0.004	0.272
urb_live_traffic_free	0.011	0.004	7.750	0.005	1.011
imp_lc_secure	–0.939	0.344	7.468	0.006	0.391
trans_km_leis_x	–0.016	0.008	4.054	0.044	0.984
wol_city	0.009	0.004	3.919	0.048	1.009

Notes: Constant blanked out, Hosmer–Lemeshow: p-value = 0.202, Nagelkerke R^2 = 0.469, Omnibus test: p-value < 0.001.

Source: Own elaboration based on the established methodological approach.

Significant influencing variables could be found by the sequential procedure. The effect of the influence quantity is expressed by the odds ratio and the importance of the influence quantity is expressed by the Wald value.

With the model set up with the stepwise approach and with the adjustment of non-significant variables, an attempt was made to avoid multicollinearity as far as possible (Table 8).

The verification of the modal fit was analysed with the calculation of the variance inflation factor (VIF).

Table 8. Multicollinearities between the independent variables of a model

Variable	Collinearity statistics	
	tolerance	VIF
ress_car	0.747	1.339
soz_income	0.929	1.076
sat_access_pt	0.888	1.126
tp_car_freedom	0.858	1.165
imp_ul_pt	0.960	1.042
ress_lic	0.897	1.115
urb_live_traffic_free	0.908	1.102
imp_lc_secure	0.973	1.027
trans_km_leis_x	0.966	1.035
wol_city	0.908	1.102

Source: Own elaboration based on the established methodological approach.

All values of the tolerance are clearly above 0.1 as well as none of the VIF values is above 5 (> 5 is a problematic high correlation)[3]. This means that the model shows no indication of multicollinearity [Akinwande et al., 2015].

5. Results

The three most important factors are the availability of a car, income, and satisfaction with access to public transport. For the practical implication, it seems logical that access to one's own car is also strongly associated with the transport mode choice for leisure activities.

For the practical implication, it seems logical that the access to one's own car is strongly related to the choice in leisure time. It is clear, moreover, that people with a high income tend to choose their own car.

[3] It should be noted that the tolerance is the inverse of the VIF and basically one of the two values is sufficient for interpretation.

In addition, the findings of the binary logistic regression analysis show that people who perceive that ownership of a car provides them with a feeling of freedom, in the majority refuse to use alternative means of transport. The previous descriptive statistics showing comfort as the most important reason for choosing a car give an indication that there is a strong correlation with the factor "car freedom". People who prefer alternative modes of transportation place less emphasis on comfort. The choice of a car as the preferred means of transport for leisure activities is almost equal in Warsaw (48.9%) and Berlin (50.4%). The percentage of driving license holders is very high in both cities, with Berlin surpassing Warsaw by almost 10%. Having a driver's license is negatively correlated with choosing GT.

Furthermore, future expectations regarding mobility in cities also influence the choice of transport. People who are in favour of a less expensive and more well-developed public transport tend to prefer alternative means of transport. Nowadays, a lack of availability together with an insufficient frequency and the resulting overcrowded public transportation are often reasons why many people prefer to travel by car. An expansion of the public transport system to allow a fast and comfortable possible journey from A to B is crucial to achieving its higher acceptance as a means of travel from urban citizens among all generations and income levels. Measures like this can be an essential cornerstone to create incentives among established drivers and to induce a change in their mobility behaviour towards their willingness to use public transport instead of the car. The same applies to the establishment of traffic-calmed zones, pedestrian and bicycle paths and the widening of sidewalks, also by reducing the number of roads and parking spaces. This may show a change in awareness, which also has an impact on actual mobility behaviour.

The regression analysis confirms the theory that the longer the distance travelled, the lower the chance of using alternative means of transport. But the effect is weak compared to the other influencing variables. The analysis also shows that the likelihood of a car holder using public transport is comparatively low compared with non-car holders, which is an obvious fact. Having a driving license achieves a similar effect. Nevertheless, people who have a driving license and no access to a car are more likely to use public transport than car holders. The availability of a monthly or annual pass for public transport plays a rather subordinate role. It was not included in the model because of a lack of significance.

The findings of the binary regression model also show that a high level of perceived safety and sufficient measures for a secure city with a low crime rate is another significant, but not that important, influencing factor. People with a high demand for security prefer to use the car. The perceived but also actual safety in public transport clearly shows that there is a need for improvement [Ingvardson, Nielsen, 2021]. In addition, safety is often linked to comfort. The last significant

variable but with a rather low importance of the influence quantity expressed by the Wald, is the positive attitude towards a preferred life in a big city because of the opportunities for leisure activities such as cultures' facilities, historical landmarks and attractions, nightlife, sports activities, etc. For urban citizens it seems to be more important to have a wide range of possibilities rather than to live in nature. They often use city parks or trips during the weekend to enjoy their free time in a green environment.

Interestingly, according to the research conducted, neither the place of residence Berlin or Warsaw, nor the different generations Z, Y and X, have a significant influence on the choice of transport for leisure activities.

Conclusions

This study has focused on the analysis of the main drivers influencing the transport mode for leisure activities. With its reference to the two capitals Warsaw and Berlin, it closes a gap that has not yet been considered in science. Based on the data collected from the sample for generations Z, Y and X, the core of the statistical analysis is a binary logistic regression based on a hierarchical model. Basically, two different categories of transportation were defined: On the one hand, the classic use of owners own vehicles, mostly, and, on the other hand, alternative means of transport such as public transport, bicycles, and walking.

The results bring some interesting findings. There is still a very strong tendency to use one's own car for leisure activities. The use of one's own car in Warsaw is even more common for shorter distances compared to Berlin. A look at the descriptive statistics shows that Warsaw has a fairly good coverage of public transport, but the frequency is relatively low compared to Berlin. In both cities, comfort was cited equally as the primary reason for using the car, indicating that many urban citizens perceive alternative modes of transportation as less convenient and cumbersome.

It also shows that an incentive for car drivers to switch to alternative modes of transportation can be created in particular if the reliability and frequency of public transport are increased [Redman et al., 2013]. Sustainability does not seem to play an essential role among car drivers, or at least it is not present in their awareness. Furthermore, car use is highly dependent on actual availability and income. Satisfaction with access to public transportation also correlates strongly with usage, confirming that it is not seen as an adequate alternative by car drivers. Frequently overcrowded trains and buses in rush hours, too frequent breakdowns and thus a lack of reliability, and costs that are still too high show that public transportation is far from being developed to the point where it is recognized as an adequate means of getting around the city [Hensher, 2000].

The high significance of the influential factor that the car gives many people a feeling of freedom confirms previous findings from the literature research [Pojani et al., 2018; Pucher, 1998]. When examining the users of alternative means of transport, it becomes apparent that the environment and health aspects are much more in focus [Jakubiak-Lasocka et al., 2014; Zalakeviciute et al., 2019]. However, there is often a lack of proper infrastructure for cyclists, also leading to an insufficient road safety [Iwińska et al., 2018].

Surprisingly, neither the different generations nor the genders have significantly different influencing factors when deciding on the means of transport for leisure time. Fundamentally, these also do not differ between Warsaw and Berlin. Only a closer look reveals that there are differences in attitudes towards the environment, car use and perceived quality of alternative means of transport. The extent to which the differences are due to cultural differences and the existing range of services can be the subject of a supplementary analysis to this study.

Secondary research has shown that Berlin, more than Warsaw, is already paving the way towards a CO_2-neutral transport policy through various pilot projects and concretely implemented measures [Rode et al., 2015]. It is not a question of completely displacing or banning motorized individual transport. Rather, the aim is to make it emission-free with the appropriate propulsion technologies and, at the same time, to expand public transportation in such a way that it is possible to get around the city quickly, comfortably, and inexpensively. At the same time, bicycle paths in the city must be expanded in such a way (key point: structural separation between bicycle paths and car roads) that all citizens feel safe, regardless of their age group [Sheldrick et al., 2017].

The findings provide indicators of attitudes toward different modes of transport. Moreover, measures can be derived that create an incentive for individuals to be more open-minded towards alternative modes of transport in the future. Therefore, it is critical to develop collaborative approaches to sustainable urban mobility that are embedded in spatial urban planning and consider behavioural economics principles being integrally implemented into public policy [Grochowski, 2015]. This also means involving citizens to increase acceptance and willingness to encourage greater use of public and non-motorized transportation [Maier, 2012]. In this context, sustainable transport concepts should be developed in the planning of urban mobility that also take leisure traffic into account.

In this context, a Sustainable Urban Mobility Plan should be developed which also considers leisure transport. A SUMP is aimed at developing urban mobility within the framework of urban architecture, starting from the political framework conditions, and covering all levels, to find solutions to traffic-related problems [Kiba-Janiak, Witkowski, 2019]. Thereby, the urban citizens are in the centre of attention. Besides the improvement of the service offer with a higher efficiency, the

focus should be on the air quality and safety in urban mobility [Pisoni et al., 2019; Spadaro, Pirlone, 2021]. A sustainable smart city should aim for an ecologically oriented green urbanism with the objective to reduce the ecological footprint, bringing these aspects increasingly back into harmony with nature [Beatley, 2006]. This also leads to a higher quality of life and health.

Focusing on a specific question and limiting the scope of this study also imposes certain limitations on this article. The survey questions asked about the preferred means of transport which is most frequently used for leisure activities. No further detailed distinction was made here. In the next step, the different types should be further differentiated. For example, people may use public transportation to visit a museum or a cinema but use their own car for daily errands. In addition, the different behavioural patterns regarding car ownership [Magdolen et al., 2021] in terms of leisure activities should also be analysed in more detail.

Moreover, two categories were formed for the bivariate regression analysis, incorporating those who drive and those who are more likely to use alternative modes of transportation, referred to in this article as "green transport". Because this is a simplification, more detailed consideration would require detailed distinctions. For example, it may make more sense to use an e-vehicle instead of running double-decker buses in a city at night, which have high emission levels with a very low passenger load. Therefore, a realistic CO_2 emission value per kilometre would have to be calculated for the different means of transport on the basis of the actual utilization as well as the consumption.

Trends show that it will be more difficult to draw up dedicated personality-based mobility profiles, since mobility is becoming increasingly heterogeneous, especially among the younger generations. Finally, the question is less whether to use one's own car or rather public transportation or the bicycle since it will not be an either-or decision in the future. Rather, the use of the means of transport will be diverse depending on the purpose of the journey and, in the wake of the sharing principle with mobility-as-a-service (MaaS) and "pay-as-you-go" payment model, various modes of transport will be combined in such a way that, depending on needs and budget, one can get from A to B in the fastest, most comfortable, most cost-effective, or most environmentally friendly way. In this way, a "mobility consumer" only pays for the actual use of the demanded mobility and not for 95% of the time that a car is parked [Burgstaller et al., 2017; Esztergár-Kiss, Kerényi, 2020; Xi et al., 2020]. A transparent display of the CO_2 emissions caused in each case can make a further contribution to raising awareness in the direction of sustainable mobility.

As a result of the convergence of different transport services, in particular the use of sharing offers ("using instead of owning"), intermodal transport use is becoming increasingly dominant among many city dwellers [Reichenbach, 2019]. In

achieving this, urban citizens must be convinced by addressing essential needs, such as easy access, fast and inexpensive connections, and convenience, to also increase their willingness to change their habitual behaviour patterns. This is shown by the results of this study, but also by other studies [Goletz et al., 2020].

This work is therefore intended to build a bridge between the "traditional thinking" in the direction of the classic use of certain means of transport, to the intermodal use of different means of transport depending on the purpose, situation, and financial budget.

Further scientific analyses in the area of mobility behaviour in leisure time should be performed. Currently, the generations of the total sample did not show a general significant influence; the next step could, however, be to examine the different generations in more detail. In addition, the mobility behaviour in everyday life, i.e., the way to work or to the educational institution, was not examined. The relationship between daily commuting and leisure mobility also represents another interesting area of investigation.

Disruptive changes caused by the Corona pandemic, which are likely to have a long-term impact on mobility behaviour, should also be investigated in the next step.

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Appendix A. Details to basic numbers and key mobility indicators for Warsaw and Berlin

Measure	Details	Source of data for Warsaw	Date of data for Warsaw	Source of data for Berlin	Date of data processing
population	–	warszawa.stat.gov.pl/en	30.06.2021	download.statistik-berlin--brandenburg.de/70fd75104b57d0fa/83cc240d450f/21-02-10.pdf	31.12.2020
area size	–	as above	–	as above	31.12.2020
population density	number of inhabitants per km2; calculated value: population / area size	as above	–	as above	31.12.2020
average age	–	ugeo.urbistat.com/AdminStat/en/pl/demografia/dati-sintesi/warszawa—-srodmiescie/1465108/4	2020	de.statista.com/statistik/daten/studie/1095771/umfrage/bevoelkerung-berlins-nach-altersgruppen	31.12.2020
percentage people in paid work	–	warszawa.stat.gov.pl/en	–	berlin.de/berlin-im-ueberblick/zahlen-und-fakten	31.12.2019
unemployment rate	–	as above	–	as above	31.12.2019
car use	calculated value of cars divided by total population	stat.gov.pl/en/topics/transport-and-communications/transport/road-transport-in-poland-in-the-years-2018-and-2019,5,6.html	31.12.2020	berlin.de/berlin-im-ueberblick/zahlen-und-fakten	31.12.2019
relative fuel costs	the average cost of fuel relative to income per capita (we calculated the affordability of fuel by averaging prices from the city's petrol stations and comparing them to mean net monthly income)	urbanmobilityindex.here.com/city/warsaw	2018	urbanmobilityindex.here.com/city/berlin	2018

Measure	Details	Source of data for Warsaw	Date of data for Warsaw	Source of data for Berlin	Date of data processing
traffic congestion index	a measure of city congestion during peak times (we compared the flow of traffic during weekday rush hours, i.e. 6–10AM and 4–8PM, to an ideal free-flow environment. This index is represented on a scale of 0–10 where 0 is least congested and 10 is most congested)	as above	2018	as above	2018
percentage of congested roads	the percentage of roads congested at peak times, i.e. 6–10AM and 4–8PM on weekdays (calculated by comparing the total length of congested roadway segments with the total length of a city's road network)	as above	2018	as above	2018
time delay in traffic	a measure of the extra time spent driving due to traffic congestion. Calculated by comparing journey times for 100km (62 mi) travelled during peak times (6–10AM and 4–8PM on weekdays) with journey times for those roads when traffic moves freely.	as above	2018	as above	2018
public transport frequency	a measure of how often a public transport service calls at a public transport stop (calculated based on average numbers of trips per public transport stop, per day)	as above	2018	as above	2018
public transport expense	the cost of a monthly transport pass as a percentage of monthly income (we calculated this based on the relative costs of a monthly public transport ticket and mean net monthly income)	as above	2018	as above	2018

Measure	Details	Source of data for Warsaw	Date of data for Warsaw	Source of data for Berlin	Date of data processing
public transport coverage	The total area of the city within 1km of a public transport stop, relative to the total area of the city.	as above	2018	as above	2018
percentage of green spaces	the percentage of a city's area which is covered in accessible green space (calculated by considering the area covered by green spaces, such as parks, lakes, and woodland, relative to the total area of the city)	as above	2018	as above	2018
public transport vs car speed	the ratio between average journey time by public transport and by car, excluding time spent parking (we randomly selected random points of interest around the city and then compared average journey times between them, at hourly intervals between 6AM and 8PM)	as above	2018	as above	2018
car use	calculated value of cars divided by total population	stat.gov.pl/en/topics/transport-and-communications/transport/road-transport-in-poland-in-the-years-2018-and-2019,5,6.html	31.12.2020	berlin.de/berlin-im-ueberblick/zahlen-und-fakten	31.12.2019
relative fuel costs	the average cost of fuel relative to income per capita (we calculated the affordability of fuel by averaging prices from the city's petrol stations and comparing them to mean net monthly income)	urbanmobilityindex.here.com/city/warsaw	2018	urbanmobilityindex.here.com/city/berlin	2018

Source: Own elaboration.

Appendix B. Variables' details

var_name	var_label	Scale	label_code	label_name
x_gen	generation	nominal	1	Z
x_gen	generation	nominal	2	Y
x_gen	generation	nominal	3	X
x_city	city	nominal	1	Warsaw
x_city	city	nominal	2	Berlin
soz_male	gender	nominal	0	no
soz_male	gender	nominal	1	yes
soz_work	job or education status	nominal	0	no
soz_work	job or education status	nominal	1	yes
soz_howner	home owner	nominal	0	no
soz_howner	home owner	nominal	1	yes
soz_income	total personal disposable income per month	nominal	1	low-income group
soz_income	total personal disposable income per month	nominal	2	middle-income group – lower range
soz_income	total personal disposable income per month	nominal	3	middle-income group – upper range
soz_income	total personal disposable income per month	nominal	4	high-income group
ress_lic	driving licence	nominal	0	no
ress_lic	driving licence	nominal	1	yes
ress_car	access to car based on cars in household	nominal	0	no
ress_car	access to car based on cars in household	nominal	1	yes
tp_car_freedom	"Owning a car gives me a feeling of…" (originally based on a 5-point Likert scale)	metric	1, 2, 3, 4, 5	I strongly agree; I agree; neither nor / neutral; I disagree; I strongly disagree
trans_typ_leis	Given a typical week, what modes of transportation do you use most often during your leisure time, in situations such as meeting friends and family, shopping, sports activities, etc.?	metric	1, 2, 3	own car / taxi / car sharing, public transport / long distance train, active commute (bike & on foot)

var_name	var_label	Scale	label_code	label_name
trans_reas_leis	main reason for means of transport for leisure time	metric	1, 2, 3, 4, 5, 6	travel time, costs, comfort, sustainability, health aspects, accessibility
trans_km_leis	travel on average on a weekend day / day off from work (originally based on a 5-point Likert scale)	metric	1, 2, 3, 4, 5, 6	below 5 km, 5 to 10 km, 10 to 20 km, 20 to 30 km, 30 to 50 km, more than 50 km
sat_access_pt	satisfaction with accessibility to public transport	metric		I am very satisfied; I am satisfied; neither satisfied nor dissatisfied; I am dissatisfied; I am very dissatisfied; not applicable / not relevant
urb_live_traffic_free	increase of subsidies for alternative means of transport (originally based on a 5-point Likert scale)	metric		I strongly agree; I agree; neither nor / neutral; I disagree; I strongly disagree
wol_city	creation of traffic-calmed zones, pedestrian, and bicycle lane (originally based on a 5-point Likert scale)	metric		I strongly agree; I agree; neither nor / neutral; I disagree; I strongly disagree
imp_lc_secure	most important factor to you for a liveable city – healthy lifestyle and environmental aspects	nominal	1, 2, 3, 4, 5, 6	affordability, urban mobility, healthy lifestyle and environmental aspects, security, information and cultural facilities, personal development opportunities
imp_ul_pt	improve public transportation overall while making it affordable (e.g., subsidized monthly/annual public transportation passes) and efficient (fast and comfortable travel from A to B)	nominal	0	no
imp_ul_pt	improve public transportation overall while making it affordable (e.g., subsidized monthly/annual public transportation passes) and efficient (fast and comfortable travel from A to B)	nominal	1	yes

var_name	var_label	Scale	label_code	label_name
trans_leis_dmt	differentiation of car vs other means of transport such as bike and public transport ("green transport")	nominal	0	car
trans_leis_dmt	differentiation of car vs other means of transport such as bike and public transport ("green transport")	nominal	1	green transport (GT)
trans_km_leis_x	travel on average per day to and from education / work in km	metric	1, 2, 3, 4, 5	below 5 km, 5 to 10 km; 10 to 20 km; 20 to 30 km; 30 to 50 km; more than 50 km

Source: Own elaboration.