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The Attractiveness of Regional Transport as a Direction for Improving Transport Energy Efficiency

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Abstract: One of the ways to improve energy efficiency in transportation is through efforts aimed at increasing the usage of public transportation by residents. This, in turn, is closely related to residents' preferences. One of the most frequently cited factors influencing the attractiveness and quality of public transportation is the frequency of connections. This is important not only for urban transport but also regional transport, which has significantly lower passenger flows. This paper aims to present how the frequency of connections affects the attractiveness of regional transport. An original method for determining the attractiveness of public transport, based on the share of adult, senior, and youth passengers with single tickets and monthly passes, is introduced. The results of research on the structure of passengers and flows to/from the district center are presented. Based on the research results, attractiveness factors are calculated for each town. The statistical analysis clearly indicates there is a strong correlation between the attractiveness of regional transport and the frequency of connections (Rs = 0.807, p = 0.001). Moreover, for every connection increase, the number of adult passengers will increase by an average of 1.5. Assuming that these additional passengers switch from individual to public transportation, the resulting reduction in energy consumption due to an increase of one connection is 0.33–0.69 kWh for each kilometer traveled by these passengers.

Keywords: public bus transport; regional transport; energy consumption of public transport; modal split; transport exclusion

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1. Introduction

In many urban areas, public transport is currently an attractive alternative to private car use. However, it should be noted that individual car transport has significantly higher energy consumption per passenger-kilometer (pkm) compared to that for bus or rail public transport. As indicated by Pérez-Martínez and Sorba [1], traveling by car with one person results in energy consumption ranging from 0.33 kWh/pkm to 0.49 kWh/pkm, while a standard bus consumes from 0.11 kWh/pkm to 0.13 kWh/pkm. According to data published in the Odyssee-Mure project [2], this disparity decreased in 2020–2021 due to lower occupancy rates in public bus transport during the SARS-CoV-2 pandemic. Despite this, the European Union emphasizes the importance of reducing energy consumption in, among other things, road transport. Consequently, actions have been intensified, leading to the adoption of the new Directive 2023/1791 on energy efficiency and amending Regulation (EU) 2023/955 by the European Parliament and the Council [3]. The goal of these regulations is to reduce final energy consumption at the EU level, including in the transport sector. The mentioned measures for improving the energy efficiency of this sector include implementing strategies promoting, among other things, a shift from individual to public transport. According to the authors, in addition to introducing new, more environmentally friendly means of transport, it is also necessary to simultaneously take action to increase the attractiveness of public transport. It is also significant that this topic is increasingly considered in the context of public health [4,5]. For this purpose, passenger preference surveys [6] are frequently conducted. Based on the literature, public transport users most often pay attention not only to travel time and reliability [7] but also the frequency of connections [8–11]. In urban transport, the level of service on tram, bus, or metro lines is typically determined by the frequency of services, defined as the number of trips per hour or the length of the interval between trips in minutes (frequency). However, for regional transport, which has much lower passenger flows [12] and must adapt its service offer to more specific needs, especially regarding school and work hours [13,14], using the concept of frequency as the number of trips per hour or time interval between trips is not always justified. There are, of course, short time intervals on some regional lines where the frequency can be, for example, three trips per hour (primarily between 7:00 and 8:00 a.m.). Still, there can also be periods when there is no service for an hour or longer (off-peak or evening periods). In such cases, the more appropriate measure of frequency is the number of pairs of connections per day.

In Polish regional bus transport, a decline in the level of services offered, including the number of connections served, has been observed for many years, with a gradual reduction in the number of trips [15,16]. As a result, many so-called "white spots"—places no public transport can reach—have appeared on the map of Poland. In the literature [17,18], this phenomenon is referred to as "transport exclusion" or "mobility exclusion". According to E. Beyazit [19], it is defined as "the loss of a person's ability to connect with various places (e.g., work or services) that are necessary for full participation in society". This problem has deepened further due to the SARS-CoV-2 pandemic. This is because for many years, regional bus transport in Poland was not subsidized, except for compensation given to carriers for lost revenue due to state-defined discounts. Since 2019, there have been additional opportunities to fund the restoration of regular bus services with public funds. However, the large number of organizers, the low competence of employees responsible for organizing transport, the lack of regulations forcing cooperation between organizers, tariff and schedule integration, and the allocation of state budget funds only for a year have not led to significant changes in the number of passengers who use bus transport, except in a few places. One of the fundamental decisions that organizers must make when planning the launch of a bus line is determining the number of trips that will be made on a given line. This significantly impacts operating costs on the one hand and the potential shift from car to bus transport on the other. Hence, key questions arise:

1. How does the frequency of connections, expressed as the number of pairs of trips per day, affect the attractiveness of a regional bus line?
2. Can a higher number of trips attract more people to public transport, especially those who do not need to use public transport, such as adults commuting daily to work?
3. How does the structure of passengers change with an increase in the number of trips?

Finding answers to these questions will allow the development of a method for determining energy consumption benefits in regional passenger transport in further research. This article focuses on the first stage, answering the above questions based on research conducted on 27 regional bus lines in various regions of Poland.

This article consists of five parts: This first section presents the issue of energy consumption in passenger transport and the importance of the attractiveness of regional public transport. Section 2 contains a literature review on determining the attractiveness of public transport and research in regional transport. Section 3 presents the proposed methodology, describing individual stages and steps. The course of research and the practical application of the methodology are described in Section 4. The final part presents a discussion, conclusions, and directions for further work.

2. Literature Review

The problem of the attractiveness of public transport is a broad and multifaceted concept. Most commonly, transport attractiveness is evaluated based on passengers' feelings expressed in surveys, which can encompass both satisfaction and preference (expectations). Factors influencing the attractiveness of public transport can be considered from two perspectives [20]:

- Macroscopic: The urban spatial layout, land use patterns, geographical environment, level of economic development, demographic characteristics, public policy, and service characteristics of public transport.
- Microscopic: Travelers' individual characteristics, travel demand characteristics, travel characteristics, and the service level of public transport.

Currently, many researchers focus on issues related to transport attractiveness, which is associated with concepts such as travel satisfaction or the broader quality of public transport [7–9,21–24].

According to research by Sukhov et al. [22], from a passenger's perspective, travel satisfaction is not linked to individual characteristics defining the quality of transport services but rather a whole set of these characteristics. Moreover, the same level of satisfaction can be achieved with different configurations of these characteristics. In studies, the frequency of connections is important for all groups of surveyed passengers, whereas other features, such as speed or intramodality, are only important for some.

One study [9] identified the qualitative characteristics of public transport that determine its attractiveness for passengers and the ways in which these characteristics need be changed to encourage car drivers to use public transport. The authors divide the characteristics defining transport quality into physical characteristics (e.g., frequency, reliability, speed, and cost), which can be assessed based on their impact on passengers, and perceived ones (comfort, sense of security), which require interaction with passengers for measurement. Another study [9] indicated that characteristics such as reliability and frequency are crucial in determining interest in public transport and passenger travel satisfaction. Similar conclusions were drawn earlier by Zhang et al. [21], who studied factors affecting passengers' satisfaction with public transport. However, identifying significant features that must be met becomes more complex when considering the attractiveness of public transport for car users [9]. Public transport services must ensure a basic level of accessibility, reliability, competitive cost, effective speed [23], and technical efficiency [25] to be competitive with private cars.

One of the key factors influencing the quality of public transport is frequency [26,27]. The satisfactory value of frequency for passengers depends on several factors. Some researchers [24,28] indicated that increasing the frequency of services can positively impact the number of passengers, including by attracting new passengers who previously used cars, both in cities and rural areas where the quality of public transport services is often lower. However, it should be noted that improving service frequency can have a much greater effect on increasing passenger numbers than lowering ticket prices [29]. On the other hand, it is important to consider the threshold frequency value below which a particular type of public transport becomes unattractive. For example, Hensher [30] indicated that passengers rate a decrease in frequency below one trip every half hour very poorly.

An analysis of publications on passenger preferences in regional public transport [8] shows that this type of transport is still given little attention. In the analyzed publications, the most frequently considered category is accessibility (the range of services offered in terms of geography, types of transport, operating hours, and frequency). However, the authors point out that there is a lack of studies on the operational aspects of accessibility, such as the hours and frequency of service.

Most studies on public transport frequency concern cities (highly urbanized areas), where the frequency is much higher than in regional transport, with considered values ranging from four trips per hour to six trips per hour. These frequencies are unattainable in regional bus transport, especially in countries where this transport is either not or only minimally subsidized by public funds, as is the case in Poland.

Similarly, studies on the potential of regional transport are much less frequently conducted by researchers. Some sources describe using the gravity model to determine demand for transport services in different regions, e.g., Greece [31], Slovakia [32], and the Czech Republic [33,34]. There are also studies on timetable optimization in regional transport [35], timetable evaluation [36], and the service frequency between local government units in the Czech Republic [37]. The advantages of a cyclic timetable-based transport system in rural areas, based on Swiss experiences, are also highlighted [38]. Research on the relationship between demand and additional services during off-peak periods [12], changes in demand during peak and off-peak periods [13], and factors affecting modal split in commuting to European cities [39] is of particular interest with respect to this work. In [40], the authors analyzed the impact of various characteristics of public transport, including prices, frequency, and inhabitants' incomes, on changes in demand over several decades in all types of transport in Tunisia.

Publications related to transport in Poland include analyses of rural areas' accessibility to district towns in six regions [41], case studies of rail connections and parallel bus lines in Lower Silesia [42], and regional transport planning [43,44] for transport plans.

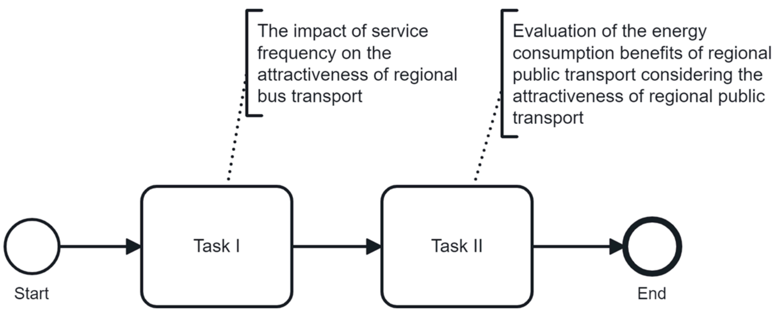
These works mainly concern transport-planning aspects, passenger preferences, and transport exclusion. Research and analyses on regional transport mainly rely on survey studies or national censuses, which contain general information but are rather limited in accuracy to larger areas (regions). It is difficult to find studies on actual demand and passenger flows between different locations and local regional centers at different times of the day or on the ticket structure used by passengers. The topic of transport preferences, as indicated by passengers in surveys of the most desired features a transport system should offer, is widely discussed. However, we could not find publications on the impacts of various features and factors related to regional transport and its surroundings on its actual use by different passenger groups and thus on the attractiveness of regional bus transport. This is significant because, ultimately, the attractiveness of a transport system is indicated by the number of passengers using it, especially those with alternative travel options.

3. Methodological Framework

Achieving the set goal required a step-by-step approach. A diagram of the procedure employed is shown in Figure 1a. The research work assumed two main tasks:

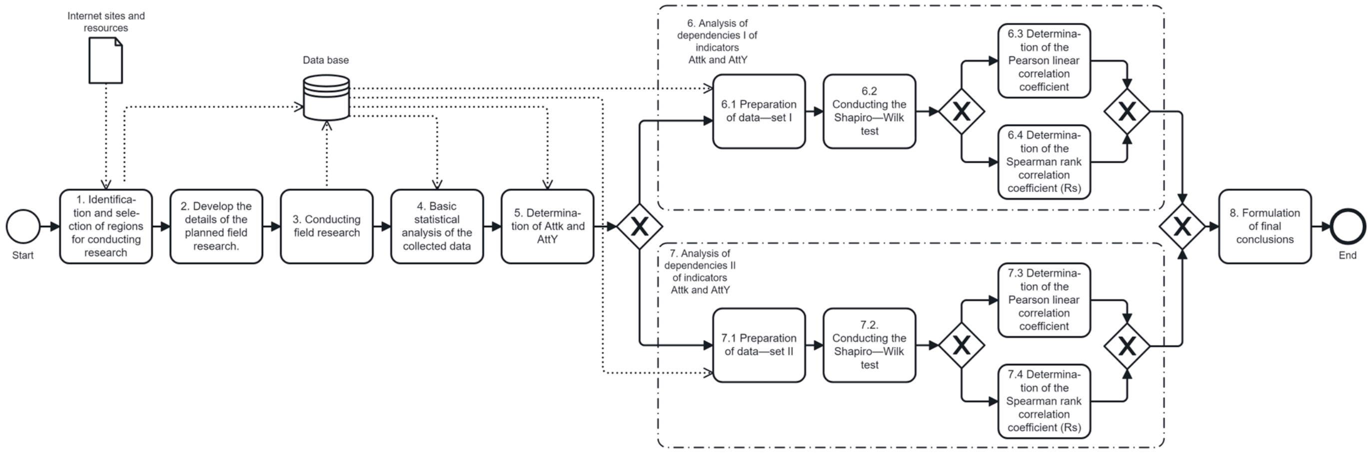
- Task I—study the impact of service frequency on the attractiveness of regional bus transport;
- Task II—assess the energy efficiency benefits of regional public transport while considering its attractiveness.

This article details Task I (Figure 1b), which consists of eight stages, two of which (Stages 6 and 7) include four steps each: preparing input data, conducting the Shapiro–Wilk test, determining the Pearson linear correlation coefficients, and determining the Spearman rank correlation.



(**a**)

Figure 1. *Cont.*



(**b**)

Figure 1. Concept of the methodology: (**a**) main stages; (**b**) steps in Stage I that are implemented and presented in the article.

In the first planned stage—the identification and selection of regions for research—it was assumed that information would be collected on regional bus transport services in a specific area (in this case, Poland). This is related to the specificity of this type of transport, as according to our previous studies, the main group of passengers is youth commuting to high schools [14] located in regional centers (district capitals). Moreover, these buses also cater to other, less numerous but significant groups, such as adults and seniors who use public transport occasionally and adults who regularly commute to work. The basic goal at this stage was to collect information from open sources (websites, reports, and travel planners). The result was the development of a database on regional transport services in the country.

The next task was to develop the details for the planned field research. Due to the lack of publicly available data on the number and structure of passengers, it was decided to conduct direct observations in regional buses. Additionally, a schedule and locations for these observations were planned. To ensure the highest possible comparability of the results, it was assumed that the observations would be conducted on weekdays, excluding Mondays and Fridays, and days before or after holidays.

Next, in Stage 3 of the proposed concept, field research was conducted, dividing passengers as follows:

- Three age groups: youth, adult, and senior;
- Ticket type: regular single ticket, discounted single ticket, monthly pass without discount, and discounted monthly pass (49%).

This division was based on the applicable Polish law, the Act of 20 June 1992, on entitlements to discounted travel on public collective transport [45].

It was assumed that field research would take the form of direct observations, where at each stop, the number of boarding and alighting passengers would be counted, and their structure and ticket type would be recorded (according to the previously presented division). The data would be recorded in an observation sheet.

Additionally, the following assumptions were made:

- The studies would be conducted on bus lines connecting the district seat with the commune seat and other localities within the administrative boundaries of the same district.
- Only bus lines that are the sole service for a given route would be included.

Based on the conducted field research, basic statistical analyses were planned (Stage 4), including the following:

- Determining the shares of individual passenger groups using public regional transport in 1 h time intervals;

- Determining the average number of passengers boarding per service in 1 h time intervals;
- Comparing the number of passengers boarding in the direction of the commune and the district in 1 h time intervals.

In the next step (5), the authors planned to calculate two indicators of transport attractiveness for a given locality:

- Adults and seniors—Att_K;
- Youth—$AttY_K$.

Both indicators allow for assessing the impact of service frequency in regional transport, expressed in the number of daily pairs of trips in locality *K*, on the attractiveness of this type of transport for different passenger groups. While the first indicator determines the attractiveness for adult passengers, who can often use other means of transport, especially individual transport, the second indicator refers to young people who cannot commute to high school by car.

For the Att_K indicator, the following formula was proposed (1):

$$Att_K = \frac{\sum_{i=1}^{n}\left[WSS_K\cdot\left(SS_{Ki}^{B}+SS_{Ki}^{A}\right)+WSA_K\cdot\left(SA_{Ki}^{B}+SA_{Ki}^{A}\right)+WMA_K\cdot\left(MA_{Ki}^{B}+MA_{Ki}^{A}\right)\right]}{P_K}, \quad (1)$$

The notations used above are defined below:

- *i*—the index of the service passing through locality *K* (round trip), where $i = 1, 2, 3, \ldots, n$, and *n* denotes all services passing through locality *K*;
- *K*—the locality index;
- *A*—the index of alighting passengers;
- *B*—the index of boarding passengers;
- SS_{Ki}^{A}—the number of seniors with single tickets alighting in locality *K* coming from the direction of the district [–];
- SS_{Ki}^{B}—the number of seniors with single tickets boarding in locality *K* coming from the direction toward the district [–];
- SA_{Ki}^{A}—the number of adults (excluding seniors) with single tickets alighting in locality *K* coming from the direction of the district [–];
- SA_{Ki}^{B}—the number of adults (excluding seniors) with single tickets boarding in locality *K* in the direction toward the district [–];
- MA_{Ki}^{A}—the number of adults (excluding seniors) with monthly passes alighting in locality *K* in the direction of the district [–];
- MA_{Ki}^{B}—the number of adults (excluding seniors) with monthly passes boarding in locality *K* in the direction facing the district [–];
- WSS_K—the weighting factor for the number of seniors (not included in the group of adults) with single tickets boarding and alighting in locality *K* [–], $WSS_K = 1$;
- WSA_K—the weighting factor for the number of adults (not included in the group excluding seniors) with single tickets boarding and alighting in locality *K* [–], $WSA_K = 2$;
- WMA_K—the weighting factor for the number of seniors (not included in the group of adults) with monthly tickets boarding and alighting in locality *K* [–], $WMA_K = 4$;
- P_K—the number of residents in locality *K*.

For the $AttY_K$ indicator, the following formula was proposed (2):

$$AttY_K = \frac{\sum_{i=1}^{n}\left[WSY_K\cdot\left(SY_{Ki}^{B}+SY_{Ki}^{A}\right)+WMY_K\cdot\left(MY_{Ki}^{B}+MY_{Ki}^{A}\right)\right]}{P_K}, \quad (2)$$

The notation used in the formula above is explained below:

- SY_{Ki}^{A}—the number of children and youth with single tickets alighting in locality *K* in the direction of the district [–];

- SY_{Ki}^{B}—children and youth with single tickets boarding in locality K in the direction toward the district [–];
- MY_{i}^{A}—the number of children and youth with monthly passes alighting in locality K in the direction of the district [–];
- MY_{Ki}^{B}—the number of children and youth with monthly passes boarding in locality K in the direction toward the district [–];
- WSY_K—the weighting factor for the number of children and youth with single tickets boarding and alighting in locality K [–], $WSY_K = 1$;
- WMY_K—the weighting factor for the number of children and youth with monthly tickets boarding and alighting in a given locality K [–], $WMY_K = 2$.

The remaining notation is the same as that in Formula (1).

The indicators Att_K and $AttY_K$ are calculated for localities K with access to a town whose functions and size qualify it as a local center of a given area. The basic amenities that such a town should provide are as follows:

- Secondary education (one or more high schools);
- Commerce (marketplace, large stores, and shopping malls);
- Employment concentration;
- Healthcare (health center, hospital, and laboratory);
- Entertainment (cinema or theater).

In Poland, such centers are usually district towns with populations ranging from 12,000 to 25,000.

Weighting factors $\mathrm{WSS_K}$, $\mathrm{WSA_K}$, and $\mathrm{WMA_K}$ in Formula (1) and $\mathrm{WSY_K}$ and $\mathrm{WMY_K}$ are based on the assumption that the higher the weight, the greater the possibility of using an alternative means of transport, such as a passenger car. The highest weight is for adults with monthly passes, but the lowest is for seniors with single tickets.

The next two stages, 6 (Dependency Analysis I) and 7 (Dependency Analysis II), involve determining the relationship between the transport attractiveness indicators Att_K and $AttY_K$ and the number of connections. Selected statistical methods were used for this purpose, with the first step being the preparation of two sets of input data.

- Set I for stage 6 (Step 6.1): For each locality K, the attractiveness indicators Att_K and $AttY_K$ are determined by the number of pairs of trips toward the town, the average number of adult passengers boarding and alighting in locality K, and the average number of children and youth boarding and alighting in locality K.
- Set II for stage 7 (step 7.1): The data from set I are aggregated into classes based on the number of round trips per day, and the attractiveness indicators Att_K and $AttY_K$ are recalculated for each class as weighted averages, using the locality population as the weight. This means that for each class, the attractiveness indicators are the sum for all localities of boarding and alighting passengers with respective weights divided by the total number of residents in all localities of that class.

Aggregating the data in Step 7.1 means that further analyses consider weighted transport attractiveness indicators for the following:

- Adults and seniors—Att^{wgh};
- Youth—$AttY^{wgh}$.

For Att^{wgh}, the following formula is proposed:

$$Att^{wgh} = \frac{\sum\limits_{K} P_K \cdot Att_K}{\sum\limits_{K} P_K}, \tag{3}$$

where the notation is the same as that in Formulas (1) and (2). The weighted travel attractiveness indicator for youth $AttY^{wgh}$ is calculated using the following formula:

$$AttY^{wgh} = \frac{\sum_{K} P_K \cdot AttY_K}{\sum_{K} P_K}, \quad (4)$$

where the notation is the same as that in Formulas (1) and (2).

Next, in Steps 6.2 and 7.2, the Shapiro–Wilk test is conducted, which, according to Guzik and Więckowska [46], allows one to arrive at the most accurate answer to whether the distribution of each variable is consistent with the normal distribution. The workflow is based on the status of the answer:

- If positive, proceed to Step 6.3 for Stage 6 or Step 7.3 for Stage 7—determining the Pearson linear correlation coefficients between variables with a normal distribution.
- If negative, proceed to Step 6.4 for Stage 6 or Step 7.4 for Stage 7—determining the Spearman rank correlation coefficients to examine the relationships between variables without a normal distribution.

The last stage (8) involves formulating conclusions based on Stages 1–7 (previously completed).

4. Implementation of the Research

4.1. Characteristics of the Research Areas

According to the methodology developed in Section 3 of this article, in Stage 1, regions where direct observations were possible due to public bus transport were identified. Publicly available information sources were used for this purpose: websites of carriers, local government units, and travel planners. As a result of the work in Stages 1 and 2, the research was selected and planned in 19 districts:

- Kolbuszowa District (powiat kolbuszowski);
- Zwoleń District (powiat zwoleński);
- Szczytno District (powiat szczycieński);
- Myszków District (powiat myszkowski);
- Wąbrzeźno District (powiat wąbrzeski);
- Przysucha District (powiat przysuski);
- Chełmno District (powiat chełmiński);
- Iława District (powiat iławski);
- Goleniów District (powiat goleniowski);
- Stargard District (powiat stargardzki);
- Włoszczowa District (powiat włoszczowski);
- Strzelin District (powiat strzeliński);
- Krotoszyn District (powiat krotoszyński);
- Kutno District (powiat kutnowski);
- Mielec District (powiat mielecki);
- Oborniki District (powiat obornicki);
- Lipno District (powiat lipnowski);
- Szamotuły District (powiat szamotulski);
- Chodzież District (powiat chodzieski).

The mentioned districts cover a total area of 17.6 thousand square kilometers, representing 5.6% of Poland's area. Considering the population, the area of the districts where the observations were made is inhabited by a total of 3.4% of Poland's population [47]. However, in the selected districts, over half of the people (54%) live in rural areas, where access to public transport is limited. For comparison, in Poland, this value is 40.5% [47]. The locations of these districts are shown in Figure 2.

The bus lines where the research was planned covered a total of 328 localities. Their size, expressed by the number of inhabitants, aggregated into seven classes, is shown in Table 1. For each class, the average number of inhabitants was calculated (inhs).

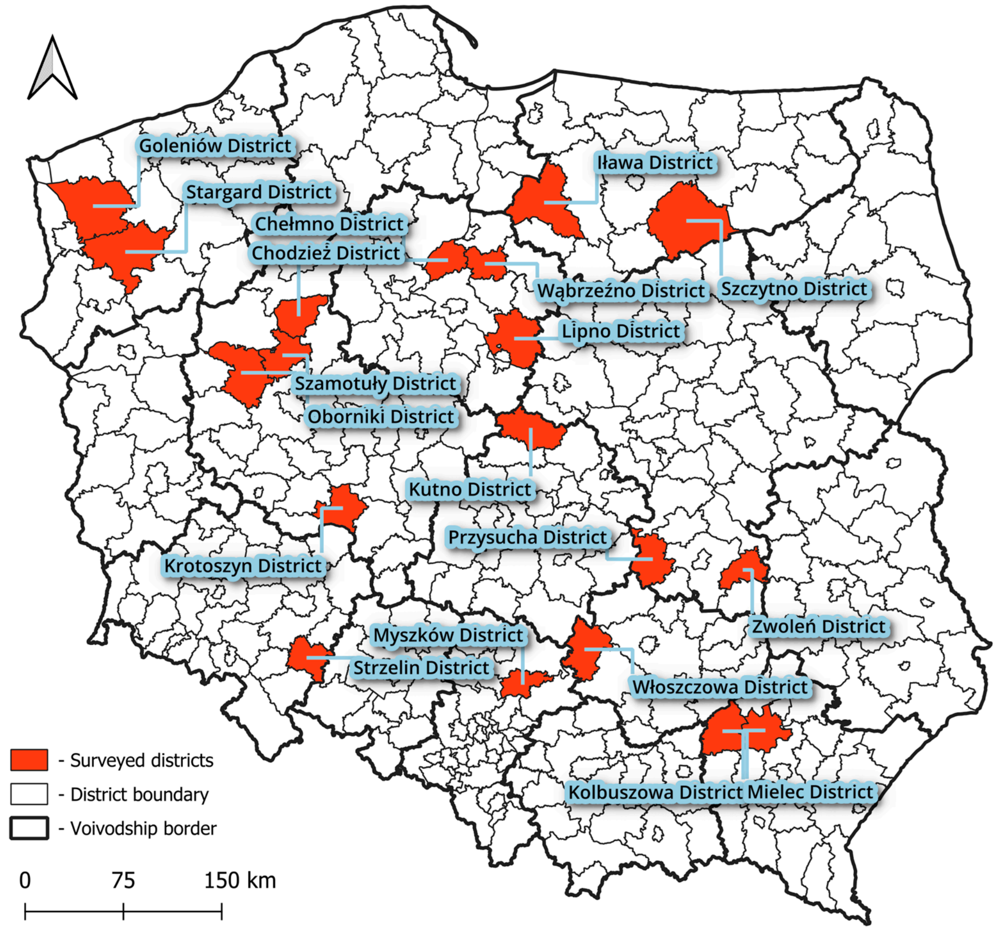


Figure 2. The districts where the research was conducted.

Table 1. The size structure of localities covered by the surveyed lines. Source: commune offices.

Class of Town Size [inhs]	Count	Share [%]	Average Town Size [inhs]
More than 10,000	16	4.9	26,259
Between 5000 and 9999	5	1.5	7745
Between 2000 and 4999	11	3.4	2932
Between 1000 and 1999	15	4.6	1449
Between 500 and 999	38	11.6	663
Between 100 and 499	187	57.0	260
Less than 100	56	17.1	61
Total	328	100.0	

By analyzing the size structures of the localities covered by the surveyed lines, the following conclusions can be drawn:

- Most localities (187) had between 100 and 499 inhabitants (57%);
- The fewest localities (5) had between 5000 and 9999 (1.5%);
- In the category of the largest localities (more than 10,000), there are only cities that are the seats of districts;
- In the second category (5000–9999), only one locality is not the seat of a district.

4.2. Limitations

Considering, on the one hand, the variable ridership from day to day and, on the other hand, the need to maintain comparability of research results on different lines, observations were carefully planned throughout a 3-month period. Due to the extensiveness of the research, only one observation of each connection was possible. Most observations took place from Tuesday to Thursday because these days have the lowest passenger fluctuations. However, in a few cases, for logistical reasons, it was necessary to conduct research on Mondays and Fridays. The research was conducted only during working days, excluding days right before and after holidays. Bus lines with no competing connections were selected for observation; however, in sporadic cases, there were other single parallel connections on part of the route.

In this study, only one factor influencing the attractiveness of public transport is considered (frequency). Still, there are other factors, like ticket prices, travel times, the number of cars per 1000 inhabitants, unemployment rate, etc. Multifactor analysis will be the subject of future research.

4.3. Observation Results

The travel direction and passenger structure research in regional bus transport (Stage 3) was conducted between 12 September and 1 December 2023, covering 27 bus lines connecting the district seats with the commune seats and other localities within the administrative boundaries of the same district.

A total of 6248 passengers were recorded during the study, for whom the travel structure is shown in Table 2.

Table 2. The number of passengers in individual groups on all surveyed lines.

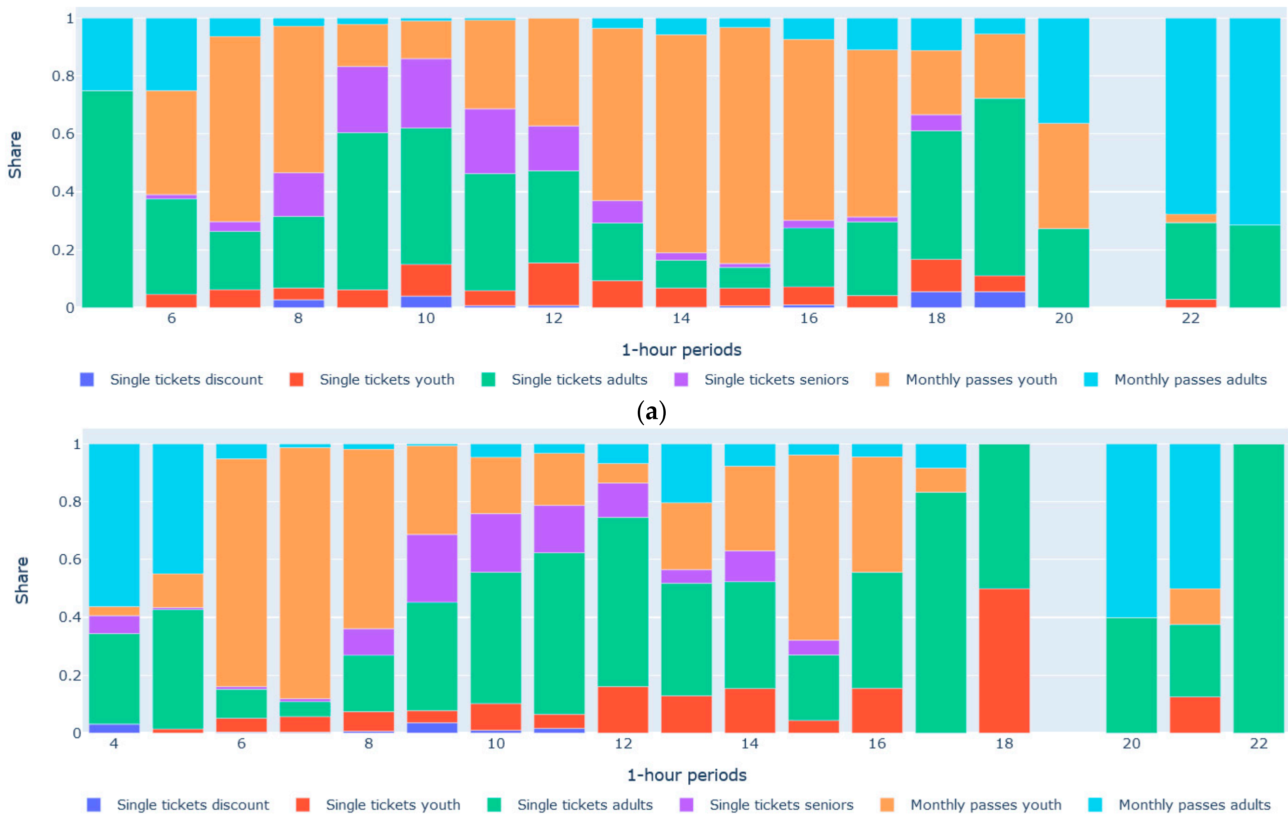
Description	Single Tickets				Monthly Passes		Total
	Discount	Youth	Adult	Senior	Youth	Adult	
Number [-]	36	407	1160	320	3955	370	6248
Ratio [%]	0.6	6.5	18.6	5.1	63.3	5.9	100.0

The main group of passengers consisted of children and youth with monthly tickets—amounting to about 63%. The second largest group of passengers (about 19%) was adults with single tickets. Youth with single tickets accounted for about 6.5% of passengers, and adults with monthly tickets accounted for about 6%. A slightly smaller group of about 5% was seniors with single tickets. To summarize, all young people, both with single and monthly tickets, constitute about 70% of all passengers. The remaining 30% are adults. About 70% of all passengers are regular users of regional bus lines holding monthly passes. It should be mentioned that none of the observed lines served the function of transporting people to primary schools, as this task is conducted by communes as separate transport for children. Hence, there is no separate category for children in this research; they are included in the youth group of passengers.

While Table 1 shows the passenger structure as an average for the entire day, Figure 3a,b show the changes in this structure in 1 h intervals throughout the day for the direction toward the commune and the district, respectively. Detailed data are provided in Tables A1 and A2.

Figure 3a shows that the largest share of students with monthly tickets to the commune, reaching 80%, is found between 14:00 and 15:59. This share is also high in the intervals of 13:00–13:59 and 16:00–17:59. In the evening hours, the share of passengers with normal monthly tickets commuting to work dominates. Adults with single tickets comprise the largest share in the morning and afternoon. In the direction of the district, the situation is reversed (Figure 3b): students with monthly tickets travel in the morning, with the highest (80%) share recorded in the interval of 7:00–7:59 and a slightly lower share in the intervals of 6:00–6:59 and 8:00–8:59, while adults with monthly tickets comprise the largest share early in the morning in the interval of 4:00–5:59. Adult passengers with single tickets comprise the largest share in this direction in the noon and evening hours. Seniors travel most frequently between 8:00 and 14:59 in both directions. The missing data for intervals

21:00–21:59 in Figure 3a and 19:00–19:59 in Figure 3b are related to the lack of bus services on all lines on which the research was conducted.



(**a**)

(**b**)

Figure 3. The share of individual passenger groups in time intervals: (**a**) toward the commune; (**b**) toward the district.

Figure 4a,b show the number of passengers boarding toward the commune and the district, as well as the average number of passengers boarding per trip in 1 h intervals.

The charts (Figure 4a,b) show that the most passengers (1283 people) boarded buses between 7:00 and 7:59 for travel toward the commune and between 15:00 and 15:59 for travel toward the district (832 people). However, slightly fewer were also in the previous time interval, i.e., 14:00–14:59 (702 people). Interestingly, the 14:00–14:59 interval had a higher value for the average number of passengers per trip than the 15:00–15:59 interval. This is because more bus trips took place in the latter interval. In the morning peak, travel toward the district prevails roughly until 9:59. Between 10:00 and 12:59, the numbers of passengers boarding in both directions are similar. After 13:00, travel toward the commune begins to dominate, except for the 21:00–21:59 interval, when trips to the district for the night shift take place. After 18:00, the number of passengers in both directions is the lowest for the entire day, which also results from the small number of connections at that time, as most carriers end service around 16:00–17:00. This is visible in the average number of passengers per trip in the evening hours. However, after 22:00, there is a fairly large increase in the number of boarding passengers and the average number of passengers per trip toward the commune due to returns from work from the afternoon shift, which most often ends at 22:00.

The smaller number of connections with a relatively high number of passengers boarding in the district's direction during 6:00–6:59 and 8:00–8:59 resulted in a fairly high average number of passengers in these intervals, which is not as noticeable in Figure 4. A similar situation occurred in the direction from the commune in the interval of 22:00–22:59;

the small number of connections resulted in high average numbers of passengers per trip, although the number of passengers was not as high as that at other times of the day.

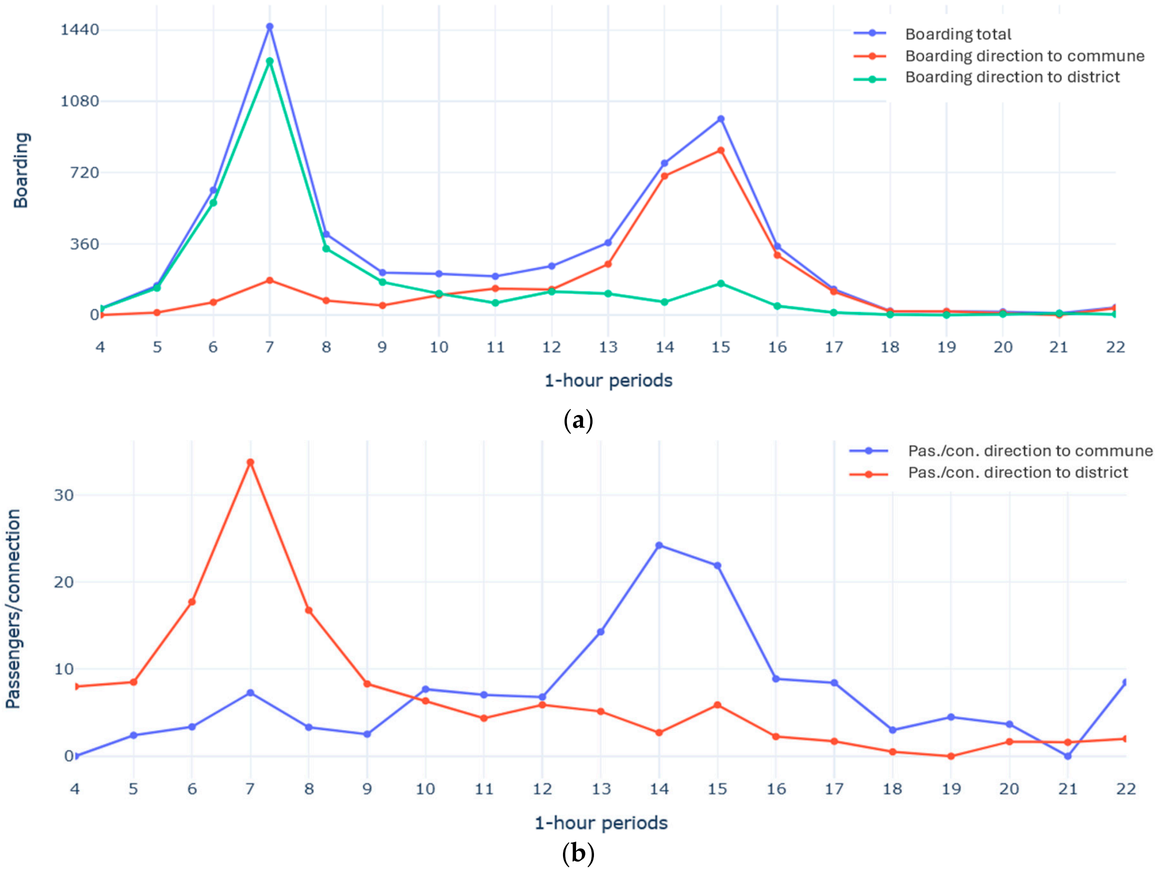


Figure 4. The number of passengers boarding in the direction of the commune and the district in time intervals: (**a**) total in all surveys; (**b**) average from all measurements.

The data on the number of passengers boarding during the afternoon peak, departing from the district town, are concentrated in the time interval corresponding to the scheduled departure time. In contrast, in the case of the morning commute to the district town, passengers gradually boarded in successive localities, and if the bus departed from them before 7:00, the passengers boarding there were assigned to the time interval 6:00–6:59. If arrival times in the district town were considered for the morning hours, then for the time interval 7:00–7:59, even higher values would be obtained at the expense of the 6:00–6:59 interval. The difference between the peak values in the morning and afternoon peak would also be greater.

4.4. Analysis of the Attractiveness Index

In accordance with the proposed methodology, in Step 5, the attractiveness indices Att_K (Formula (1)) and $AttY_K$ (Formula (2)) were determined. Subsequently, analyses of their dependence on the number of routes connecting this locality with the district seat were conducted (Stages 6 and 7). First, in Step 6.1, Data Set I was prepared. This set included a total of 296 localities, for which the following were also calculated:

- The average number of adults and seniors per trip—A_{trip}^{avg} [pax];
- The average number of children and youth per trip—Y_{trip}^{avg} [pax].

The determined index values for the selected localities, arranged in alphabetical order, are presented in Table 3. As can be observed, there is significant variability among the individual localities; e.g., the values for $AttY_K$ range from 0.000 to 0.389. This variability is due to the differing numbers of passengers boarding and alighting in each locality, as well as their age structure and the types of tickets the passengers held.

Table 3. A fragment of the data summary prepared in Step 6.1. Source: commune offices.

No.	Locality—K	Trips [-]	P_{trip}^{avg} [inhs]	Att_K [-]	$AttY_K$ [-]	A_{trip}^{avg} [pax]	Y_{trip}^{avg} [pax]
1	Bartlewo	9	250	0.144	0.114	1.056	1.611
2	Bartodzieje	8	510	0.000	0.034	0.000	1.313
3	Bebelno-Kolonia	7	408	0.077	0.042	1.692	1.308
4	Bebelno-Wieś	7	375	0.024	0.008	0.615	0.231
5	Bedlno	14	377	0.130	0.130	1.393	1.857
6	Bętlewo	8	251	0.000	0.068	0.000	1.125
7	Bielejewo	2	74	0.000	0.122	0.000	2.250
8	Binino	5	363	0.014	0.056	0.500	2.100
9	Bliżyce	2	542	0.004	0.041	0.667	7.333
10	Błachta	9	94	0.011	0.021	0.056	0.111
11	Bobolice	6	79	0.013	0.051	0.091	0.364
…	…	…	…	…	…	…	…
291	Zielonka	4	639	0.006	0.027	0.750	2.250
292	Żarki	30	4431	0.037	0.091	2.864	7.186
293	Żarnowo	1	355	0.000	0.014	0.000	3.000
294	Żąrnówko	1	81	0.000	0.000	0.000	0.000
295	Żdżary	7	277	0.000	0.000	0.000	0.000
296	Żychlin	23	7484	0.033	0.016	4.913	2.783
	Min	1	10	0.000	0.000	0.000	0.000
	Max	30	7484	0.201	0.389	5.000	25.000

Table 4, in turn, presents the results for Data Set II after its aggregation into classes of the number of pairs of trips. The individual calculated quantities are as follows:

- P_{trip}^{avg}—the average size of the locality in a given class of pairs of trips [inhs];
- occur—the number of occurrences [–];
- Att^{wgh}—the weighted attractiveness index of transportation for adults and seniors [–];
- $AttY^{wgh}$—the weighted attractiveness index of transportation for youth [–];
- PAS_{trip}^{avg}—the average number of passengers per trip overall [pax];
- PAS_{town}^{avg}—the average number of passengers boarding and alighting per locality overall [pax];
- A_{town}^{avg}—the average number of adults and seniors boarding and alighting per locality overall [pax];
- Y_{town}^{avg}—the average number of children and youth boarding and alighting per locality overall [pax].

The remaining notation is the same as that in Table 3.

In Table 4, classes not considered in the statistical analysis are marked in red. This pertains to the classes of the number of pairs of trips, 18, 23, and 30, because of the following:

- All these classes include single cases (one pair of trips—occur = 1);
- For 23 and 30, the number of inhabitants significantly deviates from the average number of inhabitants for other classes (23 trips—7484.0 [inhs]; 30 trips—4431.0 [inhs]).

In accordance with Step 6.2 of Stage 6, the Shapiro–Wilk statistical test was conducted while considering the following:

- The independent variable: the number of pairs of trips per day in a given locality (trips);
- The dependent variables: transportation attractiveness indices for adults and seniors (Att_K) and children and youth ($AttY_K$); the average number of adults and seniors per trip; and the average number of children and youth per trip (Y_{trip}^{avg}).

Table 4. Data set after its aggregation into classes of the number of pairs of trips.

No.	Trips [-]	P_{trip}^{avg} [inhs]	Occur [-]	Att^{wgh} [-]	$AttY^{wgh}$ [-]	PAS_{trip}^{avg} [pax]	A_{trip}^{avg} [pax]	Y_{trip}^{avg} [pax]	PAS_{town}^{avg} [pax]	A_{town}^{avg} [pax]	Y_{town}^{avg} [pax]
1	1	201.6	45	0.001	0.024	2.733	0.200	2.600	5	0	5
2	2	331.8	27	0.004	0.017	1.870	0.444	1.537	7	1	6
3	3	266.3	3	0.002	0.020	1.000	0.111	0.889	6	0	5
4	4	424.3	66	0.009	0.020	1.716	0.519	1.220	13	4	9
5	5	302.9	9	0.011	0.034	1.422	0.378	1.089	14	3	11
6	6	327.3	45	0.024	0.033	1.685	0.815	0.881	20	9	10
7	7	498.8	24	0.024	0.021	1.613	0.768	0.863	22	10	12
8	8	497.9	33	0.014	0.041	1.633	0.451	1.208	26	7	19
9	9	566.6	30	0.017	0.046	1.970	0.481	1.519	35	8	27
10	10	390.3	7	0.024	0.053	2.686	1.429	1.257	53	28	25
11	11	770.9	10	0.019	0.054	2.555	0.600	1.964	56	13	43
12	12	846.0	9	0.022	0.030	1.685	0.620	1.083	40	15	25
13	14	288.9	8	0.060	0.064	1.223	0.536	0.696	34	14	19
14	18	774.0	1	0.036	0.085	2.556	0.722	1.833	91	25	66
15	23	7484.0	1	0.033	0.016	7.696	4.913	2.783	354	226	128
16	30	4431.0	1	0.037	0.091	9.900	2.833	7.067	593	169	424
Min [1]	1	201.6	1	0.001	0.016	1	0.111	0.696	5	0	5
Max [1]	30	7484	66	0.06	0.091	9.9	4.913	7.067	593	226	424

[1] Values for all data from 1 to 16.

The results of the statistical analysis for this step for Data Set I are presented in Table 5 and Figure 5a–c. In Step 6.2, none of the variables were found to conform to a normal distribution. Therefore, to examine the relationships between the variables, Spearman's rank correlation coefficient, Rs, was used (until Step 6.4 in Stage 6).

Table 5. The summary of the relationships between the number of trips and the variables from Data Set I.

N = 296	Variable	R Spearman	t (N-2)	p
Trips &	Att_K	0.510	10.18	<0.001 [1]
	A_{trip}^{avg}	0.315	5.69	<0.001 [1]
	$AttY_K$	0.298	5.36	<0.001 [1]
	Y_{trip}^{avg}	−0.047	−0.81	0.418

[1] a statistically significant result.

Upon analyzing the results obtained in Steps 6.2 and 6.4, regarding the dependencies of the indices Att_K, $AttY_K$, and A_{trip}^{avg} on the number of trips, it becomes clear that the correlation coefficients marked ([1]) in Table 5 are significant. The strongest dependency on the number of trips is shown by index Att_K; the Spearman correlation coefficient, in this case, is +0.510, which means that the higher the number of pairs of trips per day, the higher the attractiveness index. Nonetheless, this dependency is moderate. Positive correlations are also shown by the indices $AttY_K$ and A_{trip}^{avg}, although the dependencies are weaker than those for Att_K. However, there is no correlation between the number of trips and the average number of children and youth per trip.

In the analysis of Data Set II (Step 7.2 of Stage 7), the following were considered:

- The independent variable: the number of pairs of trips per day in a given locality (trips);
- The dependent variables: weighted transportation attractiveness indices for adults and seniors (Att^{wgh}) and children and youth ($AttY^{wgh}$), the average number of adults per trip (A_{trip}^{avg}), the average number of children and youth per trip (Y_{trip}^{avg}), the average

number of adults boarding and alighting per locality (A^{avg}_{town}), and the average number of children and youth boarding and alighting per locality (Y^{avg}_{town}).

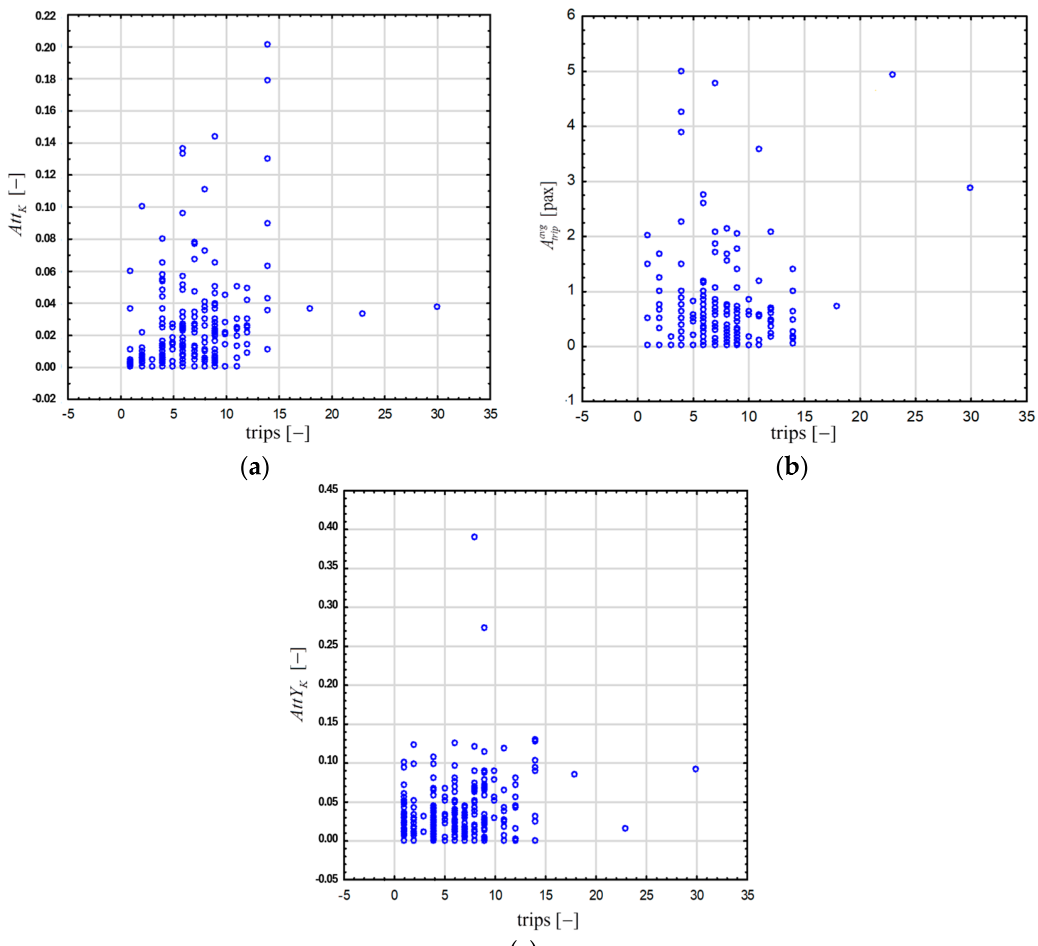


Figure 5. Dependency plots comparing (**a**) the transportation attractiveness index for adults and seniors (Att_K) and the number of trips; (**b**) the average number of adults and seniors per trip (A^{avg}_{trip}) and the number of trips; and (**c**) the attractiveness index for children and youth ($AttY_K$) and the number of trips.

Non-conformity with the normal distribution only occurred for the index Att^{wgh}. Therefore, to examine the dependencies on the number of trips, Spearman's rank correlation coefficient Rs was used (Step 7.4); the results are presented in Table 6 and Figure 6.

Table 6. The results of the statistical analysis for Data Set II—index Att^{wgh} (Step 7.4).

Variable	R Spearman	t (N-2)	*p*
Trips and Att^{wgh}	0.807	4.53	0.001 [1]

[1] a statistically significant result.

There is a strong positive correlation between the attractiveness index Att^{wgh} and the number of pairs of trips (Spearman's R coefficient of 0.807). This means the higher the number of trips, the higher the attractiveness index. The graph in Figure 6 also indicates that when the number of pairs of trips is below four per day, the attractiveness index is close to 0. Given this, one can conclude that public transportation for adults starts to become attractive when the number of pairs of trips per day is at least four.

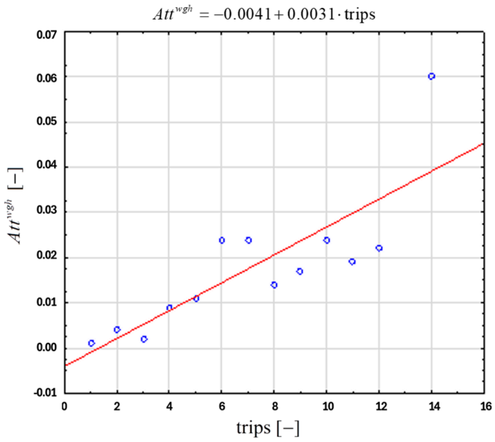


Figure 6. The dependency between the attractiveness index (Att^{wgh}) and the number of trips.

For the other dependent variables ($AttY^{wgh}$, A^{avg}_{trip}, Y^{avg}_{trip}, A^{avg}_{town}, and Y^{avg}_{town}), conformity with a normal distribution was observed. Therefore, Pearson's linear correlation coefficient r was used to examine the dependencies between these variables and the number of trips (Step 7.3); the results are shown in Table 7 and Figure 7a–c.

Table 7. The results of the statistical analysis for Data Set II—Step 7.3.

N = 13	Variable	r Pearson	t	p
Trips	$AttY^{wgh}$	0.813	4.63	0.001 [1]
	A^{avg}_{trip}	0.471	1.77	0.105
	Y^{avg}_{trip}	−0.346	−1.22	0.247
	A^{avg}_{town}	0.773	4.04	0.002 [1]
	Y^{avg}_{town}	0.783	4.17	0.002 [1]

[1] a statistically significant result.

Regarding the dependencies of the average number of adults per trip (A^{avg}_{trip}) and the average number of children and youth per trip (Y^{avg}_{town}), the obtained probability p value is above the accepted significance level of 0.05. Therefore, the correlation coefficients are insignificant. For the remaining variables, the correlation coefficients are significant; their dependency on the number of trips is shown in Figure 7a–c.

For the dependent variable $AttY^{wgh}$, the correlation coefficient r indicates a very strong positive dependency on the number of trips (r = 0.812). Strong dependencies on the number of trips were also observed for the average number of adults and seniors per locality A^{avg}_{town} (r = 0.773) and the average number of children and youth per locality Y^{avg}_{town} (r = 0.783).

The weighted transportation attractiveness index for adults and seniors Att^{wgh}, as well as the average number of adults and seniors per locality (A^{avg}_{town}), shows that for fewer than four trips, there is minimal interest in using public transportation. In contrast, for children and youth, the variables $AttY_K$ and Y^{avg}_{town} indicate some interest in public transportation even with just one pair of trips per day. This is because, on the studied bus lines, when there was a small number of pairs of trips (1–3 daily), the schedules were adjusted to the start and end times of high school classes.

For the dependencies that conformed to a normal distribution, linear regression equations could be determined, as shown in Figure 7a–c. Based on the equation for the dependency of the average number of inhabitants per locality (A^{avg}_{trip}) on the number of trips, for every increase of one trip, the number of adult passengers will increase by an average of 1.5. Assuming that the additional passengers switched from individual transportation to public transportation, the resulting reduction in energy consumption due to an increase of one trip is 0.33–0.69 kWh (the difference between the energy consumption of 1 km of travel by one passenger by car and by bus multiplied by 1.5) for each kilometer traveled by these passengers.

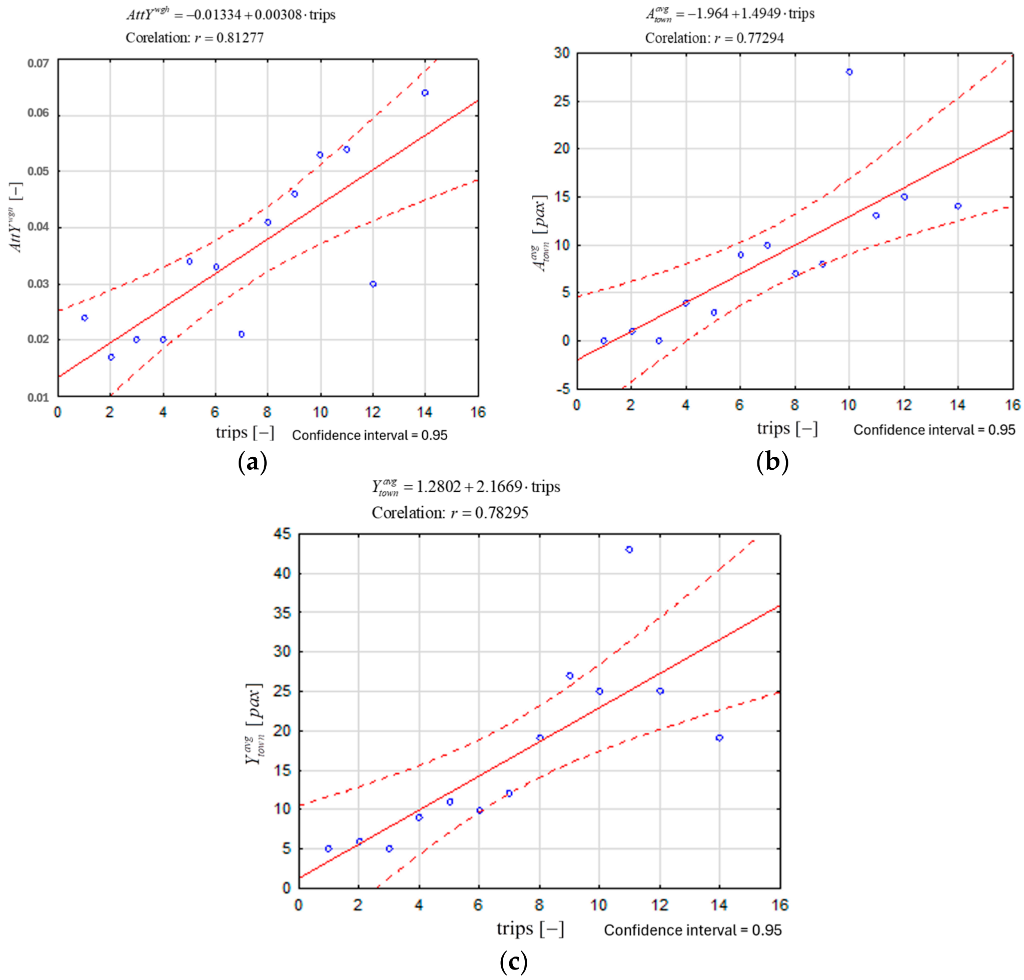


Figure 7. Dependency plots comparing (**a**) the weighted attractiveness index for children and youth ($AttY^{wgh}$) and the number of trips; (**b**) the average number of adults and seniors per locality (A_{town}^{avg}) and the number of trips; and (**c**) the average number of children and youth per locality (Y_{town}^{avg}) and the number of trips.

5. Discussion and Conclusions

This article presents Task I of the proposed approach for determining the potential energy consumption benefits based on the attractiveness of public transport by bus. Due to a lack of similar studies and analyses, it is difficult to compare the obtained results with those of other authors. Only the variability in the number of passengers throughout the day in the direction of a larger urban center and returns from it (shown in Figure 4a) is similar to what was described in [13]. The results presented in this article clearly indicate a strong correlation between the frequency of bus trips and the attractiveness of public transport for both adults and the group of children and youth. Such correlations, although obtained in a somewhat different and more general approach, are also indicated by experience and studies from countries where the policy of ensuring a high-quality public transport offer in rural areas, i.e., less urbanized areas, plays a significant role [12,38].

Although statistical analysis indicates there is a linear correlation for some variables that is dependent on the number of trips, it seems that the correlations are mostly nonlinear. After a certain number of connections is reached, further increases will cause a progressively smaller increase in the number of passengers, both adults and children and youth. In the studies, the maximum number of pairs of trips per day was 16 (excluding the discarded single cases for 18, 23, and 30 pairs of trips in Data Set II) due to the limited possibility of finding lines with a larger number of trips operating under similar conditions in Poland (outside of large agglomerations).

Due to the poor transport offer of regional transport in Poland, in most cases, it was possible to identify bus lines that were the only ones serving a given transport corridor and the analyzed localities. In other countries with better-developed regional transport, there are many localities with alternative attractive travel options to other significant urban centers, attracting residents of smaller localities.

Due to the conducted studies and the proposed approach, the authors believe that it is possible to determine the benefits related to the energy consumption of travel provided by regional public transport compared to individual car travel. In this case, the focus was on factors related to the attractiveness of public transport, which affects the number of passengers, especially adults, who often have an alternative option for individual transport.

The studies also found that the size of the district town influences the number of passengers. However, further analytical work is required to verify this. Similarly, dependencies on other factors, such as the distance of a given locality from the district town, travel time, ticket price, unemployment rate, income level of residents, or the motorization rate in the region, also need to be considered.

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Data Availability Statement: The datasets presented in this article are not readily available because the data are part of an ongoing study. Requests to access the datasets should be directed to wojciech.miechowicz@doctorate.put.poznan.pl.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Passenger share and number in individual groups in time intervals in the commune's direction.

Hours	Single Tickets [%] and [–]			Monthly Passes [%] and [–]			Total [%] and [–]
	Discount	Youth	Adults	Seniors	Youth	Adults	
4:00–4:59	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)
5:00–5:59	0.0 (0)	0.0 (0)	75 (9)	0.0 (0)	0.0 (0)	25 (3)	100.0 (12)
6:00–6:59	0.0 (0)	4.7 (3)	32.8 (21)	1.6 (1)	35.9 (23)	25 (16)	100.0 (64)
7:00–7:59	0.0 (0)	6.3 (11)	20 (35)	3.4 (6)	64 (112)	6.3 (11)	100.0 (175)
8:00–8:59	2.7 (2)	4.1 (3)	24.7 (18)	15.1 (11)	50.7 (37)	2.7 (2)	100.0 (73)
9:00–9:59	0.0 (0)	6.3 (3)	54.2 (26)	22.9 (11)	14.6 (7)	2.1 (1)	100.0 (48)
10:00–10:59	4.0 (4)	11.0 (11)	47.0 (47)	24.0 (24)	13.0 (13)	1.0 (1)	100.0 (100)
11:00–11:59	0.8 (1)	5.2 (7)	40.3 (54)	22.4 (30)	30.6 (41)	0.8 (1)	100.0 (134)
12:00–12:59	0.8 (1)	14.7 (19)	31.8 (41)	15.5 (20)	37.2 (48)	0.0 (0)	100.0 (129)
13:00–13:59	0.0 (0)	9.3 (24)	19.8 (51)	7.8 (20)	59.5 (153)	3.5 (9)	100.0 (257)
14:00–14:59	0.1 (1)	6.7 (47)	9.5 (67)	2.6 (18)	75.4 (529)	5.7 (40)	100.0 (702)
15:00–15:59	0.6 (5)	6.1 (51)	7.2 (60)	1.3 (11)	81.5 (678)	3.3 (27)	100.0 (832)
16:00–16:59	1.0 (3)	6.3 (19)	20.2 (61)	2.7 (8)	62.6 (189)	7.3 (22)	100.0 (302)
17:00–17:59	0.0 (0)	4.2 (5)	25.4 (30)	1.7 (2)	57.6 (68)	11.0 (13)	100.0 (118)
18:00–18:59	5.6 (1)	11.1 (2)	44.4 (8)	5.6 (1)	22.2 (4)	11.1 (2)	100.0 (18)

Table A1. *Cont.*

Hours	Single Tickets [%] and [–]			Monthly Passes [%] and [–]			Total [%] and [–]
	Discount	Youth	Adults	Seniors	Youth	Adults	
19:00–19:59	5.6 (1)	5.6 (1)	61.1 (11)	0.0 (0)	22.2 (4)	5.6 (1)	100.0 (18)
20:00–20:59	0.0 (0)	0.0 (0)	27.3 (3)	0.0 (0)	36.4 (4)	36.4 (4)	100.0 (11)
21:00–21:59	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)
22:00–22:59	0.0 (0)	2.9 (1)	26.5 (9)	0.0 (0)	2.9 (1)	67.7 (23)	100.0 (34)
23:00–23:59	0.0 (0)	0.0 (0)	28.6 (2)	0.0 (0)	0.0 (0)	71.4 (5)	100.0 (7)

Table A2. Passenger share and number in individual groups in time intervals in the district's direction.

Hours	Single Tickets [%] and [–]			Monthly Passes [%] and [–]			Total [%] and [–]
	Discount	Youth	Adults	Seniors	Youth	Adults	
4:00–4:59	3.1 (1)	0.0 (0)	31.3 (10)	6.3 (2)	3.1 (1)	56.3 (18)	100.0 (32)
5:00–5:59	0.0 (0)	1.5 (2)	41.2 (56)	0.7 (1)	11.8 (16)	44.9 (61)	100.0 (136)
6:00–6:59	0.4 (2)	4.8 (27)	10.1 (57)	0.9 (5)	78.8 (447)	5.1 (29)	100.0 (567)
7:00–7:59	0.3 (4)	5.4 (69)	5.1 (66)	1.0 (13)	86.9 (1115)	1.3 (16)	100.0 (1283)
8:00–8:59	0.6 (2)	6.9 (23)	19.4 (65)	9.3 (31)	62.1 (208)	1.8 (6)	100.0 (335)
9:00–9:59	3.6 (6)	4.2 (7)	37.4 (62)	23.5 (39)	30.7 (51)	0.6 (1)	100.0 (166)
10:00–10:59	0.9 (1)	9.3 (10)	45.4 (49)	20.4 (22)	19.4 (21)	4.6 (5)	100.0 (108)
11:00–11:59	1.6 (1)	4.9 (3)	55.7 (34)	16.4 (10)	18.0 (11)	3.3 (2)	100.0 (61)
12:00–12:59	0.0 (0)	16.1 (19)	58.5 (69)	11.9 (14)	6.8 (8)	6.8 (8)	100.0 (118)
13:00–13:59	0.0 (0)	13.0 (14)	38.9 (42)	4.6 (5)	23.2 (25)	20.4 (22)	100.0 (108)
14:00–14:59	0.0 (0)	15.4 (10)	36.9 (24)	10.8 (7)	29.2 (19)	7.7 (5)	100.0 (65)
15:00–15:59	0.0 (0)	4.4 (7)	22.6 (36)	5.0 (8)	64.2 (102)	3.8 (6)	100.0 (159)
16:00–16:59	0.0 (0)	15.6 (7)	40 (18)	0.0 (0)	40 (18)	4.4 (2)	100.0 (45)
17:00–17:59	0.0 (0)	0.0 (0)	83.3 (10)	0.0 (0)	8.3 (1)	8.3 (1)	100.0 (12)
18:00–18:59	0.0 (0)	50 (1)	50 (1)	0.0 (0)	0.0 (0)	0.0 (0)	100.0 (2)
19:00–19:59	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)
20:00–20:59	0.0 (0)	0.0 (0)	40.0 (2)	0.0 (0)	0.0 (0)	60.0 (3)	100 (5)
21:00–21:59	0.0 (0)	12.5 (1)	25 (2)	0.0 (0)	12.5 (1)	50.0 (4)	100.0 (8)
22:00–22:59	0.0 (0)	0.0 (0)	100 (4)	0.0 (0)	0.0 (0)	0.0 (0)	100.0 (4)
23:00–23:59	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)	– (0)

Table A3. The number of passengers boarding and the average number of passengers per trip in the direction of the commune and district in individual time intervals.

Hours	Direction to Commune (Gmina)		Direction to District (Powiat)	
	Boarding Passengers	Passenger/Connection	Boarding Passengers	Passenger/Connection
4:00–4:59	0	0.00	32	8.00
5:00–5:59	12	2.40	136	8.50
6:00–6:59	64	3.37	567	17.72
7:00–7:59	175	7.29	1283	33.76
8:00–8:59	73	3.32	335	16.75
9:00–9:59	48	2.53	166	8.30
10:00–10:59	100	7.69	108	6.35
11:00–11:59	134	7.05	61	4.36
12:00–12:59	129	6.79	118	5.90
13:00–13:59	257	14.28	108	5.14
14:00–14:59	702	24.21	65	2.71
15:00–15:59	832	21.89	159	5.89
16:00–16:59	302	8.88	45	2.25
17:00–17:59	118	8.43	12	1.71
18:00–18:59	18	3.00	2	0.50
19:00–19:59	18	4.50	0	0.00
20:00–20:59	11	3.67	5	1.67

Table A3. *Cont.*

Hours	Direction to Commune (Gmina)		Direction to District (Powiat)	
	Boarding Passengers	Passenger/Connection	Boarding Passengers	Passenger/Connection
21:00–21:59	0	0.00	8	1.60
22:00–22:59	34	8.50	4	2.00
23:00–23:59	7	3.50	0	0.00

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