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Activities Related to an Electromobility Strategy as a Part of Low Carbon Energy Transition: A Survey in Polish Communes

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Abstract: The aim of this article is to diagnose the situation of electromobility in local government units of Polish municipalities. Besides the main features of the communes, the issue of type of strategy that is being built was raised, what are the trends in this respect, and how public transport fits into them? The empirical basis was a survey conducted in 2020 using the CAWI (computer assisted web interview) method, covering all 2477 communes in Poland. Responses were received from 2230 municipalities (90% response rate). Based on the statistical analysis, the main conclusion is that rural communes are less willing to implement the electromobility strategy, but if they decide to do so, they develop long-term strategies. Another conclusion is that the amount of budget revenue per capita does not affect decisions on building an electromobility strategy. Also, a general tendency in Poland is an increase in the propensity to invest in electromobility, mainly in infrastructure for users, compared to public transport and electric buses. The main implication of the study is that Polish public authorities now have background information regarding the theme that can be useful in developing guidelines for local electromobility strategy implementation.

Keywords: electromobility; low carbon energy; local governments; survey; questionnaires

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1. Introduction

One of the less frequently analyzed factors in the conversion to a low carbon economy is the activity of local municipalities, even if local municipalities play a relevant role in decisions regarding the energy transformation on a basic level. One such decision is the implementation of electromobility [1]. For example, in Sweden, among six primitive scenarios of energy saving in urban transportation, the use of electric car technology was demonstrated to be the second most effective. The most effective was doubling the existing seat occupancy. In short, in a combined strategy, electromobility can help to reduce fuel consumption while simultaneously increasing the number of passengers, which resulted in the reduction in energy usage per passenger per kilometer and at the same time the reduction in greenhouse gas generation in cities [2].

In spite of the need to put into effect electromobility strategies and legal standards, up to now there has been little research validating the adopted solutions in practice in public entities, particularly at the local government level [3]. Local strategic actions in electromobility are essential to achieve a long-term reduction in the carbon footprint, mainly combined with local programs for wind [4] and solar [5] energy. To bridge this research gap, with a specific focus on Poland, the purpose of this article is to diagnose the situation of

electromobility in local government units of Polish municipalities. The main element of the diagnosis was the development of an electromobility strategy by a given local government. The development and adoption of such a strategy are determinants of the willingness and will to make changes. The research method is a survey.

Several factors motivate the choice of the theme and the research strategy. There is insufficient research about electromobility at the local government level in Poland. To the best of our knowledge, the standing literature on the matter lacks information concerning Polish municipalities in effecting an electromobility policy, and evidence on whether such a policy applies in practice and what it entails. Furthermore, to the best of our knowledge, there is no consistent data on drivers or barriers to electromobility strategies implemented by the local government. The main factors determining the adoption of such strategies were whether a given self-government has a rural or urban character and the wealth of a given self-government measured by budget revenues per commune inhabitant. Another motivation of the research is to check whether the nature of the commune can influence the type of strategy.

The main technology relies on a questionnaire conducted among Polish municipalities in 2020, followed by statistical analysis. The research also comprises a literature review and investigation of legal acts on electromobility in local government units which entered into force on 1 January 2022. To bridge the research gap, the article poses two research questions:

RQ1: Is the scope and scale of activities related to the development of electromobility different in particular types of municipalities? and

RQ2: What types of activities related to the development of electromobility were undertaken by municipalities in the period covered by the survey?

The survey tests hypotheses derived from RQ1 and RQ2:

Hypothesis 1 (H1). *The type of community influences having or not an electromobility strategy;*

Hypothesis 2 (H2). *The budget revenue per capita of a community influences having or not having an electromobility strategy;*

Hypothesis 3 (H3). *The type of community influences the type of electromobility strategy (individual, short-range; public, mid-range; collective, long-range);*

Hypothesis 4 (H4). *The intention of municipalities to invest in electromobility changed in the last four years; and*

Hypothesis 5 (H5). *The intention of municipalities to buy electric buses changed in the last four years.*

The rest of the article comprises a background section including a literature review on clean energy, public transportation and electromobility, along with the duties of local governments. It also includes sections describing the research approach and data sources, the results of the survey, and a final section with conclusions.

2. Background

2.1. Perspectives of Energy Reduction in Public Transportation: Electromobility

Climate change and shortages of raw material, combined with the uncertainties of the extension of the useful life of natural resources, are motivations for changing consumer behavior. According to the World Energy Outlook 2021 statistical review, oil reserves already mapped can meet the current consumption for roughly 50 years or even less. However, the energy transition affects oil and gas investment [4]. Alternative fuel engines are increasingly replacing fossil fuel engines, both due to depletion of natural reserves and damage to the environment. In the case of electric motors, it should be noted that the energy required should ideally come from renewable sources, such as wind [5] and

solar [6], to ensure low GHG production. Such considerations embody the concept of electromobility [7].

Electromobility is a highly interconnected branch of industry that focuses on meeting mobility needs from a sustainability perspective and, at the same time, on economically produced vehicles using electric motors. The degree of electrification, that is, the functions supported by electric power, may vary according to the model, which increases flexibility and empowers the transport sector as electric vehicles can use different types of energy sources [8]. Furthermore, the introduction of electric vehicles to the mass market is associated with an increased demand for resources, e.g., the use of lithium in lithium-ion batteries for electric vehicles, which can rise significantly in the coming years due to the increasing production of electric vehicles [9].

In the meantime, authorities all over the world have been emphasizing the development of electromobility by introducing new legal regulations. With the Paris Climate Agreement in force, the EU is committed to a global transition toward a low carbon economy. In addition, the European Union has underpinned the goal of climate neutrality by 2050 under the European Green Deal, according to the written statement made by the European Union (EU) Commission. The Commission aims to reduce carbon emissions by at least 55% by 2030 and to 0% by 2050. Other goals are to increase the share of renewable energy to 40% of the total electricity production in EU countries by 2030, promote the growth of the market for zero- and low-emission vehicles, and ensure appropriate infrastructure to charge vehicles [9]. So far, reductions in GHG emissions have been implemented in two blocks using emissions trading-EUETS, a centrally managed mechanism for electricity, industry, aviation and sectors outside of emissions trading, including transportation.

Member States are responsible for meeting the targets. In the communication entitled the "European Green Deal", the European Commission requires the reduction in GHG emissions in the European territory until achieving climate neutrality in 2050. The transportation sector has a prominent role in bridging the challenge. In Poland, the sector accounts for 24% of the amount of CO_2 emissions. Between 2005 and 2017, Polish transportation increased emissions by 76%, while the EU decreased them by 3%. In addition, from 2026 on, road transportation companies will be charged by emissions trading, which will put a price on pollution. Such a charge intends to drive companies to employ alternative fuels and invest in clean technologies [10].

Statistical forecasting reported by the 2018 United Nations "World Urbanization Prospects" state that 70% of the global population would live in cities by 2050, which reinforces the recommendation of the European Commission to urban governments to consider sustainable goals in their mobility strategies [11]. Reinforcing the importance of local municipalities in leading low carbon emission transformations, researchers from the Aarhus University in Denmark stated that most local governments have the key tools and financial means to successfully execute energy innovations [12]. A study with Swedish local authorities that implemented sustainable clean energy policy and innovative tools reinforces the importance of local government in low carbon strategies [13]. The study comprised three specific areas: actions undertaken by municipalities towards citizens and the business environs, undertakings of municipalities for collaboration with other entities, and challenges related to such activities.

Several studies and reports focus on the role that the nature of local communes and government can play in electromobility. Studies carried out in Japan indicate the advantage of urbanized areas over rural ones regarding low carbon targets. Municipalities promote the concentration of services in the so-called urban function induction-encouraged areas (UFIA), reducing the demand for transportation. In such areas, the greater the level of concentration, the less need for transportation [14].

Spanish studies also confirm that it is not uncommon for municipalities, metropolitan areas, and cities to implement efforts to introduce intelligent management systems, including traffic management. An example is a platform based on the UNE 178104 standard, providing a holistic architecture integrating information from various urban planning

processes implemented in the city of Vitoria-Gasteiz in Spain [15]. On the other hand, another study shows that changes in electromobility may be limited by parallel demographic developments, population distribution in suburban areas, and the growth of road infrastructure [16]. Differences in the challenges posed by urban and rural areas affect the type of economic decisions regarding electromobility, especially in public transportation. Deciding on electric buses may be largely based on economic and technological considerations [17].

A study in Poland [18] observed that small municipalities, mostly rural self-governments, allot more financial means per capita than large cities towards introducing modern-day solutions in climate and energy policy implementation. Naturally, it is the low population density in rural areas that contributes to such a result. In some cases, local heads allocate quite a lot more funds per capita than city mayors and presidents. In the case of energy innovations in transportation, rural communes invested the most financial resources per capita than other types of entities. In cities, an average of PLN 118.33 per capita was spent in 2020 on acquiring low- and zero-emission transportation equipment and installations, such as advanced traffic management systems, public transportation, vehicle sharing systems, and the advancement of energy efficient and low-emission transportation. Lower financial outlays in this regard were incurred in urban–rural communes (PLN 10.91 per person), mostly for the creation of bicycle lane infrastructure or the expansion of car parks at railway stops in the park-and-ride system. No investments in this area were carried out in the analyzed rural communes. As many as 63% of the studied municipalities did not incur costs for energy innovations in transport. This was because rural communes do not have their own public transport companies and, as a coordinator of public transport systems, they contract out to private entities or adjacent municipalities. Moreover, in rural areas, there remains a low accessibility of cycling infrastructure [18].

Other analysis shows that electromobility is the outcome of a mixture of economic, urban, social, and technological characteristics. Zero- or low-emission buses are more common in big cities. One further factor which impacts the implementation of electromobility is the proximity to the site of low-emission bus manufacturers. An investment in low-emission buses should take into consideration an answer to the problem of whether low-emission vehicles are typified by a greater or lesser loss of value in relation to the vehicles with conventional power [19].

Research also confirms that by the implementation of electric cars in Poland, the following aspects should be considered: the specific nature of the Polish economy, its energy system, the situation with its infrastructure, and actual social needs [20].

Other than published studies, the local official strategic documents also play an important role in assessing the innovativeness of municipalities regarding transportation and energy policies. The largest number of strategic documents devoted exclusively to climate and energy policy was found in municipalities (85.7%). In other municipalities, energy policy has been included as an additional priority in the overall local development strategy. In rural municipalities, over 60% adopted strategic action plans for sustainable energy policy. In the remaining local governments, the problems of climate and energy policy belonged to another strategic document. In urban–rural communes, every tenth local government failed to include activities related to the energy transformation in the strategy, and in only half, a separate document concerning climate and energy policy was created [18].

Although the purpose of [18] is quite different, on the one hand, it can be a supplement and, on the other hand, a polemic. While [18] based their observations on the analysis of 30 local governments, the currently presented research covered all local governments in Poland, and their results do not coincide with previous findings.

2.2. Institutional Background: Public Attributes and Prerogatives of Polish Local Government Units Regarding Electromobility

In Poland, public administration functions on two levels: the state and territorial self-government. The state oversees its territory, establishes legislation, ensures public

security, manages the economic matters, guarantees minimum sustenance for its citizens, as well as establishes and provides financial support of higher education institutions, theatres, and national museums.

Local government is divided into three tiers: municipalities (gmina), districts (powiat), and regions (województwo). As of 31 December 2019, there were 16 regions, 314 districts, and 2477 municipalities. The municipality is the elementary unit of the local government; the districts exceed the competencies of municipalities, while regions are beyond both. The levels of local government are independent of each other and are financed via different sources.

There are three types of municipalities in Poland: urban, comprising towns; rural, comprising villages; and urban–rural, comprising towns and the adjacent villages. Some of the urban municipalities are given a specific status of cities with district rights: one administrative center executes the tasks of both the municipality and the district simultaneously. Cities which have district rights do not constitute a separate level of local government and are still categorized as municipalities.

Out of all the municipalities, 302 are urban, including 66 cities with district rights, 638 are urban–rural, and 1537 are rural municipalities. Our study concentrates on municipalities, including cities, which have district rights. All municipalities complete the same obligatory tasks and have the same sources of income, however their financial standing is different for reasons that are objective, such as the number of residents, and not for legal status [21].

In Poland, the main document that shapes the state policy on electromobility is the "Strategy for Responsible Development" [19] adopted in 2017. Based on this strategy, the Electromobility Development Program was introduced. The Program assumes activities in five areas: changing the awareness of potential users, developing a system of benefits for the user of an electric vehicle, developing manufacturers in the electromobility segment, regulatory changes conditioning the development of electromobility, and adjustment of the power grid system.

The implementation of the Electromobility Development Program was divided into stages. Stage I (2016–2018) was preparatory. Conditions were created for the development of electromobility on the regulatory side. Among other things, tools for the integration of electric vehicles into the grid were proposed and instruments for the development of charging infrastructure were identified to accelerate the process of its construction. It was also the phase of implementation of pilot programs aimed at increasing the interest of society in electromobility and thus changing people's awareness in this respect. A system of incentives for the purchase of an individual, company, or public vehicle was tested.

Stage II (2019–2020) provided for the compilation of a catalog of good practices of public communication on electromobility. The topic of the sustainable use of transport was introduced into the core curriculum of the school and early childhood education. It was taken on to increase the interest in electromobility of local government units, including municipalities. Construction of electric vehicle supply infrastructure has been started.

Stage III (planned for 2020–2025) assumes increasing awareness to such an extent that the popularity of electric cars in households and public transport will lead to the creation of a fashion for ecological transportation, which will naturally stimulate demand. The built charging infrastructure will be an additional pro-demand factor. It is assumed that the infrastructure will be developed to be able to power 1 million electric vehicles. It is also assumed that public administration, including municipalities, will use electric vehicles in their fleets, while making charging infrastructure available to residents to further popularize electromobility [20].

In Poland, public entities must use low-emission transportation. According to [20], local government units, except for municipalities and districts whose population does not exceed 50,000, must provide city transportation services by employing a fleet of at least 30% of zero-emission buses, namely electric or natural gas vehicles. Public entities should also ensure that the share of electric vehicles of service providers must equal or exceed 30%

of the total number of vehicles. The legislator assumed the target achievement of 30% in the scope of the aforementioned stages, as presented in Figure 1.



Figure 1. The obligation of entities performing public tasks to use low-emission means of transport in municipalities with more than 50,000 inhabitants.

Furthermore, the Art. 76 of [20] determines that all contracts concluded by local government entities with more than 50,000 people involving public attributions and resulting from acts on the municipal government and the district government (except for collective transportation), that does not comply with the limitations regarding electric or natural gas vehicles, must expire by operation of law on 31 December 2022. Examples of contracts subject to expiration are the collection of municipal waste, maintenance, and care of greenery, water supply, collection of liquid waste, as well as social services such as health protection, social assistance, care and education, culture, and physical culture.

Another obligation of municipalities defined by law is the guidelines for a network of charging points for electric vehicles. By 31 December 2020, the minimum number of charging points installed in publicly accessible charging stations located in municipalities was:

A total of 1000 in municipalities with more than 1,000,000 inhabitants, where at least 600,000 motor vehicles have been registered and there are at least 700 motor vehicles per 1000 inhabitants;

A total of 210 in municipalities with more than 300,000 inhabitants, where at least 200,000 motor vehicles have been registered and there are at least 500 motor vehicles per 1000 inhabitants;

A total of 100 in municipalities with more than 150,000 inhabitants, where at least 95,000 motor vehicles have been registered and there are at least 400 motor vehicles per 1000 inhabitants; and

A total of 60 in municipalities with more than 100,000 inhabitants, in which at least 60,000 motor vehicles have been registered and there are at least 400 motor vehicles per 1000 inhabitants.

3. Research

3.1. Research Description

The survey was conducted in 2020 using the CAWI method (computer assisted web interview). A request was sent to the offices of all municipalities in Poland asking for completion of an electronic questionnaire. The survey comprised 2477 municipalities. Thise number contains 1533 rural, 642 urban–rural, and 302 urban ones, including 66 municipalities towns which have county rights. Responses were obtained from 2230 municipalities (response rate of 90%), which can be considered a representative sample of the entities in question.

A total of 60.2% of the responses obtained were from rural municipalities, followed by urban–rural (25.6%), urban (11.8%), and cities with county rights (2.4%). The largest number of municipalities were from Mazowieckie (12.2%), Wielkopolskie (9.2%), and Lubuskie (8.6%). With regard to the number of residents, the majority of the respondents were municipalities with up to 10,000 residents (63%). The research group consisted mainly of municipalities with an average income below 3000 PLN per person (32.2%), followed by municipalities with revenue per person above 5000 PLN (19.9%). A total of 2177 (97.6%) municipalities admitted to not having an electromobility development strategy. Only 53 municipalities prepared such a document.

3.2. Hypotheses Derivation and Methodology

A survey offers a set of multivariate data that allows the derivation of hypotheses to be tested by statistical methods chosen according to the nature of the data [22]. The survey tested the aforementioned hypotheses derived from the research questions.

The nature of the available data is dichotomous and indicates the Pearson's chi-squared test as the best method. This test is universally used for categorical data to test the premise that the frequency distribution of specific events observed in the studied data is consistent with a particular theoretical distribution. In short, it tests whether the observed variances occurred by chance or due to different origins [23].

Responses allow for forming contingency tables with the independent or precursor variables in the columns and the dependent or successor variables in the rows. The test requires calculating the observed and expected frequencies for each cell. Observed frequencies stem from counting the responses to the questionnaires, whereas expected frequencies are calculated taking supposing that the distribution of responses is uniform. It requires dividing the number of answers by the number of possibilities. If the two sets of frequencies differ significantly, according to a given test, the study accepts the hypothesis that the independent variable influences the dependent one. The chi-squared test measures the difference comparing the chi-squared statistics for the contingency table with a reference value, which depends on the degrees of freedom (DoF) of the table. The DoF is obtained by multiplying the number of rows minus one by the number of columns minus one. If the chi-squared statistic is greater than the reference value, the test accepts, with a given significance, that the distribution of the observed frequencies differs from the distribution

of expected frequencies. Consequently, the independent variable influences the dependent one. A complementary test, Cramer's V, aiming at measuring the association between two nominal variables [24], may help to verify the intensity of the influence.

Equation (1) calculates the chi-squared statistics X^2

$$X^2 = \sum \frac{(f_o - f_e)^2}{f_e} \quad (1)$$

In which:
f_o = observed frequency; and
f_e = expected frequency for all cells.
Equation (2) calculates the Cramer's V estimator.

$$V = \sqrt{\frac{X^2}{n(M-1)}} \quad (2)$$

In which:
n = sample size; and
M = minimum value between the number of rows and columns.

Cramer's V estimator ranges from 0 to 1. If below 0.05, it indicates weak or no association; from 0.05 to 0.15, intermediate association; and above 0.15, strong association [23].

4. Results

Table 1 reports the number of communes that decided to develop or not develop an electromobility strategy, according to the type of community.

Table 1. Influence of the type of community (urban–rural) on the existence of a strategy.

EM Strategy	Rural		Urban–Rural		Urban		County		Sum	%	X^2	$X^2_{0.05}$	V
	f_o	f_e	f_o	f_e	f_o	f_e	f_o	f_e					
No	1323	1311	562	556	246	257	46	53	2177	97.6%	61.83	7.815	0.167
Yes	20	32	8	14	17	6	8	1	53	2.4%			
Sum	1343	1343	570	570	263	263	54	54	2230	100%			

The X^2 statistics overcomes the $X^2_{0.05}$ reference value valid for a DoF = 3 and a significance level of 5%. It is possible to conclude that the type of community influences the decision of developing an electromobility strategy. Therefore, the dependent variable, the decision of having or not having an electromobility strategy, depends on the type of community. Cramer's V estimator indicates a strong association. The table informs that the rural and urban–rural communes are less prone than urban communes and counties to develop a local electromobility strategy. A second test comparing the aggregation of rural and urban–rural communes against the aggregation of urban communes and counties confirms the result (X^2 = 48, $X^2_{0.05}$ = 3.841, DoF = 1). Therefore, it is possible to enunciate that rural communes are less prone to developing an electromobility strategy than urban communes are.

Table 2 reports the number of communes that decided to develop or not develop an electromobility strategy, according to the budget revenue per capita, in PLN, the Polish currency.

The X^2 statistics do not overcome the $X^2_{0.05}$ reference value valid for a DoF = 2 and a significance level of 5%. It is possible to conclude that the budget revenue per capita does not influence the decision of developing an electromobility strategy. Therefore, the dependent variable, the decision of having or not having an electromobility strategy, does

not depend on the budget revenue per capita. Furthermore, as the Cramer's V estimator reaches a very low value, the association does not exist.

Table 2. Number of communes that decided to develop or not develop an electromobility strategy.

EM Strategy	<3500		3500–4500		>4500		Sum	%	X^2	$X^2_{0.05}$	V
	f_o	f_e	f_o	f_e	f_o	f_e					
No	781	776	394	397	724	727	1899	97.4%	2.56	5.991	0.03
Yes	15	20	13	10	22	19	50	2.6%			
Sum	796	796	407	407	746	746	1949	100%			

The next test involves investigating the relationship between the type of community and the type of initiatives (long-, mid-, short-term) targeted by the electromobility strategy. During the execution of environmental regional strategies, players may target various objectives, ranging from individual, opportunistic, short-term to collective, transformative, long-term initiatives [25], passing by graduations. The survey identified nine specific electromobility initiatives addressed by communes. Researchers classified them as short-term, individual-focused; mid-term, public-focused; and long-term, collective-focused. Short-term, individual-focused initiatives are the (i) separation of parking spaces for electric cars, (ii) construction of a charging station for private electric vehicles, and (iii) exemption of electric cars from fees in the paid parking zone. Mid-term, public-focused initiatives are the (i) introduction of electric cars for the public administration offices, (ii) exemption of electric vehicle charging points from property tax; (iii) reduction or exemption from tax on means of zero-emission vehicles, (iv) construction of charging infrastructure for public transport, and (v) development and modernization of public transport based on electric vehicles. Long-term, collective-focused initiatives are the (i) education and raising awareness of electromobility, and (ii) introduction of zero-emission zones in the territory.

Table 3 reports the number of communes that decided to develop different types of initiatives of electromobility, according to the type of the community.

Table 3. Influence of the type of community (urban–rural) on the range of the strategy.

EM Strategy	Rural		Urban–Rural		Urban		County		Sum	%	X^2	$X^2_{0.05}$	V
	f_o	f_e	f_o	f_e	f_o	f_e	f_o	f_e					
Short-term	32	33.8	21	22.1	64	65.9	60	55.1	177	43.4%	16.78	12.592	0.143
Mid-term	21	21.2	5	13.9	46	41.4	39	34.6	111	27.2%			
Long-term	25	22.9	25	15.0	42	44.7	28	37.4	120	29.4%			
sum	78	78	51	51	152	152	127	127	408	100%			

The X^2 statistics overcomes the $X^2_{0.05}$ reference value valid for a DoF = 6 and a significance level of 5%. It is possible to conclude that the type of community influences the type of initiative developed in the local electromobility strategy. Therefore, the dependent variable, the range of the electromobility strategy, depends on the type of community. Cramer's V estimator indicates an intermediate to a strong association. The table informs that the urban–rural communes are more prone to developing long-term initiatives and counties failed at aiming for such types of targets. A second test comparing the aggregation of rural and urban–rural communes against the aggregation of urban communes and counties confirms the result (X^2 = 9.28, $X^2_{0.05}$ = 3.841, DoF = 1). Therefore, it is possible to enunciate that rural communes are more prone to develop long-term initiatives inside an electromobility strategy than urban communes are.

Table 4 reports the number of communes that decided to invest more or less than 500 million PLN in the years 2017–2020 in electromobility strategic issues.

Table 4. Amount of investment dedicated to electromobility strategic issues between the years 2017–2020.

Investment	2017		2018		2019		2020		Sum	%	X^2	$X^2_{0.05}$	V
	f_o	f_e	f_o	f_e	f_o	f_e	f_o	f_e					
<500 M	30	31	67	72	67	72	76	66	240	82.2%	12.43	7.815	0.206
>500 M	8	7	20	15	20	15	4	14	52	17.8%			
Sum	38	38	87	87	87	87	80	80	292	100%			

The X^2 statistics overcomes the $X^2_{0.05}$ reference value valid for a DoF = 3 and a significance level of 5%. It is possible to conclude that the intention of communes in investing in electromobility has changed over the period. The Cramer's V estimator indicates a strong association. Given that the intention of investing has changed, it is possible to extract from the table that the main change was the increased intention of investing less than 500 M PLN. In 2017, only 30 communes have invested up to 500 M PLN, whereas in 2020 76 did this, overcoming the expected frequency of 66 out of 80 communes.

Table 5 reports the number of communes that decided to buy electric buses, spending more or less than 10 million PLN in the years 2017–2018 and 2019–2020. Owing to the small size of the sample, resulting in cells with small values, each period aggregated two years.

Table 5. Temporal evolution of the intention of buying electric buses by communes.

Investment	2017–2018		2019–2020		Sum	%	X^2	$X^2_{0.05}$
	f_o	f_e	f_o	f_e				
<10 M	13	15	16	14	29	64.4%	1.26	7.815
>10 M	10	8	6	8	16	35.6%		
Sum	23	23	22	22	45			

The X^2 statistics do not overcome the $X^2_{0.05}$ reference value valid for a DoF = 1 and a significance level of 5%. It is possible to conclude that the intention of communes in investing in electromobility has not changed in the period. The test excludes the Cramer's V estimator owing to the low sample size, which strongly biases the estimation [26]. Communes do not become more prone to purchase electric buses in the period 2017–2020. Given that the intention of investing has increased, as stated before, it is possible to conclude that the increment of investment does not concentrate on buses but other elements of the electromobility strategy.

5. Conclusions

The research carried out the analysis of selected factors influencing the construction of the electromobility strategy in Polish municipalities. The study comprised the entire population of all Polish municipalities (it was not a sample). The statistical tests carried out based on the collected materials indicate that the nature of the community, whether it is urban or rural, affects the involvement in electromobility, measured by the tendency to create an electromobility strategy (Table 6). Municipalities more often choose this strategy, while rural ones, more extensive ones, less often build an innovation strategy. This is confirmed by the studies found in the literature showing that in more urbanized centers, it is easier to implement the principles of sustainable and low-emission transport. It should be noted, however, that rural communes are more inclined to build long-term strategies.

It is surprising, however, that the per capita income is not a factor determining the propensity to create an electromobility strategy. Therefore, it is not the determining factor of this type of innovative attitude. As it turns out, neither building low-emission strategies is a privilege of the rich, nor are poorer communes treated as a more economical solution.

Table 6. Synthesis of the conclusions of the hypothesis.

Hypothesis	Conclusions	Main Implication
H1	The type of community influences having or not having an electromobility strategy	Rural areas are less prone to implementing an electromobility strategy
H2	The budget revenue per capita does not influence having or not having an electromobility strategy	Communes develop electromobility strategies or not, regardless of their budget revenue per capita
H3	The type of community influences the type of electromobility strategy	Rural communes are more prone to developing long-term strategies
H4	The intention of communes to invest in electromobility changed in the last four years	The willingness to invest up to 500 M PLN increased in the period
H5	The intention of communes to buy electric buses does not vary in the last four years	The intentions of communes increased in other concerns, not in electric buses

The research has also shown that the propensity to invest in electromobility in municipalities has increased over the last four years. However, the propensity to electrify public transport has not increased. This means that local governments find other ways to support electromobility. We can pose the hypothesis that local governments need to avoid the burden of buying expensive rolling stock and prefer to invest in infrastructure, and the cost of buying vehicles (electric cars) is borne by individual users.

Further implications of the study entail the connection of the current findings with the incoming concept of open innovation. The open innovation model argues that innovative enterprises can hire outside ideas and consolidate knowledge to help develop new products and services [27]. Therefore, ideas from external players can contribute to enhancing innovative products in various forms, such as licensing agreements or start-up initiatives [28]. Bearing in mind the open innovation model, the findings of this survey may be incorporated by developer companies in new, innovative products and services aiming at supporting the implementation of electromobility strategies in Polish communes.

The research project has provided fresh data to help implement electromobility initiatives in the municipalities that have not had them until now. It can also provide strategic information regarding the relationship between municipalities and electromobility. Such a huge amount of data usually requires a systematic approach to be managed. When research projects generate public information to improve public policies, information management difficulties can usually be reduced with the aid of a technological product, such as an APP. In the open innovation model, companies and selected partners create and sell concepts in the form of valuable products for specific markets [29]. A new, innovative product should be developed for supporting further implementations of municipal electromobility strategies. Eventually, replications of the survey in other regions may lead to similar support products to help implement electromobility in other countries. This is a side, secondary implication of our study.

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