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Trends in the Field of Electromobility—From the Perspective of Market Characteristics and Value-Added Services: Literature Review

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Abstract: Electromobility is one form of transport that is suitable for achieving the goals of carbon neutrality. Therefore, if stakeholders want to be informed, the aim of the article is to examine trends in the field of electromobility. Trends are explored using a systematic literature review. The selected areas are specific factors affecting electromobility, which are market characteristics and value-added services. A specific area of inquiry is important for the reason that if businesses providing or dealing with electromobility are successful in the market, it is necessary to analyse their market position or characteristics of the market in which they operate. If it is clear which laws apply in the market, the company can adapt its offer to the trends that affect the given business segment. The same applies to policy makers, new knowledge can be applied in policy making. Data, about the market and services that are offered on the market, provide knowledge to stakeholders that focus their activities on electromobility. Furthermore, this article provides not only information about the current state of affairs, but also further directions research should take to map electromobility from point of view of market characteristics and value-added services.

Keywords: electromobility; market characteristics in transport; value-added services in transport

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1. Introduction

The quality of life is significantly influenced by the environment in which we live and therefore the great efforts of mankind are directed precisely to the sustainability and improvement of this environment. The long-term development of electromobility can be seen as a solution to climate protection and the interests of the regulated automotive industry. In the automotive industry, this manifests itself primarily in the pressure to reduce car consumption and reduce CO_2 emissions, i.e., carbon dioxide. Tightening limits are forcing car manufacturers to reduce the volumes of their cars' engines, introduce new expensive technologies that will reduce the mentioned emissions, or even limit the production of some fuel-efficient engines.

The European Union has set targets to (i) become carbon neutral by 2050 and (ii) achieve a 55% reduction in emissions by 2030. To meet these targets, passenger cars—which today represent around 12% of EU CO_2 emissions—must rapidly decarbonise [1].

The solution to these challenges could be the expansion of the vehicles powered by electricity, generally known as electromobility. This term can be defined as movement using electrical energy [2]. In other words, authors Scheffels and Grauers define it as electric cars and other means of transport powered at least partially by electricity, as well as the requirements and circumstances related to them [3,4].

Electric cars have become a more frequent subject of public discussions since about 2009, even though their history dates back to the 19th century [5,6]. Nowadays, electromobility is mainly concerned with the operation of electric vehicles, i.e., the operation of electric cars, electric motorcycles and bicycles (e-bikes), and means of mass transport, including trams, metros, trolleybuses and electric buses, ships, and planes. Hybrid vehicles also marginally fall into this area—these vehicles use multiple drive systems to operate, at least one of which is electric [7].

Concerning the changing needs of consumers regarding their mobility, which in the future should be simpler, more flexible, cheaper and more sustainable, electromobility seems to be an ideal alternative [8]. Therefore, this article aims to map trends in the field of electromobility. Attention is paid to the most current trends, while, given the scope of this issue, these trends are related to selected key areas and factors affecting electromobility.

Theoretical Background

Electromobility is affected not only by its technological aspects. Kolz and Schwarz, in their study from 2017, identified this research gap and pointed out key areas of influence that affect electromobility (Tables 1 and 2). Global areas were identified using STEP analysis. Local areas were identified by analysing scientific papers dedicated to the issue of electromobility [9].

Table 1. Global areas that influence electromobility.

Global Area of Influence	Description
Economy	Immediate competition for electro mobility and economic development.
Technology	Incremental or radical technological advances in electromobility.
Politics	General and specific policy framework for electro mobility (e.g., political stability or legislation).
Society	Social change in society, e.g., with regard to the demographic composition or values.
Environment	Environmental aspects of the conservation of the natural environment (e.g., greenhouse gas emissions).

Reproduced from Kolz and Schwartz (2017) [9].

Table 2. Local areas that influence electromobility.

Global Area of Influence	Description
Technical state	Technological features of an electric vehicle.
Usage	Use of electric vehicles.
Value-added services	Services that influence the attractiveness or functionality of electromobility.
Automobile manufacturers	Behaviour of automotive manufacturers in the context of electromobility.
Energy industry	Behaviour of the actors in the energy industry in the context of electromobility.
Market characteristics	Competition and cooperation between market participants.

Reproduced from Kolz and Schwartz (2017) [9].

To identify factors of each area of influence, Kolz and Schwarz carried out further in-depth literature research. They further state that potential influence factors are not only evaluated by the frequency of their mentions but also by their degree of differentiation, their degree of integration, and their research area as well as their comprehensibility and their precision. If two factors show a significant similarity and refer to the same reference aspect, they are combined and condensed to one influence factor [9].

Overall, 55 influence factors impact global and local areas of influence on electromobility. From these factors, 29 are global and 26 are local. Table 3 summarises the findings.

Table 3. Electromobility influence factors.

Global Area of Influence	Global Factors of Influence
Economy	Oil price, electricity price, battery price, total cost of ownership, exchange rate, competition.
Technology	Drive technology, battery technology, infrastructure, integration of functions, security.
Politics	Governmental funding, regulation, taxes and charges, laws, energy and climate policy, standardization.
Society	Demographic change, awareness, value change, user acceptance, mobility behaviour, urbanization, metropolisation.
Environment	Sustainability, climate change, environmental awareness, resource availability, recycling.
Local Area of Influence	**Local Factors of Influence**
Technical state	Range, charging concepts, charging time, lightweight design, safety.
Usage	Available information, everyday life, costs, image, visibility, commercial use.
Value-added services	Financing offers, ICT-based services, multimodal concepts, workshop availability, private car sharing, long-time battery services.
Automobile manufacturers	Model diversity, stand-alone platform, service concepts
Energy industry	charging infrastructure, renewable energy, smart grid.
Market characteristics	Increased competition, co-operation, market penetration of electric vehicles.

Reproduced from Kolz and Schwartz (2017) [9].

All the factors listed in Table 3 affect electromobility to varying degrees for all parties involved in it. Manufacturers, customers, states, and cities, each of them has decision-making processes linked to each of the areas described in Table 3.

If we take this into account, then for all stakeholders to make informed decisions affecting their functioning, it is necessary to analyse and research trends in the field of electromobility. The investigation of current trends is carried out within the presented article for the identified local and global areas and the factors assigned to them, which are listed in Tables 1–3.

2. Methodology

To identify trends related to electromobility, a systematic literature review (SLR) was conducted. The methodology we used is derived from research dealing with SLR [10–13], while the overall framework of the used methodology is derived from the study by Mengist et al. from 2020 [14]. The framework itself consists of six phases, where each phase has specific outcomes and applicable methods (Table 4).

Table 4. Framework for SLR.

Phase	Outcomes	Methods
Protocol	Defined study scope	-
Search	Search strategy	Searching strings
	Search studies	Search databases
Appraisal	Selecting studies	Defining inclusion and exclusion criteria
Synthesis	Extract data	Extraction template
	Categorise data	Categorise the data on iterative definition
Analysis	Data analysis	Quantitative categories, description, and narrative analysis
	Results and discussion	Data analysis, gap identifications and result comparison
	Conclusion	Deriving conclusion and recommendation

Table 4. *Cont.*

Phase	Outcomes	Methods
Report	Report writing	Preferred reporting items for systematic reviews and meta-analysis (PRISMA) methodology
	Journal article production	Summarizing the report result

The protocol phase has the task of recognizing the scope of the investigated issue. According to [14], this phase is aimed at finding answers to the following questions: What is the state-of-the-art in areas of research? What types of these areas have the most studies? What are the current challenges in the areas of research?

If we know the scope of the investigated issue, we proceed to the search phase, where the investigated issue is transformed into keywords. Subsequently, the keywords are part of the search queries of selected scientific databases.

The search itself can provide search results for a relatively large number of scientific publications. Not all publications are suitable for the research area. Therefore, in the appraisal phase, those works are excluded that do not directly relate to the investigated research area.

The appraisal phase can be defined according to [14], following on from [15,16], in more detail using four specific sub-phases (the name is highlighted in bold):

- Identification of scientific papers according to the selected domain that matches defined keywords. This match is identified in the title/abstract/keyword parts of the article. The approach of this sub-phase is thematic.
- Screening of paper titles, where the emphasis is placed on the exclusion of duplicates, grey literature, editorial letters, etc.
- Eligibility of identified articles, by abstract and main body reading. Those articles that do not match the area of research are excluded.
- Articles that are suitable for selected areas of research are included in SLR.

After the inclusion of selected articles, a synthesis takes place: sorting of the acquired knowledge and categorization of identified relevant studies. After the synthesis, it is necessary to analyse the data by choosing an appropriate method of analysis. An example can be the ABC curve [17], with the help of which it is possible to evaluate which publications are the most valuable from the point of view of the established criteria and, conversely, which are the least valuable.

At this point in the SLR, it is clear which publications are suitable for the research area from the initial analysis. This means that in the next phase of the SLR, the conclusions of the identified studies are formulated in terms of the scope of the research, which is defined in the first step of the entire SLR.

The methodology according to [14] also points to the creation of reports, according to the PRISMA methodology, which is presented in the studies of Liberati et al. (2009) and Page et al. (2021) [18,19]. As part of our research, we did not create a PRISMA report, which is essentially a checklist, due to the limited scope of this article.

3. Results

The range of issues related to electromobility is relatively broad. It is generally reported to be an area of transport that has strong dynamics. This dynamic results from the transformation of the automotive industry, which is largely influenced by international initiatives such as the Paris Agreement, from the conclusions of which the Green New Deal and European Green Deal were formulated. The core of the transformation is the transition from combustion engines and electric engines (or other alternatives to gasoline-powered engines).

As already mentioned, electromobility is influenced by global and local factors. Each of the identified factors can be reformulated into keywords (KW) that are suitable for the implementation of the first step of SLR. Some factors were not transformed into KWs due to their generality, which would harm article searches. The negative impact would be that articles that are explicitly outside the topic of this article would be included in the search result.

To make the search complete, for SLR (finding the trends related to the selected factors influencing electromobility), the selected factors were supplemented with the KW "electromobility". Search queries were performed in the Web of Science and Scopus databases (Table 5), assuming that these databases contain the latest and most state-of-the-art publications related to the issue of electromobility. At the same time, the articles and scientific publications that are published in the Web of Science and Scopus are also published in other recognised databases. Therefore, we implemented SLR using only these two databases.

Table 5. Availability of search queries in Web of Science and Scopus databases.

Keywords for Global Factors	Web of Science	Scopus
oil price, electricity price, battery price, drive technology, battery technology, infrastructure, security, regulation, taxes and charges, laws, energy and climate policy, demographic change, user acceptance, mobility behaviour, sustainability, climate change, environmental awareness, recycling	Available	Available
standardization, urbanization, resource availability	-	Available
governmental funding	-	-
Keywords for local factors	**Web of Science**	**Scopus**
charging concepts, charging time, lightweight design, safety, commercial use, ICT-based services, private car sharing, service concepts, charging infrastructure, renewable energy, smart grid, market penetration, co-operation	Available	Available
visibility, multimodal concepts, long-time battery services	-	Available

Other search parameters were related to year limits. If the purpose of the conducted research is to characterise trends in electromobility, the time frame included in the search is from 2021 to the present. We assume that the period of the last two years sufficiently captures the latest scientific outputs, from which it is possible to formulate electromobility trends.

The resulting number of publications that were found (by searching for the combination of KW electromobility with KWs listed in Table 4) is equal to 3831. This is a relatively large number of publications. Therefore, to fulfil the goal of SLR (to find trends related to the selected factors influencing electromobility) we narrowed this scope to a selected area of interest, which is the local area of influence—market characteristics and value-added services and removed duplicities. According to these criteria, the range of identified articles was narrowed down to 216.

A specific area of inquiry is important for the reason that if businesses providing or dealing with electromobility are successful in the market, it is necessary to analyse their market position or characteristics of the market in which they operate. If it is clear what laws apply in the market, the company can adapt its offer to the trends that affect the given business segment. Data, about the market and services that are offered on the market, provide knowledge to policymakers that focus their activities on electromobility.

Thus, as other criteria for narrowing down the scope of identified articles, screening of titles of articles was carried out. The key for screening was whether the topic of the article is related to the areas of influence: value-added services and market characteristics, for which there are factors such as ICT-based services, multimodal concepts, private car sharing, long-time battery services, market penetration, and co-operation.

As a result of the screening, which involved a thorough analysis of the identified abstracts and article titles, the number of identified articles was reduced to 78 articles. From these articles further screening was needed because not every article was relevant to our research. Another screening, therefore, excluded another 30 articles, and the final number of articles, from which we derived data for our analysis, is 48.

In general, the articles were divided into two thematic units, where each unit had thematic sub-groups into which the identified articles within the SLR could be categorised (Table 6).

Table 6. Availability of search queries in Web of Science and Scopus databases.

Market Characteristics	Value-Added Services
Market transition and regional disparities	Charging management
Buying decisions—influencing factors and incentives	Power grid
Green gas reduction—importance and predictions	Energy sources
Urban transport—e-buses and e-scooters	Charging infrastructure

3.1. Market Characteristics

Orfanou et al. (2021) [20] summarise the electric vehicles (EVs) market (from the point of view of charging infrastructure, e-vehicle fleet, incentives, technology, campaigns, legislation, enforcement, education, research, and innovation). In their article, they state that the number of electric vehicles is still low, and not all European cities have made progress in this direction. There are indications that regions with significant progress in the field of electromobility should still elaborate a lot to increase their performance in most of the analysed aspects.

The past two years were significantly affected by the COVID-19 pandemic. Rokicki et al. (2022) [21] state that even though the pandemic changed the economic situation in Europe, it has not slowed down the pace of introducing electromobility, and may have even accelerated it.

If the changes are related to the transition from internal combustion engines to electric, how long will this transition take? The answer to this question was dealt with by Rabiega et al. (2021) [22] in their article which is a case study focusing on Poland. They state that if the goal is climate neutrality, which is to be achieved by 2050, then in 2050, approximately 30% of vehicles with combustion engines will still be on the road, which will lead to 80% reductions in emissions and an increase in demand for electricity and hydrogen (Figures 1 and 2).

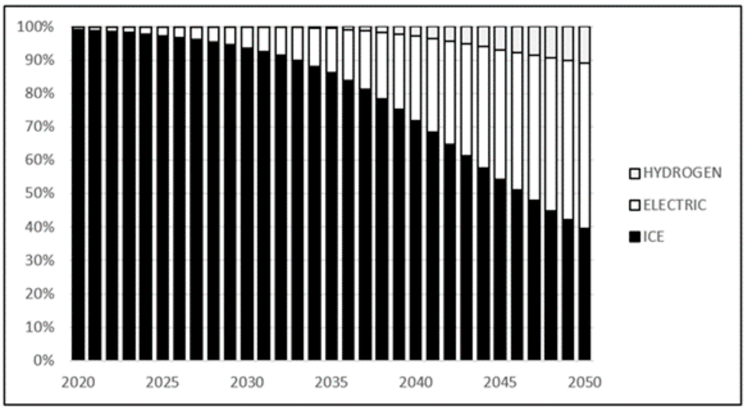

Figure 1. Structure of passenger cars in Poland in the years 2020–2050 by engine type according to Rabiega et al. (2021) [22].

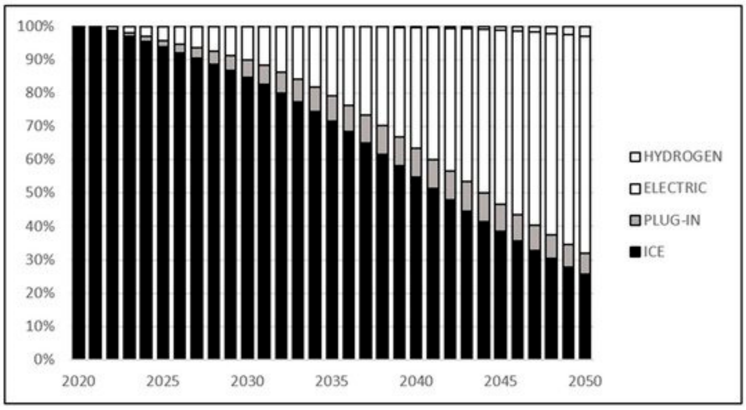

Figure 2. Structure of buses in Poland in the years 2020–2050 by engine type according to Rabiega et al. (2021) [22].

Šoltés et al. (2021) [23] state that it is currently not demonstrable that there is an impact of electromobility on the reduction in greenhouse gas emissions at the national levels of EU countries. It is possible to assume that with the increase in the share of EVs on the roads (as stated in the study by Rabiega et al.), there will be a reduction in greenhouse gasses, which will also be read by aggregated statistics (Eurostat, OECD, etc.).

When achieving the set goals of reducing greenhouse gas emissions, the existing power grid will face challenges due to intermittency and the non-dispatchable nature of wind and solar energy production. Colmenar-Santos et al. (2021) [24] came up with a solution in the form of a strategy based on a novel grid technique that is presented and evaluated for the optimal integrated operation of renewable resources and EVs to increase the penetration of renewable energy.

If enough EVs charge during peak hours, costly grid expansions may be needed. Wangsness et al. (2021) [25] propose a new economic model for passenger transport in the greater Oslo area, where applying tariffs differentiated between peak and off-peak periods will help strike a better balance between grid investment costs and EV-owners' disutility of charging during off-peak hours.

According to the study by Indonesian authors Alamsjah et al. (2021) [26], four dimensions are currently key when choosing an EV (electric vehicle): socio-demographic, technical, economic, and behavioural (Figure 3). Their study is regional and focuses on Indonesia.

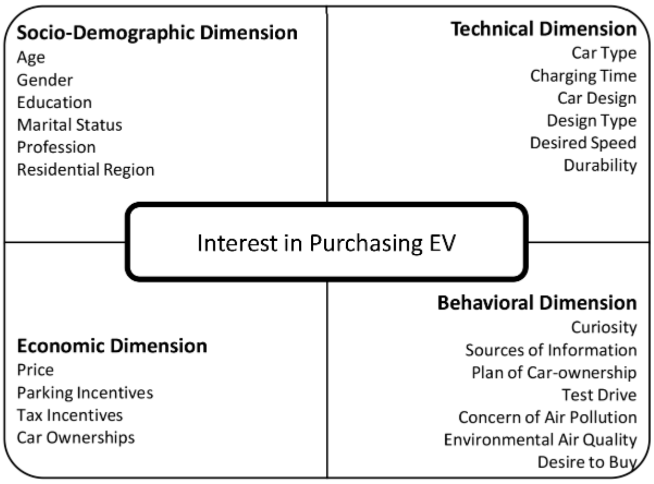

Figure 3. Areas of consumer interest in purchasing EVs according to Alamsjah et al. (2021) [26].

According to the conclusions of the study, understanding of EVs is constructed dominantly based on information available online. The price of EVs, as well as tax incentives, is an influential factor affecting their intention of purchasing. From the perspective of EV performance, charging time to the vehicle fuel capacity of fewer than three hours is acceptable to the majority of the participants. SUV and city car types are preferable. The vehicle's durability is also highly regarded. The intention to purchase an EV is influenced by the factors of age and education level but not by the factors of sex, marital status, or employment.

Another similar view is provided in a study by Bera and Maitra (2021) [27] which provides the view of consumers in the Indian market toward the plug-in hybrid electric vehicle (PHEV). According to the findings of this study, charging time, battery warranty, and price are crucial when consumers decide whether or not to buy a PHEV. The same factors influencing consumers, as in the case of the Indian market, are found by Haidar and Rojas Aguilar (2022) [28], Rosales-Tristancho and Carazo (2021) [29], Kongklaew (2021) [30], and Singh et al. (2021) [31] with the difference that in the case of their study it is the French, Spanish, Thai and Indian markets. Hasan (2021) [32], researching the Norwegian EV market, points to the fact that in addition to the battery, charging and price-related factors, environmental aspects associated with EVs are also important when purchasing them. Esteves et al. (2021) [33] point to the fact that for Spanish consumers electric vehicles (EVs) represent a viable option to reduce ecological damage and improve public health.

The purchase of a classic car with an internal combustion engine is often influenced by the reliability of the car, which takes the form of not only the low failure rate of the vehicle but also the driving range. As pointed out by Higueras-Castillo (2021) [34], Rotaris et al. (2021) [35] (in the case of the Slovenian and Italian markets, respectively), and Skowrońska-Szmer and Kowalska-Pyzalska (2021) [36] (in the case of Polish market) the same factors influence the purchase of EVs.

Rommel and Sagebiel (2021) [37] point to another important factor, which is the availability of charging stations. Their research focused on the German market, where a fundamental finding is the indication of low preferences for battery electric vehicles for consumers, who are house owners in sub-urban regions. This consumer group, as a potential representative of the middle-class, can be characterised as ideal for future EV purchases. Therefore, marketing efforts should be more focused on this consumer group.

Zimm (2021) [38] states that great discrepancies exist across countries regarding EV support and uptake. EV diffusion is conceptualised as an outcome of policy diffusion based on national characteristics and international mechanisms.

Even so, studies by Baldursson et al. (2021) [39] and Hasan and Mathisen (2021) [40], implemented in Norway, the Netherlands, and China, point to the fact that if certain concessions are provided, consumers tend to think about electrifying their fleet of vehicles. Broadbent et al. (2022) [41], from an analysis of the New Zealand EV market, reports similar findings: those who responded positively favoured incentives designed to affect purchase price reductions and increase nationwide fast-charger deployment of EVs. If incentives are a factor affecting whether consumers buy EVs, Macioszek (2021) [42] states that the promotion of EVs in Poland should be centred around incentive programs. From the analysis of the Greek market, these findings are supplemented by Geronikolos and Potoglou (2021) [43], who point out that incentives should be also considered for different socio-economic segments of the population to prevent inequalities and match their preferences. Similar findings are reported by Bitencourt et al. (2021) [44], who state that high prices may still be the major barrier to EV diffusion in Brazil, keeping EVs inaccessible to the majority of the population.

If incentives, in the form of subsidies and various benefits from the state, are a motivator to buy an EV, then another incentive, according to Jreige et al. (2021) [45] who analysed the Lebanon market, is increasing fuel taxes. According to Kunle and Minke (2022) [46] (French, German and Norwegian markets), Sahoo et al. (2022) [47] (Indian market), and Singh et al. (2021) [48] (Indian market), when EVs are available in the market, regulatory incentives and policies have to match consumer preferences. Among direct subsidies, policies affecting the purchase price of EVs are identified as the most effective instrument. The analysis further prompts a duality between national incentives and local programs supporting EV adoption. Furthermore, Oryani et al. (2022) [49] point out that in Iran even non-monetary policies are positively connected with the acceptance rate of EVs.

The discussion regarding electromobility focuses not only on EVs but also on other areas connected with electromobility, such as electric roadways (ER), electric buses, and electric scooters. According to Konstantinou et al. (2021) [50], currently, in the USA, public acceptance in general seems to be related to charging patterns, the safety of commute routes, and safety concerns for ERs among other factors, and depends on the implementation time of the technology. Pietrak and Pietrak (2021) [51], in their study that took place in Poland, state that economic benefits resulting from implementing zero-emission buses in an urban transport fleet are limited by the current energy mix structure of the given country. An unfavourable energy mix may lead to increased emissions of SO2 and CO_2 resulting from the operation of this type of vehicle. Therefore, achieving full effects in the field of electromobility in the given country depends on taking concurrent actions to diversify the power generation sources. Vallejo-Morales et al. (2021) [52] state that sales of e-scooters and e-scooter sharing services in Spain are growing. Perceived value, security, and technophilia (strong enthusiasm for technologies) are the main determinants of intentions to use and buy e-scooters.

3.2. Value-Added Services

If EVs are to successfully penetrate the market, EV-related services with added value must be provided. It can be assumed that these services bring additional value not only for consumers but also for producers in the form of information that can be used in other business-related activities.

Coban et al. (2022) [53], in their case study which focuses on the area of present-day Turkey, state that electric road construction appears to be a low-cost alternative to the current road construction trend. If a large battery is replaced with a smaller battery for each new vehicle sold, after three years, enough savings will be made to electrify all highways and main roads in Turkey.

New possibilities brought by electromobility can significantly reduce external costs generated by transport by incorporating rail transport into the urban delivery systems. According to the case study by Pietrak et al. (2021) [54], which took place in Poland's Szczecin, this reduction is possible by using the LFR electric trains. Furthermore, another advantage of the adoption of electric trains is the reduction in negative effects generated by urban freight transport, which leads to achieving a coherent zero-emission system for handling cargo and passenger flows in cities.

Electromobility brings new possibilities for building intelligent integrated infrastructures connecting energy, transport, and urban infrastructure. Vilathgamuwa et al. (2022) [55], researching this issue, created a proposal for the mobile-energy-as-a-service (MEaaS) concept for system-wide integration of energy, transport, and urban infrastructures for sustainable electromobility in cities (Figure 4).

The proposal takes into account measures of optimal real-time power grid operationality, where different electricity demand scenarios should be modelled for different times of the day, considering the customer behaviour influenced by electricity price, mobility trip purpose, time, and customer convenience. Taking these aspects into account, the model focuses on what principles and rules encompassing transport, power, and civil engineering aspects should apply to in the context of cities. An important part of the model is the development of flexible incentive-based pricing mechanisms for MEaaS (where this involves optimal bidirectional charging through V2X/X2V of mobile/stationary EVs).

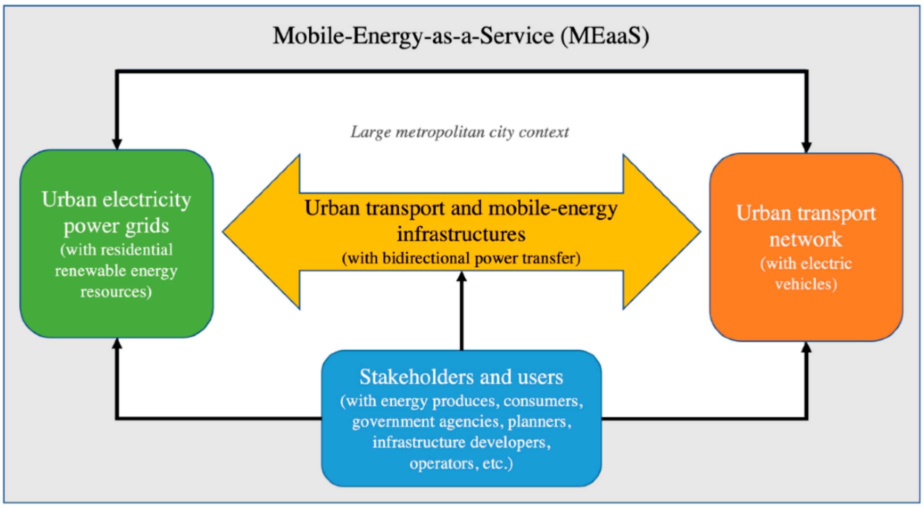

Figure 4. Conceptual framework of MEaaS according to Vilathgamuwa et al. (2022) [55].

According to one of the most recent studies by Patel et al. (2021) [56], there is a trend of linking blockchain technology with EV charging systems. The model is designed in such a way that every time an EV owner charges their car, they must pay for the vehicle charging service electronically. These payments are secured using blockchain technology. This means that, in the case of this model, blockchain is used for communication between vehicles and charging stations.

The penetration of electromobility into the market requires the creation of new infrastructure. According to Geronikolos and Potoglou (2021) [43], who dealt with the issue, the EVs market requires strategic allocation of public charging infrastructure and national coverage to enable electric vehicles to travel within and out of the urban core. To ensure this strategic allocation, electricity providers should ensure that the network would be able to withstand the increased electricity demand that the public charging points and electric vehicles would create.

From the point of view of the smart cities concept, Anthony (2021) [57] points out that EVs can actively promote the development of a smart grid via two-way communication—vehicle-to-grid and grid-to-vehicle. This form of cooperation is key in the creation of smart city concepts. There are several options for providing EV charging services. Arif et al. (2021) [58] go further and statethat to support grid reliability and to encourage consumers to buy and use EVs, parking lot owners should provide services on a basis of the vehicle-to-grid, grid-to-vehicle, parking lot-to-grid, and parking lot-to-vehicle.

According to Fernandez (2021) [59] and their study, which focused on Spain, the most likely future transport electrification scenario is BEVs equipped with a higher battery capacity and, consequently, the increased installation of fast-charging facilities. A suitable strategy lies in the development of a charging network at the workplace, allowing a slow charging of batteries during working hours. This strategy is less commercially attractive but represents the best option from the perspective of low emissions and electric grid reinforcement.

Charging an electric car is one of the basic attributes of owning an electric car. Regarding charging, the driver may be interested in where they can charge their electric car, how long will charging take, and how much it will cost. Schulz and Rode (2022) [60] studied whether public charging infrastructure drives battery electric vehicle adoption. They analysed data for the years 2009 to 2019 and focused mainly on rural areas in Norway where a public charging network began to be built in selected years. They identified that ownership of electric cars increased by 200% in five years and therefore came to the conclusion that public charging infrastructure serves as a stimulus to the diffusion of battery electric vehicles.

Teoh (2021) [61] dealt with the charging strategy of urban freight transport and proposed four unique charging strategy types: downtime, opportunity, intrusive, and emergency charging. Each charging strategy has a strong influence on the financial and operational performance of the transport operation and requires different types of charging systems and services to function. Downtime strategy is synonymous with in-house charging or overnight charging. Opportunity strategy is synonymous with destination charging. Intrusive charging happens when vehicle users want to charge it quickly during long or mid trips or commutations. Emergency charging is when a driver is alerted to a particular condition of the battery level while driving.

The importance of the charging infrastructure was the subject of the article by Li et al. (2021) [62]. The findings of this article formulate a way for finding an optimal charging station location for EVs. Their work uses an improved genetic algorithm to locate public charging stations by considering the investment of charging station operators and the travel costs of battery electric vehicle owners. The methodology they proposed uses the multi-population genetic algorithm to provide more feasible allocations for public charging stations and according to their calculations, it could reduce total costs by 7.6%.

We have to look at charging an electric vehicle not only from the driver's point of view but also from the point of view of the impact on the electric network charging electric cars. Authors Shibl et al. (2021) [63] emphasise the importance of electric vehicle charging management since the charging of a high number of EVs harms the distribution system. They have contrasted many machine learning algorithms and they picked the most reliable that will minimise power losses and voltage fluctuations and achieve peak performance by flattening the load curve and also minimise the costs.

The Greek scientists Karapidakis et al. (2021) [64] examined the hosting capacity of the power network in the metropolitan area of the capital city of Crete island—Heraklion. Greece is in an early stage of EV adoption, but they are already using significant incentives, which aim to subsidise the purchase of EVs and chargers to install 1000 new charging stations in the next few years and 10,000 charging points in the medium term. The research showed that the hosting capacity of charging EVs in the power grid of the city of Heraklion is 3862 slow-charging EVs that could simultaneously be charged under an average charging profile by the city's grid infrastructure, even at the N-1 criterion of all the transformers. On the other hand, the number of fast charging EVs is considerably lower at 2316. At peak demand, when all the transformers work properly, the grid can simultaneously host 6993 EVs, mainly in the slow and medium-charge modes.

The management of the charging of electric vehicles was the scope of the research conducted by Kriukov et al. (2021) [65]. The first article proposed a decentralised EV charging control (DEV-CC) system that can be executed by the existing on-board electronic control units (ECUs) and used dedicated short-range communication (DSRC) to establish communication between EVs. The proposed DEV-CC adapts the EV charging power depending on the low-voltage distribution network (LVDN) voltage levels measured by the EVs themselves. The main purpose of the proposed DEV-CC was to charge all the EVs connected to the LVDN without allowing the voltage to drop below the imposed limit. As the results of the article showed, the proposed DEV-CC manages to charge all EVs while maintaining the voltage levels within the LVDN above the allowable limits. The proposed DEV-CC does not require any investments from the distribution system operator (DSO), can be implemented on EVs with minimal costs, and is a viable solution to expensive smart grid systems.

The follow-up article by Kriukov and Gavrilas (2021) proposed and tested the behaviour of a novel decentralised EV charging control system (DEV-CC). In this paper, the response of the DEV-CC to variations in the power production of distributed generation (DG) sources is tested, and the results are compared to the results in the first paper mentioned above. The results showed that the DEV-CC system proposed in [64] dynamically adapted to the variations in power produced by the DG sources. To adapt to these variations, DEV-CC did not require any additional improvements or any additional data to be acquired from the DG source or the grid [66].

French authors Krim et al. (2021) [67] assessed the role and benefits of photovoltaic (PV) for PV-powered charging infrastructures for EVs by better energy management. This management is performed by a microgrid based on PV panels installed on roofs or car parking shades, EV charging terminals, electrochemical stationary storage, and public grid connection. Their work aimed to define the economic aspects, feasibility, and preliminary requirements for this system, to avoid overloading the power grid and guarantee a higher percentage of clean energy. The proposed methodology was presented through the modelling and development of a techno-economic tool for local stakeholders, allowing them to manage and correctly size EV charging stations. It is divided into three phases. The first phase informs local stakeholders of the necessary space and the maximum sizing as well as the generated cost to install a PV-powered charging station (PVCS). During the second phase, the total cost of the PVCS is adjusted according to the users' budgets and needs. The third phase presents a detailed qualitative analysis of the user-defined configuration. In this phase, the main objective is to assess the performance of the PVCS, and then, to improve its sizing and its operating modes aiming at increasing the use of PV energy, while minimizing energy supplied by the power grid. In addition, it allows evaluation of the PVCS performance by proposing an energy balance according to different charging scenarios (virtuous scenario, critical scenario, realistic scenario, and personalised scenario) and weather conditions. Moreover, this tool is reproducible in peri-urban areas since it can handle any location. Due to the tool's manageability and simplicity compared to alternative calculation software, the tool is adjusted to be suitable for a wide spectrum of target groups, including experts and non-experts. The charging mode can influence the PV benefits, and the EVs can depend more/less on PV and the public grid. With a slow charging mode, the EVs can be charged mainly with PV energy and stationary storage systems. Whereas, in fast charging mode, EVs can be charged mainly with the public grid. The fast-charging mode can not only reduce PV benefits but also have an impact on the power grid and increase the electricity bills.

4. Discussion

4.1. Implications for Policymakers

If we were to divide the trends in the field of market characteristics into subgroups, the latest findings regarding electromobility can be categorised into those findings that relate to the overall market situation [20–24] and other forms of EV use [50–52]. Furthermore, the findings relate to factors affecting the purchase of EVs [25–37] and support from the state [38–49], which is one of the important factors that lead consumers to buy EVs.

Findings regarding the overall situation in the EV market are, in the context of geographical scope, focused mainly on the area of Europe or the European Union. These findings cannot be generalised. It can be assumed that changes, as a result of EV penetration into the market, will vary and depend on geographic location. According to these findings, it follows that the market for EVs is relatively small, which means that the impact of EVs on reducing emissions is still negligible. Although the supply of EVs is relatively high and the impact of emissions on the environment is relatively high, EVs have not sufficiently replaced vehicles with a combustion engine. If the goals of institutions such as the EU are to achieve carbon neutrality or a low-carbon economy, it can be assumed that by 2050, not only in Poland but also on the roads in other EU countries, there will still be around 30% of cars with a combustion engine. Electromobility is directly related to charging stations. If the effects of electromobility are to be associated with the reduction in emissions on the European continent, it is necessary to use renewable energy sources so that they are continuously available to a sufficient extent for the network of charging stations.

The road network should adapt to the development of electromobility. Findings from the US indicate that road electrification should lead to increased road safety and the availability of charging infrastructure. Electric cars are often synonymous with electromobility.

Do not forget about other forms of transport, such as buses and motorbikes. By electrifying them, it is possible to provide various forms of innovative services, which can ultimately lead to emission reductions.

For the approach of new businesses producing or providing EVs, it is necessary to know not only the general situation in the EV market but also specific factors affecting the purchasing behaviour of consumers when purchasing EVs. The findings related to the factors mainly concern European and Asian consumers. Of these, it can be said that the price and overall reliability of EVs are key for consumers. Overall reliability can be understood in particular as vehicle charging time and the availability of a network of charging stations. In the case of consumers from Asia, these are the same factors that are important when consumers decide to buy EVs.

In the case of state subsidies and regulations related to electromobility, it is possible to talk about the fact that there are different approaches across different countries of the world. However, one thing is certain: state support for the purchase of EVs leads consumers to a positive perception of EVs, while it is appropriate if these forms of subsidies respect the preferences and demographic characteristics of consumers on the market. If emission reduction goals are to be achieved, it is appropriate for the state to support incentive programs aimed at forcing consumers to change their behaviour to purchase EVs. An example of incentives is increasing the fuel tax.

4.2. Implications for Electromobility Services Providers

The findings regarding value-added services can be divided into subgroups that focus on the electrification of transport services [53–55] and the provision of charging station services [43,55,56,58–67].

Several trends can be observed in the electrification of transport services. One of them is the already-mentioned possibility of road electrification as a suitable alternative to classic roads. Complex electrification should be stimulated by the transition to EVs with smaller batteries that are easier and faster to charge. Within the framework of multimodal concepts, it is important to look at transport connections, in which electromobility is the main word when achieving emission reduction goals. An example is electrified trains, which can reduce not only external costs but also the total emissions produced by freight and passenger transport. The connection of different types of transport with the goals of reducing emissions creates a prerequisite for the functioning of concepts such as mobile-energy-as-a-service, which connects transport, energy, and urban infrastructure into a single unit. This concept aims to create a system that will support sustainable transport in large cities.

The provision of charging station services is key to achieving the transition from classic vehicles with internal combustion engines to vehicles with electric motors. As part of the planning of the network of charging stations, there are today methodologies according to which it is possible to investigate whether the network of charging stations in cities is capable of charging a large number of EVs at the same time. The same applies to planning their appropriate geographical placement.

When building a network of charging stations, it is advisable to take into account that the network of charging stations should be strategically located to allow EVs to travel outside urban areas. The more available charging stations, the greater the consumer preference for EVs. Charging stations should be available as much as possible within workplaces. People are working, their EVs are being charged, and their positive consumer preferences related to electromobility are growing with it. The recommended charging technologies, contributing to the construction of smart cities concepts, have several forms: grid-to-vehicle, vehicle-to-grid (in situations where, for example, using a solar panel, the vehicle obtains energy that it returns to the grid), parking lot-to-vehicle (the parking lot represents an element of the vehicle charging system), and parking lot-to-grid. To achieve sustainability goals, it is advisable to connect charging stations with photovoltaics, while a suitable and effective way to control charging stations is decentralised charging control.

4.3. Agenda for Future Research

Electromobility is affected by various areas of influence and factors associated with them. These areas can be local as well as global in nature. This article aimed to examine only selected areas related to market penetration and value-added services. Therefore, a limitation of this article is that it does not examine all areas and factors affecting electromobility. This limitation is an opportunity for further research to investigate other areas affecting electromobility.

Based on this fact, it can be concluded that the market for EVs, where services for the support of EVs are provided in addition to EVs, can be characterised as a place where demand and supply for EVs meet. Determinants of demand and supply can be directly linked to other areas and factors affecting electromobility. This means that the investigation of these determinants links all other areas and factors with the areas of market characteristics and value-added services (Figure 5).

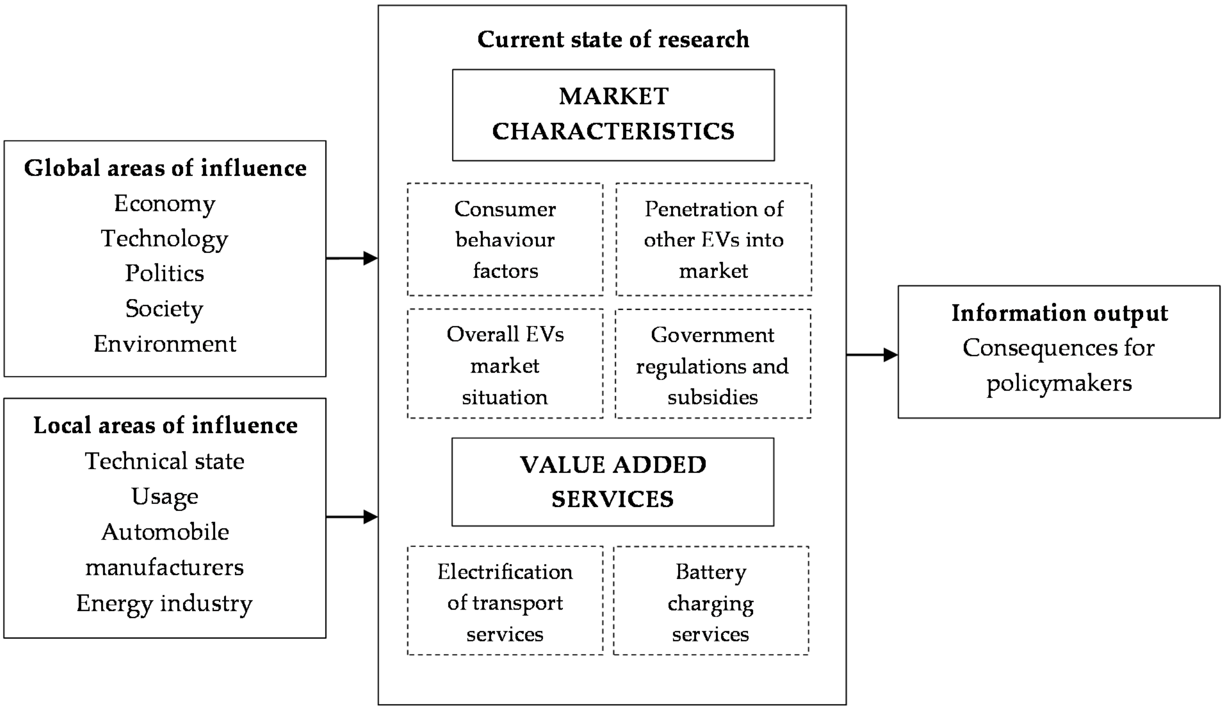

Figure 5. Framework for future research.

If the current research focuses on the investigation of factors (such as price, charging time, etc.) influencing consumers to use EVs, then it is appropriate to investigate the influence of global economic factors on consumer behaviour. How will the rising price of energy and fuel affect consumer attitudes towards EVs? What value will EVs bring to consumers if the price of electricity is higher relative to the price of oil?

It is similar in the case of technology. How will new technologies applied to EVs influence consumer behaviour? New technologies can relate to adaptable battery charging technologies, which will satisfy the needs of EV owners suitably with their potential mobility or scalability.

In the case of government activities, it is necessary, depending on each state, to search and research the right forms of subsidies, regulations, and initiatives. Any change in the legal framework supporting or regulating the field of electromobility should seek such possibilities of supporting electromobility that will lead consumers to have a more positive than the negative attitude towards EVs. In many cases, electromobility is synonymous with ecological transport. Research that is connected to technologies and the environment should also focus on investigating how consumer preferences will change in relation to battery recycling options.

If several different factors affecting consumer attitudes are known today, it is appropriate to investigate how these factors change over time, or it is appropriate to look for other influencing factors. An example can be information transparency regarding the safety and economic benefit of electric cars, or the availability of a network of authorised service centres in which every consumer can service their EV if the vehicle in question is defective.

One of the criteria for SLR was to filter the literature based on the year of publication. Within the article, the years 2021 and 2022 are considered. This may represent another limitation of the article as well as an opportunity for future research. Time is of the essence. If protecting the planet is the driving force behind electromobility, all activities aimed at supporting it should be effective. Whether they are effective needs to be investigated. Thus, all government incentives and regulations should be reviewed over time.

Many studies devoted to the issue of market characteristics and value-added services are geographically limited. Therefore, another topic for research could be the application of various research results within the environment of different countries. Comparing the results of the same research across different countries can lead to findings that will benefit all stakeholders.

5. Conclusions and Policy Implications

Electromobility is the use of electrical energy to drive vehicles. It is an ecological replacement for the drive, which is based on the burning of fossil fuels, which, as we know, produce carbon dioxide emissions. The increase in the number of emissions in our air harms the overall climate. The planet is getting warmer. From the previous text, it could be implied that the use of electric cars is highly ecological. However, even in the production and use of electric cars, ecological challenges must be addressed, specifically in the production and recycling of batteries, which serve as the main source of electric car propulsion and have a shorter life cycle than internal combustion engines. The EU is preparing tougher battery regulations, which are expected to come into force in 2022–2023. Once passed, these regulations will require new circular partnerships between battery manufacturers and recyclers. Among other measures, recycling will need to increase, more recycled materials will be required in the production of new batteries and "battery passports" will be introduced to ensure traceability [68].

The importance of electromobility and its management is therefore growing. This concept is becoming more and more popular and is a common part of the thinking of government policymakers. If the importance of electromobility is high, it is necessary to investigate trends related to this issue.

This is the aim of this article, in which an SLR has been created regarding specific areas and factors affecting electromobility. The selected factors for which the analysis was carried out related to the area of market characteristics and value-added services. By knowing the market conditions for EVs, EV sellers can better understand the environment in which they have to provide value-added services. If information about what value-added services are provided on the market is available, policymakers can better adapt government regulations, initiatives, incentive programs, and regulations to the supply and demand of the electromobility market.

Considering the stated goal of the article, it can be concluded that all the findings should provide policymakers and managers working in the field of transport with answers to questions related to aspects of electromobility that are the most current (from 2021 and 2022) and that relate to the EV market and value-added services provided in this market.

In addition, the article also provides topics for further directions of research activities, which could influence the further direction of research, which is focused on the field of electromobility.

Policy implications should take into account that if electromobility is to contribute to reducing emissions, trends in electromobility need to be long-term and continuously investigated. If the state correctly sets the forms of support and regulation of EVs, it can have a positive impact on various other types of national policies—from social and economic to environmental.

The reviewed literature provided clues that indicate where the policy of the states should go to support the expansion of electromobility on their territory. The price factor is and will be a priority for most customers when they decide to buy an electric vehicle [26,27,29–32,34–36,41–44,47,48]. In addition to the price of the vehicle, the price factor also includes the price of fuel and/or electricity, the cost of maintaining an electric car and various incentives provided by the state. The possibilities of how to influence the cost of the electric vehicle for the citizen are:

- Subsidies: purchase grants, scrappage scheme, various bonuses.
- Tax benefits: registration tax, ownerships tax, value-added tax, eco tax.
- Local incentives: parking fees, toll road fees, ferry ride fees, bus lane use, reserved parking, additional subsidies.

State instruments differ according to the tax and environmental policy in the given state. They are also influenced by socio-economic factors and, last but not least, the quality of the electrical network. The quality of the electrical network and its capacity together with the location of charging stations are other key factors that influence the willingness to buy electric cars and also the number of electric cars that can be actively used in a given country [24,43,50,51,53,55,57,58,60–66].

Therefore, the state's priority regarding electromobility should be the topic of charging electric vehicles, with regard to number of charging stations, distribution of charging stations, capacity of electrical network, electricity taxes, the price of the electricity, alternative sources of electricity and charging subsidies.

In Europe, the leader of electric car integration is Norway. The country has been committed to promoting electromobility since the 1990s. This fact is also supported by the research of trends in the field of electromobility, which was reflected in several articles [25,32,39,40,46–48,61]. By the end of 2020 there were 489,779 electric cars and plug-in hybrids registered from a total of 2,810,480 units. Furthermore, in 2020 more than 70% of all cars sold in Norway were electric. The state strategy for promoting the electromobility is built on the tax cuts and heavy investment in publicly administered EV charging infrastructure as [69–71]:

- Public funding for fast charging stations every 50 km on main roads.
- Oslo's expansion of its budget for EV charging infrastructure deployment in 2018.
- Doubling the budget allocated to housing associations for installing chargers, to reach 20 million NOK (2.1 million EUR).
- Certain local service stations have begun to replace petrol pumps with EV chargers, upping the local charging infrastructure available to EV owners.

As already mentioned, national initiatives regarding electromobility are specific to each country, but with Norway being the leader, Norwegian government initiatives can serve as a basis for policymakers in other countries.

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