Review

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Light Electric Vehicles and Sustainable Transport in Urban Areas: A Bibliometric Review

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Review

Light Electric Vehicles and Sustainable Transport in Urban Areas: A Bibliometric Review

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Abstract

The use of light electric vehicles, such as e-bikes and e-scooters, is increasingly being adopted as a sustainable transport solution in urban areas. This is driven by the need for cleaner, faster, and space-efficient mobility solutions in urban areas. Although research on LEVs has grown over time, it remains fragmented across disciplines, creating a need for an integrated study on how LEVs contribute to sustainable transport in urban areas. This study conducted a bibliometric review to identify key themes in light electric vehicles and sustainable transport in urban areas and proposed future research agendas based on the conceptual patterns and research gaps. It utilised the Scopus database, focusing on the 552 publications from 2000 to 2025 retrieved on 30 September 2025. The Biblioshiny application (version 5.0) was used to perform bibliometric performance analysis and science mapping techniques. Results revealed that the publication trend steadily rose from 2015, with a significant upsurge after 2020, with an annual growth rate of 18.69%. Three dominant themes were identified: sustainability, integration with public transport, and technological innovations, alongside underexplored areas such as shared e-micromobility, freight delivery, as well as policy and governance. Future research should capture full lifecycle impacts, expand access to light electric vehicles beyond current user groups, and align rapid technological advances with inclusive governance frameworks.

Keywords: light electric vehicle; sustainable transport; urban; bibliometric review

1. Introduction

Urban areas globally face transport-related challenges, including traffic congestion, infrastructural limitations, air and noise pollution [1–6]. For example, only about 52 per cent of the world's urban population has convenient access to public transport, and the transport sector contributes roughly one-quarter of global energy-related carbon emissions [6]. With the number of vehicles in the world's top 100 cities expected to grow by 36 per cent by 2030 [7], these challenges are likely to intensify. As a result, there has been a shift from the use of private cars to emerging mobility solutions such as micro-vehicles to improve urban transportation [1,8]. Light electric vehicles (LEVs), such as e-bikes, e-scooters, and e-skateboards, have emerged as a key innovation for promoting urban sustainability [1,2,9]. They are a critical component of the transition to low-carbon, user-centered urban mobility systems. Urban areas that have integrated LEVs into their broader transport systems have witnessed transformations in urban form, land use, and citizen mobility behaviors [10,11]. These transformations align with the global commitments to the United Nations' Sustainable Development Goal (SDG) 11 - Sustainable Cities and Communities – which calls for an inclusive, safe, resilient, and sustainable urban areas. These developments demonstrate the growing potential of LEVs in promoting sustainable transport in urban areas.

There is, however, no universally agreed definition of light electric vehicles [1]. Various scholars define light electric vehicles differently. For instance, light electric vehicles refer to micromobility modes powered by a battery-powered electric motor, and are characterised by their light weight, energy efficiency, and spatial demands [12]. These include e-scooters and e-bikes, which are limited to 25 kilometres per hour (km/h), as well as electric two-wheelers with a speed limit of 45 km/h [12]. Similarly, LEVs refer to small, lightweight electric-powered vehicles weighing less than 350 kg and a maximum speed of 45 km/h [13]. A light vehicle is a low-weight motorised transport with limited speed, often up to 45 km/h, used mainly for urban trips [1]. This ranges from micro-vehicles, such as e-scotters, to light three- or four-wheeled vehicles [1]. In this study, a light electric vehicle can be defined as a small, lightweight battery-powered transportation mode designed for short urban trips, with a limited speed of up to 45 km/h.

From an urban sustainability perspective, LEVs support sustainable urban development. Sustainable transport entails reducing dependence on fossil fuels, lowering air pollution and excess carbon dioxide emissions, easing congestion, and resolving inequities in access to transportation [14]. LEVs are changing how people travel over short distances in urban areas, effectively transforming urban transportation [15]. LEVs reduce carbon emissions, require less urban space, and provide flexible transportation options to conventional vehicles for short trips in urban areas [16,17]. They have the potential to support clean, quiet urban areas that enhance the physical well-being of citizens [18,19]. In addition, they promote equity in transportation by providing affordable, reliable, and equitable transportation options. Moreover, they enhance the human experience of urban transport by providing a pleasant atmosphere created by the built environment [20].

Despite these advantages, the large-scale use of LEVs in urban areas is hindered by numerous challenges, including safety concerns, inadequate charging infrastructure, high initial costs, limited riding range, and long charging times [21–24]. Regulations for micromobility remain weak in many cities, creating gaps in safety rules, road-use guidelines, and infrastructure [24]. Infrastructure remains one of the most critical obstacles to LEV and micromobility adoption, as many cities still lack safe, dedicated lanes and basic facilities needed for everyday use [24]. Urban regulations and infrastructure design have struggled to keep pace with the uptake of LEVs in some countries. In agreement, Ombati [25] recommends more research on how regulatory frameworks can be designed to facilitate fair and inclusive transitions to socially sustainable e-mobility solutions. While LEVs can potentially reduce noise and pollution [26], riders can still be exposed to particulate matter and noise pollution from other vehicles in cities [27,28]. Riders also use more physical energy than other modes **[29].** Thus, their sustainability potential depends on supportive infrastructure, policy frameworks, and technological advancements.

Although numerous studies have explored LEVs from different perspectives, the current literature remains fragmented and lacks an integrated understanding of how LEVs contribute to sustainable transport in urban areas. Prior studies are dispersed across multiple disciplines, such as urban planning [1,2,17,19,21], social sciences [3,12], engineering [13], and environmental science [16,18,20]. Existing studies also focus on isolated themes, such as barriers [22,23], adoption intentions [3,13,30,31], sustainability impacts [32,33], land use [1], and safety [34]. Although some reviews have explored some specific issues, such as safety [35], policy frameworks [9], and environmental benefits [16], little is known of a study that employed bibliometric techniques to review existing studies on LEVs and sustainable transport in urban areas. Thus, this review provides a comprehensive bibliometric mapping of LEVs in relation to sustainable transport in urban areas. The following research objectives guide the study:

1. To identify the key themes used in light electric vehicles and sustainable urban transport research.
2. To propose future research agendas in light electric vehicles and sustainable urban transport research.

The next phase of the paper is structured as follows: Section 2 focuses on the materials and methods; Section 3 presents the results; Section 4 discusses the findings; and Section 5 concludes the study with recommendations for future research.

2. Materials and Methods

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Given the rapid growth and interdisciplinary nature of this field, a bibliometric review offers a timely and rigorous approach to mapping its intellectual structure. Bibliometric analysis allows for the systematic quantification of research patterns, including the evolution of themes, prolific authors and institutions, influential publications, and knowledge gaps [36]. To achieve the objectives, 725 publications were retrieved from the Scopus database on 30 September 2025 using the following search query: Title-Abs-Key((("electric") AND ("bike" OR "bicycle" OR "cycle" OR "two wheeler" OR "three wheeler" OR "trike" OR "tricycle" OR "motorbike" OR "motorcycle" OR "scooter" OR "rickshaw" OR "micromobility" OR "moped" OR "hoverboard" OR "skateboard" OR "rideable" OR "quadricycle" OR "unicycle") OR "e-bike" OR "e-bicycle" OR "e-cycle" OR "e-two wheeler" OR "e2w" OR "e3w" OR "e-three wheeler" OR "e-trike" OR "e-tricycle" OR "e-motorbike" OR "e-motorcycle" OR "e-scooter" OR "e-rickshaw" OR "e-micromobility" OR "e-moped" OR "pedelec" OR "personal electric vehicle" OR "PEV" OR "light electric vehicle" OR "LEV" OR "micro electric vehicle" OR "MEV" OR "e-quadricycle" OR "L-category vehicle" OR "neighborhood electric vehicle" OR "e-unicycle" OR "shared micromobility") AND (("sustainable") AND ("transport" OR "transit" OR "mobility")) AND ("urban" OR "town" OR "city" OR “cities” OR "metropolitan")). Combining the listed keywords and Boolean operators was meant to minimise the risk of missing relevant studies. The Scopus database was utilised because it is a reputable source of metadata records required in bibliometric studies [37]. In addition, the Scopus database provides wider, inclusive content coverage, more complete and structured metadata compared to other databases such as Google Scholar and Web of Science [38,39].

The inclusion criteria for publications comprised of articles, conference papers, book chapters, and reviews written in English and published between 2000 and 2025. The timeframe was selected to understand the evolution of LEVs' research in the 21st century. The abstracts and topics of the 725 retrieved publications were screened for relevance, resulting in 552 publications. The exclusion criteria applied to publications that lacked topics, abstracts, or were irrelevant. The excluded irrelevant publications related to topics on heavy electric vehicles, such as buses and trucks, non-urban transport contexts, and sustainability studies not specifically addressing LEVs. These exclusions refined the required data set to include only those strictly aligned with the topic. There were no duplicates identified during the screening of abstracts and topics. This was done by manually comparing publication titles, authors, and years. The 552 publications were exported from the Scopus database in a CSV Excel file for bibliometric analysis (Supplementary File S1). The analysis, comprising performance analysis (such as top authors, journals, affiliations, and citation analysis) and science mapping (such as thematic map and thematic evolution), was performed using the Biblioshiny application (version 5.0), an interactive web interface within the Bibliometrix R package. This process involved generating relevant performance indicators and science mapping visualisations using built-in functions to compute performance indicators and generate relevant science mapping visualisations. These were used to identify key research themes and development over time on the topic. The future research agendas were derived from conceptual patterns, research gaps, and emerging themes. Results show that research on LEVs and sustainable urban transport is rapidly growing (18.69% annual growth), and relatively young (average age 3.64 years) (Table 1). The dominance of articles and conference papers, with few reviews, highlights the need for synthesis and consolidation of existing knowledge on the topic.

Table 1. Descriptive summary of the 552 publications (2000–2025).

Description	Results
Timespan	2000:2025
Sources (journals, books, etc.)	207
Documents	552
Annual growth rate %	18.69
Document average age	3.64
Average citations per doc	14.68
References	4144

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DOCUMENT CONTENTS	
Keywords plus (ID)	3042
Author's keywords (DE)	3960
AUTHORS	
Authors	3295
Authors of single-authored docs	0
AUTHORS COLLABORATION	
Single-authored docs	0
Co-authors per doc	11
International co-authorships %	20.83
DOCUMENT TYPES	
Article	324
Book chapter	28
Conference paper	188
Review	12

3. Results

This section is organised into two parts: performance analysis and science mapping. These results were used to understand the underlying themes and underexplored areas from which future research agendas were proposed.

3.1. Performance Analysis

The first phase, from 2000 to 2014, reveals little research output, with less than six publications per year (Figure 1). The use of LEVs for sustainable transport in urban areas was a new concept during this phase. From 2015, the number of publications began to grow steadily, increasing from 9 to 15 by 2019. This phase coincided with the early implementation of SDGs. The phase, from 2020 to 2023, reveals significant research output, peaking at 118 publications in 2024. The use of LEVs became common in urban areas during this phase driven by demand for clean transport, and technological advancements. The drop in publications to 103 in 2025 is due to the incomplete year, but is expected to rise above the record in 2024 once all publications are indexed.

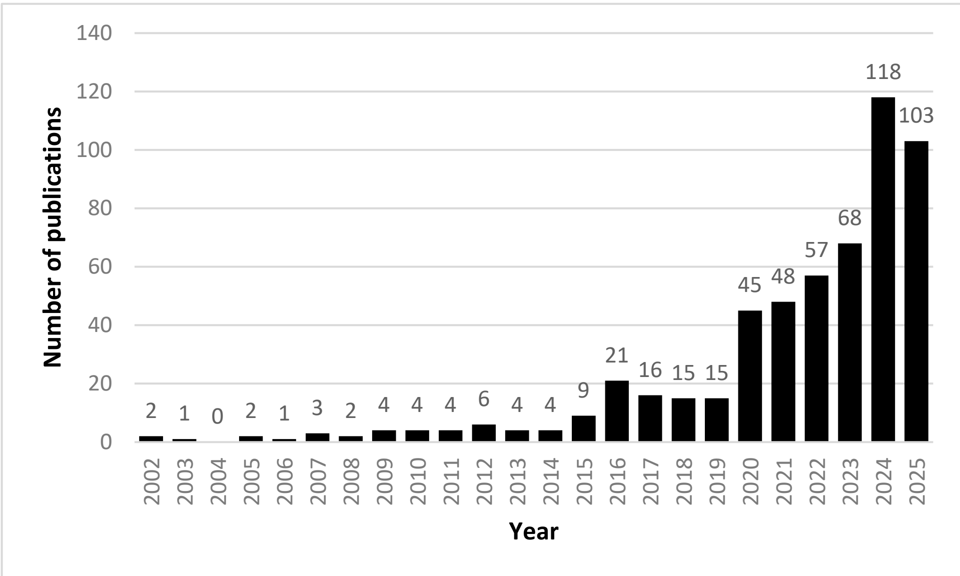

Figure 1. The annual number of publications.

3.1.1. Top Journals on the Topic

The *Sustainability* journal is the most influential journal, with 33 publications, an h-index of 15, an m-index of 1.667, and 726 total citations calculated from 2017 (Table 2). This is a broad emerging journal with the highest m-index, focusing on areas like the environment, policy, and technological aspects directly linked to LEVs and sustainable transport in urban areas. The *Energies* and *Transportation Research: Part A and D* are also emerging journals focusing on specialised topics. For instance, the *Energies* journal covers specialised topics in energy technologies, batteries, and charging systems. The top journals, such as *Sustainability, Sustainable Cities and Society, Transportation Research Part D, Energies*, and *Journal of Cleaner Production*, focus on the environmental and urban sustainability theme. The *Transportation Research Part A, Journal of Transport Geography*, and *Case Studies on Transport Policy* focus on the policy theme. Journals like *Sustainability, Energies,* and the *Journal of Cleaner Production* focus on an additional theme known as technological advancements in LEVs, particularly in areas such as batteries, charging systems, and cleaner manufacturing. Thus, the top journals concentrate on sustainability, policy, and technology.

Table 2. Top 10 journals on light electric vehicles and sustainable transport in urban areas (2000–2025).

Rank	Journal	h-Index	g-Index	m-Index	TC	NP	PY_Start
1	Sustainability (Switzerland)	15	26	1.667	726	33	2017
2	Transportation Research Part D: Transport and Environment	14	20	1.273	1306	20	2015
3	Sustainable Cities and Society	12	15	0.8	516	15	2011
4	Transportation Research Part A: Policy and Practice	10	15	1.111	549	15	2017
5	Energies	9	17	1.125	310	17	2018
6	Journal of Cleaner Production	8	11	1	417	11	2018
7	Journal of Transport Geography	8	9	0.8	419	9	2016
8	Transportation Research Procedia	6	12	0.6	146	15	2016
9	Case Studies on Transport Policy	4	6	0.667	79	6	2020
10	European Transport Research Review	4	6	0.364	240	6	2015

h-index: Hirsch's index. g-index: Egghe's index. m-index: Hirsch's mean index. TC: Total citations. NP: Number of publications. PY Start: Publication year start.

3.1.2. Top Authors on the Topic

Table 1 reveals 3 295 authors contributed to publications on the topic. *Campisi Tiziana* is the most influential author, with nine publications, a h-index of 5, an m-index of 1.25, and 38 total citations calculated as from 2022 (Table 3). This is an influential emerging author with the highest m-index, focusing on areas such as user behavior, policy, and infrastructure design, as well as the safety of LEVs in sustainable urban mobility. *Severengiz Semih* is also an influential emerging author with an m-index of 1.25 from seven publications computed from 2022. The author focuses on areas like user acceptance, charging innovations, shared mobility, and the role of LEVs in reducing emissions for both passenger and freight transport. *Cherry Christopher R.* is a veteran author with the highest number of total citations (333) from four publications, counted from 2007. The author's influential studies focus on LEV areas like user behavior, sustainability impacts, and integration with public transport.

Table 3. Top 10 authors on light electric vehicles and sustainable transport in urban areas (2000–2025).

Rank	Element	h-Index	g-Index	m-Index	TC	NP	PY_Start
1	Campisi, Tiziana	5	5	1.25	38	9	2022
2	Severengiz, Semih	5	6	1.25	40	7	2022
3	Cherry, Christopher, R.	4	4	0.211	333	4	2007
4	Comi, Antonio	4	5	1	77	5	2022
5	Schelte, Nora	4	4	1	35	4	2022
6	Tesoriere, Giovanni	4	4	1	26	4	2022
7	Abbasi, Sorath	3	3	0.5	301	3	2020

8	Behrendt, Frauke	3	4	0.3	215	4	2016
9	Castiglione, Marisdea	3	3	0.75	68	3	2022
10	De Vincentis, Rosita	3	3	0.75	68	3	2022

h-index: Hirsch's index. g-index: Egghe's index. m-index: Hirsch's mean index. TC: Total citations. NP: Number of publications. PY Start: Publication year start.

3.1.3. Top Author Affiliations on the Topic

Top author affiliations are institutions linked to the most prolific researchers based on the number of publications credited to them. Table 4 shows Italy leads with nine institutions, followed by Germany and China, each with three institutions. Developing economies in Africa and South America are underrepresented in the list of top author affiliations.

Table 4. Top author affiliations on light electric vehicles and sustainable transport in urban areas (2000–2025).

Rank	Institution	Frequency
1	Università Degli Studi Di Brescia	40
2	Ruhr-Universitat Bochum	28
3	Alma Mater Studiorum Università Di Bologna	21
4	Politecnico Di Milano	21
5	College of Engineering	20
6	Southeast University	20
7	Budapest University of Technology and Economics	19
8	Not reported	19
9	Deutsches Zentrum Für Luft- Und Raumfahrt (Dlr)	18
10	Università Degli Studi Di Firenze	17
11	Tongji University	15
12	Università Degli Studi Di Enna "Kore"	15
13	Università Degli Studi Roma Tre	15
14	Universidad Politécnica De Madrid	14
15	Università Degli Studi Di Padova	14
16	Sapienza Università Di Roma	13
17	Technische Universität Braunschweig	13
18	Università Degli Studi Di Roma "Tor Vergata"	13
19	Aristotle University of Thessaloniki	12
20	Beijing Jiaotong University	12

3.1.4. Top Countries on the Topic

Table 5 shows that Italy leads in scientific production with 304 publications, followed by India (182), Germany (169), and China (165). Research in Italy primarily focuses on LEVs, smart digital mobility, and inclusive urban transport solutions. Research in India mainly focuses on electric scooters as affordable, low-carbon solutions for urban mobility and last mile delivery. Furthermore, research on the topic shows Europe as the dominant hub (13 countries), with Asia as an emerging region with four countries. Africa and South America are not featured in the list of most productive countries.

Table 5. Top 20 countries' scientific production on light electric vehicles and sustainable transport in urban areas (2000–2025).

Rank	Country	Frequency
1	Italy	304
2	India	182
3	Germany	169

4	China	165
5	Spain	118
6	United States of America	106
7	United Kingdom	90
8	Portugal	67
9	Poland	58
10	Indonesia	54
11	Greece	46
12	Netherlands	39
13	France	32
14	Belgium	31
15	Sweden	30
16	Turkey	28
17	Colombia	26
18	Ireland	24
19	Australia	21
20	Switzerland	21

3.2. Science Mapping

3.2.1. Co-Authorship Analysis

Co-authorship analysis helps identify collaboration patterns in a topic, for example, among countries affiliated to various researchers [36]. Country collaboration maps are used to graphically represent the direction and intensity of research collaborations among countries [40]. European countries (specifically, Italy, Germany, and the United Kingdom) have the strongest collaborations (thickest line) with China (Figure 2). The USA also reported stronger collaborations with the European countries and China. For instance, research collaborations between the USA and China relate to themes such as LEV innovations, service quality improvement, and transportation energy efficiency. The highest research output (represented in dark blue) was also noted in European countries (specifically, Italy, Germany, and the United Kingdom), the USA, China, and India. Some research output (represented in light blue colour) is emerging from countries such as Brazil, South Africa, Canada, and Australia. For instance, research emerging from South Africa relates to the feasibility assessment of LEVs in terms of their impact on the grid and charging infrastructure. Most countries in Africa are underrepresented in research output (represented in grey colour).

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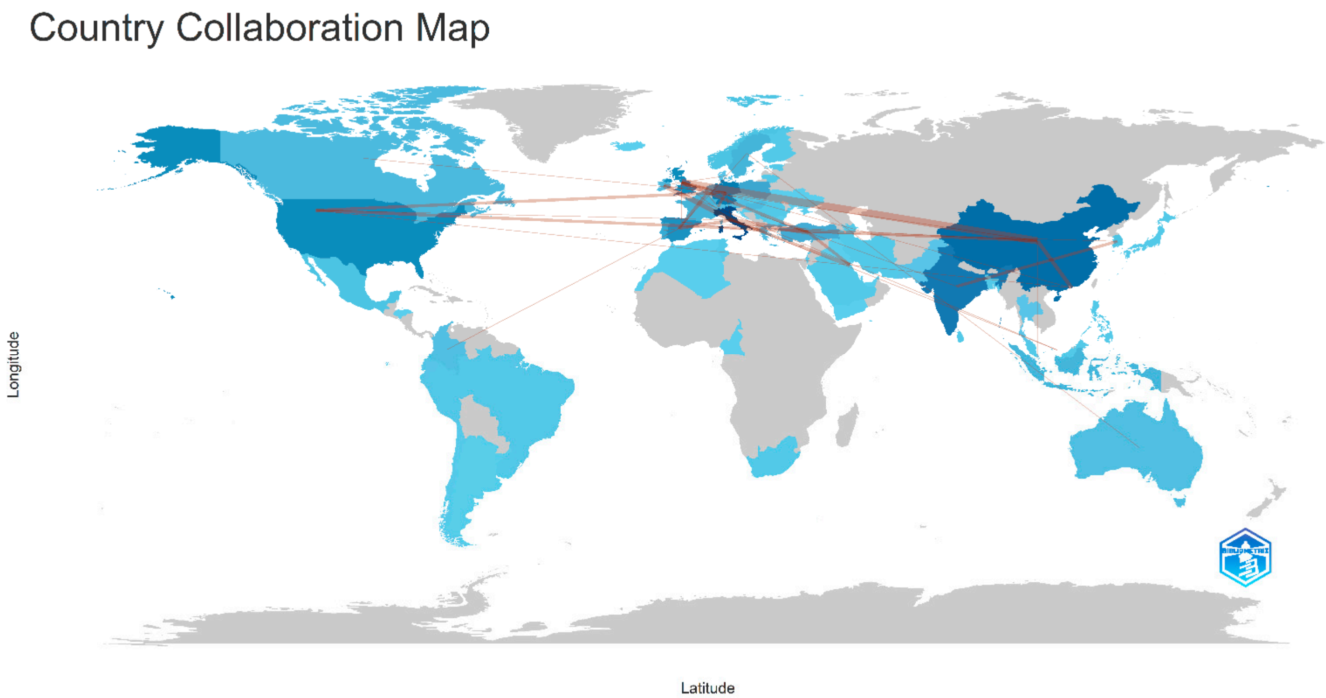

Figure 2. Country collaboration map on light electric vehicles and sustainable transport in urban areas (2000–2025).

3.2.2. Word Analysis

Word analysis helps identify commonly used keywords from publications on a topic and their interrelationships. For instance, a word cloud is used in word analysis to visually represent the keywords commonly used in publications and their relationships on a topic [41]. The keywords used in the search query, as well as generic and methodological terms, were excluded when generating the word cloud (Supplementary File S2). This is because the excluded words appear in most publications and are likely to overshadow other important terms meant to reveal intellectual patterns. Some of the generic or methodological terms excluded are *article, surveys, regression analysis, case-studies, vehicles, transportation,* and *China*. *Greenhouse gas emissions, public transport, smart city, shared mobility,* and *freight transportation* were each merged with their related variants (Supplementary File S3). Figure 3 shows *public transport* as the most prominent keyword, located at the centre of the word cloud. This shows that the integration of LEVs into public transport is core to urban transport systems. Other keywords in the integration with public transport theme include *transport system* and *sharing systems*. *Environmental impact* is located at the centre of the word cloud. Other keywords in the sustainability theme include *greenhouse gas emissions, global warming, air pollution, air quality, lifecycle assessment, energy efficiency, energy utilisation, climate change, economic and social effects.* This reflects the foundational role that the LEVs play in reducing emissions, improving energy efficiency, and improving the quality of life in urban areas. *Smart city* is also located at the centre of the word cloud. Other keywords in the technological innovations theme include *secondary batteries, machine learning,* and *battery management systems.* This cluster demonstrates how LEV technologies and digital urban systems facilitate the promotion of sustainable transport in urban areas. The operational and planning theme include keywords like *urban planning, transportation planning, travel behaviour, decision-making, sensitivity analysis, transportation policy, decision making, economics,* and *transportation mode*. This highlights the need for policy frameworks, economic viability, and user-centered mobility planning in urban areas. Keywords such as *last mile, fleet operations, optimisation, accessibility,* and *freight transport* represent emerging areas of future research focused on the operational and logistical aspects of LEVs' adoption in urban areas. However, the word cloud underrepresents keywords related to *governance, equity, infrastructure, health* and *safety* of LEVs.

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Figure 3. Word cloud on light electric vehicles and sustainable transport in urban areas (2000–2025).

3.2.3. Thematic Mapping

Thematic mapping uses keywords to visually represent the importance or development of words within a topic [41]. This is visualised using four quadrants displayed in Figure 4: motor themes - central and developed, basic themes - central but undeveloped, emerging or declining themes - peripheral and undeveloped, and niche themes - peripheral yet well-developed [42,43]. The keywords used in the search query, as well as generic and methodological terms, were also excluded when generating the thematic map (Supplementary File S2). *Greenhouse gas emissions, public transport, smart city, shared mobility,* and *freight transportation* were each merged with their related variants (Supplementary File S3).

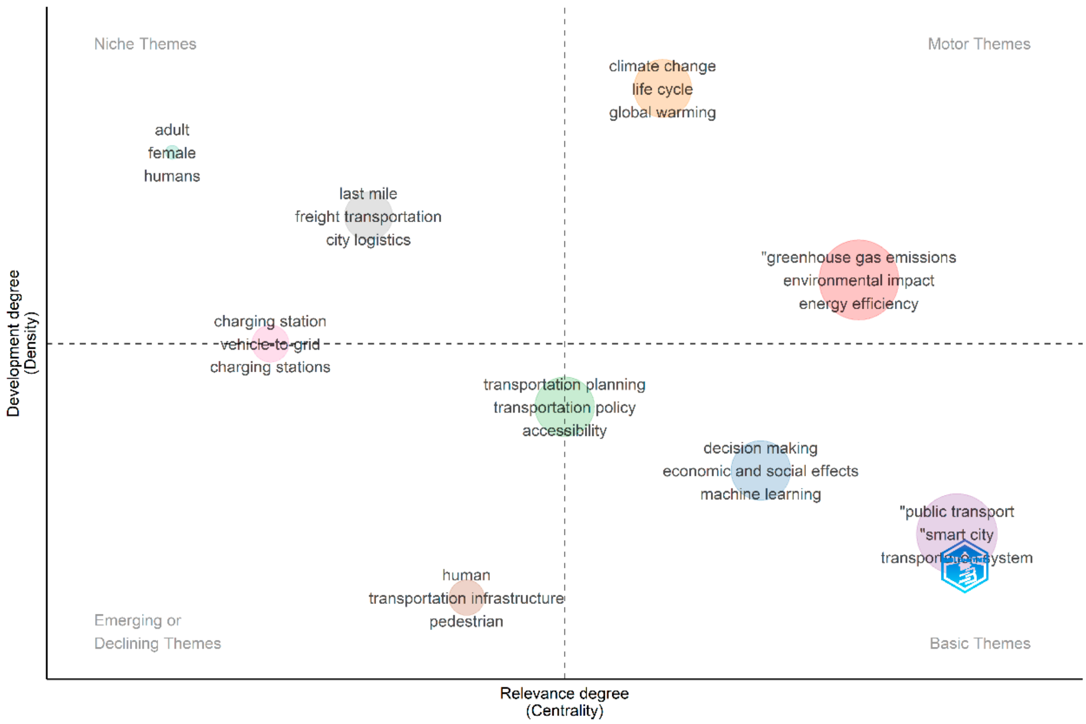

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Figure 4. Thematic map on light electric vehicles and sustainable transport in urban areas (2000–2025).

Figure 4 shows that sustainability-related research, including keywords like *climate change, life cycle, global warming, greenhouse gas emissions,* and *energy efficiency,* are positioned as a motor theme. This is a well-developed and central theme to the topic, thus forming the foundation for contributing to sustainability by reducing transport-related emissions and ensuring energy efficiency in urban areas. The basic theme includes keywords like *smart city, transportation systems, public transport, decision-making, machine learning, economic and social effects* that are central but less developed. This highlights that the integration of LEVs with public transport is central to smart cities, promoting intelligent and sustainable transport in urban areas. Since these are relevant but underexplored areas, extensive research is necessary to harness the potential of LEVs for sustainable transport in urban areas. The niche theme includes keywords like *last mile, freight transportation,* and *city logistics*. This highlights the specialised but underexplored areas where LEVs can enhance freight delivery in urban areas. In addition, keywords such as *adult, female,* and *male* suggest that social and demographic studies remain underexplored. The emerging or declining theme, including keywords like *charging stations, vehicle-to-grid, transportation infrastructure, human,* and *pedestrian*. This indicates that infrastructure and human-centered aspects are either just starting to gain attention or are not receiving enough attention from researchers.

3.2.4. Thematic Evolution

Thematic evolution was divided into four periods based on the trend in the increasing number of publications, as shown in Figure 1. The keywords used in the search query, as well as generic and methodological terms, were also excluded when generating the thematic evolution (Supplementary File S2). *Greenhouse gas emissions, public transport, smart city, shared mobility,* and *freight transportation* were each merged with their related variants (Supplementary File S3). The evolution of LEVs and sustainable transport in urban areas research shifts from broad environmental issues to specialised, narrower, technology-driven, user-centered, and policy-oriented issues (Figure 5). From 2000 to 2014, researchers primarily focused *on greenhouse gas emissions, pollution, public transport,* and general electric vehicle technologies such as *fuel cells* and *automobiles.* This lays the foundation for environmental sustainability for LEVs development. A focus on smart city issues characterised the period from 2015 to 2019 as the *smart city* keyword connects previous and subsequent periods. In addition, keywords such as *secondary batteries* and *smartphones* suggest a shift from general environmental concerns to technology-driven transport in urban areas. From 2020 to 2023, research areas became increasingly interconnected, with a primary focus on *public transport, smart city, environmental impact,* and *performance*. This shows a need to balance environmental concerns, system performance, and technological advancements. The presence of the keyword *transport infrastructure* shows a crucial component required to support the evolution of smart and sustainable transport in urban areas. The 2024 to 2025 period includes keywords like *energy policy, traffic congestion, consumption behaviour, innovation, charging(batteries),* and *machine learning*. This shows a shift toward policy, operational concerns, and technological advancements. The post-2025 period has already begun focusing on user and behavioural areas, such as *accessibility, human*-centric choices, *eco-friendly* options, *shared mobility,* and the role of *policymakers*. In addition, the focus has continued on advanced technologies such as *charging (batteries), machine learning,* and *optimisation*. This shows that future research on LEVs and sustainable transport in urban areas should not only be technology-driven but also user-centered. *Shared mobility, built environment, roads and streets* reflect the need to integrate LEVs into urban spaces. It was noted that the topic of *public transport* and environmental issues, such as *greenhouse gas emissions, pollution, environmental impact,* and *eco-friendly* solutions, recur across the thematic evolution. This highlights their crucial role in addressing broad environmental issues , as well as specialised, narrower, technology-driven, user-centered, and policy-oriented issues, in promoting sustainable transport in urban areas.

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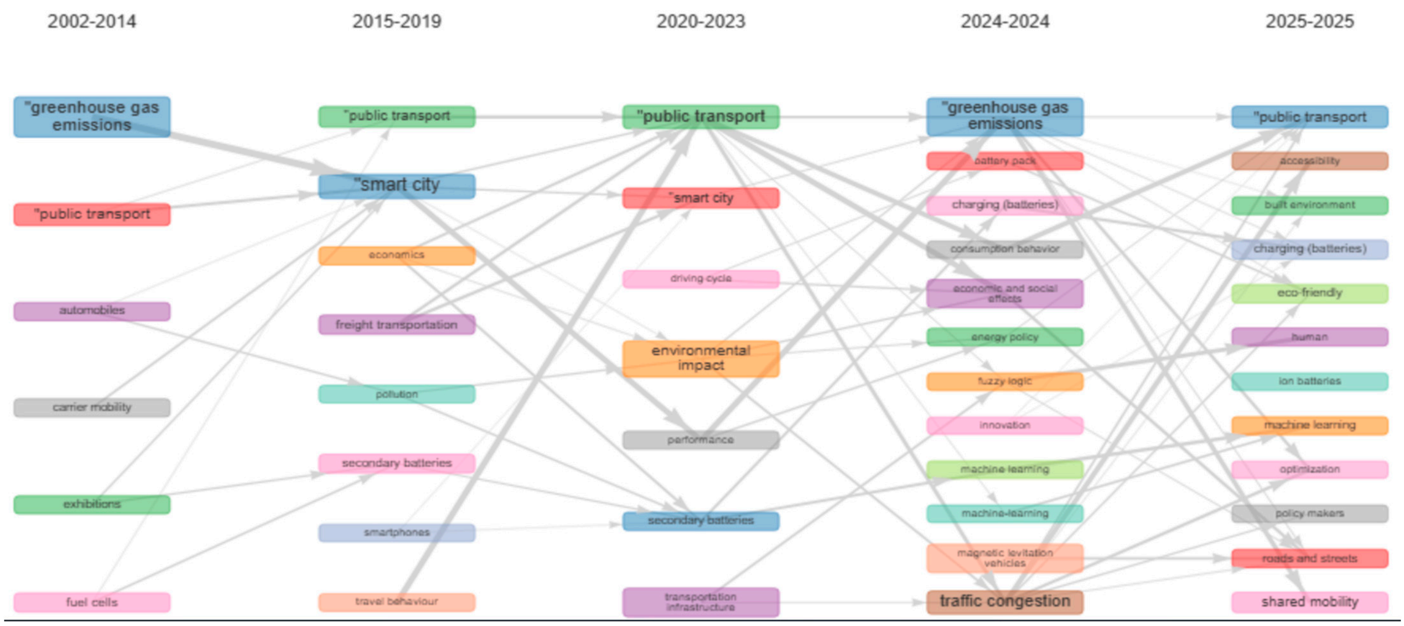

Figure 5. Thematic evolution on light electric vehicles and sustainable transport in urban areas (2000–2025).

3.2.5. Citation Analysis

Table 6 outlines the most-cited studies on LEVs and sustainable transport in urban areas. Oeschger et al. [15] have the highest citations per year, at 43.50, for their review of the integration of micromobility and public transport. The review is influential on the topic by setting research priorities in the social impacts of integrating micromobility and public transport. These include reducing inequalities and promoting social inclusion. The top cited publications focus on key themes like integration with public transport, adoption drivers and sociodemographic profiles, freight transportation, sustainability and efficiency trade-offs, and safety. Integration of LEVs with public transport emerges as a key theme in the top cited publications on the topic [15,44–50]. Although studies have explored user preferences and the reasons for integrating micromobility with public transport, few have examined its social impacts. These include reducing societal inequalities and promoting social inclusion [15]. Existing studies show that bike sharing and e-scooters are utilised to either replace or complement other modes of transport, such as walking and public transport [44–47,49]. For instance, in Norway, bike sharing complements public transport in areas lacking a metro and rail network [45]. In the USA, shared e-scooters compete with the bus transportation system in downtown areas but complement it in areas outside downtown [49]. However, the LEVs are primarily used by young, educated men [44,45,51]. This reveals some underexplored groups, such as low-income individuals, women, and older people. The use of e-scooters for transportation is discouraged due to safety issues, arising from the non-use of helmets, inconsistent regulations, and riding under the influence [34]. The increasing use of e-mobility devices has led to conflicts over the sharing of street space, raised concerns about road safety, and resulted in an increase in traffic offenses [52]. This shows that gaps remain in the regulatory frameworks that can enhance the safety of LEVs, thereby offering sustainable transport in urban areas. The theme of sustainability and efficiency trade-offs also features prominently in the list of top-cited publications [32,33,46,51,53–55]. Weiss et al. [32] noted that LEVs such as e-bikes and scooters have the potential for energy efficiency. However, environmental benefits such as reduced emissions from the use of electric two-wheelers may differ regionally due to factors like infrastructure characteristics, electricity mix, geographic conditions, and mode-shift behaviour [53]. In urban areas, electric cargo bikes can replace conventional vans, resulting in a reduction in carbon emissions [55]. However, the use of LEVs in last mile freight delivery in urban areas remains an underexplored area. Bike-sharing has been adopted mainly in densely populated areas, particularly by individuals concerned about climate change [51].

Ecer et al. [33] developed a robust framework to assess the sustainability of micromobility options. Despite the focus on sustainability studies, little attention is given to the lifecycle impacts of LEVs, including those from manufacturing, maintenance, and disposal. Adoption drivers and sociodemographic profiles also emerge as a theme in the top-cited publications [30,33,44,51,52,56]. For instance, the key sustainability factors used to evaluate and rank micromobility solutions include scenic adoption, accidents, and computing time [33]. Behavioral factors include perceived values, risks, performance, and social image [30,31]. Social, behavioral, economic, and infrastructural barriers hinder value co-creation in the e-bike sharing system in China [56]. Adoption is also influenced by policies and charging infrastructure [30,31,55]. Melo and Baptista [55] further demonstrate that policy support enables wider use of electric cargo bikes in urban areas. However, some gaps remain in the models regarding shared LEV usage and safety concerns. It was noted that most of the top-cited publications are based in urban areas from Europe, the USA, and Asia, leaving a gap in African and South American urban areas where infrastructure and cultural contexts differ.

Table 6. Top 10 most cited publications on light electric vehicles and sustainable transport in urban areas (2000–2025).

Author(s) and year	Title	Total Citations Per Year	Findings
Oeschger et al. [15]	Micromobility and public transport integration: The current state of knowledge.	43.50	The paper reviewed studies on the integration of micromobility and public transport. While most studies have focused on user preferences and reasons for integration, few have examined the social impacts, such as reducing societal inequalities and promoting social inclusion.
Laa & Leth [44]	Survey of e-scooter users in Vienna	33.17	The paper analysed the socio-economic profiles and usage patterns of e-scooter users in Austria. Most users are young males with good education, moving away from walking and public transport. It was recommended that cities should have policies that adequately allocate more space to cycling infrastructure.
Eccarius & Lu [30]	Adoption intentions for micro-mobility–Insights from electric scooter sharing in Taiwan.	30.33	The paper examined factors influencing the usage of e-scooter sharing services in Taiwan among university students. Students are most likely to use the service if it meets their values and transport needs.
Badia & Jenelius [46]	Shared e-scooter micromobility: review of use patterns, perceptions and environmental impacts	27.33	The paper reviewed studies on usage patterns, perceptions, and environmental impacts of shared e-scooter micromobility. Most studies indicate that shared e-scooters are used for leisure and are replacing walking and public transportation. However, limited studies have been undertaken on integration with public transport.
Böcker et al. [45]	Bike sharing use in conjunction to public transport: Exploring	25.67	The paper analysed the potential use of bike sharing when combined with public transport in Norway and how its use

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	spatiotemporal, age and gender dimensions in Oslo, Norway.		differs by age and gender. Bike sharing is used to complement public transportation, especially in areas without a metro or rail network. It is mainly used by young men, with women and older users underrepresented.
Weiss et al. [32]	Energy efficiency trade-offs in small to large electric vehicles	25.67	The study analysed the energy efficiency trade-offs in electric vehicles using energy consumption data from Germany, supplemented with additional data from China, Norway, and the USA. Results showed that energy use increases with vehicle mass, highlighting the efficiency potential of lighter EVs such as e-bikes and scooters.
Ecer et al. [33]	Sustainability performance analysis of micro-mobility solutions in urban transportation with a novel IVFNN-Delphi-LOPCOW-CoCoSo framework	22.67	The study presented a robust decision-making framework to evaluate the sustainability performance of micro-mobility solutions. Results showed that scenic adoption, computing time, and accidents are key sustainability factors, with electric scooters identified as the most promising micro-mobility solutions.
Mouratidis [51]	Bike-sharing, car-sharing, e-scooters, and Uber: Who are the shared mobility users and where do they live?	20.50	The study examined the factors influencing the use of bike-sharing and e-scooters in Norway. While bike-sharing is mostly used by young, single men concerned about climate change, e-scooter users are young, less educated men without disabilities in populated areas.
Eccarius & Lu [31]	Powered two-wheelers for sustainable mobility: A review of consumer adoption of electric motorcycles	19.00	The review paper on electric motorcycle adoption found that perceived value, risks, performance, social image, policies, and charging infrastructure influence consumer adoption. There still exist gaps in how shared use models operate, how social norms influence adoption, and how safety concerns affect users.
Kazemzadeh et al. [34]	Electric scooter safety: An integrative review of evidence from transport and medical research domains	19.00	The paper reviewed studies on the safety of e-scooters. Inexperienced riders, parking risks, and interaction risks were identified as the primary safety concerns associated with e-scooters. In addition, accidents primarily involve young male users. However, gaps remain in helmet use, consistent regulations, and riding under the influence.
Weiss et al. [53]	On the electrification of road transportation - A review of the environmental, economic, and social performance of electric two-wheelers	18.27	The paper reviewed studies on the environmental, economic, and social performance of electric two-wheelers. Electric two-wheelers can reduce energy use and emissions in road transport. However, their overall sustainable

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			performance varies regionally due to factors such as infrastructure characteristics, electricity mix, geographic conditions, and mode shift behaviour.
Bigazzi & Wong [47]	Electric bicycle mode substitution for driving, public transit, conventional cycling, and walking	18.00	The paper examined published studies to identify the mode substitution effects of electric bicycles. E-bikes mainly substitute public transport, followed by conventional bicycles.
Deveci et al. [48]	Sustainable e-scooter parking operation in urban areas using fuzzy Dombi based RAFSI model	17.33	The paper presented a model for determining the optimal parking location of e-scooters in urban areas. The best strategy for arranging sustainable parking slots is the use of geo-fenced hubs that are accessible via public transport.
Zagorskas & Burinskienė [52]	Challenges caused by increased use of e-powered personal mobility vehicles in European cities	17.00	The paper reviewed existing studies to identify challenges of e-powered mobility vehicles in Europe. The use of e-powered personal mobility vehicles in Europe creates major problems with street-space sharing, road safety, and traffic offences.
Ma et al. [56]	Value co-creation for sustainable consumption and production in the sharing economy in China	16.86	The study investigated how value co-creation in the sharing economy supports sustainable consumption and production in China. Social, behavioral, economic, and infrastructural barriers hinder the value co-creation process.
Luo et al. [49]	Are shared electric scooters competing with buses? A case study in Indianapolis	16.20	The study examined whether shared e-scooters compete with or complement bus transportation in Indiana, USA. E-scooters compete with the bus system in downtown areas and complement bus transport in areas outside Indiana's downtown, where bus coverage is low.
de Mello Bandeira et al. [54]	Electric vehicles in the last mile of urban freight transportation: A sustainability assessment of postal deliveries in Rio de Janeiro-Brazil	16.00	The study reviewed the use of electric vehicles as sustainable alternatives for last mile delivery of parcels. There is a trend of adopting smaller electric vehicles alongside bicycles, tricycles, and light delivery vehicles for more sustainable last mile urban deliveries.
Ma et al. [57]	Co-evolution between urban sustainability and business ecosystem innovation: Evidence from the sharing mobility sector in Shanghai	15.63	The paper examined how innovations, such as electric vehicle sharing, contribute to the development of a sustainable urban city in China. The study suggested increased awareness and coordinated governance of the co-evolution in urban systems to transform toward sustainability.
Melo & Baptista [55]	Evaluating the impacts of using cargo cycles on urban logistics: Integrating traffic, environmental and operational boundaries	15.11	The study examined the impact of electric cargo bikes from a public policy perspective in Portugal. E-cargo bikes can replace up to 10% of conventional delivery

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			vans in areas within a 2 km radius, reducing CO_2 emissions by up to 73%.
Lv et al. [50]	Spatiotemporal assessment of carbon emission reduction by shared bikes in Shenzhen, China	15.00	The study developed a model used to calculate carbon emission reductions from transport mode substitution and electrification trends in China. Shared bikes reduce emissions by 96 g in the central urban areas of Shenzhen city, mainly near subways, showing strong support for public transport.

4. Discussion

The findings presented in Section 3 reveal that the publication trend in existing research has had a substantial rise since 2020. The substantial growth since 2020 reflects rising academic and policy interest in understanding how LEVs contribute to sustainable transport in urban areas. The themes used in current research on LEVs and sustainable transport in urban areas remain uneven, with some themes attracting more research than others. Research on the topic focuses on three dominant themes: sustainability, integration with public transportation, and technological innovations. These themes confirm that the topic is becoming more interdisciplinary. Prominent authors, including *Campisi Tiziana, Severengiz Semih,* and *Cherry Christopher*, focus their research efforts on the three dominant themes. The sustainability theme was identified as the most dominant theme in the word cloud, based on keywords such as *environmental impact, greenhouse gas emissions, global warming, lifecycle assessment, and energy efficiency*. Prominent journals like *Sustainability* and the *Journal of Cleaner Production* contain research that primarily focuses on sustainability issues. While the top-cited publications emphasise the energy efficiency benefits of LEVs such as e-bikes and scooters [32], the lifecycle impacts from production to disposal remain underexplored. Such omissions suggest that current research may underestimate the broader sustainability implications of large-scale LEV deployment in urban areas. de Mello Bandeira et al. [54] assert that comprehensive sustainability assessments must account for environmental, social, and economic impacts across the entire lifecycle of electric mobility technologies**.** In addition, Oeschger et al. [15] advance this theme by identifying future research priorities related to the social dimension. These include the potential to reduce inequalities and promote inclusion in the urban use of LEVs. This supports the global commitments to the United Nations' SDG 11, which calls for an inclusive, safe, resilient, and sustainable urban area.

The integration of LEVs with public transport was also identified as a dominant theme. This corresponds to findings from top-cited publications, which show that integration with public transport is one of the most frequently addressed themes, with LEVs often complementing or substituting for buses or walking in urban areas [15,44–50]. Research evidence from India and other leading countries indicates a focus on e-scooters and e-bike sharing systems as an affordable and low-carbon mobility solution in urban areas. From an urban planning perspective, the finding suggests that LEVs are increasingly positioned as either complementary to or substitutes for existing public transport systems. This aligns with claims that urban areas are shifting from private cars to emerging micro-vehicles to improve urban mobility [1,8]. Technological innovation was also identified as a dominant theme, with strong representation from countries such as Italy and inclusion of journals such as *Energies* and the *Journal of Cleaner Production*. The thematic map reveals a research focus on specialised topics, such as *charging stations* and *vehicle-to-grid*. Shaheen and Cohen's [9] study reinforces this theme by demonstrating how emerging innovations continue to shape mobility planning globally.

Beyond the dominant themes, this review identified a few underexplored themes. These include shared electric micromobility services, equity and inclusion, freight delivery, as well as policy and governance. Top authors, such as *Campisi Tiziana, Severengiz Semih,* and *Cherry Christopher*, focus some of their research efforts on these underexplored themes. The top-cited publications revealed that adoption of LEVs in urban areas is influenced by functional aspects such as performance, safety, and cost. Furthermore, adoption is influenced by psychosocial factors like perceived risks, environmental values, and social image [30,31,33,51]. Other factors include enabling infrastructure, policies, and charging availability [31]. However, gaps remain in understanding how shared use models work for LEVs, as well as how social norms and safety concerns influence the adoption of LEVs. Findings from the thematic evolution post-2025 indicate interest in user needs and behaviours is emerging. Furthermore, findings from the thematic map further reveal that social and demographic aspects remain underexplored. LEV usage in urban areas is concentrated among young, educated men, leaving low-income groups, women, and older people significantly underrepresented [44,45,51]. The dominance of user groups with specific demographic characteristics suggests the need for policy and planning interventions that broaden participation and reduce exclusion in the adoption and usage of LEVs. Cairns et al. [58] further note that behavioural responses to micromobility vary across contexts, reinforcing the need to design inclusive and equitable LEV options. Policy and planning frameworks also emerge as an underexplored theme. Journals such as *Transportation Research Part A* and *Case Studies on Transport Policy* emphasise the importance of regulatory measures and infrastructure planning for sustainable transport in urban areas. Findings from the word cloud highlight the role of *fleet operations, travel behavior,* and *transportation policy* in urban transport. The limited attention to governance models underscores a lack of integrative evaluations of sustainability outcomes in urban transport. In agreement, Ombati [25] recommends more research on how regulatory frameworks can be designed to facilitate fair and inclusive transitions to socially sustainable e-mobility solutions. Freight delivery emerged as an underexplored area despite its growing relevance in urban logistics. Keywords such as *last mile, fleet operations*, and *city logistics* reveal increasing interest in understanding how LEVs can enhance sustainable freight systems in urban areas. Most top-cited publications indicate that electric cargo bikes can reduce emissions and improve last mile delivery efficiency [54,55]. This aligns with Mogire's [59] finding that freight transportation in urban areas is a critical topic for green innovations aimed at improving delivery efficiency and reducing carbon emissions. This suggests that there is an opportunity for future research to investigate how LEVs can enhance freight transport in urban areas.

5. Conclusions

A bibliometric review was undertaken to identify dominant and underexplored themes and recommend future research agendas on LEVs and sustainable transport in urban areas. It was observed that there is an increasing trend in research on the topic, driven by policy changes, technological advancements, and growing demand for clean transport. It was also established that existing research revolves around three dominant themes. These include sustainability, integration of LEVs with public transport, and technological innovations. A few studies highlighted underrepresented themes: shared e-micromobility, equity and inclusion, freight delivery, as well as policy and governance. The future research agenda should focus on the research gaps identified in these themes.

- Sustainability emerged as one of the most dominant themes. This included studies on the role of LEVs in relation to air quality and energy efficiency at the operational phase, ignoring the lifecycle impacts from manufacturing, maintenance, and disposal. Future studies should focus on assessing the lifecycle impacts of LEVs across various urban areas, especially in developing economies. This can include evaluating battery production and recycling pathways, as well as end-of-life waste systems in various urban areas. This can guide urban areas in setting realistic sustainability targets and policies for LEV adoption.
- Integration of LEVs with public transport was identified as a dominant theme. In addition, it was found that LEVs are commonly used in urban areas by younger generations. Future studies should focus on how LEVs can be more effectively integrated with public transport to promote equitable and sustainable mobility in urban areas. For example, future research studies should focus on the excluded groups, such as older generations, women, and individuals from low-

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income backgrounds. This may include examining accessibility, affordability, and behavioural barriers to ensure that integration of LEVs with public transport supports inclusive planning in urban areas.

- Technological innovation emerged as a dominant theme. However, social and policy frameworks supporting technological innovations remain underexplored. Future studies should examine how smart mobility applications influence equity in the use of LEVs in urban areas. In addition, comparative studies can be conducted across urban areas to identify best practices for aligning technological innovations with supportive regulatory and policy environments. For instance, such studies can clarify how governance models, data-sharing rules, and safety regulations influence the successful deployment of LEVs across various urban areas.
- Shared e-micromobility was identified as an underexplored theme. However, gaps exist about the equity impacts and safety concerns of shared e-micromobility in urban areas. Future studies can examine the shared services provided to disadvantaged groups, the safety risks associated with shared usage, and viable governance and business models to support these shared services. This can help urban planners to develop inclusive and safe shared e-micromobility solutions that meet the needs of diverse users in urban areas.
- Freight delivery was identified as an underexplored theme. Although a few studies have examined the role of electric cargo bikes in last mile delivery, existing research remains limited to specific contexts in Europe and South America. Future studies should examine the operational, economic, and policy implications of utilising LEVs for freight delivery in diverse urban contexts, particularly in developing economies. This includes evaluating business models, regulatory frameworks, and infrastructure requirements necessary to support the deployment of LEVs in freight delivery systems.

The bibliometric review was based on studies indexed in the Scopus database. This was due to its broad coverage and strong compatibility with science mapping tools. Whereas the extracted studies are relevant and comprehensive, using a single database may introduce selection bias, as some high-quality publications available in other databases might have been excluded. Future studies can utilise other databases, such as the Web of Science and Google Scholar, for comparative insights. The review utilised keywords captured in Section 2 to identify relevant publications on LEVs and sustainable transport in urban areas. Due to the young nature of the topic, emerging concepts may not be consistently used across studies and might have been excluded. Future studies can update the search strings with the new keywords as the topic advances. Finally, the review only included publications written in English, excluding relevant studies published in languages like Chinese and Russian. While this is a common practice in bibliometric studies to ensure consistency in metadata processing, it introduces a potential language bias that could limit the geographical diversity of the mapped research landscape. Future studies may address this limitation by incorporating multilingual databases or translation tools to capture a more diverse list of publications.

Overall, this bibliometric review extends knowledge on LEVs and sustainable transport in urban areas. The review has consolidated fragmented studies by identifying a coherent framework of three dominant themes (sustainability, integration with public transport, and technological innovations) and a few underexplored themes (shared e-micromobility, equity and inclusion, freight delivery, as well as policy and governance). This establishes a foundation for future frameworks on the topic. The review also emphasises the shifting focus in research from broad environmental issues to specialised, narrower, technology-driven, user-centered, policy-oriented concerns. Furthermore, the identified research gaps, such as lifecycle impacts, equitable integration with public transport, governance models, inclusive shared services, and freight applications, offer a focused agenda for strengthening future policy and planning decisions. For instance, policymakers need to design regulations that promote equitable access to LEVs in urban areas.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

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