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One Policy Does Not Fit All Mode–Policy Fit in Electric Two-Wheeler Transitions: A Comparative Bibliometric and Lexical Analysis of Policy and Governance Research 2000–2025

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Abstract

Electric two-wheelers share electric propulsion, but policy questions for sustainable transportation differ across vehicle types and uses. This study examines 973 Scopus records published during the period 2000–2025 using bibliometric mapping and non-exclusive lexical coding across six governance domains and five life-cycle stages. Lexical profiles suggest shared operational visibility in scooter- and bicycle-labelled records and greater market-formation and incentive visibility in motorcycle/moped records. A later paired retrieval shows sensitivity to the governance query condition. Two researchers independently coded a stratified 100-record sample and resolved disagreements by consensus. Design-weighted mode F1 ranged from 0.676 to 0.968, whereas weighted precision was 0.344 for regulation/standards and 0.326 for operation/integration; maintenance/second-life recall was 0.081. These errors prevent interpreting dictionary shares as validated thematic prevalence or downstream research gaps. Keyword communities also vary across specifications. Mode–policy fit is therefore presented as a framework for generating contextual evaluation questions, rather than an empirically validated account of policy needs or effectiveness. The study supplies reproducible lexical outputs, completed human validation and explicit limits on their substantive interpretation.

Keywords: electric two-wheelers; mode–policy fit; policy mix; governance; life cycle; sustainable transportation

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1. Introduction

Electric two-wheelers (ETWs) encompass diverse mobility functions and institutional settings. Pedal-assist bicycles may use cycling networks and connect to public transport; shared standing scooters bring parking and pedestrian-access questions; electric mopeds and motorcycles may substitute for combustion-powered vehicles in personal

or commercial travel. These are contextual distinctions, not universal vehicle classifications. Environmental and social performance also depends on the displaced mode, electricity mix, vehicle lifetime, battery production, fleet collection and end-of-life treatment [1–4].

This heterogeneity creates a policy-design problem. A speed rule, parking permit, or geofencing requirement designed for a shared standing e-scooter addresses a different bottleneck from a purchase incentive, battery-swapping standard, or industrial localization measure aimed at electric motorcycles. Likewise, a cycling-infrastructure intervention that improves e-bike integration may have limited relevance to commercial motorcycle fleets. Treating ETWs as a homogeneous policy object can therefore obscure differences in transition stage, externalities, governance level, and life-cycle risk. The central policy question is not simply which instruments support ETW electrification, but which combinations of instruments fit which modes, at which stage of market and life-cycle development.

Existing syntheses provide detailed accounts of individual modes and themes. Cadavid and Salazar-Serna [5] map motorcycle-market policies; Zhou et al. [6] analyze long-run e-bike research; Firdaus et al. [7] examine ETW adoption; Yurdakul et al. [8] synthesize e-scooter research; and Mogire [9] reviews light electric vehicles and sustainable urban transport. Their differing units and scopes make it difficult to compare attention across modes using common governance and life-cycle categories. The contribution sought here is that comparative layer, rather than a claim that ETW policy has not previously been reviewed.

Recent studies further clarify why adoption, operating rules, and life-cycle accountability should be examined together. Nosratzadeh et al. [10] identify an evaluation gap in e-bike financial-incentive programs, distinguishing the existence of a program from evidence of its effects. Zhang et al. [11] examine acceptance of battery-swapping services, linking infrastructure provision with user behavior. Achal and Vijaya [12] review AI-enabled circularity in the Indian electric-two-wheeler industry, while Eduardo et al. [13] compare end-of-life scenarios for an electric moped. These contributions show that a governance review needs to connect market entry, daily use, and downstream responsibility rather than equating sustainability with sales or adoption alone.

Governance also has different units of analysis. Gürbüz and Gürbüz [14] examine sustainability committees and environmental disclosures at the transport-firm level. The present study instead maps policy-related vocabulary across vehicle terminology subsets; it neither measures corporate-governance performance nor infers public-policy outcomes from firm-level evidence.

Appendix E (Table A4) positions the study using reported corpus size, analytic object and comparison design. The analytical corpus ends in 2025; later studies are used only to interpret its findings. For example, Martin et al. [15] identify interacting infrastructure, fiscal-policy, cost and perception barriers in African e-bicycle markets. This evidence cautions against treating a vehicle label as sufficient to identify the binding policy constraint.

Aims and Contributions

The objective is to compare research attention using a common governance-domain and life-cycle vocabulary, while distinguishing shared concerns from mode-related differences. Mode–policy fit (MPF) is an interpretive framework for translating these profiles into candidate evaluation questions. It is not a fitted statistical model, a validated measure of policy alignment or an estimate of an instrument's effect.

The study contributes a reproducible comparison of overlapping terminology subsets, a governance-by-life-cycle lexical description based on distinct textual matches, and a completed semantic audit. The frozen profiles show shared operational matches in

scooter and bicycle records alongside larger market-formation and incentive match shares in motorcycle/moped records. These differences persist under overlap exclusions but are not established thematic differences: the human audit identifies substantial false positives and category-dependent misses. Robustness means sensitivity to the specified analytical choices, not proof of semantic accuracy or causal validity. Mean pairwise ARI across 30 Louvain seeds is 0.702 and nested-subset category-rate Spearman correlation is 0.989; these describe partition agreement and internal consistency. Executable code and aggregate outputs are supplied, while detailed metadata access remains subject to applicable licensing conditions.

RQ1: How has the policy-relevant ETW knowledge domain evolved, and which conceptual associations are visible?

RQ2: How do governance-domain and life-cycle profiles differ across e-bike/pedelec, e-scooter, and electric-motorcycle/moped terminology subsets?

RQ3: Which profiles motivate questions for mode-specific policy evaluation, and how sensitive are those profiles to overlapping tags?

RQ4: Which downstream topics have low lexical visibility within the search-defined corpus, and what evidence would be needed to interpret that visibility?

2. Conceptual Framework

Mode–policy fit builds on four complementary lenses. The multi-level perspective treats ETWs as socio-technical transitions in which technologies, infrastructures, markets, user practices, industrial networks, and regulation co-evolve [16]. Policy-mix theory shifts attention from isolated measures to combinations of objectives, instruments, implementation processes, and characteristics such as consistency, coherence, credibility, and comprehensiveness [17,18]. Polycentric governance locates authority and learning across national governments, municipalities, manufacturers, platforms, users, and communities [19]. Life-cycle and mobility-justice perspectives broaden evaluation beyond uptake to environmental burdens, access benefits, safety risks, labor effects, repair, material recovery, and the distribution of decision power [20–22].

A transition bottleneck is a constraint that may impede adoption, safe use, system integration or responsible vehicle retirement. Affordability, network discontinuity, pedestrian conflict and battery take-back illustrate candidate constraints. None is measured directly in this study. A governance domain identifies an instrument or institutional area, such as regulation, infrastructure or incentives. The six domains are non-exclusive analytical categories informed by policy-mix and life-cycle perspectives, not a complete or empirically validated taxonomy of public policy.

A governance level identifies where authority, implementation, or accountability resides: national or regional government, municipality, manufacturer or industry body, platform or fleet operator, and community or user. These levels can interact. For example, a national vehicle standard and a municipal parking rule can apply to the same device. Governance levels are interpretive dimensions here, not systematically coded variables, and the metadata cannot establish which actor implemented an instrument.

Life-cycle stages distinguish the object of governance over time. Design/production concerns vehicle and battery design, manufacturing, and supply chains; market formation concerns purchase, adoption, demand, and affordability; operation/integration concerns riding, charging or swapping, parking, sharing, and connection with transport systems; maintenance/second life concerns repair, durability, refurbishment, and reuse before final disposal; end-of-life concerns collection, waste treatment, recycling, and material recovery. A record may address several stages, and second-life references do not by themselves demonstrate a technically safe or economically viable reuse application.

MPF separates three evidentiary steps (Figure 1). First, matched mode, governance and life-cycle terms establish a lexical profile; substantive thematic prevalence is not established. Second, that profile is interpreted alongside contextual literature to formulate a candidate implementation question. Third, policy inventories, actor responsibilities and measured outcomes would be needed to evaluate actual fit in a specified setting. Only the first step is computed here. The operational evaluation framework developed below makes the transition to proposed evaluation questions explicit. No scalar MPF score or causal link is estimated.

Recent transition-policy research reinforces the distinction between instrument attention and implementation. Kanger et al. [23] distinguish intervention points along transition pathways, while Oltmer and Löhr [24] emphasize actors and policy processes in the formulation and evaluation of policy mixes. These developments support asking who implements a policy and at which transition stage. Actor behavior and implementation quality are not measured in this metadata analysis; they are explicit targets for subsequent validation.

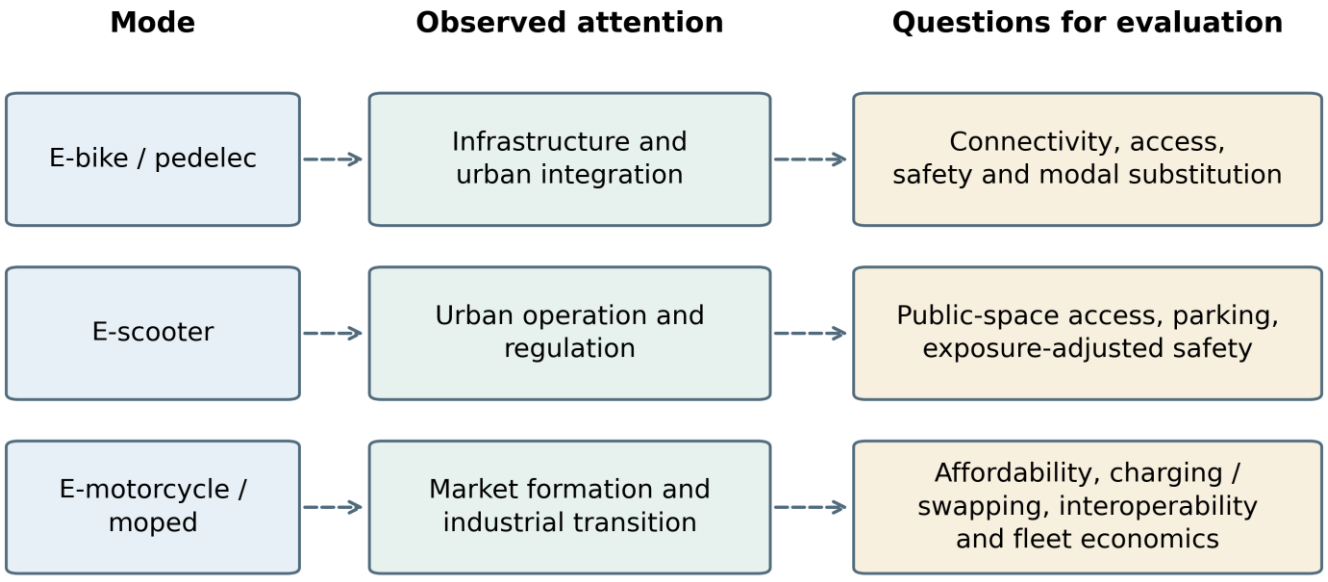


Figure 1. Mode–policy fit as a lexical-signal-to-evaluation diagnostic. "Lexical match signal" denotes dictionary matches, not validated thematic prevalence. Dashed arrows connect interpretive questions; they do not represent estimated causal relationships. Governance levels and outcomes are not coded causal variables.

3. Materials and Methods

3.1. Review Design and Reporting Boundary

This comparative bibliometric and lexical analysis uses the Scopus record as its observational unit. Descriptive bibliometrics describe the retrieved literature; author-keyword mapping examines conceptual associations; and explicit lexical rules summarize governance/life-cycle attention across overlapping vehicle terminology subsets [25,26]. The corpus is search-defined and has not undergone full-text intervention eligibility or study-quality assessment. It therefore cannot support a systematic synthesis of policy effects.

Figure 2 documents corpus identity and the parallel analysis branches. PRISMA 2020 emphasizes transparent reporting of evidence identification and selection [27], but the

present diagram is an analysis-flow disclosure rather than a claim that full systematic-review screening was performed. All 973 records remain in the descriptive corpus; keyword availability and explicit vehicle identification define separate analysis branches.

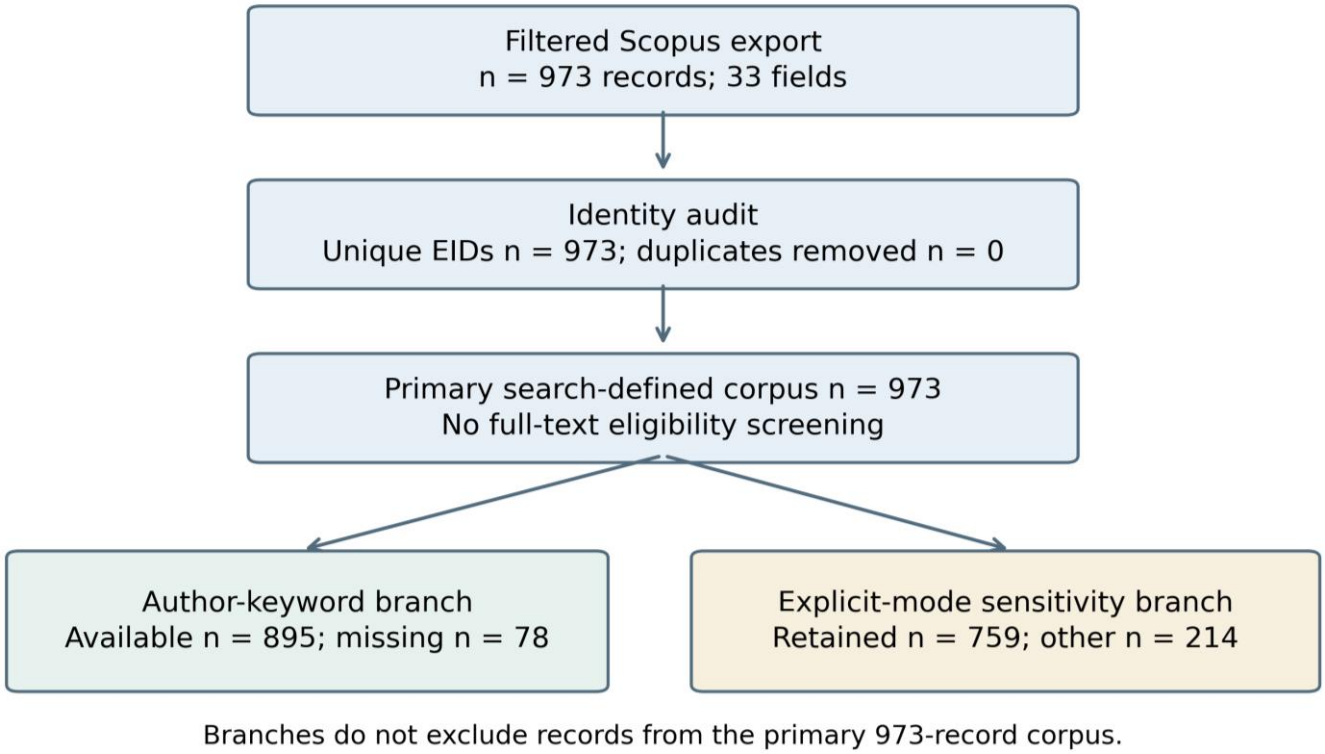


Figure 2. Corpus identity audit and analysis branches. The keyword and specificity branches do not reduce the primary n = 973. Retrieval/export dating is reported in Section 3.2 rather than inside the diagram.

3.2. Database Selection and Search Boundary

The frozen Scopus export is dated 14 August 2026 and covers publication years 2000–2025, retaining English-language articles and reviews. The retrieval/export date and publication cutoff are different quantities: retrieval in 2026 does not add 2026 publications. The original export filename and accompanying archive documentation agree with the author-confirmed date. The verified SHA-256 checksum is 82919d3eeb312e7a38dcd7bbfba6a9c134628753928f186d8ee3617e801e1118. Appendix A reproduces the original query.

Scopus provides a common identity key, author and affiliation fields, source information, author/index keywords, and a fixed citation snapshot [28]. A single database avoids introducing cross-database duplicates and incompatible citation measures into the comparison. This is a comparability rationale, not a claim of comprehensive coverage. Dimensions, Web of Science, and discipline-specific collections could extend regional or disciplinary coverage, but require a separate harmonized search and deduplication design. The input here is the exported CSV; no web crawler is used in the analysis.

The original query requires both an ETW expression and a governance/policy expression. Several query terms—such as regulation, traffic management, parking management, urban planning, and battery recycling—also occur in the coding specification. The observed category shares are therefore conditional on that governance-enriched retrieval. A high operational or regulatory share cannot be interpreted as an unbiased distribution

across all ETW research. The explicit-mode sensitivity subset is drawn from the same conditioned corpus and cannot estimate this selection effect.

3.3. Identity Audit and Calculation of Descriptive Indicators

The CSV contains 973 records and 33 fields: all EIDs are unique, and 942 records have nonblank unique DOIs. It includes 939 articles, 34 reviews, 433 distinct source titles and 3449 Scopus Author IDs. All records contain an abstract; author keywords are present for 895 (91.98%) and index keywords for 747 (76.77%). These field-availability counts describe the export, not the substantive completeness of each abstract. The checksum and descriptive aggregates were recomputed from the frozen input.

Table 1 indicators are export-field calculations, not counts of keyword search hits. Documents are rows after identity checks; sources are distinct source-title strings. Author IDs are split on semicolons and deduplicated within and across records. The average author count is the sum of record-level unique ID counts divided by 973. Citations use the frozen cited by field: totals, arithmetic mean, median, and the corpus h-index are calculated directly. The h-index is the largest h for which at least h records each have at least h citations. A nonblank Open Access field is counted as metadata visibility, not an independent legal-access verification. The seven most-cited records are reported in Table 2.

Table 1. Verified characteristics of the frozen Scopus corpus.

Indicator	Value	Interpretation
Documents	973	939 articles; 34 reviews
Publication window	2000–2025	Frozen complete-year window
Sources	433	Multidisciplinary dispersion
Scopus author identities	3449	Indexed author IDs; identity uncertainty remains
Mean authors/document	4.10	Unique author IDs per record
Single-authored records	63 (6.47%)	One unique author ID in the record
Total citations	26,689	Snapshot: 14 August 2026
Mean/median citations	27.43/12.00	Right-skewed distribution
Open-access records	536 (55.09%)	Based on nonblank Scopus OA field
International collaboration	220/967 (22.75%)	Six records lack a recognized country suffix
Corpus h-index	82	Based on citation snapshot

The country parser uses an explicit whitelist of affiliation suffixes and a small disclosed alias map, including Türkiye → Turkey and Viet Nam → Vietnam. Incomplete address endings are not guessed from cities or states. Each resolved country receives one whole-count credit per record or 1/k fractional credit when k countries are resolved. International co-authorship requires at least two resolved countries. These indicators describe affiliations rather than empirical study locations. The code and country labels make this conservative parsing rule auditable.

Citation counts are a 14 August 2026 export snapshot. Annualized visibility is cited by/max(1, 2026−publication year), which adjusts calendar exposure but is not field normalization. Growth is calculated as CAGR = 100 × [(N_end/N_start)^(1/years) − 1], with alternative base years reported rather than presenting a single base-sensitive growth statistic.

3.4. Keyword Normalization and Community Uncertainty

Author keywords are split on semicolons, converted to Unicode NFKC lowercase text, hyphens normalized to spaces, and whitespace collapsed. An explicit finite thesaurus merges listed synonyms, including e-bike/electric bicycle/pedelec and singular/plural

electric-vehicle forms; no unreported stemming is applied to author keywords. Each normalized term is counted at most once per record. The full executable thesaurus is supplied in Supplementary File S2 (thesaurus.json), with principal mappings in Appendix D (Table A3).

Terms occurring in at least eight documents define the primary network (47 nodes; 299 links; 925 document-level pair co-occurrences). Edge weights are association strength c_ij/(w_i w_j), where c_ij is co-occurrence count and w_i and w_j are document frequencies [29]. Weighted Louvain uses resolution 1.0 and seed 42. Node and edge insertion is sorted. Robustness varies minimum frequency (5, 8, 10) and random seed (0–29); all 435 pairwise ARIs among the 30 partitions are retained.

The seed-42 solution has six communities, but the 30-seed runs return five, six, or seven communities. Mean pairwise ARI is 0.702, median 0.682, and range 0.397–1.000. These values indicate partial partition agreement; no universal qualitative ARI thresholds are assumed, and no uniquely stable community count is claimed. Labels in Table 3 summarize the assigned terms and are interpretive rather than predefined vehicle classes.

Louvain supplies the primary exploratory partition; its use does not imply superiority over other community-detection algorithms. Leiden provides an algorithm comparison motivated by its connectivity safeguards [30]. Weighted Leiden uses the same graph, resolution 1.0 and seed 42, iterating to convergence. The reported comparison returns seven communities and ARI 0.734 against the primary Louvain partition. The reported Louvain communities are connected in this graph, but differences between algorithms remain part of the uncertainty.

3.5. Temporal Normalization

Temporal summaries use four fixed intervals: 2000–2014 (N = 77), 2015–2019 (N = 141), 2020–2022 (N = 267), and 2023–2025 (N = 488). The long initial interval pools sparse early output; later intervals provide finer descriptive resolution as publication volume increases. These are reporting bins, not statistically detected transition points. For keyword k in period p, $R(k,p) = 100 \times n(k,p)/N(p)$, where n(k,p) counts records containing the normalized author keyword. Each term is counted once per record.

The multiplier 100 is a reporting scale, not a sample size or a decision to merge 100 documents. Missing author keywords remain in the primary denominator. Availability rises from 59/77 records (76.6%) in 2000–2014 to 128/141 (90.8%), 249/267 (93.3%) and 459/488 (94.1%) in later periods. We therefore also calculate rates among records with author keywords as a denominator check. The temporal analysis displays the 20 most frequent normalized terms across the pooled corpus, rather than a preregistered list of expected terms. Unequal bin lengths and changing metadata availability preclude dating precise thematic turning points.

3.6. Lexical Coding and Distinct Textual Evidence

Titles, abstracts, author keywords, and index keywords are concatenated and normalized using the same lowercase/hyphen/whitespace procedure. The six governance families and five life-cycle stages are non-exclusive. Governance concerns regulation/standards, incentives, infrastructure/planning, information/education, industrial/innovation, and circularity/EPR. Life-cycle stages concern design/production, market formation, operation/integration, maintenance/second life, and end-of-life. Their conceptual definitions are given in Section 2, representative indicators in Appendix C (Table A2), and every implemented regular expression in the supplied rules.json and analyse.py.

A governance-by-stage cell requires two matched literal strings in normalized text that differ and occupy nonoverlapping character spans. A match can be a single word or

a multiword phrase, as specified by the regular expressions; distinctness is assessed between the matched strings and spans, not between category names. This rule prevents one identical expression, or an embedded substring, from supplying both axes. Repeated instances of an identical literal string also fail the rule. Separate textual matches do not imply statistical or semantic independence, or an implemented relationship between instruments. Each qualifying record contributes once per cell and may enter several cells. Missing fields are empty; no unobserved text is imputed.

For example, in "Parking management supports commuting", parking management supports infrastructure/planning and commuting supports operation/integration; the expressions differ and occupy disjoint spans, so the corresponding cell is counted. "Recycling" alone fails circularity/EPR × end-of-life because the same string supports both dimensions. "Recycling supports material recovery" qualifies because the two matched expressions differ and do not overlap. These are constructed illustrations of the implemented rule, not quotations from corpus records. Appendix C provides additional explanation, and record_match_evidence.jsonl stores the evidence for all 973 records.

Lexical matches measure the visibility of expressions in metadata. Broad terms such as regulation, standard, design and operation can occur in technical or incidental contexts. The implementation does not resolve negation or semantic relevance. The independent human audit described below demonstrates substantial category-dependent errors; traceable rules and reproducible output do not establish semantic accuracy. Substantive interpretation is therefore restricted to lexical visibility and candidate questions for subsequent investigation.

Independent semantic coding was completed by Shaowei Miao and Dong Li on the same stratified sample of 100 records from the frozen 973-record corpus. Each reviewed title, abstract, author keywords and index keywords, without requiring full text, and judged four mode labels, six governance domains and five life-cycle stages. One coder was involved in the study design, so complete blinding to the conceptual framework is not asserted. The submitted independent files were retained unchanged. Sixty-seven binary disagreements and one uncertain judgment across 51 records were resolved by consensus on 29 October 2026, yielding 1500 final binary labels. Pre-consensus agreement and Cohen kappa use the original judgments; the one uncertain judgment is excluded only from the economic-incentives reliability calculation (n = 99). The final reference is a two-coder consensus, not an independent third-party gold standard.

Sampling seed 20261028 selected seven mutually exclusive strata with population/sample counts 12/12 (untagged), 114/20 (multiple tags), 43/18 (single tag with downstream matches), 370/15 (other scooter), 267/15 (other bicycle), 92/10 (other motorcycle/moped) and 75/10 (other generic). Strata were defined using frozen automated labels; rare or ambiguous records were enriched. Category-specific sample precision, recall and F1 and design-weighted ratio point estimates using N_h/n_h are reported separately. Weights sum to 973; they do not turn the sample into a full-corpus human review. No confidence intervals or mode-stratified accuracy estimates are claimed. The frozen dictionaries were not tuned on these annotations. This validation covers individual labels, not the semantic correctness of the 30 co-mention cells or actual policy effectiveness. Aggregate results are in Human_Validation_Results_2026-10-29; original annotations, evidence and final consensus are supplied as non-published material.

3.7. Mode Tags Overlap and Specificity Checks

Four terminology families are matched non-exclusively across title, abstract, and keyword fields: e-scooter (461), e-bike/pedelec (367), e-motorcycle/moped (144), and generic/mixed ETW (127). The last category is an explicit generic-terminology tag, not auto-

matically the complement of the other tags. E-scooter expressions can be ambiguous between standing and seated vehicles; the tag is treated as a terminology subset; sample validation does not establish its accuracy across the entire corpus.

There are 114 multi-tagged records: 90 have two labels and 24 have three; 847 have one and 12 have none. Total assignments are 1099 = 847 + 2×90 + 3×24. Pairwise intersections are reported in Appendix E (Table A6), not inferred from the difference between tag totals and corpus size. Exclusive one-label profiles are additionally recalculated to assess whether shared records drive the comparative pattern.

The stricter identification subset requires an explicit mode expression in the title or author keywords and retains 759 records (78.01%). Categories and co-mention rules are reapplied, and Pearson and Spearman correlations summarize similarity to the full-corpus profiles. Because the subset is nested within the full corpus, these correlations are internal consistency checks, not independent validation against a gold standard. A separate lexical-coverage check omits the 12 records without any mode tag, leaving 961. Neither restriction is a relevance adjudication or an ETW-only control retrieval. Mode differences are reported descriptively as percentage-point contrasts; overlapping subsets and the selected corpus cannot be treated as independent population samples.

A separate paired retrieval was supplied by the author on 28 October 2026 using the Appendix A queries and the same publication window (2000–2025), document types and language criterion. Query A retained the governance/policy AND-block (971 records); Query B omitted that block (2386 exported records). One B record was labelled Japanese in the exported language field and was excluded, leaving 2385 English records. EIDs were unique within each export, and all 971 A records occurred in the eligible B export; B contained 1414 additional records. The same frozen dictionaries were applied to both exports. Category rates and A-minus-B percentage-point contrasts are descriptive because the corpora are nested. This later retrieval does not replace the 973-record frozen primary corpus. Aggregate results and input checks are supplied in Paired_Retrieval_Results_2026-10-28.

In the later paired retrieval, regulation/standards occurred in 58.50% of A versus 28.34% of B (+30.15 percentage points), and infrastructure/planning in 29.35% versus 19.12% (+10.23 points). Operation/integration remained prominent in both (76.93% versus 72.12%, +4.81 points); maintenance/second life was uncommon in both (3.50% versus 3.48%, +0.02 points), as was end-of-life (2.47% versus 1.76%, +0.71 points). These contrasts demonstrate sensitivity to the governance retrieval condition, especially for regulation/standards. They do not validate semantic coding or estimate policy effectiveness. The broader export also contains lexical false positives: one lemonade study uses E2W as an experimental sample code. B therefore denotes a broader query-defined export, rather than an adjudicated census of ETW research.

3.8. Software and Reproducibility

The analysis follows the fully specified MPF-R2-1.0 computational rules. This executable specification governs all revised results and supersedes values quoted from earlier manuscript versions; it does not assert recovery of an unavailable historical implementation. The pipeline produces record labels, matched strings/spans, mode intersections, exclusive profiles, category marginals, co-mention cells, keyword graphs and partitions, temporal rates, affiliation-country labels and stability outputs. A fresh run on the frozen input under Python 3.12.14, the stated package versions and PYTHONHASHSEED = 0 reproduced all 20 supplied aggregate files and all four record-level evidence files byte-for-byte. The additional descriptive audit was also rerun. Per-file comparisons, input checks and the execution environment are documented in Supplementary File S1 and Verification/reproduction_report.json. These checks establish computational reproducibility, not semantic validity.

The environment uses Python 3.12, pandas 2.2.3, NumPy 2.3.5, Matplotlib 3.10.8, NetworkX 3.6.1, igraph 0.11.9, leidenalg 0.10.2, SciPy 1.17.0, and adjustText 1.3.0. Supplementary File S2 supplies executable code, exact matching rules, finite thesaurus mappings and installation/run instructions; Supplementary File S3 supplies aggregate outputs. Access to the frozen source export and detailed record-level metadata is subject to applicable database licensing conditions. These materials have not been deposited in a public repository. The cited-reference field is absent, so no co-citation or bibliographic-coupling result is presented.

4. Results

4.1. Corpus Profile and Base-Year Sensitivity

Table 1 summarizes the reported corpus characteristics. The mean citation count exceeds the median, indicating a skewed visibility distribution. Author IDs represent indexed identities rather than confirmed unique people. Single-authored records are listed separately from mean authors per document; their share is 63/973 × 100 = 6.47%.

The four periods contain 77, 141, 267, and 488 records; 77.60% were published during 2020–2025. Output rises from 23 records in 2015 to 200 in 2025, giving CAGR 24.15%. Alternative bases give 21.60% for 2005–2025 (4 to 200 records) and 27.88% for 2010–2025 (5 to 200). The 2000–2025 value is 23.61% but starts from only one record. None of these bases removes all small-number sensitivity; the range illustrates why growth should not be reduced to one apparently precise rate. The annual trajectory is retained as Figure A1 in Appendix E.

4.2. Sources and Citation Visibility

The literature is widely dispersed, although transport-policy, safety, sustainability, and engineering outlets form a visible core. Sustainability (Switzerland) published 49 records, followed by Transportation Research Record (33), Transportation Research Part D: Transport and Environment (29), Transportation Research Part A: Policy and Practice (27), and Case Studies on Transport Policy (21). Citation density differs sharply from volume: among leading outlets, Journal of Transport Geography (88.36 citations/document), Accident Analysis and Prevention (84.80), and Transportation Research Part D (84.21) have high corpus-specific averages.

Figure 3 identifies distinct publication outlets, not alternative names for a common thematic category. Case Studies on Transport Policy and Transport Policy are separate journal titles and are retained separately to preserve source-level meaning. They could be pooled for a different question about transport-policy journal families, but that aggregation would require an explicit classification rule. Here the concentration in transport, safety, and sustainability outlets helps explain why operational and injury topics are visible in the subsequent maps.

Table 2 reports the most-cited records at the fixed 14 August 2026 snapshot. These are corpus-specific visibility indicators; they should not be read as present-day citation counts or an age-neutral ranking of evidence strength. The documents cover different research designs and therefore are not interchangeable sources of policy-effect estimates.

The annualized values in Table 2 divide frozen citation counts by max(1, 2026 − publication year). This is a simple calendar-age adjustment; it does not control for field, article type or within-year exposure.

The seven influential records illustrate different kinds of policy-relevant evidence. Fishman and Cherry [31] and Oeschger et al. [32] synthesize bicycle and integration research; Cherry and Cervero [33], McKenzie [34], and Sanders et al. [35] examine travel or use patterns. Trivedi et al. [36] document scooter injuries, while Mai et al. [37] address

charging engineering. Their citation visibility does not make these designs interchangeable tests of policy effectiveness.

World Electric Vehicle Journal contributes 12 of 973 records (1.23%). Its representation follows the source-field count, rather than a venue-based inclusion or citation quota.

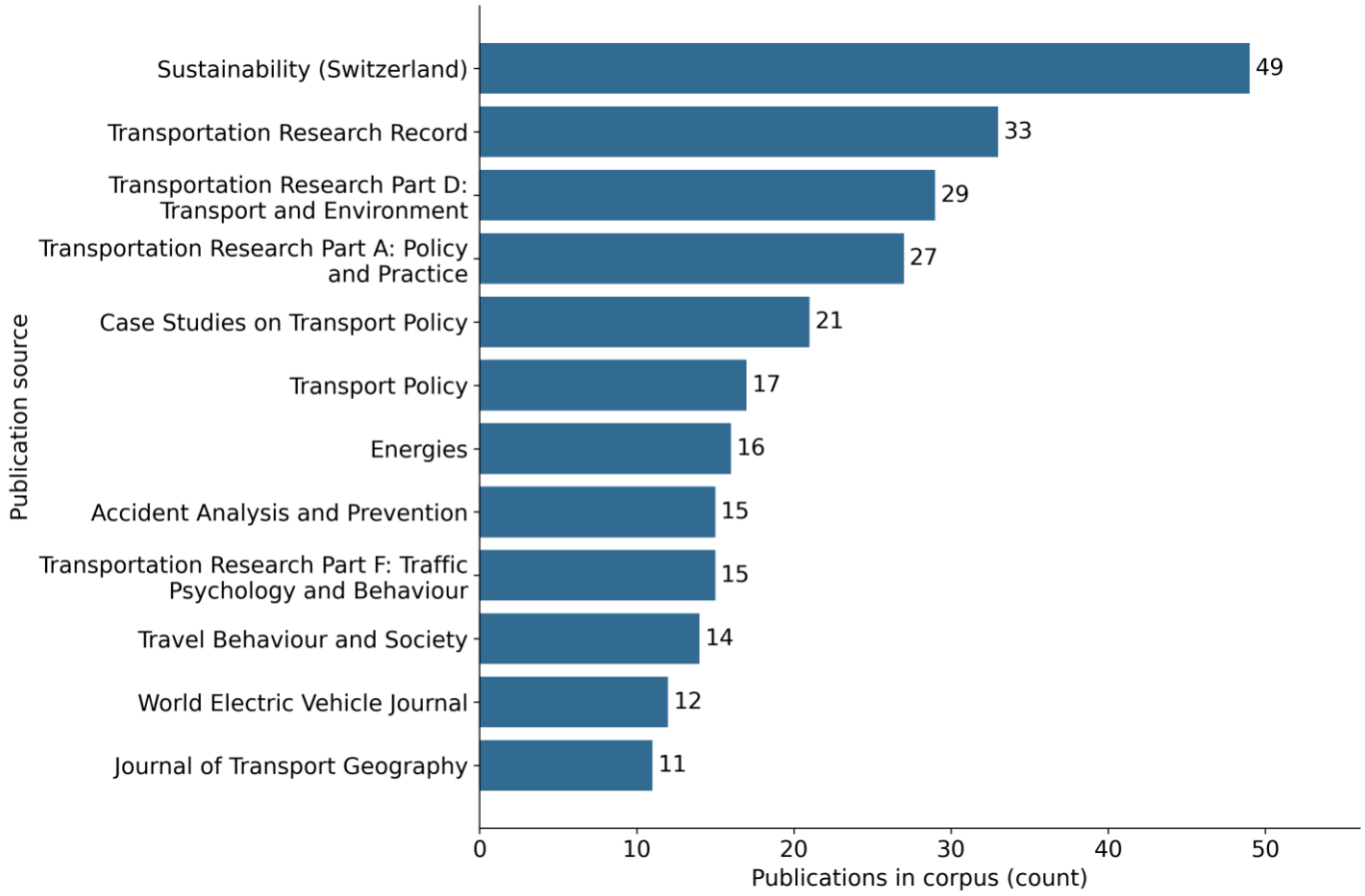


Figure 3. Leading publication sources. Horizontal axis: corpus record count; vertical axis: distinct journal/source title. Case Studies on Transport Policy and Transport Policy are separate journals.

Table 2. Seven most-cited records in the 14 August 2026 export snapshot.

Document	Year	Cited by	Citations/Year *	DOI
E-bikes in the Mainstream: Reviewing a Decade of Research [31]	2016	428	42.8	10.1080/01441647.2015.1069907
Injuries Associated With Standing Electric Scooter Use [36]	2019	404	57.7	10.1001/jamanetworkopen.2018.7381
Spatiotemporal Comparative Analysis of Scooter-Share and Bike-Share Usage Patterns in Washington, D.C. [34]	2019	400	57.1	10.1016/j.jtrangeo.2019.05.007
Micromobility and Public Transport Integration: The Current State of Knowledge [32]	2020	349	58.2	10.1016/j.trd.2020.102628
Use Characteristics and Mode Choice Behavior of Electric Bike Users in China [33]	2007	273	14.4	10.1016/j.tranpol.2007.02.005
Inductive Power Transfer for Massive Electric Bicycles Charging Based on Hybrid Topology Switching With a Single Inverter [37]	2017	264	29.3	10.1109/TPEL.2017.2654360

To Scoot or not to Scoot: Findings From a Recent Survey About the Benefits and Barriers of Using E-Scooters for Riders and Non-Riders [35]	2020	260	43.3	10.1016/j.tra.2020.07.009

* Citations per year were calculated by dividing each document's Scopus citation count as of 14 August 2026 by max(1, 2026 − publication year). Values are rounded to one decimal place.

4.3. Affiliation Geography and Identity Uncertainty

Figure 4 shows conservative country-suffix counts. The leading whole-count positions are United States 176, China 171, Taiwan 75, United Kingdom 61, India 59, Indonesia 50, Australia 47, Italy 46, Germany 43, and Canada 40. International co-authorship is visible in 220 of 967 country-resolved records (22.75%). Fractional counts allocate one record across its resolved countries. These values concern author affiliations, not study locations or policy impacts.

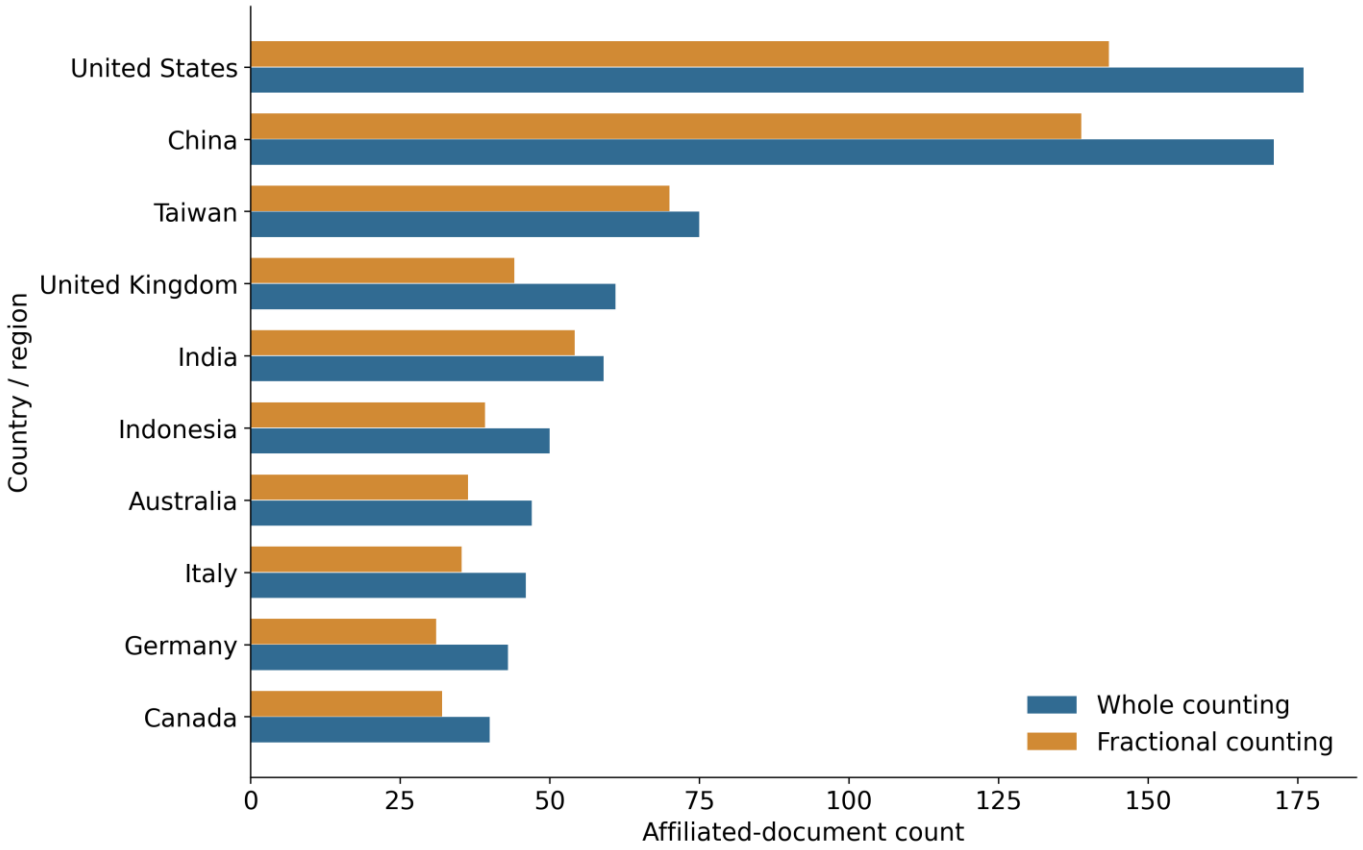


Figure 4. Whole and fractional country/region participation. Horizontal axis: affiliated-document credit; vertical axis: recognized affiliation country/region. Counts use the disclosed suffix parser and alias map.

The identity audit reports 13 of 3495 normalized full-name strings (0.37%) associated with multiple author IDs, including Chih-Hong Lin (15034894300 and 57223642383; Table A5). These may represent homonyms or split identities, not confirmed database errors. The denominator is normalized name strings, not the 3449 author IDs. Name variants linked to one ID are a different issue, so 0.37% is a limited collision-screening result, not an estimate of all author-identity uncertainty.

4.4. Conceptual Associations and Algorithm Dependence

The primary keyword graph has 47 nodes and 299 links. Figure 5 and Table 3 report its six-community seed-42 partition. The largest community mixes bicycle, micromobility,

motorcycle, shared-system, behavioral, and sustainability vocabulary; it is not a clean vehicle partition. Injury terminology, bicycle human factors, policy/equity, system integration, and an engineering-control satellite form other groupings. Thus, mode differentiation is tested through explicit profiles below rather than assumed from visually separated network colors.

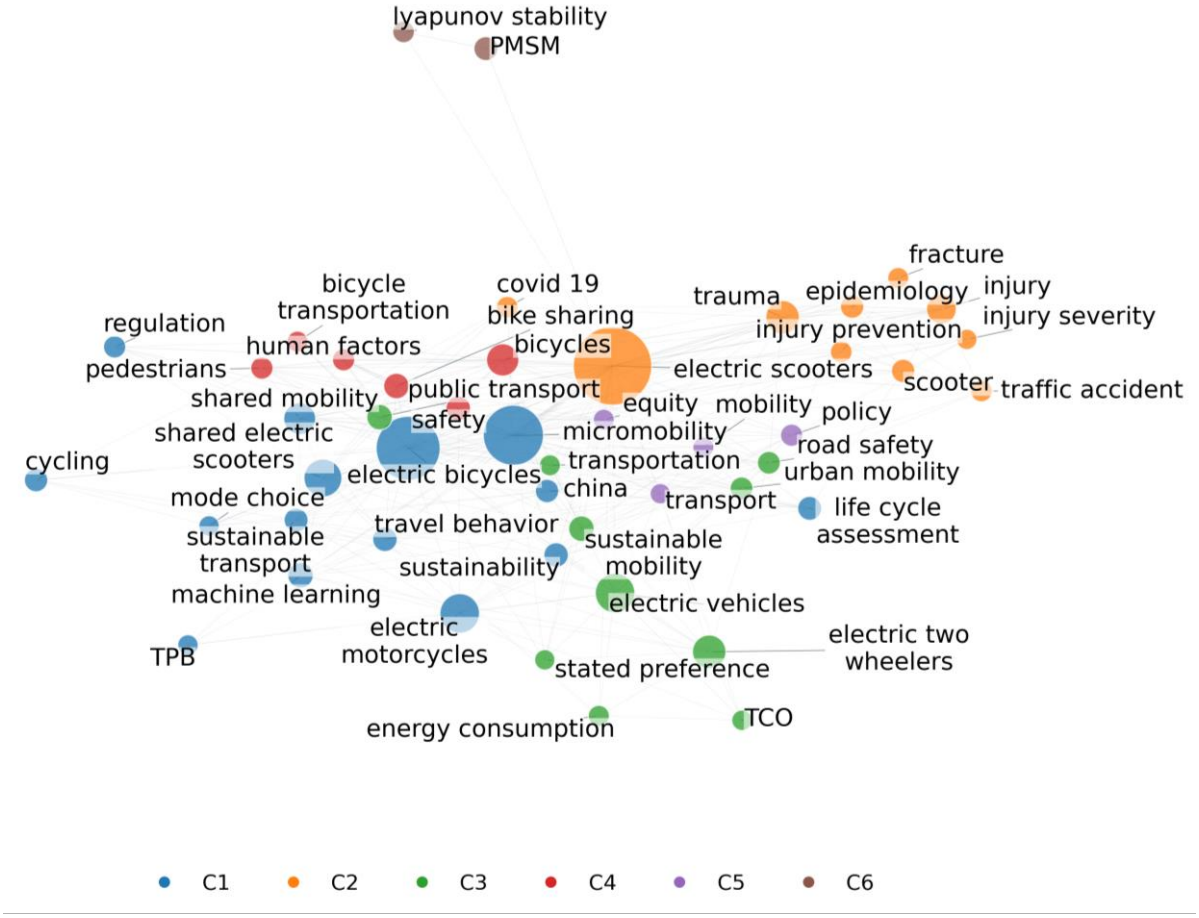


Figure 5. Fully relabeled author-keyword association network. Node size denotes document frequency; color denotes primary Louvain membership; links denote co-occurrence with association-strength weights. Layout coordinates have no substantive units. PMSM = permanent magnet synchronous motor; TPB = theory of planned behavior; TCO = total cost of ownership.

Table 3. Interpretive labels of the primary six-community Louvain solution.

Cluster	Interpretation	Nodes	Assigned Terms	Weighted Mean Year
C1	Mixed electric-mobility adoption and shared systems	15	electric bicycles; micromobility; electric motorcycles; shared electric scooters; shared mobility; machine learning; sustainability; travel behavior; life cycle assessment; sustainable transport; China; cycling; regulation; mode choice; theory of planned behavior	2021.91
C2	Scooter injury and epidemiology	10	electric scooters; trauma; injury; epidemiology; scooter; COVID-19; injury prevention; traffic accident; fracture; injury severity	2022.15
C3	Vehicle systems integration and techno-economics	10	electric vehicles; electric two wheelers; public transport; sustainable mobility; road safety; urban mobility; energy consumption; transportation; stated preference; total cost of ownership	2022.15

C4	Bicycle use and human factors	6	bicycles; bike sharing; safety; human factors; pedestrians; bicycle transportation	2022.35
C5	Policy equity and mobility	4	policy; equity; mobility; transport	2022.57
C6	Electric-drive control satellite	2	permanent magnet synchronous motor; Lyapunov stability	2014.21

The weighted mean year of a community averages each node's mean publication year using keyword document frequency as weight. It locates the temporal center of associated terminology, not a dated causal transition. Threshold and algorithm checks in Section 4.8 show that the number and boundaries of communities vary; the thematic labels should be read at that level of uncertainty.

4.5. Temporal Attention

Figure 6 shows that electric-bicycle terminology reaches 26.2 records per 100 documents in 2015–2019, whereas electric-scooter and micromobility terminology reach 29.6 and 18.7 in 2020–2022. The scooter rate then falls to 26.0 in 2023–2025; the pattern is not a monotonic succession of one mode by another. Using only records with available author keywords as denominators preserves these local peaks: bicycle terminology reaches 28.9 in 2015–2019 and scooter terminology 31.7 in 2020–2022. The full numerators and both denominator series are retained with the analytical outputs.

Earlier bicycle work and later shared-micromobility reviews provide a retrospective context for the vocabulary shifts [31,38,39]. The maps describe changing keyword visibility rather than changes in actual policy priorities. A declining proportion can coexist with increasing publication counts, while missing keywords, pooled-term selection and unequal period lengths affect historical interpretation.

4.6. Governance and Life-Cycle Co-Visibility

Table 4 reports non-exclusive category marginals. Regulation/standards and operation/integration have the highest visibility in their respective dimensions. Their prominence must be interpreted conditionally on the governance-filtered search. A record can match expressions in several families and stages; the percentages are not components summing to 100%.

Table 4. Governance-domain and life-cycle metadata visibility.

Dimension	Category	Records	Share
Governance	Regulation/standards	570	58.58%
Governance	Economic incentives	102	10.48%
Governance	Infrastructure/planning	287	29.50%
Governance	Information/education	155	15.93%
Governance	Industrial/innovation	126	12.95%
Governance	Circularity/EPR	23	2.36%
Life cycle	Design/production	296	30.42%
Life cycle	Market formation	387	39.77%
Life cycle	Operation/integration	749	76.98%
Life cycle	Maintenance/second life	33	3.39%
Life cycle	End-of-life	23	2.36%

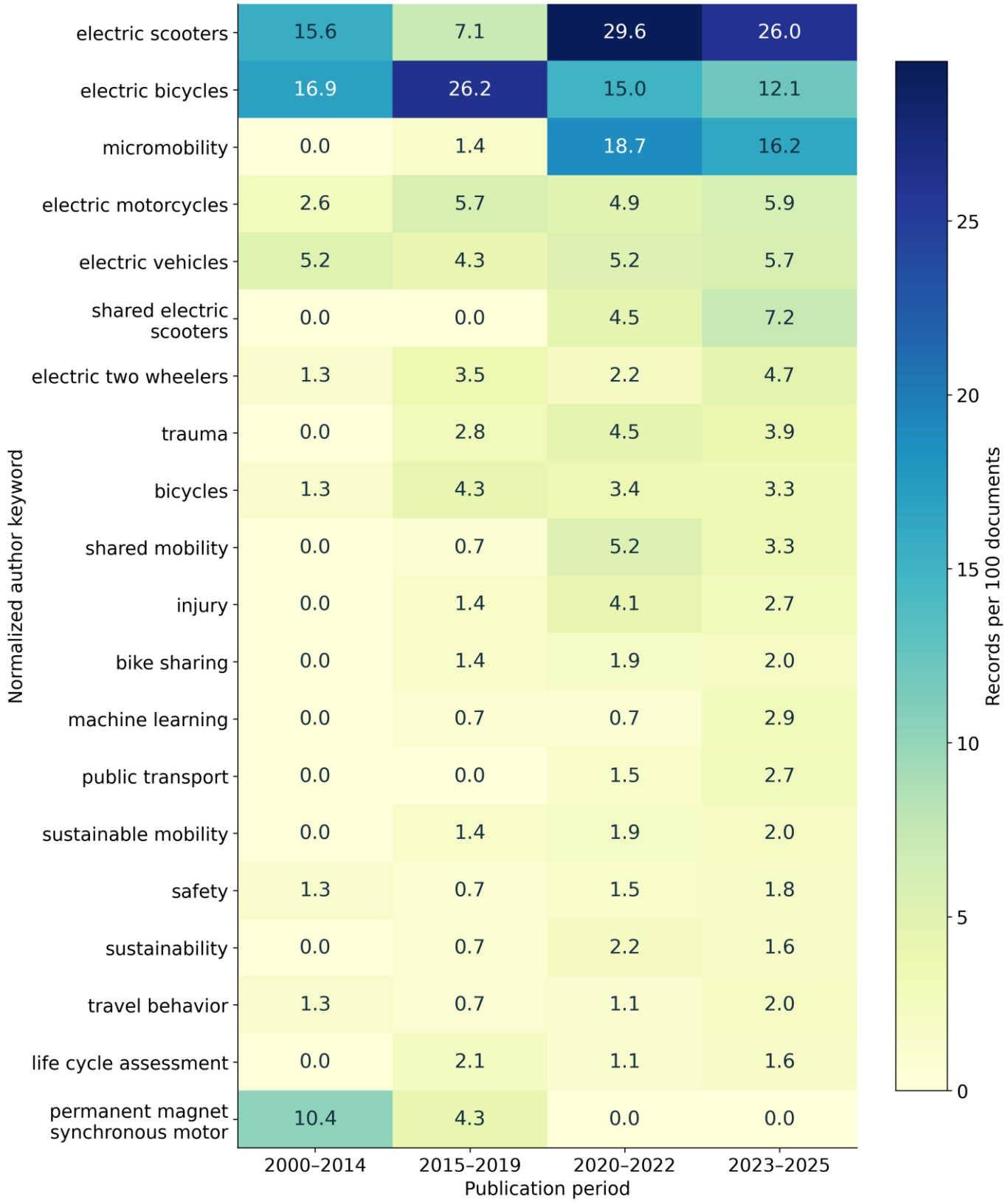


Figure 6. Period-normalized keyword attention. Horizontal axis: publication period; vertical axis: normalized author keyword; color/cell values: records containing the term per 100 period documents. Each term contributes at most once per record; all period records are in the denominator.

Figure 7 counts records containing distinct governance and life-cycle expressions. Regulation/standards × operation/integration contains 433 records; infrastructure/planning × operation/integration contains 259; and incentives × market formation contains 82.

The matrix locates co-visibility, but its largest cells also reflect large category marginals. No null-model comparison is made, so these counts are not estimates of excess association or implemented policy combinations.

The regulation row sums to 804 (178 + 166 + 433 + 17 + 10), exceeding its 570-record marginal because a record can contribute to several life-cycle cells. Formally, n(g,s) counts qualifying records in cell (g,s), whereas Σ_s n(g,s) counts record–stage incidences and need not equal the unique-record marginal n(g). Each cell counts a qualifying record only once. Identical-expression exclusions can also make a cell smaller than the intersection of its two category marginals.

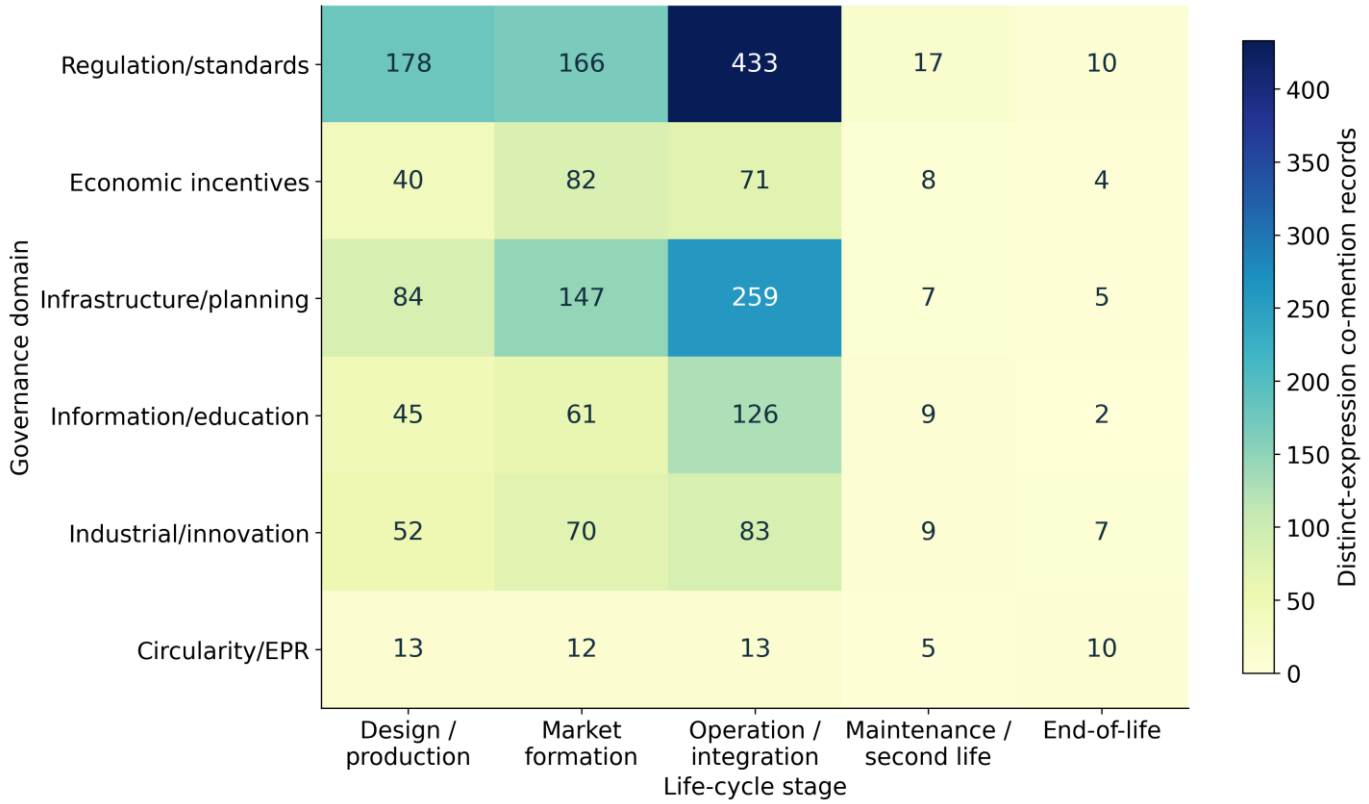


Figure 7. Governance × life-cycle co-mentions. Horizontal axis: life-cycle stage; vertical axis: governance domain; cells/color: records with different literal matches at nonoverlapping spans. Each record contributes at most once per cell but may enter several cells. Thus Σ_s n(g,s) is a count of record–stage incidences and can exceed the unique-record marginal n(g).

4.7. Mode Profiles and Operational Evaluation Questions

Figure 8 reports shared lexical matches and unequal comparative match-rate contrasts. Operation/integration appears in 383/461 scooter records (83.1%) and 296/367 bicycle records (80.7%), only 2.4 percentage points apart. Regulation differs by 4.1 points (63.8% versus 59.7%). In contrast, motorcycle/moped records exceed scooter records in market formation by 27.4 points (63.2% versus 35.8%), incentives by 17.6 (24.3% versus 6.7%), and industrial/innovation matches by 13.5 (22.2% versus 8.7%). Bicycle infrastructure match frequency exceeds scooter match frequency by 6.4 points (34.6% versus 28.2%). These are dictionary-match contrasts, not validated differences in substantive research themes or market needs. Section 4.9 quantifies classification errors; no mode-specific error correction is applied.

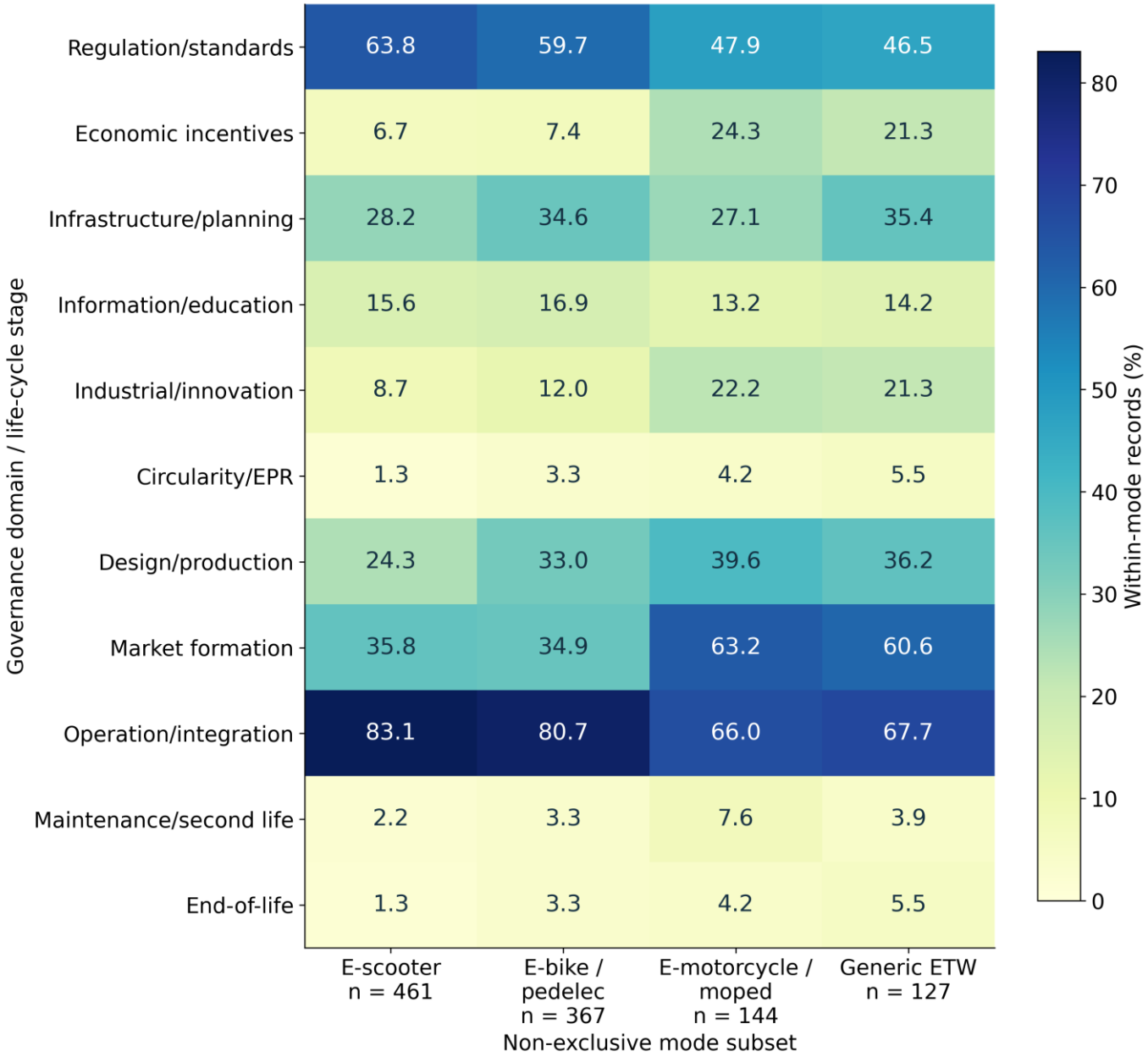


Figure 8. Mode-specific metadata visibility. Horizontal axis: mode subset with its denominator; vertical axis: governance domains followed by life-cycle stages; cell/color: within-subset percentage. Denominators are e-scooter n = 461, e-bike/pedelec n = 367, e-motorcycle/moped n = 144 and generic ETW n = 127. Tags and coded categories overlap, so percentages need not sum to 100%. Terminology does not establish standing-versus-seated scooter classification.

Removing all 114 multi-tagged records leaves exclusive subsets of scooter 380, bicycle 282, motorcycle/moped 102 and generic ETW 83. The motorcycle–scooter contrasts remain positive: 32.3 percentage points for market formation, 21.7 for incentives and 18.8 for industrial/innovation. The bicycle–scooter infrastructure contrast remains 6.3 points. Overlap therefore does not wholly explain the principal pattern, although exclusion changes the analyzed record sets and does not validate vehicle classifications.

Table 5 translates lexical signals into candidate evaluation questions that require contextual evidence. The mode column gives the denominator for every within-mode percentage. Only the signal column summarizes coded findings. The implementation questions and outcomes are proposed tests, not observations of implemented instruments, identified bottlenecks, or optimal policy combinations. Smaller subsets are more sensitive

to individual coding decisions; the percentages are descriptive and are not accompanied by population confidence intervals.

Table 5. Mode–policy fit from lexical signals to questions for operational evaluation. Signals are uncorrected dictionary-match rates; substantive prevalence and mode-specific accuracy are not established.

Mode and n	Lexical Match Signal	Implementation Question to Test	Outcome Evidence Needed
E-scooter n = 461	Operation/integration 83.1%; regulation 63.8%. Shared dictionary matches; substantive prevalence is not established.	Can municipal parking/speed rules and platform compliance address local public-space and safety constraints?	Exposure-adjusted injuries; parking compliance; pedestrian access
E-bike/pedelec n = 367	Operation/integration 80.7%; infrastructure 34.6% (6.4 points above scooter records).	How do network continuity, classification and transit integration interact in a specified use case?	Connectivity; accessibility; mode substitution; safety
E-motorcycle/moped n = 144	Market formation 63.2%; incentives 24.3% (27.4 and 17.6 points above scooter records).	How do finance, incentives and charging/swapping rules interact with household or fleet constraints?	Total cost of ownership; sustained uptake; interoperability
Generic ETW terminology n = 127	Market formation 60.6%; industrial/innovation 21.3%	Which vehicle-specific constraints are obscured by generic ETW terminology?	Disaggregated vehicle/use-case outcomes; instrument interactions
Cross-mode n = 973	Maintenance/second life 3.39%; end-of-life 2.36%; circularity/EPR 2.36%. Dictionary breadth differs.	How can producers, fleets, repairers and waste authorities coordinate responsibility?	Repair access; safe reuse; traceability; collection/recovery

4.8. Robustness and Remaining Validity Limits

Table 6 separates sensitivity checks by the uncertainty they address. Threshold, seed and algorithm checks concern graph specification; full-versus-strict correlations concern nested-corpus consistency; and exclusive-tag profiles concern shared records. Omitting the 12 untagged records changes category shares by at most 0.97 percentage points: operation/integration is 749/961 (77.94%), maintenance/second life 33/961 (3.43%) and end-of-life 23/961 (2.39%). This lexical-coverage check does not demonstrate the relevance of all retained records or resolve selection circularity.

Table 6. Recomputed specification and overlap checks.

Check	Recomputed Result	Meaning
Keyword frequency ≥5	96 nodes; 605 links; 9 communities	1384 pair co-occurrences
Keyword frequency ≥8	47 nodes; 299 links; 6 communities	925 pair co-occurrences
Keyword frequency ≥10	35 nodes; 203 links; 5 communities	733 pair co-occurrences
Louvain seeds 0–29	5/6/7 communities: 10 runs each; mean ARI 0.702; median 0.682	Partial partition agreement; not a unique cluster count
Leiden comparison	7 communities; ARI with Louvain 0.734	Algorithm dependence remains
Explicit-mode subset	n = 759; category ϱ 0.989; r 0.999	Nested-corpus consistency
Domain × stage vector	ϱ 0.994; r 0.999	Thirty-cell profile comparison
Exclusive-mode profiles	114 multiply tagged records removed	Principal operational/market contrast remains
Mode-expression coverage	961 records; maximum category shift 0.97 percentage points	Lexical coverage only; not relevance validation

4.9. Human Validation of Lexical Labels

The human reference revealed substantial category-dependent errors. Sample mode precision/recall/F1 was 0.839/1.000/0.912 for scooter, 0.595/1.000/0.746 for bicycle, 0.895/1.000/0.944 for motorcycle/moped and 0.542/0.929/0.684 for generic terminology. Design-weighted mode F1 ranged from 0.676 to 0.968. Sample precision was 0.263 for regulation/standards, 0.056 for information/education and 0.344 for operation/integration; corresponding weighted estimates were 0.344, 0.100 and 0.326. Sample maintenance/second-life recall was 0.333 (one of three consensus positives), with weighted recall 0.081. Consequently, the lexical profiles cannot establish the substantive prevalence or absence of these research themes. The 973-record outputs remain reproducible descriptions of dictionary matches; they are not human-corrected thematic estimates.

Before consensus, mode-label kappa ranged from 0.861 to 0.929. Operation/integration had 79% agreement and kappa 0.521. Information/education had 98% agreement but kappa 0.000 because one coder marked no positives and the other marked two. Industrial/innovation and circularity/EPR had kappa 1.000 with only five and two common positives, respectively. These sparse positive counts constrain interpretation. High human agreement for a label does not imply that the automated dictionary agrees with the final reference. All 15 reliability estimates, confusion counts and sample/weighted accuracy estimates are reported without selective omission.

5. Discussion

5.1. Knowledge Diversification and the Limits of Cluster Labels

For RQ1, Figures 5 and 6 and Table 3 indicate shared conceptual space across injury, user behavior, system integration, adoption and policy, rather than clean vehicle-specific knowledge communities. The mixed largest community and the variation from five to seven communities suggest that any mode comparison requires explicit profiles and adequate semantic validity, rather than reliance on network colors. The validation audit shows that the present lexical profiles do not yet establish that validity. This extends the mode-focused syntheses of Fishman and Cherry [31], Eccarius and Lu [40] and Yurdakul et al. [8] with a common comparative vocabulary. Mogire [9] offers a broader LEV sustainability mapping. The temporal results further suggest diversification without establishing a fixed sequence of policy stages.

5.2. Lexical Contrasts and Limits of Substantive Interpretation

For RQ2, the lexical comparison provides candidate questions rather than validated thematic contrasts. The 2.4-point scooter–bicycle operational match contrast is smaller than the 27.4-point motorcycle–scooter market-formation match contrast (Figure 8), but the human audit does not establish accuracy within each mode subset. Weighted precision for operation/integration is only 0.326 overall; shared matches therefore cannot establish a common substantive operational emphasis. Injury and public-space studies independently explain why operational evidence matters: Trivedi et al. [36] document clinical injuries, while Gössling [38], Bozzi and Aguilera [39] and Kazemzadeh et al. [41] synthesize policy and safety concerns. These cited studies support evaluation questions; the automated profile alone cannot establish their relative prevalence or exposure-adjusted policy effects.

For bicycles, the infrastructure profile is compatible with integration research [32], but it should not erase affordability and incentive questions. Nosratzadeh et al. [10] report limited rigorous evidence about e-bike incentive effectiveness; Martin et al. [15] identify interacting cost, fiscal-policy, infrastructure and perception barriers in African settings. The weaker incentive visibility in bicycle-labelled records is thus a bibliographic contrast,

not grounds for withholding bicycle incentives. Motorcycle market-formation matches can be contextualized using the adoption synthesis of Eccarius and Lu [40], while Zhang et al. [11] connect swapping acceptance to user behavior. The policy relevance of each profile depends on local use and institutional context.

Service design and user circumstances further qualify vehicle-level interpretation. McKenzie [34] finds different usage patterns for shared scooters and bicycles in Washington, D.C.; Cherry and Cervero [33] examine mode choice among Chinese electric-bike users. Sanders et al. [35] and Mesimäki and Lehtonen [42] distinguish users from non-users, while Agustina et al. [43] consider adoption influences in Indonesia. These studies differ in setting and design, so they contextualize the profiles rather than constitute a pooled causal explanation of them.

Terminology also crosses regulatory boundaries. The e-scooter tag is not restricted to verified standing devices, and an e-bike label does not necessarily identify a uniform pedal-assist category across countries. Fonseca-Cabrera et al. [44] examine users' regulatory knowledge, while Zhang et al. [45] distinguish evidence needs for scooter regulation. Both reinforce the need to specify vehicle class, user group and setting before translating a bibliographic profile into a policy proposal.

5.3. From Comparative Attention to Policy Evaluation Questions

For RQ3, MPF contributes a structured translation process (Table 5), rather than demonstrating policy fit. An observed profile first identifies a lexical signal that requires semantic verification. Contextual evidence then helps select a candidate constraint, after which an evaluation must specify the instrument, implementing actor, target group and outcome. Policy-mix theory makes instrument interactions and implementation characteristics central to this final step [17,18]. Figure 7 identifies locations of lexical co-visibility; it does not measure policy coherence, credibility or comprehensiveness.

For example, the same operational lexical signal in scooter records could motivate a question about parking compliance in one setting and injury exposure in another. These are alternative evaluation questions, not findings about implemented policies. A local policy inventory and outcome data would determine which question is appropriate. Nosratzadeh et al. [10] similarly distinguish implementing an incentive from evaluating its effects, illustrating why metadata attention cannot complete the causal step.

Shared-micromobility guidance [46,47] provides concrete categories for developing policy inventories, including street allocation, vehicle operation, user education and enforcement. Those categories can be linked to Table 5 by recording who implements an instrument, for whom, and with what measurable outcome. The proposed integration is an application pathway, not evidence that the present dataset observes implementation.

Sutopo et al. [48] examine stakeholder-informed early standardization for electric-motorcycle battery swapping in Indonesia. Their approach connects technical requirements with stakeholder needs, providing a concrete setting for evaluating coordination between infrastructure provision and vehicle standards. In MPF terms, this motivates testing how standard-setting processes and stakeholder participation interact with the requirements of a particular vehicle and market context.

Bashir et al. [49] develop a computer-vision and IoT framework for detecting motorcycle helmet and rider-count violations. The study concerns motorcycles without isolating electric propulsion. It illustrates a possible monitoring input for enforcement evaluation; detection performance alone does not establish reductions in injuries or improvements in policy effectiveness. Such outcomes would require separate evaluation before the technology could support claims about policy fit.

The governance-filtered retrieval also limits the interpretation of fit. A profile can appear aligned partly because the search and dictionary privilege related words. The later

paired retrieval quantifies descriptive differences between query-defined populations, including a 30.15-percentage-point difference for regulation/standards. It does not separate substantive relevance from lexical overlap or establish a causal selection effect. The appropriate claim is that the bibliographic evidence suggests where future evaluation should focus, not that it demonstrates what regulators should implement or how effective an instrument will be.

5.4. Downstream Attention and Life Cycle Accountability

For RQ4, operation/integration (76.98%) and maintenance/second life (3.39%) differ in lexical match frequency, but the audit prevents interpreting this contrast as evidence of a substantive downstream-attention gap. Weighted operation/integration precision is 0.326, and weighted maintenance/second-life recall is 0.081, based on only three consensus positives in the sample. Both overmatching and missed downstream content affect the comparison. Chen et al. [50] examine a spent-battery recycling network, Zhang et al. [51] address pedelec-sharing battery maintenance and replenishment, Eduardo et al. [13] compare electric-moped end-of-life scenarios, and Achal and Vijaya [12] synthesize ETW circularity questions. These separately cited studies provide entry points for governance synthesis; their relative representation is not established by the lexical rates.

Recent bibliometric studies offer complementary technology-oriented perspectives. Miao et al. [52] map artificial-intelligence research in electric two-wheelers across engineering, safety, shared mobility and user-oriented applications. Tee et al. [53] situate vehicle electrification within battery value chains, critical-material constraints, circularity and sustainable supply chains. These perspectives help frame questions about how technical applications connect with life-cycle responsibilities and implementing actors. Their research maps do not, by themselves, establish which policy instruments are effective for a particular vehicle mode or setting.

The downstream categories also require conceptual care. Maintenance sustains service, second-life use changes an asset's application, and recycling concerns material recovery; their evidence requirements differ. Maintenance/second life is grouped here for coarse metadata mapping, not because the processes are interchangeable. Moreover, broad operational terms and narrower repair or disposal expressions have unequal opportunities to match, so the percentages cannot be interpreted as comparable measures of real-world policy adequacy. A defensible research agenda is to examine how existing technical evidence addresses responsibility, safety, access to repair and collection, rather than infer a regulatory vacuum from low lexical rates.

Battery recycling and extended producer responsibility were eligible governance expressions in the original query. Their eligibility does not establish adequate detection or an unbiased downstream research gap. Human validation found few positives and substantial errors in downstream labels, including limited maintenance/second-life recall. Query structure, indexing, synonyms, field availability and dictionary breadth all affect detection. A downstream-attention gap remains a hypothesis requiring independently validated evidence, rather than an established finding from these rates.

5.5. Scope and Validity Limitations

The corpus covers one database, English-language articles and reviews and a fixed publication window. Broad query terms admit adjacent engineering and clinical records, including titles about cardiopulmonary exercise testing. Retention of all 973 records preserves the archived search-defined input; it is not a claim that every record is a relevant policy study. Neither the explicit-mode subset nor the 961-record lexical-coverage check replaces full relevance assessment. Coverage, relevance and construct validity are therefore distinct limitations.

Overlap between retrieval and coding terms creates selection circularity: observed governance/life-cycle shares are conditional on the policy/governance AND-clause used to define the study population. Terms such as parking management, traffic management and urban planning can influence both retrieval and subsequent category assignment. In the later paired retrieval, infrastructure/planning was 10.23 percentage points higher and operation/integration 4.81 points higher in A than in B. Their high shares cannot be treated as wholly emergent features of all ETW research. The comparison is descriptive, uses a later database snapshot and retains query-level lexical false positives; it does not resolve semantic relevance or establish representativeness. The nested specificity comparison addresses a separate question.

Literal matching can misinterpret negation, technical terminology and incidental mentions. Distinct spans prevent mechanical reuse but do not establish semantic independence or construct validity. The completed human audit identifies substantial false positives in governance and operational categories and false negatives for maintenance/second life. Accordingly, neither raw shares nor their differences establish validated thematic prevalence. The sample is stratified and enriched, some consensus-positive counts are very small, and no mode-specific accuracy or confidence interval is established. Co-mention cells were not semantically validated. The dictionaries were kept frozen rather than adjusted and re-evaluated on the same 100 annotations.

Vehicle tags overlap and can be ambiguous; exclusive-tag results remove overlap without proving classification accuracy. A strict title/author-keyword subset is nested inside the same search and is an internal consistency test. Affiliation countries are not policy-study locations, suffix parsing leaves incomplete addresses unresolved, and exact-name collisions are not confirmed identity errors. Citation counts are historical and depend on age/field. Network results depend on thesaurus, thresholds, resolution, seed and algorithm; Leiden comparison quantifies one additional choice without resolving all uncertainty. The export lacks cited references, precluding co-citation and bibliographic-coupling analysis.

6. Conclusions and Future Work

6.1. Findings and Contribution

Three findings summarize the analysis. First, the frozen dictionaries produce reproducible differences between mode-labelled profiles, including operational, market-formation and incentive matches; overlap exclusions preserve some contrasts. Second, the completed human audit shows that several governance and life-cycle match shares are poor proxies for substantive themes. In particular, low operational precision and low maintenance/second-life recall prevent concluding that the apparent upstream–downstream imbalance is a research gap. Third, keyword communities vary across specifications, supporting transparent reporting of analytical choices rather than a fixed cluster taxonomy.

The empirical contribution is a transparent description and validation audit of a lexical mapping procedure, including evidence of its limitations. MPF is retained as a conceptual framework for organizing candidate contextual evaluation questions. The uncorrected profiles do not establish mode-specific policy needs, thematic prevalence or a preferred policy portfolio. Such claims require better semantic identification and independent implementation evidence.

The analysis concerns 973 archived records, overlapping terminology tags and lexical categories with quantified, heterogeneous errors. The 100-record consensus does not replace full-corpus annotations or correct the published profile denominators. Conclusions remain bounded by query selection, relevance ambiguity and classification error; they

support methodological diagnosis and testable questions, rather than population claims about all ETW research or judgments about policy adequacy.

6.2. Future Validation and Application

Future work should improve semantic identification and assess it on a separate held-out reference sample before using the profiles as thematic prevalence estimates. The present 100-record sample has already been independently coded and adjudicated and should not also be treated as an untouched test set after dictionary tuning. Broader retrieval, explicit relevance assessment and additional positive examples would help address ambiguous E2W uses and sparse downstream categories. The completed later paired retrieval assesses query selection rather than semantic validity. Implementation studies could subsequently test whether vehicle constraints, instrument combinations and actor responsibilities predict sustained use, safety, affordability, accessibility, repairability or material recovery.

MPF could be integrated into policy-mix evaluation by connecting each candidate question in Table 5 to a documented policy inventory, named implementing actors, a target population and longitudinal or quasi-experimental outcome evidence. Oltmer and Löhr [24] and Kanger et al. [23] provide complementary actor and transition perspectives for that extension. Analytical code and dictionaries are supplied in Supplementary File S2, and aggregate supporting outputs in Supplementary File S3.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/wevj17120634/s1, File S1: Detailed technical methods, data schema and aggregate verification notes (DOCX/PDF); File S2: Executable analysis and figure code, matching rules, thesaurus and environment requirements; File S3: Aggregate analytical outputs and descriptive checks. Files S1–S3 are organized within the accompanying supplementary archive. Original source metadata and detailed record-level evidence are supplied separately as non-published material.

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Institutional Review Board Statement: Not applicable. This study analyzes bibliographic metadata and does not involve human participants or non-public personal data.

Data Availability Statement: The complete search strategy and analytical procedures are documented in the manuscript, appendices and Supplementary File S1. Analysis code, coding dictionaries, finite thesaurus mappings and parameter settings are supplied in Supplementary File S2; aggregate outputs are supplied in Supplementary File S3. Independent figure files accompany the submission. The original 973-record, 33-field Scopus export is identified by SHA-256 in Supplementary File S1. The frozen export and detailed record-level matching evidence are supplied separately for editorial/reviewer assessment as non-published material; subsequent access is available from the author upon reasonable request, subject to applicable database licensing conditions. The checksum verifies file identity when the file is accessible; it does not establish public access. No public repository or repository DOI is claimed.

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

Appendix A. Retrieval and Selection-Effect Protocol

TITLE-ABS-KEY(
("electric two-wheel*" OR "electric two wheel*" OR "electric 2-wheel*" OR "electric 2 wheel*" OR E2W OR
"e-bike*" OR ebike* OR "electric bicycl*" OR pedelec* OR "speed pedelec*" OR "electric scooter*" OR
"e-scooter*" OR escooter* OR "electric moped*" OR "e-moped*" OR "electric motorcycl*" OR
"e-motorcycl*" OR "battery electric motorcycl*" OR "shared e-scooter*" OR "shared electric scooter*" OR
"electric micromobil*")
AND
(policy OR policies OR "public policy" OR governance OR govern* OR regulat* OR legislat* OR law OR laws OR legal OR
standard* OR certificat* OR homologation OR ban OR bans OR banning OR restrict* OR subsid* OR incentive* OR rebate* OR
taxation OR "public procurement" OR "road access" OR "right of way" OR licens* OR registration OR enforcement OR
"policy mix*" OR "urban planning" OR "transport planning" OR "traffic management" OR "parking management" OR equity OR
justice OR inclusion OR affordability OR "extended producer responsibility" OR "battery recycling")
)
AND PUBYEAR > 1999 AND PUBYEAR < 2026
AND NOT TITLE-ABS-KEY("mobility scooter*" OR wheelchair*)
AND (LIMIT-TO(DOCTYPE,"ar") OR LIMIT-TO(DOCTYPE,"re"))
AND LIMIT-TO(LANGUAGE,"English")

Archived export date: 14 August 2026. Publication window: 2000–2025. English articles and reviews. This is the original retrieval, not a new search conducted during revision.

The governance/policy AND-block defines the policy- and governance-related primary study population. Query B removes only this block while retaining the ETW expressions and the other limits. The author supplied both new exports on 28 October 2026; the eligible paired corpora contain 971 A records and 2385 B records after one B record labelled Japanese was excluded. This later comparison is reported separately from the frozen 14 August 2026 primary corpus (973 records), so changes in database indexing are not attributed to the query contrast. The export filenames, hashes, exclusion, overlap and aggregate rates are recorded in the supplementary paired-retrieval results.

Appendix B. Input Integrity and Specification Audit

Table A1 records input integrity and results produced by the specified MPF-R2-1.0 pipeline. The audit distinguishes immutable file identity from outputs that depend on explicit coding and network choices.

Table A1. Input integrity and recalculated outputs.

Item	Value
Frozen records/fields	973/33
Unique EIDs/unique nonblank DOIs	973/942
Author keyword records	895
Scopus sources/author IDs	433/3449
SHA-256	82919d3eeb312e7a38dcd7bbfba6a9c134628753928f186d8ee3617e801e1118

Keyword graph	47 nodes/299 links/925 pair co-occurrences
Primary communities/strict subset	6/759
Multi-tagged/untagged records	114/12
Louvain mean/median ARI	0.702075/0.682351
Leiden communities/cross-algorithm ARI	7/0.733604
Country-resolved/international records	967/220

Appendix C. Complete-Rule Location and Worked Examples

The exhaustive implemented patterns are stored in rules.json and analyse.py; Table A2 summarizes the families for reading. Strings, spans, binary labels and co-mention outputs for every record are provided separately in the non-published material package. Matching uses normalized text and explicit word boundaries; author-keyword normalization uses a finite alias map rather than unstated stemming.

Table A2. Governance and life-cycle lexical families.

Dimension	Family	Representative Lexical Indicators
Governance domain	Regulation/standards	regulation/regulatory; legislation; law/legal; standards; licensing; registration; enforcement; bans/restrictions; certification; homologation; permits; mandates; helmet-law and speed-limit expressions
Governance domain	Economic incentives	subsidies; incentives; rebates; taxation/tax credits; purchase grants; financial support; fiscal support/incentive expressions
Governance domain	Infrastructure/planning	infrastructure; charging stations/networks; battery-swapping stations/networks; bicycle/bike/cycle lanes; parking facilities/management/policy; curb management; public-transport/transit integration; urban/transport planning; land use; traffic management
Governance domain	Information/education	education; training; awareness; campaigns; information provision; risk communication; safety education
Governance domain	Industrial/innovation	manufacturing; industrial; innovation; research and development/R&D; supply chains; local content; public procurement
Governance domain	Circularity/EPR	recycling; extended/producer responsibility; take-back; second life; end-of-life; circular economy; battery waste; right to repair
Life-cycle stage	Design/production	design; manufacturing; production; battery production/chemistry; supply chains; technology development
Life-cycle stage	Market formation	adoption; purchase intention; willingness to pay/adopt/purchase; consumers; market/demand; affordability; ownership; total cost of ownership
Life-cycle stage	Operation/integration	operation; charging; battery swapping; sharing; parking; roads/traffic; public transport/transit; trips; riding/riders; commuting; first/last mile; routing
Life-cycle stage	Maintenance/second life	maintenance; repair/repairability; durability; second life; reuse; refurbishment; remanufacturing
Life-cycle stage	End-of-life	end-of-life; disposal; battery waste; recycling; take-back; material recovery

Worked rule example 1: “Parking management supports commuting”. The governance phrase parking management and the life-cycle expression commuting are different and have disjoint spans; count infrastructure/planning × operation/integration once. Example 2: “Recycling” alone cannot count circularity/EPR × end-of-life. Example 3: “Recycling supports material recovery” can count that cell because the two expressions are distinct and nonoverlapping. Single words and multiword phrases are treated by the same string-and-span rule. Multiple instances of the identical word recycling alone do not pass, and neither does an embedded substring. A record can count in several cells, explaining

why matrix row sums can exceed category marginals. These constructed examples illustrate the stated rule, not independent human semantic validation.

Appendix D. Finite Thesaurus

Table A3 gives the complete finite alias groups. Unicode NFKC, lowercasing, hyphen-to-space normalization and whitespace collapse are applied to both aliases and observed keywords. Canonical labels are normalized by the same function. Unlisted keywords are retained as normalized strings.

Table A3. Full finite author-keyword alias groups.

Canonical Label Before Normalization	Explicit Aliases
electric bicycles	e-bike; e-bikes; ebike; ebikes; electric bike; electric bikes; electric bicycle; electric bicycles; e-bicycle; e-bicycles; pedelec; pedelecs
electric scooters	e-scooter; e-scooters; escooter; escooters; electric scooter; electric scooters; trottinette électrique
shared electric scooters	shared e-scooter; shared e-scooters; e-scooter sharing; shared electric scooter; shared electric scooters
electric motorcycles	e-motorcycle; e-motorcycles; electric motorcycle; electric motorcycles
electric two-wheelers	electric two wheeler; electric two wheelers; electric two-wheeler; electric two-wheelers; e2w
micromobility	micro mobility; micro-mobility
public transport	public transportation; public transit
travel behavior	travel behaviour
sustainable transport	sustainable transportation
life cycle assessment	life-cycle assessment; lca
policy	policy mixes; policies
regulation	regulations
bicycles	bicycle; bicycles
injury	injuries
traffic accident	traffic accidents; accidents de la circulation
bike sharing	bike-sharing; bikeshare; bikesharing; bicycle-sharing
electric vehicles	electric vehicle; electric vehicles

Appendix E. Context Comparisons and Metadata Diagnostics

Table A4 compares studies with a common unit: reported corpus size, main analytic object, and whether the same joint mode × governance × life-cycle comparison is part of the reported design. This is a scoped comparison of reported methods, not a ranking of study quality or an assertion that earlier studies ignored policy or life-cycle topics.

Table A4. Comparisons using common quantitative and design anchors.

Study	Reported Corpus n	Main Object/Method	Joint Mode–Domain–Stage Scheme
Cadavid & Salazar-Serna [5]	103	Motorcycle-market policies; tech mining and keyword clusters	Not part of the reported comparison design
Yurdakul et al. [8]	313	E-scooter interdisciplinary bibliometrics and systematic synthesis	Not an across-ETW-mode matrix
Mogire [9]	552	Broad LEV urban sustainability mapping	Not the six-domain/five-stage mode comparison

Oltmer & Löhr [24]	82	Actors and policy-mix components in transitions	Actor/process coding; different unit and purpose
This study	973	Non-exclusive mode tags; six governance domains; five stages	Explicit joint comparison, with overlap and specification checks

Table A5 lists potential exact-name/ID collisions. They are not adjudicated author errors; estimating all disambiguation problems would require additional identity information. The main text focuses on influential documents rather than author-name rankings.

Table A5. Full-name strings associated with more than one Author ID.

Normalized Full Name	Author IDs
chen, zheng	56941076900; 57196284387
huang, wenjuan	56316715700; 57226353975
jin, tao	57221018437; 58434660200
li, liang	57205268329; 58075927800
li, xiao	57714553500; 58748356000
li, yan	59070373500; 59945960300
lin, chih-hong	15034894300; 57223642383
liu, yan	56365843500; 57858182600; 57858950900
mitchell, gary	55641165800; 59138351500
wang, chen	56014811800; 59832878600
wang, wei	56948437900; 59104087600; 60399683500
wang, xuesong	55736845400; 58405966300
yang, qing	23390882900; 36770139200

Table A6 gives pairwise intersections. Ninety records have two tags and twenty-four have three, so the six pair counts sum to 162 = 90 + 3×24, not the 114 unique multi-tagged records. Exclusive and complete tag combinations are also supplied as machine-readable outputs in Supplementary File S3.

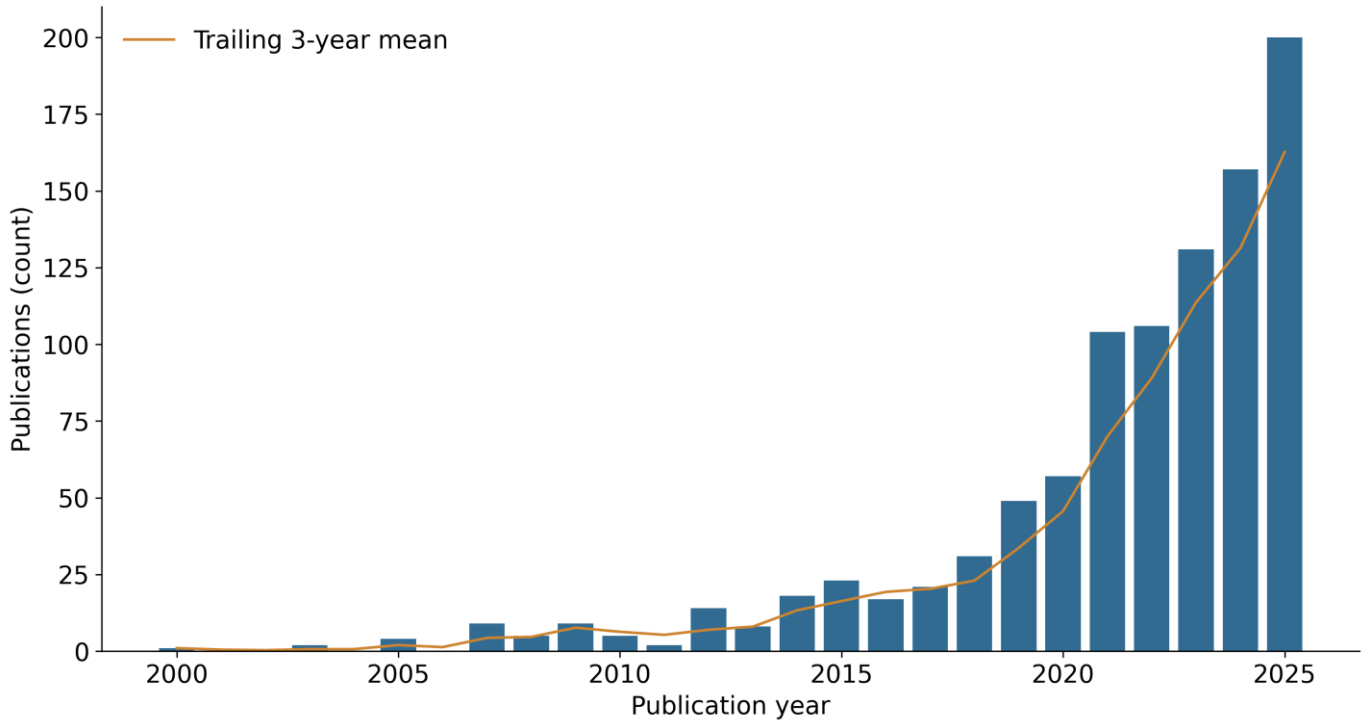


Figure A1. Annual publication output. Horizontal axis: publication year; vertical axis: record count. The line is a trailing three-year mean with available-year windows at the beginning. Publication growth is not policy effectiveness.

Table A6. Pairwise mode-tag intersections.

Mode A	Mode B	Records
E-scooter	E-bike/pedelec	56
E-scooter	E-motorcycle/moped	19
E-scooter	Generic/mixed ETW	26
E-bike/pedelec	E-motorcycle/moped	23
E-bike/pedelec	Generic/mixed ETW	26
E-motorcycle/moped	Generic/mixed ETW	12

Appendix F. Execution Protocol and Output Scope

F1 Preserve the original CSV bytes and verify the checksum in Supplementary File S1. Install the pinned environment from S2_Code/requirements.txt and set PYTHONHASHSEED = 0. Run S2_Code/analyse.py on corpus_original.csv, followed by S2_Code/draw_figures.py on its outputs. The exact commands and additional descriptive-audit command are provided in the supplementary README. All input transformations and output schemas are explicit in these files. Verification/reproduction_report.json records the completed frozen-input rerun; Paired_Retrieval_Protocol supplies the queries; Paired_Retrieval_Results_2026-10-28 reports the completed later comparison, which is separate from the frozen-input rerun.

F2 The pipeline exports record labels and match spans, pairwise overlaps and tag combinations, exclusive-mode profiles, category coverage, domain-stage counts, keyword graphs and clusters, threshold and seed checks, Leiden membership, temporal rates, country labels/counts/links and author-name/ID diagnostics. The additional descriptive audit exports profile_contrasts.csv, lexical_coverage_check.csv and temporal_metadata_check.csv.

F3 The author-keyword network is constructed once from sorted nodes and edges with document-level full counting and association-strength weights. The program runs seeds 0–29 at threshold eight and computes all 435 pairwise ARIs. Leiden uses the same weighted graph and resolution; its membership table is supplied.

F4 Record-level co-mention decisions require different literal expressions and disjoint spans. Each qualifying record contributes at most one to a given matrix cell; categories and cells remain non-exclusive. All summary rates derive from the disclosed row-level arrays. Internal count invariants are checked in the program, but those assertions do not establish semantic accuracy.

F5 The executable pipeline supports verification of matching decisions and reproduction of aggregate counts. Independent human coding and consensus validation were completed for 100 records and are reported in Section 4.9 and supplementary Human_Validation_Results_2026-10-29. They reveal substantial semantic errors in some categories; software assertions, nested-subset correlations and network checks are not substitutes for this audit. The 100 records were not used to tune the frozen dictionaries.

F6 Supplementary Files S2 and S3 provide the executable code, exact dictionaries, finite thesaurus and aggregate supporting outputs. The frozen source export and detailed record-level evidence are supplied separately as non-published material and are available from the author upon reasonable request, subject to applicable licensing conditions. No public repository deposit or persistent repository identifier is asserted.

References

1. Ewert, A.; Brost, M.; Eisenmann, C.; Stieler, S. Small and light electric vehicles: An analysis of feasible transport impacts and opportunities for improved urban land use. *Sustainability* **2020**, *12*, 8098. https://doi.org/10.3390/su12198098.
2. Hollingsworth, J.; Copeland, B.; Johnson, J.X. Are e-scooters polluters? The environmental impacts of shared dockless electric scooters. *Environ. Res. Lett.* **2019**, *14*, 084031. https://doi.org/10.1088/1748-9326/ab2da8.
3. Moreau, H.; de Jamblinne de Meux, L.; Zeller, V.; D'Ans, P.; Ruwet, C.; Achten, W.M.J. Dockless e-scooter: A green solution for mobility? Comparative case study between dockless e-scooters, displaced transport, and personal e-scooters. *Sustainability* **2020**, *12*, 1803. https://doi.org/10.3390/su12051803.
4. Weiss, M.; Dekker, P.; Moro, A.; Scholz, H.; Patel, M.K. On the electrification of road transportation: A review of the environmental, economic, and social performance of electric two-wheelers. *Transp. Res. Part D Transp. Environ.* **2015**, *41*, 348–366. https://doi.org/10.1016/j.trd.2015.09.007.
5. Cadavid, L.; Salazar-Serna, K. Mapping the research landscape for the motorcycle market policies: Sustainability as a trend—A systematic literature review. *Sustainability* **2021**, *13*, 10813. https://doi.org/10.3390/su131910813.
6. Zhou, J.; Li, Z.; Dong, S.; Sun, J.; Zhang, Y. Visualization and bibliometric analysis of e-bike studies: A systematic literature review (1976–2023). *Transp. Res. Part D Transp. Environ.* **2023**, *122*, 103891. https://doi.org/10.1016/j.trd.2023.103891.
7. Firdaus, T.A.; Yuniaristanto; Damayanti, R.W. Bibliometric analysis: The development of research on electric two-wheeler adoption in the last decade (2014–2024). *IOP Conf. Ser. Earth Environ. Sci.* **2025**, *1488*, 012022. https://doi.org/10.1088/1755-1315/1488/1/012022.
8. Yurdakul, G.; Aydin, N.; Olanrewaju, O.A. Interdisciplinary perspectives on e-scooters: A bibliometric and systematic analysis of the current research. *IET Intell. Transp. Syst.* **2025**, *19*, e70107. https://doi.org/10.1049/itr2.70107.
9. Mogire, E. Light electric vehicles and sustainable transport in urban areas: A bibliometric review. *World Electr. Veh. J.* **2026**, *17*, 23. https://doi.org/10.3390/wevj17010023.
10. Nosratzadeh, H.; Bhowmick, D.; Carmona, A.B.R.; Pearson, L.; Thompson, J.; Thai, T.; Beck, B. Implementing without evaluating: The missing link in understanding the effectiveness of financial incentive programs for e-bikes. *Cities* **2025**, *156*, 105528. https://doi.org/10.1016/j.cities.2024.105528.
11. Zhang, F.; Lv, H.; Sun, N.; Ji, Y. Insights into User Acceptance of Battery Swapping Services for Sustainable Micromobility using the Unified Theory of Acceptance and Use of Technology 2 Model. *Transp. Res. Rec.* **2025**, *2679*, 770–786. https://doi.org/10.1177/03611981241264111.
12. Achal, D.K.; Vijaya, G.S. AI-Enhanced Circular Economy and Sustainability in the Indian Electric Two-Wheeler Industry: A Review. *World Electr. Veh. J.* **2025**, *16*, 638. https://doi.org/10.3390/wevj16110638.
13. Eduardo, S.; Recklies, E.A.; Nikolic, M.; Severengiz, S. A Comparative Life Cycle Assessment of End-of-Life Scenarios for Light Electric Vehicles: A Case Study of an Electric Moped. *Sustainability* **2025**, *17*, 6681. https://doi.org/10.3390/su17156681.
14. Gürbüz, H.; Gürbüz, C. The mediating effect of the sustainability committee on the relationship of size of board of directors with environmental sustainability disclosures: A study in the transportation sector. *Sustainability* **2025**, *17*, 3165. https://doi.org/10.3390/su17073165.
15. Martin, E.; Andrieu, V.-M.; Ebbefeld, R.; Giki, P.; Manyasa, E.M.; Kost, C. Barriers to scaling up electric bicycles in eight African countries: Infrastructure, policy, cost, and perception. *Sustain. Earth Rev.* **2026**, *9*, 3. https://doi.org/10.1186/s42055-026-00121-9.
16. Geels, F.W. Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Res. Policy* **2002**, *31*, 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8.
17. Kivimaa, P.; Kern, F. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Res. Policy* **2016**, *45*, 205–217. https://doi.org/10.1016/j.respol.2015.09.008.
18. Rogge, K.S.; Reichardt, K. Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Res. Policy* **2016**, *45*, 1620–1635. https://doi.org/10.1016/j.respol.2016.04.004.
19. Ostrom, E. Polycentric systems for coping with collective action and global environmental change. *Glob. Environ. Change* **2010**, *20*, 550–557. https://doi.org/10.1016/j.gloenvcha.2010.07.004.
20. Marques, D.L.; Coelho, M.C. A literature review of emerging research needs for micromobility—Integration through a life cycle thinking approach. *Future Transp.* **2022**, *2*, 135–164. https://doi.org/10.3390/futuretransp2010008.
21. McQueen, M.; Abou-Zeid, G.; MacArthur, J.; Clifton, K. Transportation transformation: Is micromobility making a macro impact on sustainability? *J. Plan. Lit.* **2021**, *36*, 46–61. https://doi.org/10.1177/0885412220972696.
22. Sheller, M. *Mobility Justice: The Politics of Movement in an Age of Extremes*; Verso: London, UK, 2018.

23. Kanger, L.; Sovacool, B.K.; Noorkõiv, M. Six policy intervention points for sustainability transitions: A conceptual framework and a systematic literature review. *Res. Policy* **2020**, *49*, 104072. https://doi.org/10.1016/j.respol.2020.104072.
24. Oltmer, M.; Löhr, M. Tracing actors in policy mixes for transitions: A systematic literature review and insights from policy process theories. *Environ. Innov. Soc. Transit.* **2025**, *56*, 100989. https://doi.org/10.1016/j.eist.2025.100989.
25. Aria, M.; Cuccurullo, C. Bibliometrix: An R-tool for comprehensive science mapping analysis. *J. Inf.* **2017**, *11*, 959–975. https://doi.org/10.1016/j.joi.2017.08.007.
26. Donthu, N.; Kumar, S.; Mukherjee, D.; Pandey, N.; Lim, W.M. How to conduct a bibliometric analysis: An overview and guidelines. *J. Bus. Res.* **2021**, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070.
27. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. https://doi.org/10.1136/bmj.n71.
28. Baas, J.; Schotten, M.; Plume, A.; Côté, G.; Karimi, R. Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quant. Sci. Stud.* **2020**, *1*, 377–386. https://doi.org/10.1162/qss_a_00019.
29. van Eck, N.J.; Waltman, L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* **2010**, *84*, 523–538. https://doi.org/10.1007/s11192-009-0146-3.
30. Traag, V.A.; Waltman, L.; van Eck, N.J. From Louvain to Leiden: Guaranteeing well-connected communities. *Sci. Rep.* **2019**, *9*, 5233. https://doi.org/10.1038/s41598-019-41695-z.
31. Fishman, E.; Cherry, C. E-bikes in the mainstream: Reviewing a decade of research. *Transp. Rev.* **2016**, *36*, 72–91. https://doi.org/10.1080/01441647.2015.1069907.
32. Oeschger, G.; Carroll, P.; Caulfield, B. Micromobility and public transport integration: The current state of knowledge. *Transp. Res. Part D Transp. Environ.* **2020**, *89*, 102628. https://doi.org/10.1016/j.trd.2020.102628.
33. Cherry, C.; Cervero, R. Use characteristics and mode choice behavior of electric bike users in China. *Transp. Policy* **2007**, *14*, 247–257. https://doi.org/10.1016/j.tranpol.2007.02.005.
34. McKenzie, G. Spatiotemporal comparative analysis of scooter-share and bike-share usage patterns in Washington, D.C. *J. Transp. Geogr.* **2019**, *78*, 19–28. https://doi.org/10.1016/j.jtrangeo.2019.05.007.
35. Sanders, R.L.; Branion-Calles, M.; Nelson, T.A. To scoot or not to scoot: Findings from a recent survey about the benefits and barriers of using E-scooters for riders and non-riders. *Transp. Res. Part A Policy Pract.* **2020**, *139*, 217–227. https://doi.org/10.1016/j.tra.2020.07.009.
36. Trivedi, T.K.; Liu, C.; Antonio, A.L.M.; Wheaton, N.; Kreger, V.; Yap, A.; Schriger, D.; Elmore, J.G. Injuries associated with standing electric scooter use. *JAMA Netw. Open* **2019**, *2*, e187381. https://doi.org/10.1001/jamanetworkopen.2018.7381.
37. Mai, R.; Chen, Y.; Li, Y.; Zhang, Y.; Cao, G.; He, Z. Inductive power transfer for massive electric bicycles charging based on hybrid topology switching with a single inverter. *IEEE Trans. Power Electron.* **2017**, *32*, 5897–5906. https://doi.org/10.1109/TPEL.2017.2654360.
38. Gössling, S. Integrating e-scooters in urban transportation: Problems, policies, and the prospect of system change. *Transp. Res. Part D Transp. Environ.* **2020**, *79*, 102230. https://doi.org/10.1016/j.trd.2020.102230.
39. Bozzi, A.D.; Aguilera, A. Shared e-scooters: A review of uses, health and environmental impacts, and policy implications of a new micro-mobility service. *Sustainability* **2021**, *13*, 8676. https://doi.org/10.3390/su13168676.
40. Eccarius, T.; Lu, C.-C. Powered two-wheelers for sustainable mobility: A review of consumer adoption of electric motorcycles. *Int. J. Sustain. Transp.* **2020**, *14*, 215–231. https://doi.org/10.1080/15568318.2018.1540735.
41. Kazemzadeh, K.; Haghani, M.; Sprei, F. Electric scooter safety: An integrative review of evidence from transport and medical research domains. *Sustain. Cities Soc.* **2023**, *89*, 104313. https://doi.org/10.1016/j.scs.2022.104313.
42. Mesimäki, J.; Lehtonen, E. Light electric vehicles: The views of users and non-users. *Eur. Transp. Res. Rev.* **2023**, *15*, 33. https://doi.org/10.1186/s12544-023-00611-3.
43. Agustina, R.; Yuniaristanto; Sutopo, W. Factors influencing electric motorcycle adoption in Indonesia: Comprehensive psychological, situational, and contextual perspectives. *World Electr. Veh. J.* **2025**, *16*, 106. https://doi.org/10.3390/wevj16020106.
44. Fonseca-Cabrera, A.S.; Llopis-Castelló, D.; Pérez-Zuriaga, A.M.; García, A. Assessing micromobility users' knowledge of regulations: Valencia (Spain) case study. *Safety* **2025**, *11*, 36. https://doi.org/10.3390/safety11020036.
45. Zhang, Y.; Nelson, J.D.; Mulley, C. Learning from the evidence: Insights for regulating e-scooters. *Transp. Policy* **2024**, *151*, 63–74. https://doi.org/10.1016/j.tranpol.2024.04.001.
46. Shaheen, S.; Cohen, A. *Shared Micromobility Policy Toolkit: Docked and Dockless Bike and Scooter Sharing*; University of California: Berkeley, CA, USA, 2019. https://doi.org/10.7922/G2TH8JW7.

47. International Transport Forum. *Safe Micromobility*; International Transport Forum Policy Papers No. 85; OECD Publishing: Paris, France, 2020. https://doi.org/10.1787/0b98fac1-en.
48. Sutopo, W.; Prianjani, D.; Fahma, F.; Pujiyanto, E.; Rasli, A.; Kowang, T.O. Open Innovation in Developing an Early Standardization of Battery Swapping According to the Indonesian National Standard for Electric Motorcycle Applications. *J. Open Innov. Technol. Mark. Complex.* **2022**, *8*, 219. https://doi.org/10.3390/joitmc8040219.
49. Bashir, M.T.; Almutairi, A.; Sikandar, M.A.; Khan, M.M.H.; Alanazi, A.O.; Khan, M.H.N. AI-driven real-time detection of motorcycle traffic violations using YOLOv8 and IoT-based analytics. *Sci. Rep.* **2026**, *16*, 21494. https://doi.org/10.1038/s41598-026-52641-1.
50. Chen, F.; Yang, B.; Zhang, W.; Ma, J.; Lv, J.; Yang, Y. Enhanced recycling network for spent e-bicycle batteries: A case study in Xuzhou, China. *Waste Manag.* **2017**, *60*, 660–665. https://doi.org/10.1016/j.wasman.2016.09.027.
51. Zhang, C.; Dong, M.; Luan, T.H.; Ota, K. Battery Maintenance of Pedelec Sharing System: Big Data Based Usage Prediction and Replenishment Scheduling. *IEEE Trans. Netw. Sci. Eng.* **2020**, *7*, 127–138. https://doi.org/10.1109/TNSE.2019.2901833.
52. Miao, S.; Rasli, A.; Tee, M.; Li, D.; Du, K.; Xue, G.; Huan, H.; Liang, W. Mapping Artificial Intelligence in Electric Two-Wheelers: Paradigm Evolution, Technology–Application Specialization, and Emerging Frontiers (2015–2025). *World Electr. Veh. J.* **2026**, *17*, 547. https://doi.org/10.3390/wevj17100547.
53. Tee, M.; Miao, S.; Rasli, A.; Li, D.; Liang, W.; Xue, G. Green Energy Vehicles in the Global Energy Transition: Technological Evolution, Critical Materials, and Sustainable Supply Chains—A Bibliometric and Thematic Review (2015–2025). *Energies* **2026**, *19*, 4878. https://doi.org/10.3390/en19204878.

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