The Building Renovation Passport from a Data Perspective

A structured literature review supporting the RENODAT WP1 Go/No-Go decision

Bottom line

The Building Renovation Passport (BRP) literature has converged on *what* a passport should contain and diverged on *how* that content should be represented. At least six distinct data models or attribute sets have been proposed for the passport and its companion Digital Building Logbook (DBL) since 2018, and when two of them are compared element-by-element the semantic overlap is low: Karami et al. (2024) report "very low similarity" between current DBL/DBP models and find metadata largely absent, concluding that automated comparison fails because identical terms rarely exist across models. This is the central finding for a data-focused decision. The BRP's conceptual layer is mature enough to build on, its semantic layer is not standardised, and its empirical bottleneck is upstream of both: the data needed to populate a passport for an individual building is incomplete, of contested accuracy, and unevenly digitalised across Member States.

For a project defining BRP data requirements, the evidence supports proceeding, but the defensible scope is narrower than the literature's ambition. Building *another* conceptual attribute list would add to a crowded and unvalidated field; specifying requirements against verified national data availability, with explicit provenance, quality and update semantics per field, addresses the gap that every reviewed data model leaves open. Governance, meaning who owns, updates and is liable for passport data, is the thinnest evidence base of the four data dimensions examined (17 of 128 in-scope papers), and is the area where a decision made now rests most heavily on assumption.

Evidence base and how it was assembled

This review works from the RENODAT state-of-the-art workbook (198 coded records: 166 papers, 16 projects, 16 policy/grey-literature items; 159 marked in scope for WP1) and extends it with an independent sweep of OpenAlex across the four data dimensions, plus one step backward and forward on the citation graph from five anchor papers. Fifty-nine records not present in the workbook were added, principally on EPC data quality, semantic/ontology work, urban building energy modelling from registry data, material-passport data requirements, and 2025–26 DBL publications. Every DOI in the workbook resolved against CrossRef and none carried a retraction flag. The combined, screened corpus is provided as a table (218 records) alongside this review.

Two features of the corpus shape how much weight its conclusions can bear.

First, the passport-specific literature is very young: of 37 in-scope papers whose titles address renovation passports, building passports, or logbooks directly, 22 were published in 2024–25. Second, it is weighted toward proposal rather than test. Sixteen of those 37 papers report no case building or dataset at all. Review and policy syntheses are least often grounded (2 of 9), followed by data-model and schema papers (5 of 9); national implementation studies (7 of 9) and tool prototypes (5 of 6) fare better. The schema figure matters more than its rank, because a data model that has never been populated from real building data is the specific prior art a requirements exercise would otherwise inherit. Author teams are also concentrated. Spanish, Italian and Portuguese groups produced 25 of the 37 passport-specific papers, so the "European" data model in the literature is substantially an Iberian–Italian reading of the European problem.

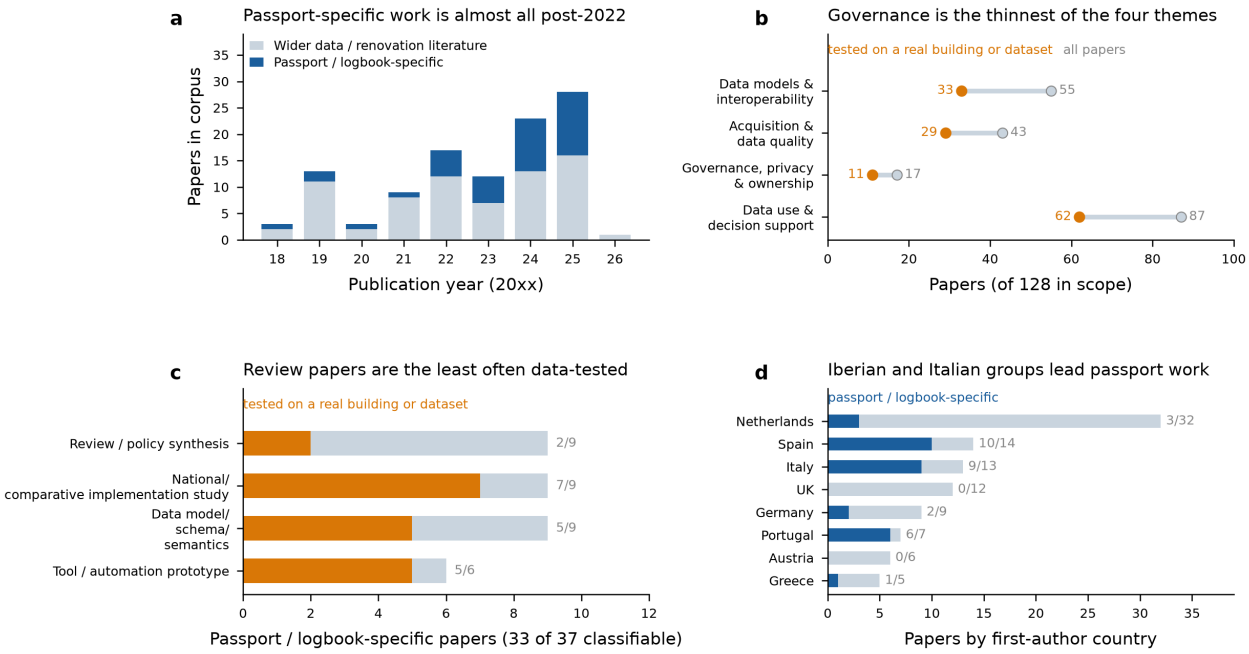

Figure 1. Corpus map: publication timeline, thematic coverage, share of passport-specific papers tested on a real building or dataset by output type, and author-team geography

The regulatory data mandate

The 2024 EPBD recast converted the passport from a voluntary national experiment into a scheme every Member State must offer. Under Article 12 and Annex VIII of Directive (EU) 2024/1275, Member States must introduce a renovation passport scheme by 29 May 2026, based on the common framework in Annex VIII, of voluntary use by building owners unless a Member State decides to make it mandatory. Member States may allow the passport to be drawn up and issued jointly with the energy performance certificate, and must ensure it is stored in, or accessible via, the digital building logbook where one is available. The Directive's own definition ties the two instruments together: a digital building logbook is a common repository for all relevant building data, including energy performance certificates, renovation passports, smart readiness indicators and life-cycle global warming potential data.

This matters for data requirements in three concrete ways, all set out in the European Commission's implementation guidance annexes for the recast Directive — *Renovation passport (Article 12, Annex VIII)*, annex 4 and *Databases for the energy performance of buildings (Article 22)*, annex 5. The passport's baseline must reflect the building's *current* state: quantification is to be based on the building's present condition and technical systems rather than historical data or previous assessments, which implies a current technical survey and, where appropriate, an energy audit. Content is not left open — passports must carry current energy performance, a roadmap of renovation stages, applicable minimum national energy standards, fossil-fuel heating phase-out schedules, estimated energy savings and projected greenhouse-gas reductions. And the database provisions push the passport into a national data infrastructure rather than a document, since the "full certificate" concept requires the entire EPC, including Annex V information plus country-specific indicators, to be uploaded to national databases.

Hwang et al. (2025) is the most useful synthesis of how these instruments interlock: reviewing 31 EU policy documents and 17 project reports across nine digital instruments, they position BRP–DBL integration as the key lever and standardised data formats as the precondition. Their framework is a policy mapping rather than a technical specification, and the authors themselves flag that regional discrepancies in data quality and data needs, and the economic feasibility of the instruments, remain unstudied. Both caveats bear directly on WP1, because the regulatory mandate fixes *what* must be reported, not *whether the data exists at the required granularity in any given Member State*.

Data models, semantics and interoperability

Six models, no convergence

The proposal literature is dense and largely self-referential. Sesana and Salvalai (2018) set the baseline by comparing the three operational schemes — Flanders' Woningpas, France's P2E, Germany's iSFP — and framing the passport as a remedy for information asymmetry about building quality, a framing inherited from earlier property-market work on performance signalling (Lützkendorf & Speer 2005). Sesana et al. (2020) produced the first concrete data model, ALDREN's BuildLog plus RenoMap for non-residential buildings, explicitly designed around what existing EU databases (Eurostat, Building Stock Observatory, EPC registers, TABULA/EPISCOPE) could supply, and stated plainly that validation of the structure was deferred to future work.

Successive proposals have added attributes rather than resolving representation. Gómez-Gil et al. (2022) compared four European DBL models (iBRoad, ALDREN, X-tendo, the EU framework study) across seven dimensions and found common features but wide divergence. Malinovec Puček et al. (2023) consolidated iBRoad, ALDREN, BIM4EEB and X-tendo into the EUB SuperHub eight-category structure yielding a three-domain rating. Gómez-Gil et al. (2024) proposed the renovation-focused DBrL data model with entities and relationships, and a companion contribution specifies 163 attributes across five modules (Gómez-Gil et al. 2024b) — filtered, notably, to attributes proposed by at least half of existing European DBL initiatives, which makes it a consensus artefact of the proposal literature rather than an independent requirements derivation. Karami et al. (2026) then integrate a semantic comparison of DBL and EPC models into a further harmonised proposal.

The pattern is worth naming: each new model is validated against previous models, not against building data. That is why the semantic-mapping results are the most informative papers in this cluster. Karami et al. (2025) map DBL against EPC schemas to enable data reuse and produce a matched/unmatched element list; the authors note that current sources lack 3D and dynamic data and that such datasets are expensive to capture and maintain. Their earlier conference analysis is blunter about why harmonisation is hard: element meanings are uncertain without context (the example given is a bare field named "Address"), and similarity percentages between models stay low, so knowledge-based rather than automated integration is required (Karami et al. 2024).

The standards stack exists but is not wired into the passport

Work on formal semantics for building data is more mature than the passport literature that would consume it. Böhms (2019) — the DG-GROW deliverables D2.1 and D2.2 on standard form and meaning for logbook data and its linked-data implementation, held as grey literature in the workbook without a DOI — remains the most explicit attempt to give DBL fields machine-readable semantics, anchored in ISO 12006-3, ISO 23386 and EN 17412-1. Ontology work is available for adjacent needs: Daneshfar et al. (2022) build and expert-validate an ontology representing surrounding geospatial and environmental data for renovation tasks, and Lygerakis et al. (2022) survey knowledge-graph ontologies for building energy efficiency and identify the gaps. Information-requirement specification has its own standards track, with Akbas et al. (2025) integrating IDS and LOIN XML schemas under ISO 19650, while warning that both standards evolve, so integrations need maintenance.

Three papers demonstrate that the BIM-to-passport path is technically feasible at case scale. Ugliotti and Stradiotto (2025) cluster the Italian APE EPC XML schema into nine categories, map them to IFC 4/4.3 entities and automate extraction with a Dynamo script on a real building. Mpouzianas et al. (2024) parse IFC models into a data model, compute baseline energy and generate prioritised retrofit scenarios, subject, as the authors state, to the BIM file being precisely authored to include the fields the tool parses. Fenz et al. (2023) report RenoDSS auto-generating scenarios and KPIs from IFC with roughly 80% time saving at two pilot sites, conditional on the model carrying second-level space boundaries. The shared conditional is the

finding: these pipelines work when a high-quality IFC model exists, which for the existing residential stock is the exception.

The wider benchmarking evidence confirms this. Rueda-Esteban et al. (2024) characterise national and international building data resources on four dimensions and find that half are only partially or not digitalised, that several are developed at BIM level but lack adequate compatibility formats, and that most do not account for LCA at all. And the integration barriers are not primarily technical: interviewing four European DBL initiatives in Germany, the UK, France and Belgium, Çetin et al. (2026) find that barriers to linking digital product passports with logbooks are "less technical than semantic, procedural, and organizational", naming absent ontologies and unstructured data among the key challenges.

Confidence. High that no converged BRP/DBL data model exists and that semantic heterogeneity is the binding technical problem, reported consistently by independent groups using different methods. Moderate that formal semantic approaches (linked data, ontologies, IDS/LOIN) can resolve it, since no reviewed study demonstrates a semantically specified passport populated at portfolio scale.

Data acquisition and quality: the binding constraint

EPC data is the obvious feedstock and the weakest link

Because the EPBD permits joint issuance and shared databases, EPC registers are the default source for passport baselines. The literature on their quality is substantial and unflattering. Hardy and Glew (2019) analyse errors in the English EPC database directly; Mangold et al. (2015) address how to handle data uncertainties when Swedish EPC data is used to describe stock energy use. Pasichnyi et al. (2019) make the structural argument that matters most here: systematically mapping 79 papers, they identify thirteen application domains for EPC data far beyond the instrument's original purpose, and argue that conventional data-quality studies "fail to expose the essential problems". Their six-level validation method, tested on four Swedish samples, concludes that EPC data needs added or revised features and assured interoperability before such reuse is safe. A passport built on EPC feedstock inherits exactly this problem, and inherits it at the individual-building level where errors do not average out.

Cross-national comparability compounds it. Sesana et al. (2024) assess EPC indicator implementation across all 27 Member States with a cross-comparative matrix and find significant disparities, particularly in thermal comfort and smart readiness, attributable to the absence of a common methodology and to local regulatory differences; energy performance class and primary energy use are widely implemented, but compliance with EU standards varies. For a passport intended to be recognisable across borders, this means field-level semantics cannot be assumed even where field *names* match.

Then there is the gap between calculated and metered performance. Cozza et al. (2020) use 1,172 Swiss buildings with both theoretical and metered consumption and find an average −23% performance gap before retrofit (actual below calculated) narrowing to +2% after, and their systematic review of the phenomenon attributes it principally to modelling of building characteristics and occupant behaviour (Cozza et al. 2021). Dutch evidence at scale points the same way: analysis of roughly 1.2 million non-profit dwellings over 2010–2014 finds actual savings from thermal renovations diverging from predictions (van den Brom et al. 2018). A passport that promises "estimated energy savings" per renovation step is promising a number the literature says is systematically biased unless the calculation basis is corrected or metered data is incorporated.

The recommendation layer is separately problematic. Gonzalez-Caceres et al. (2020) critically review the EPBD's recommendation list of measures and document its barriers and challenges — relevant because the passport is, functionally, the recommendation list upgraded to a sequenced roadmap. Older user-side evidence suggests the information alone does little. A survey of nearly 2,000 Southampton homeowners who bought within the scheme's first year established awareness of EPCs but "little impact on

decision-making or price negotiation", with results inconclusive on whether retrofits followed from certificates (Watts et al. 2011).

Registry and open data: promising, and quantified

The most decision-relevant recent finding is that national registries can carry more of the load than the proposal literature assumes. Assessing existing Portuguese datasets against EU DBL data requirements, Mêda et al. (2024) report a match ranging from 90.6% down to 82.6% depending on aggregation level (cadastral parcel, building, building unit). That is a far more encouraging number than the qualitative "data is scattered" framing common elsewhere, though it measures the *presence of fields*, not their accuracy or currency.

The counterweight comes from the two-country gateway study: examining public building data in Aragón (Spain) and Lombardy (Italy), Gómez-Gil et al. (2022) find few sources interoperable with a future European DBL and produce region-specific dataflow schemes instead of a general one. Denmark, a digitalisation frontrunner, shows the same texture: three public registers established for taxation, preservation and energy-saving purposes can be repurposed for renovation-potential and circularity assessment, but the mapping also exposes data gaps, outdated entries and registration errors (Andersen et al. 2021).

Where open data is sufficient, archetype and modelling methods can bridge the rest. Ahern and Norton (2020) derive 35 reference dwellings characterising 406,918 dwellings from an EPC dataset, and show that default U-values and standardised thermal-bridging values inflate estimated savings potential. Johari et al. (2023) build an automated UBEM from Swedish GIS property maps and EPCs, reporting mean absolute percentage errors of 26% and 22% against EPC data for two cities, improving to 21% at district and 10% at city level. That gradient bounds what registry-driven modelling can support: credible for portfolio and policy questions, and still carrying roughly a quarter error at the individual-building level, which is the level at which a passport makes its promises. Two 2026 papers take the archetype route directly into passport generation (Nardelli et al. 2026; Iliste et al. 2025, the latter using Estonian cadastral and planning open data across nine buildings), which makes the accuracy question urgent rather than academic.

Two automation routes address the unstructured residue. Urlainis et al. (2025) benchmark 16 LLM configurations on extracting qualitative summaries, quantitative summaries and risk levels from building inspection reports, framing this as an alternative to rigid schemas. Çetin et al. (2023) take the requirements-first path for material passports: three validation rounds with 38 participants in European social housing, a data template tested on a Dutch case, and an explicit list of critical data gaps: material composition, presence of toxic or hazardous content, condition assessment, reuse and recycling potential. Their method is the closest analogue in the corpus to what a rigorous BRP requirements exercise would look like, and their gap list is a useful prior for what will be missing.

Confidence. High that EPC-derived data carries material error and cross-national semantic inconsistency, and that calculated savings diverge from metered outcomes, with multiple independent national datasets agreeing. High that national registries cover a substantial but incomplete share of passport fields, with the specific coverage figure (82.6–90.6%) established for Portugal only and not transferable without local verification. Moderate that archetype/UBEM inference can fill individual-building gaps to a tolerance the passport's promises require; the published error levels suggest it cannot yet.

Governance, ownership and privacy: the thinnest evidence

Seventeen of 128 in-scope papers touch governance, privacy or ownership, and only eight of the 37 passport-specific papers do. The work that exists is mostly architectural proposal rather than evaluation.

The clearest treatment of the privacy problem is Andriamamonjy and Ma (2025), who observe that logbook contents (certificates, smart readiness indicators, consumption data) may constitute sensitive personal data under GDPR, that resulting concerns over privacy, confidentiality and control could limit market adoption,

and that a logbook must permit secure owner control alongside regulated third-party access; they propose the Solid specification as the mechanism. This is a design proposal, not evidence of adoption.

Trust and provenance are approached through distributed ledgers. BUILDCHAIN proposes a blockchain-backed decentralised knowledge graph tracing life-cycle activities and credentials, extending the logbook concept with a decentralised architecture in which actors log and trace every change (Landi et al. 2025); the project's own design deliverables, as coded in the workbook, acknowledge a lack of research on blockchain-based BIM. General construction-sector work on ledger-based provenance exists (Çelik et al. 2022), and hybrid-blockchain product-passport architectures document a real trade-off between transparency, integrity, privacy and cost. None of this has been demonstrated on a national passport scheme.

Where the governance literature is strongest is on roles and stakeholders rather than technology. Mêda et al. (2022) supply BPMN process maps for logbook data flows across three lifecycle phases, validated by focus group, giving the who/when/what of data collection while conceding low granularity in the maps. Hwang (2024) maps which stakeholders provide versus consume which data across the AECO sectors. Ibba et al. (2024) attack the prior question of what counts as "valuable data" and note there is still no clear agreement on what logbooks should do, what data they need, or how they fit with existing construction software. The permit-side analysis reaches the same conclusion from another angle: Mêda et al. (2024) find substantial overlap between digital building permits and logbooks and argue their potential is realised only under a cohesive framework supporting continuous data updates and stakeholder collaboration.

Delivery-side governance has better empirical grounding, though it addresses service models rather than data rights. Elgendy et al. (2024) benchmark 14 integrated home renovation service providers across the Netherlands, Belgium, France and Austria, distinguishing public, private and public-private business models, and note that private models often fall short on community engagement.

Confidence. Low to moderate on all governance conclusions. The GDPR exposure of logbook/passport content is well argued but not tested; no reviewed study evaluates an operational access-control or data-ownership regime for a national passport scheme against real users. This is the largest evidence gap bearing on a Go/No-Go decision, because governance failures surface after deployment, when they are expensive to fix.

Data use: what the passport is for

The use case with the strongest evidence is portfolio and policy analytics rather than individual advice. Registry-driven decision support is demonstrated repeatedly: data-driven decision support for stock retrofit policy (Re Cecconi et al. 2022), UBEM in support of Renovation Wave neighbourhood targeting in Dublin using TABULA archetypes and EPC validation across roughly 9,000 dwellings (Buckley et al. 2021), and Dutch semantic 3D city models with BAG and EPC open data validated at municipal and national scale (Sánchez 2025, TU Delft doctoral thesis; no DOI located). A parallel line proposes the logbook as a decarbonisation-monitoring instrument: Gómez-Gil et al. (2023) map EU decarbonisation objectives to progress indicators and DBL fields, concluding for Spain that a logbook could supply over half the mandatory and a high share of optional indicators.

Individual-building sequencing, the passport's actual purpose, is thinner but improving. Nicoletti et al. (2025) formulate passport scheduling as a mixed-integer linear program maximising net present value under debt-pressure and energy-poverty constraints, reaching nZEB in nine years over three phases for a Braga social-housing apartment with the energy-poverty index falling from 21.8% to 0.6%; the authors restrict CO_2 accounting to the operational phase and use a monthly quasi-steady-state method. Related work models staged retrofits against household budget restrictions using Spanish income microdata (Maia et al. 2024). Both introduce a data category the reviewed passport data models barely carry: household financial capacity. Since the Directive itself requires attention to affordability and vulnerable households, this is a

substantive requirements gap rather than a modelling curiosity.

The demand side is where the corpus is genuinely rich, largely thanks to Dutch behavioural research, and it delivers a warning about information-centric instruments. Transaction costs — search effort, finding reliable contractors — act as barriers independent of price across renovation stages for 3,776 Dutch homeowners (Ebrahimigharehbaghi et al. 2020), and cost, complexity and information rank as principal barriers in national survey analysis (Ebrahimigharehbaghi et al. 2019). UK fieldwork finds even engaged homeowners struggling with information overload and a lack of trusted local sources, with local authorities positioned as credible intermediaries (Wise et al. 2024). And the one clean test of a digital feedback instrument in the corpus is negative: over 16 months across 519 Dutch households, smart-meter apps produced no measured consumption reduction despite users reporting higher awareness (Geelen et al. 2019). On acceptance specifically, the survey evidence is more encouraging — across 14 Spanish cities, the importance households attach to a combined logbook-plus-passport scheme correlates with perceived one-stop-shop value, and three distinct preference profiles emerge (Espinoza-Zambrano & Marmolejo-Duarte 2025) — but stated importance is not uptake.

Confidence. High that registry-driven analytics supports portfolio-scale renovation planning. Moderate that optimisation-based sequencing produces defensible individual roadmaps, on single-case demonstrations. High that information provision alone does not change renovation behaviour, which bounds what a passport can be expected to achieve regardless of data quality.

Gaps, disconfirming evidence and open questions

No impact evaluation of any passport scheme exists in this corpus. Woningpas has operated since 2018, iSFP since 2017, P2E since 2015, yet targeted searching surfaced no study measuring whether receiving a passport changes renovation behaviour, sequencing or investment. Every claimed benefit (overcoming information asymmetry, avoiding lock-in, unlocking finance) is argued from mechanism, not measured. Given the negative smart-meter-app result and the weak EPC decision-making findings, this absence should be treated as a live risk rather than a neutral gap.

Data quality is characterised at stock level, not passport level. The error and uncertainty literature concerns aggregate statistics and stock models. What a passport needs is per-building field-level accuracy, currency, and provenance. No reviewed study reports the accuracy of the specific fields a passport would publish for a specific building against a ground-truth survey.

Update semantics are unspecified everywhere. The Directive requires the passport to reflect the building's current state, and the corpus contains no proposed model that specifies field-level update triggers, responsible parties, or staleness handling. Signorini et al. (2025) frame the logbook as a response to fragmented information-gathering across a lifecycle involving many actors with differing access levels, but the governance of continuous update remains, in the permit-side authors' words, the condition on which the whole concept depends.

Dutch-specific data availability is not assessed against passport requirements. The corpus contains strong Dutch behavioural research, the BAG registry catalogue and 3D city-model work, but no equivalent of the Portuguese data-discovery exercise establishing what fraction of passport fields BAG, the EPC register, NTA 8800 assessments and related sources actually cover, at which aggregation level, with what currency. This is the single most decision-relevant missing input.

Non-residential and multi-owner buildings are underserved. The concrete non-residential data model is ALDREN's, explicitly awaiting validation. Homeowner-association contexts appear in barrier research but not in data-model work, despite governing a large share of the multifamily stock.

Circularity and whole-life carbon fields are proposed but not populated. Bills of materials in logbooks remain "the exception and not common practice", and material-passport data requirements identify composition, hazardous content and reuse potential as critical gaps. Open LCA-capable data models exist (Röck et al. 2024), with input data availability and granularity acknowledged by their authors as an open challenge.

What this means for the decision

The scientific and regulatory rationale for the work is solid: a Member State obligation exists with a fixed 2026 deadline, the passport is explicitly tied to logbook and database infrastructure, and the literature demonstrates a genuine unresolved problem in the semantic and availability layers rather than a solved one being re-solved. Feasibility is well supported for requirements definition grounded in registry data, and less well supported for anything depending on high-quality per-building BIM models.

The main risks are three. Contributing another conceptual attribute list to a field that already has six unvalidated ones would produce a deliverable indistinguishable from prior art. The mitigation is to make verified national data availability, provenance and update semantics the primary contribution rather than the attribute inventory. Governance is under-evidenced, so any data-sharing or ownership design will rest on assumption; the mitigation is to treat GDPR exposure and access control as explicit design questions with named alternatives rather than deferred details. Third, the behavioural evidence caps the benefit: better passport data will not by itself raise renovation rates, so success criteria should be framed around data completeness, accuracy and reuse rather than renovation outcomes the instrument cannot deliver alone.

Evidence sufficient to close the remaining questions is obtainable and specific: a Dutch field-level data-discovery exercise on the Portuguese model, quantifying coverage of Annex VIII-derived fields across BAG, the EPC register and municipal sources at parcel, building and unit level; a per-building accuracy check of a candidate field set against survey ground truth for a small sample; and a documented governance option analysis for ownership, update responsibility and third-party access. The first two are the ones that would most change the shape of a WP1 data specification.

Sources

The full screened corpus is in the accompanying reference table: 218 records with themes, methodology, empirical grounding, author-stated limitations, and provenance flagging whether each record came from the workbook or was added by this review.

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