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Collaborative Governance for Urban Micro-Hubs under Deep Uncertainty: Evidence from Rome Logistics Living Lab

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Abstract

Urban micro-hubs are promoted as last-mile solutions, yet deployment often remains unstable in complex cities where scarce kerbside space, multi-actor coordination, and shifting operational constraints interact with deep uncertainty. This paper analyses Rome's micro-hub workstream developed through the Logistics Living Lab within the LOCUS project to explain how acceptability and governance conditions shape implementability at the tactical–operational interface. A document-led embedded single-case design combines a targeted evidence synthesis with analysis of Living Lab minutes and project outputs, triangulated with a governance-model questionnaire (n = 12) and a workshop satisfaction survey (31 submissions recorded; 14 usable responses for descriptive summaries). Findings suggest that acceptability is conditional on early closure on operational definition and target fit, credible space governance matched to monitoring capacity, and data routines that support adaptive adjustment without undermining trust. Governance preferences do not identify a universal "best" model; feasibility depends on matching coordination burden to space regimes, underpinned by a clear public role, decision rights, and transparent exception handling. The paper contributes a procedural toolkit that translates these conditions into auditable closure gates and early-warning signals for emerging setbacks, including an optional continuous storytelling module to sustain narrative coherence and procedural legitimacy as design iterates under deep uncertainty.

Keywords: Urban freight transport; micro-hubs; deep uncertainty; collaborative governance; Living Labs; policy acceptability; implementation setbacks; procedural toolkit; storytelling.

1 Introduction

Urban freight transport policies often lose stability when strategic intent is translated into tactical rules and then into operational routines. Classic implementation research shows that policy design can be undermined by fragmented responsibilities, weak coordination, and the accumulation of small decision points that generate delay, drift, or redesign (Pressman & Wildavsky, 1973; Matland, 1995; Lipsky, 2010). This paper examines that translation problem in the domain of urban micro-hubs. Micro-hubs require operationally credible arrangements on access, space, management responsibilities, and day-to-day routines, which makes them a useful lens to observe how governance and acceptability conditions shape implementability at the tactical–operational interface (Crainic, Ricciardi, & Storchi, 2009; Gruber, Kihm, & Lenz, 2014).

The analytical frame is decision making under deep uncertainty. Deep uncertainty is understood as a condition in which analysts and decision-makers cannot confidently specify the correct system model, probability distributions for key uncertainties, and/or a shared valuation of outcomes (Walker et al., 2013). In these contexts, policy performance depends on robustness and adaptive capacity rather than on point-forecast optimisation (Kwakkel, Haasnoot, & Walker, 2016).

Acceptability is treated as an actor-specific evaluation of a policy measure that precedes, and does not coincide with, post-implementation acceptance or compliance. This framing is consistent with transport research that distinguishes attitudes towards a measure from behavioural responses after implementation (Schade & Schlag,

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2003; Schuitema, Steg, & Forward, 2010). Governance is treated as the set of rules, roles, and coordination arrangements through which public and non-public actors make and implement decisions, with a specific focus on collaborative governance. Collaborative governance is defined as a governing arrangement in which public agencies directly engage non-state stakeholders in a formal and deliberative process oriented towards joint problem solving and implementation (Ansell & Gash, 2008; Emerson, Nabatchi, & Balogh, 2012).

Within this frame, a Living Lab is treated as a governance device that supports iterative experimentation, monitoring, and adjustment in real-life settings, rather than as episodic consultation (Bergvall-Kåreborn & Ståhlbröst, 2009; Leminen, Westerlund, & Nyström, 2012). The paper uses Rome as an embedded single case to examine how these concepts operate in practice when a micro-hub measure is developed through a Logistics Living Lab setting and must be translated into implementable routines.

The analysis addresses two research questions that were stated in the accepted abstract: RQ1 asks what conditions maximise stakeholder acceptability of micro-hubs in complex urban contexts, and RQ2 asks which governance configurations best support the deployment of a micro-hub network in such contexts. The contribution is empirical and procedural. Empirically, the study reconstructs how acceptability signals and governance constraints emerge and interact along the strategic–tactical–operational chain in the Rome setting. Procedurally, it derives a toolkit that specifies minimum process outputs and routines required to translate a micro-hub concept into implementable delivery under deep uncertainty, framed as transferable procedural requirements rather than as claims of outcome equivalence across cities.

The remainder of the paper is organised as follows. Section 2 describes data and methods. Section 3 builds a literature benchmark through a targeted evidence synthesis. Section 4 sets out Rome as an implementation setting and positions micro-hubs within the local planning chain and Living Lab process. Section 5 reports findings on acceptability and governance configurations and presents the procedural toolkit as part of the results. Section 6 discusses implications under deep uncertainty and derives policy implications. Section 7 concludes.

2 Data and methods

The study adopts an embedded single-case design centred on Rome. The empirical focus is the micro-hub workstream developed through the Rome Logistics Living Lab and the associated LOCUS WP5 materials. The aim is explanatory and mechanism oriented. It specifies how deep uncertainty shapes the translation of a micro-hub concept into implementable rules and routines, and how acceptability and governance conditions affect that translation (Yin, 2018; Beach & Pedersen, 2019).

The analysis operationalises implementation instability through the concept of policy setbacks. Setbacks are treated as observable discontinuities along the translation process, including delayed closure, repeated redesign, reliance on derogations or informal accommodation, and uneven feasibility once proposals meet street-level constraints. This definition supports within-case mechanism reconstruction, without presuming a binary success–failure outcome (Matland, 1995; Pressman & Wildavsky, 1973).

Three constructs guide extraction and coding. Acceptability is treated as an actor-specific evaluation of the measure that precedes, and does not coincide with, post-implementation compliance. Governance is treated as the set of decision rights, accountability arrangements, capacity, and routines that stabilise delivery over time. Engagement is treated as a structured process with identifiable outputs and traceable feedback, rather than as episodic consultation. These constructs are used as analytic categories to keep claims anchored to observable evidence.

2.1 Empirical material and data sources

The empirical base combines three streams of material; Table 1 summarises the empirical base and its analytical role.

First, documentary sources are used to reconstruct the formal planning and translation context in which micro-hubs are framed. This material is treated as primary evidence to establish stated intent, attributed responsibilities, and the extent to which delivery prerequisites are specified. Documents are analysed as part of the institutional record, not as background description (Prior, 2003; Bowen, 2009).

Second, the qualitative corpus consists of stakeholder-meeting minutes and related Living Lab outputs produced during the micro-hub governance workstream. The core minutes cover the period from 2 December 2024 to 19 March 2025, complemented by an additional structured written contribution dated April 2025. These texts record feasibility constraints, contested points, and proposed enabling conditions while options are being built, which makes them suitable for mechanism-oriented interpretation.

Stakeholder identification and contact followed a simple relevance screen. Priority was given to actors with operational activities within the metropolitan area of Rome; when this criterion was not met, stakeholders were retained only if they had proven experience in last-mile delivery at the national or international level. Figure 1 summarises this contact and exclusion logic.

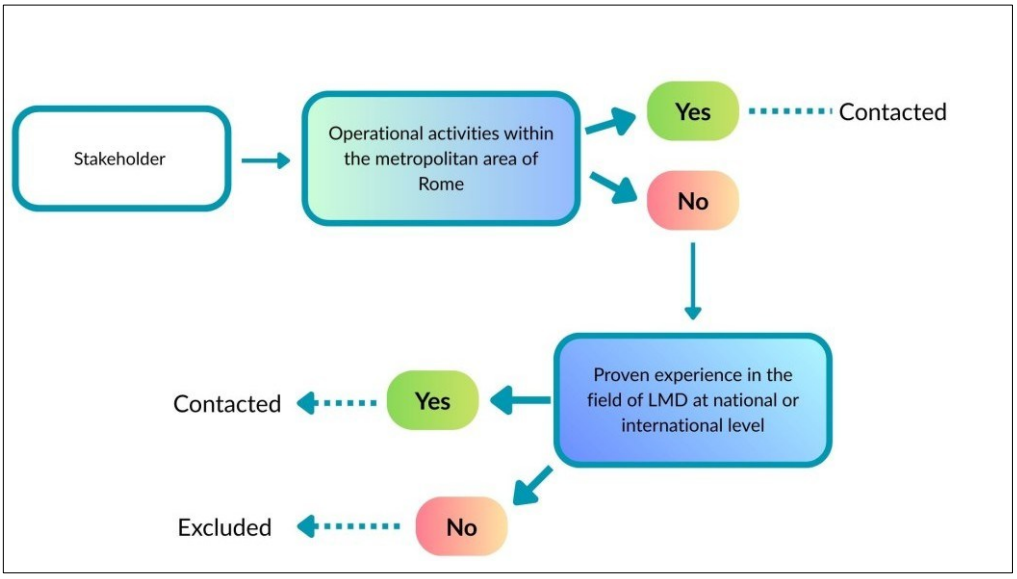

Fig. 1. Stakeholder contact logic adopted for the Rome Logistics Living Lab micro-hub workstream.

Third, two survey instruments provide structured signals used for descriptive triangulation. A governance-model questionnaire captures stakeholder preferences and judgements on governance conditions and feasibility constraints (n = 12). A workshop satisfaction questionnaire captures ex post perceptions of clarity, utility, and support needs for the tools discussed during the Stakeholder Workshop held on 3 July 2025 (31 submissions recorded in the dataset; 14 usable responses for the descriptive summaries reported in this paper). Open-ended responses are retained as qualitative evidence to support interpretation, rather than being mechanically transformed into quantitative codes.

Table 1. Empirical material and analytical role in the Rome case study.

Material stream	Period / N	Analytical role
Documentary sources	2022–2025	Reconstruct the planning chain, formal intent, attributed responsibilities, and delivery prerequisites.
Living Lab minutes and related outputs	Dec 2024–Jul 2025	Trace feasibility constraints, contested points, and enabling conditions while governance options are being built.
Governance-model questionnaire	n = 12	Provide small-N descriptive triangulation on feasibility conditions and governance-model preferences.
Workshop satisfaction questionnaire	31 submissions; 14 usable	Summarise perceived clarity, utility, and support needs; retain open-ended feedback for interpretation.

2.2 *Analytical procedure and quality safeguards*

The analysis proceeds through an auditable sequence that links raw evidence to claims.

Document analysis uses a structured extraction grid to record each source's implementation level, attributed responsibilities, stated sequencing, enabling dependencies, and any explicit provisions on monitoring, enforcement, and data routines. The same grid captures engagement outputs and whether feedback translation mechanisms are specified. This approach limits interpretive drift and supports traceability from formal intent to operational prerequisites (Prior, 2003; Bowen, 2009).

Qualitative analysis applies a guided but open coding strategy, combining thematic sensitivity with a matrix logic aligned with the Framework Method. Coding aligns with the research questions and records evidence under a limited set of categories: acceptability conditions, governance requirements, operational constraints, and proposed enabling routines. This structure enables systematic comparison across meetings while keeping claims anchored to specific excerpts (Gale et al., 2013; Schreier, 2012).

Survey analysis remains strictly descriptive. The governance questionnaire is treated as small-N and diagnostic. Results are reported with item-level denominators where needed and without statistical inference. The workshop questionnaire is used to summarise perceived clarity and usefulness of the decision-support tools discussed, and to retain narrative feedback that qualifies interpretation. For the workshop questionnaire, 31 submissions were retained in the archived workbook, but only 14 sufficiently complete responses were used for the descriptive

summaries reported in this paper; non-usable submissions were excluded from analysis and should not be interpreted as analytical observations.

The toolkit is derived through explicit mapping. It translates recurrent mechanism claims and enabling conditions into a gated set of minimum procedural outputs and routines. This mapping is constrained by the literature benchmark developed in Section 3 and by the Rome evidence base, so that the toolkit remains a traceable analytical output rather than a generic recommendation.

Credibility is strengthened through triangulation across documentary evidence, meeting minutes, and survey signals. Dependability is supported through standardised extraction, a stable coding structure, and an explicit audit trail that records corpus boundaries and coding decisions (Yin, 2018).

In conclusion, the paper aims to maintain a high ethical standard of data management. Consequently, survey responses are treated as anonymous. Qualitative materials are handled as project documents produced within a bounded engagement setting. Where operational details could be sensitive, reporting prioritises mechanism relevance over fine-grained operational disclosure.

3 Literature benchmark: a targeted evidence synthesis for implementability

This section establishes a literature-based benchmark to support mechanism-oriented interpretation of the Rome case and to ground the procedural toolkit presented in the findings. The benchmark is needed because implementability at the tactical–operational interface depends on enabling conditions that are often treated implicitly in city logistics research, where attention frequently concentrates on optimisation, technology, or behavioural response under comparatively stable institutional assumptions (Crainic, Ricciardi, & Storchi, 2009). Implementation research, by contrast, shows that instability can emerge when policy designs rely on coordination capacity, enforcement credibility, and operational routines that are not specified or are difficult to sustain in multi-actor settings (Pressman & Wildavsky, 1973; Matland, 1995; Lipsky, 2010). The benchmark therefore targets recurrent procedural and governance requirements emphasised in the urban freight, implementation, and stakeholder-engagement literatures, and it provides a structured reference point against which the Rome evidence is interpreted.

3.1 Targeted evidence synthesis approach

The benchmark is built through a targeted evidence synthesis following scoping-style evidence mapping logic. The approach prioritises breadth of coverage and mechanism consolidation over exhaustive capture and statistical aggregation. This choice matches the paper's purpose, which is to specify "what must be in place" for an operational measure to become deliverable, rather than to estimate average treatment effects across heterogeneous contexts. The search strategy is frozen ex ante, executed in a single bibliographic database, and complemented by backward citation checks to stabilise coverage of foundational contributions. The frozen search string, filters, and inclusion logic are reported in Appendix A to ensure reproducibility while keeping reporting proportionate to conference-paper constraints (Arksey & O'Malley, 2005; Levac, Colquhoun, & O'Brien, 2010; Peters et al., 2020). Screening follows a pragmatic relevance standard. Studies are retained when they provide explicit statements on implementation conditions, governance arrangements, acceptability dynamics, stakeholder engagement mechanisms, monitoring and enforcement, data requirements, or operational feasibility constraints in urban freight and closely related sustainable mobility interventions. Evidence charting records each source's policy family, implementation level, mechanism claims, and the procedural or organisational conditions invoked. Synthesis then consolidates recurring requirements into a compact benchmark used in Sections 5 and 6.

3.2 Minimum implementability requirements at the tactical–operational interface

The synthesis consolidates a set of minimum requirements that recur across the urban freight and implementation literatures when measures move from design to operational delivery. First, implementability requires decision-grade baselines and shared problem definitions. Without credible information on demand patterns, operating constraints, and kerbside conditions, stakeholders cannot evaluate trade-offs, and rule design drifts towards either over-specification or exception-driven accommodation (Crainic et al., 2009; Lipsky, 2010).

Second, rules must be operationally executable, which implies clarity, enforceability, and an explicit model for exception handling. Implementation studies emphasise that ambiguity can sometimes sustain coalitions at adoption stage, but it becomes a liability when frontline decision-making must translate vague intent into consistent practice (Matland, 1995; Pressman & Wildavsky, 1973). In urban freight contexts, the same logic applies to access, stopping, and space-use regimes where scarce kerbside space creates unavoidable conflicts that must be governed through credible routines.

Third, monitoring and enforcement capacity is not an "add-on". It is part of the design. Where monitoring is weak or sanctions lack credibility, actors adapt through informal practices, which can protect short-term operability while eroding procedural legitimacy and consistency over time (Lipsky, 2010). This requirement extends beyond

policing. It includes data governance rules, responsibility allocation, and feedback mechanisms that allow rules to be adjusted without undermining trust.

Fourth, engagement must be continuous and reciprocal rather than episodic. Collaborative governance research shows that multi-actor arrangements require clear participation rules, transparency on how inputs affect decisions, and minimal accountability devices to avoid consultation fatigue and strategic disengagement (Ansell & Gash, 2008; Emerson, Nabatchi, & Balogh, 2012). In practical terms, implementability depends on whether stakeholder participation generates decision-grade outputs and whether these outputs are translated into operational specifications, not only into general endorsement.

Fifth, operational measures require an explicit governance configuration that matches the coordination burden. Measures such as micro-hubs distribute costs and benefits across carriers, receivers, property interests, and public authorities. The benchmark therefore treats governance as a design variable, not as a context assumption. At minimum, implementability requires clarity on decision rights, responsibilities for daily management, performance monitoring, and dispute resolution, alongside a credible public role in space allocation and rule enforcement.

These requirements form the benchmark used later to interpret the Rome evidence. The benchmark does not imply that a single configuration "works everywhere". It specifies the minimum procedural content that must be generated and stabilised for a measure to move from concept to routine under deep uncertainty.

3.3 Continuous storytelling as engagement infrastructure

Storytelling is treated in this paper as a structured, iterative narrative device that helps render complex interventions intelligible, legitimate, and actionable for diverse audiences. In science and risk communication, narrative formats can improve comprehension, attention, and retention relative to purely analytical messaging, particularly under conditions of uncertainty or contested evidence (Dahlstrom, 2014). In policy processes, narratives shape problem definitions, causal attributions, and perceived legitimacy, thereby influencing coalition dynamics and support for interventions (Jones & McBeth, 2010; Shanahan, Jones, & McBeth, 2011). In transport policy, acceptability research likewise shows that perceived fairness, procedural clarity, and trust in implementation condition support for measures, suggesting that narrative coherence about goals, trade-offs, and responsibilities can operate as an enabling condition rather than a communication afterthought (Schade & Schlag, 2003; Schuitema, Steg, & Forward, 2010).

Within this paper's analytical frame, storytelling is explicitly distinguished from governance and from persuasion. It is treated as a potential engagement infrastructure that supports continuous participation by making decision rationales transparent, clarifying the "rules of the game," and stabilising expectations as measures evolve under deep uncertainty. This positioning matches the paper's operational separation of constructs—where engagement is defined through traceable participatory devices and feedback, and acceptability is treated as actor-specific support conditional on feasibility and perceived distributional impacts.

Under deep uncertainty, iteration is necessary, but iteration without legibility can quickly be interpreted as arbitrariness; continuous storytelling is therefore relevant insofar as it helps actors track what is stable, what is changing, and why changes remain justified in light of new evidence and constraints.

For sustainable mobility measures at the tactical-operational interface, this function is especially salient because implementability hinges on whether stakeholders can translate strategic intent into executable routines without resorting to informal accommodation. Here, storytelling can contribute by maintaining a shared interpretation of the measure's operational meaning (who does what, under which rules), and by keeping distributional implications visible when costs and benefits are unevenly allocated across groups (e.g., operational disruption concentrated on some operators while wider benefits accrue to the city). In this sense, continuous storytelling is a procedural device that can reinforce accountability: it links engagement inputs to observable adjustments, reduces interpretive drift across stages of the planning chain, and complements the benchmark requirement that engagement be continuous, reciprocal, and connected to decision-grade outputs

Empirically, the Rome evidence is examined for traces of sustained narrative work (recurrent framings, consistent rationales, explicit updates on objectives and constraints, and continuity in how trade-offs are explained), as well as for stakeholder signals indicating demand for clarity and continuity. Where such traces are limited, storytelling is framed as a plausible leverage point for design-to-implementation translation and as a focused research agenda rather than as an established causal explanation.

4 Rome as an implementation setting: planning chain and operational interface

Rome is used as an information-rich case to examine how a micro-hub measure is specified and made more or less implementable when policy intent moves from strategy to tactical definition and towards operational routines. The analysis treats the local planning chain as an empirical object rather than a generic backdrop. It reconstructs how policy commitments are formalised, how translation instruments define measures and prerequisites, and how

collaborative procedures structure option-building under administrative and operational constraints (Roma Capitale, 2022; Roma Capitale, 2024).

The case is bounded to avoid over-claiming. The study does not infer citywide implementation performance from planning statements. It observes the translation process while it takes shape, using documentary traces and Living Lab materials (Roma Servizi per la Mobilità, 2023; TRElab Roma Tre, 2025). This boundary is central to the argument: the paper explains conditions for implementability and governance feasibility under deep uncertainty, without treating co-design activity as equivalent to institutionalised routine delivery.

4.1 Strategic anchoring and logistics-specific translation

At the strategic level, Rome's Sustainable Urban Mobility Plan is adopted through a formal assembly act (Roma Capitale, 2022). In this paper's logic, formal adoption matters because it anchors objectives and an implementation trajectory within an institutional commitment. It does not, by itself, demonstrate operational activation of freight measures. The strategic plan therefore functions as the baseline against which later translation choices can be assessed (Roma Capitale, 2022).

At the tactical level, Rome introduces a dedicated logistics framing through the approval of SULP guidelines (Roma Capitale, 2024). This step matters because it positions urban logistics as an object of planning that requires internal coherence across instruments, rather than as a set of isolated projects. It also enables an explicit discussion of prerequisites that typically determine whether operational measures can move beyond pilots, including decision-grade baselines, space governance choices, and credible monitoring arrangements (Roma Capitale, 2024).

The micro-hub measure sits at the tactical–operational interface. It requires concrete closure on site logic, eligibility and access rules, operational management responsibilities, and the routines through which day-to-day conflicts are handled. This interface positioning explains why governance and acceptability conditions are treated as design constraints rather than as ex post obstacles in the remainder of the paper.

4.2 The Logistics Living Lab as process infrastructure

The Rome Logistics Living Lab is treated as a process infrastructure that links measure design to delivery-oriented specification (Roma Servizi per la Mobilità, 2023; TRElab Roma Tre, 2025). It is not treated as episodic consultation. In the city logistics literature, living labs are commonly framed as real-life experimental environments where iterative cycles of design, testing, monitoring, and adjustment are supported through multi-actor participation (Nesterova & Quak, 2016). This framing is used here as an analytical lens to interpret the Rome process, not as a claim that a full-scale operational system is already in place.

In this reading, the Living Lab has three analytically relevant functions. First, it creates continuity, enabling repeated interaction across phases when feasibility constraints cannot be fully known ex ante (Nesterova & Quak, 2016). Second, it produces decision-relevant information, by surfacing operational constraints and incentive misalignments early, while governance options remain adjustable (TRElab Roma Tre, 2025). Third, it enables traceability, because minutes and related outputs provide an auditable record of how options are framed, contested, refined, and stabilised (TRElab Roma Tre, 2025).

The empirical window for Living Lab material is bounded to the period from 2 December 2024 to 3 July 2025, because this interval contains the stakeholder-meeting minutes and related materials available in the corpus, as well as the associated workshop stage (TRElab Roma Tre, 2025). This boundary is treated as a feature of the design: it makes it possible to analyse translation work while it occurs, and it avoids conflating early co-design outputs with later delivery outcomes that would require a different evidence base.

4.3 Micro-hubs as socio-technical measures and the governance-model workspace

Micro-hubs are treated here as socio-technical measures rather than as facilities. They imply access and use rules, role allocation, daily operating routines, and responsibility for management and monitoring (Katsela et al., 2022). This definition is essential for both research questions. It keeps the analysis focused on implementability, not on generic support for a concept.

Within Rome's micro-hub workstream, LOCUS provides the governance-model workspace that structures option-building. Three WP5 working documents formalise alternative governance configurations and specify how these options can be discussed with stakeholders and assessed for transferability (LOCUS Project, 2025a; LOCUS Project, 2025b; LOCUS Project, 2025c). In this paper, these documents function as boundary objects. They stabilise the language used to discuss models, clarify the dimensions along which options differ, and create comparability across stakeholder inputs collected during the Living Lab process.

The evidence base combines process traces and structured signals. Meeting minutes and related Living Lab outputs capture feasibility constraints and contested points while options are being formed (TRElab Roma Tre, 2025). Two survey instruments support descriptive triangulation. A stakeholder questionnaire validates and assesses governance models for micro-hubs (n = 12) (TRElab Roma Tre, 2025). A workshop satisfaction survey

records perceived clarity, usefulness, and involvement quality after the Stakeholder Workshop held on 3 July 2025 (31 submissions recorded in the dataset; 14 usable responses for the descriptive summaries reported in this paper) (TRElab Roma Tre, 2025). These instruments do not support statistical generalisation. Their function is diagnostic. They provide structured signals of convergence and divergence that qualify mechanism-oriented interpretation.

5 Findings: deep uncertainty as a driver of setbacks, and what makes micro-hubs implementable

This section reports the findings through a deep uncertainty lens. It interprets observable implementation instability as policy setbacks. Under deep uncertainty, decision-makers cannot specify models, probabilities, and value trade-offs ex ante. They therefore rely on iteration and adjustment (Walker et al., 2013; Kwakkel et al., 2016). Iteration produces learning only when governance channels it into controlled closure and monitorable routines. Where governance is weak or under-specified, iteration tends to surface as setbacks. These include delays in closure, repeated redesign, reliance on derogations, and uneven feasibility once proposals meet street-level constraints (Pressman & Wildavsky, 1973; Matland, 1995; Lipsky, 2010).

Empirically, the findings draw on the Rome micro-hub workstream developed within LOCUS and the associated Logistics Living Lab process. The evidence base combines four inputs. It includes three LOCUS WP5 working documents that formalise governance alternatives and transferability reasoning (LOCUS Project, 2025a; LOCUS Project, 2025b; LOCUS Project, 2025c). It includes Living Lab minutes and related outputs covering the core engagement window (TRElab Roma Tre, 2025). It includes a stakeholder validation questionnaire on micro-hub governance models (n = 12) (TRElab Roma Tre, 2025). It also includes a workshop satisfaction survey (31 submissions recorded in the dataset; 14 usable responses for the descriptive summaries reported in this paper) used as descriptive support rather than for inference (TRElab Roma Tre, 2025).

5.1 RQ1 – Acceptability conditions for implementable micro-hubs

Acceptability is treated as an actor-specific evaluation of a measure, distinct from post-implementation compliance. In transport policy, acceptability depends strongly on perceived feasibility, distributional impacts, and trust in implementation capacity (Schade & Schlag, 2003; Schuitema et al., 2010). LOCUS evidence confirms that micro-hubs are not evaluated as universally suitable or unsuitable. In the governance questionnaire, perceived supply-chain compatibility with micro-hubs is moderately positive on average, with a mean of 3.75 on a 1–5 scale (n = 12), but responses remain heterogeneous (TRElab Roma Tre, 2025). The minutes help explain this heterogeneity. Micro-hubs are supported when they reduce access uncertainty and operational conflict. They are resisted when they impose additional handling burdens or disrupt already-optimised delivery routines without credible compensation mechanisms (TRElab Roma Tre, 2025).

A first acceptability condition concerns operational definition and target fit. Stakeholders do not evaluate "micro-hubs" in the abstract. They evaluate who can use them, for which tasks, with which rules and routines, and under which constraints. Without closure on these points, acceptability remains provisional. Under deep uncertainty, provisional acceptability increases redesign risk because key actors keep reopening core parameters at each iteration.

A second condition concerns space governance as enabling infrastructure. Across minutes and structured responses, access rules and the governance of loading and unloading space are treated as prerequisites (TRElab Roma Tre, 2025). The questionnaire points to strong agreement that governance should differentiate between centre and periphery contexts, with a mean of 4.75 on a 1–5 scale (n = 12). It also points to high agreement that municipal support is essential, with a mean of 4.58 on a 1–5 scale (n = 12) (TRElab Roma Tre, 2025). This convergence implies that tactical translation must incorporate space governance early. Otherwise, uncertainty is displaced onto street-level discretion and exception handling, which undermines perceived fairness and feasibility.

A third condition concerns data governance. LOCUS materials and meeting records treat data routines as enabling conditions for planning, monitoring, and iterative correction (LOCUS Project, 2025a; TRElab Roma Tre, 2025). At the same time, willingness to share operational information depends on credible confidentiality safeguards and clear limits to data use, especially where information has competitive value. In mechanism terms, weak data governance increases uncertainty about exposure and opportunism. That uncertainty reduces willingness to commit and delays closure on feasible operating arrangements.

A fourth condition concerns piloting as a standardisation device. Under deep uncertainty, pilots are valued when they generate transferable minimum standards and routines. They are treated as fragile when they remain isolated demonstrations, because learning dissipates and discretion becomes an operational substitute for implementable design (Lipsky, 2010; Matland, 1995). LOCUS WP5 framing aligns with this logic by treating piloting as a staged learning pathway that should end in replicable guidance rather than in a one-off experiment (LOCUS Project, 2025b; LOCUS Project, 2025c).

Finally, acceptability is linked to network scale. In the questionnaire, a majority of respondents select a mixed network logic as the most effective solution for Rome, combining local micro-hubs with a wider coordinated

structure (n = 12) (TRElab Roma Tre, 2025). The minutes link this preference to Rome's internal heterogeneity and to the need to combine local adaptation with minimum common standards. This result connects RQ1 and RQ2 directly. A mixed network implies differentiated configurations, but it also requires a shared governance backbone to prevent fragmentation.

5.2 RQ2 – Governance configurations that support deployment

LOCUS WP5 formalises four governance models that differ by exclusivity, managerial neutrality, and the role of the public actor (LOCUS Project, 2025a; LOCUS Project, 2025b). The models are treated as implementable arrangements, not as abstract archetypes. Their feasibility depends on space regimes, coordination burdens, and credible monitoring routines.

Questionnaire ratings indicate a modest hierarchy rather than a consensus. On a 1–5 evaluation scale (n = 12), Model B has the highest mean rating (3.25), followed by Model A (3.08). Model D has a lower mean (2.50), while Model C is rated lowest on average (2.25) (TRElab Roma Tre, 2025). This pattern is consistent with the process evidence. Some actors prioritise standardisation, security, and unified responsibility. Others prioritise economic sustainability and lower entry barriers. Shared options become viable only when a neutral manager, enforceable rules, and credible cost-sharing are specified. High-coordination options face friction where they require integration with already-optimised private networks and where cooperation touches competitively sensitive elements (TRElab Roma Tre, 2025). Table 2 condenses the questionnaire outputs used in this paper.

Table 2. Governance questionnaire results used in the findings.

Indicator	Result
Feasibility conditions	
Compatibility between proposed supply-chain characteristics and micro-hubs	3.75
Need to differentiate governance between central and peripheral areas	4.75
Need for municipal support	4.58
Governance model ratings	
Model B	3.25
Model A	3.08
Model D	2.50
Model C	2.25

Governance preferences also track the space regime. Where space is private or strongly controlled, exclusive management may appear more feasible. Where space is public or shared, neutral and shared management becomes more plausible, conditional on rule credibility and public coordination capacity (TRElab Roma Tre, 2025). This has a direct implication for design. Governance configuration cannot be selected as a normative template. It must be selected as an adaptation to the space and enforcement conditions that determine whether daily routines can be executed without continuous renegotiation.

Across models, three minimum governance functions recur. First, a credible public role is required to stabilise access rules and the space regime that micro-hubs depend on. Second, data governance must be specified as an enabling condition for monitoring and iterative adjustment. Third, engagement must be connected to traceable feedback and closure routines, otherwise it increases coordination costs without reducing uncertainty (Ansell & Gash, 2008; Emerson et al., 2012; TRElab Roma Tre, 2025). These functions are not add-ons. They define whether adaptation under deep uncertainty becomes controlled adjustment or visible setbacks.

5.3 Engagement as a mechanism that prevents setbacks only when it produces closure

Collaborative governance scholarship stresses that engagement supports implementation when participation is structured, deliberation is linked to decision-making, and accountability devices are present (Ansell & Gash, 2008; Emerson et al., 2012). The Rome Living Lab evidence supports a narrow mechanism claim. Engagement reduces setback risk when it accelerates closure on operational gates, clarifies responsibilities, and stabilises acceptable trade-offs (TRElab Roma Tre, 2025). Engagement becomes weak when it produces discussion without decision-grade outputs, or when inputs do not translate into visible adjustments in rules, responsibilities, or pilot design.

This claim is consistent with the deep uncertainty lens. Engagement does not remove uncertainty. It can reduce uncertainty about what will be implemented, by whom, under which rules, and through which adjustment routines. That reduction is precisely what limits redesign loops and exception-driven delivery.

5.4 Procedural toolkit as a finding

The toolkit is presented as a finding because it is derived from the mechanism account and anchored to the LOCUS evidence base. It treats micro-hub implementation as a gated trajectory. A phase is complete only when an accountable owner exists and a usable artefact is produced for delivery. This logic converts iteration into structured learning and makes change auditable.

The toolkit requires early closure on four minimum outputs. It requires an operational definition of the micro - hub and its target flows, so the object of governance is not ambiguous. It requires a space governance settlement compatible with enforcement and monitoring capacity. It requires a data governance arrangement that supports monitoring and adaptive correction without undermining trust. It requires a pilot design that produces transferable standards rather than project-bounded demonstrations (LOCUS Project, 2025c; TRElab Roma Tre, 2025). These gates are framed as minimum conditions. They do not prescribe a single model. They specify what must be produced to keep adaptation from appearing as setbacks.

Early-warning control is treated as part of delivery governance. Repeated failure to close phase outputs, accelerating exception requests, and discontinuities in data routines are treated as leading indicators of emerging instability. The aim is not to eliminate adjustment. The aim is to ensure that adjustment remains predictable, accountable, and monitorable under deep uncertainty.

5.5 Continuous storytelling within the toolkit: when it is actionable and what it should contain

Continuous storytelling is treated as a procedural module that stabilises implementation under deep uncertainty, rather than as an external communication add-on. Under deep uncertainty, iterative adjustment is unavoidable. Adjustment becomes a source of setbacks when actors perceive rules and trade-offs as arbitrary, opaque, or shifting without an accountable rationale. In such conditions, sustained narrative coherence can function as an enabling routine by reducing uncertainty about intentions, responsibilities, and change control, thereby protecting procedural legitimacy while design choices evolve (Shanahan et al., 2011; Dahlstrom, 2014).

The module is actionable only when governance assigns ownership for decision logs, update rules, and evidence disclosure. It is also actionable when the measure involves visible burdens or contested space use, because ambiguity and exception handling are more likely to trigger conflict and perceived unfairness in such settings (Lipsky, 2010; Matland, 1995). Finally, it is actionable only when the implementation pathway is staged and monitorable, because continuous storytelling is credible only when anchored to visible feedback loops and trackable milestones (Ansell & Gash, 2008; Emerson et al., 2012).

In content terms, the narrative must provide a stable spine while distinguishing what is fixed from what remains provisional. It should clarify the operational meaning of the measure, the target users and flows, and the expected trade-offs. It should specify the rules of the game as a procedural contract: how decisions are taken, which actors hold decision rights, how stakeholder inputs are processed, and what counts as admissible evidence for change. It should also clarify what will be monitored, how results will be communicated, and how performance signals translate into adjustments. This is where storytelling reinforces governance. It makes adaptation legible and predictable, reducing the likelihood that inevitable iteration is interpreted as arbitrary rule change.

Finally, storytelling should be embedded in pilot design. Pilots should be narrated as structured learning devices, with explicit learning questions and publication commitments for results and decisions. This supports transferability because it helps convert iterative adjustment into codified routines rather than isolated demonstrations. In mechanism terms, continuous storytelling supports implementability when it makes closure visible, lowers perceived arbitrariness of change, and limits the translation of uncertainty-driven iteration into setbacks.

6 Discussion and policy implications

The Rome findings support a specific reading of deep uncertainty. Under deep uncertainty, policy design rarely remains stable, because key parameters of the problem and the feasibility of operating arrangements become visible only through iteration (Walker et al., 2013; Kwakkel et al., 2016). Iteration is not a weakness per se. It becomes a weakness when delivery governance cannot convert iteration into disciplined learning.

This is where setbacks become analytically useful. Setbacks are treated as observable manifestations of adaptation without procedural closure. When responsibilities remain ambiguous, when monitoring is not integrated into the design, and when engagement does not produce decision-grade outputs, adaptive pressure tends to surface as delayed closure, repeated redesign, derogations, and uneven feasibility once proposals meet street-level constraints (Pressman & Wildavsky, 1973; Matland, 1995; Lipsky, 2010). In this sense, deep uncertainty raises the need for adjustment, while governance quality determines whether adjustment remains controlled or becomes instability.

The Rome micro-hub workstream shows that the tactical–operational interface is particularly exposed. Micro-hubs require concrete closure on what is being implemented, who holds decision rights, how space is governed, how data are handled, and how pilots will generate transferable routines. When these gates stay open, the process accumulates transaction costs and becomes vulnerable to drift. When these gates close early, uncertainty remains manageable because adaptation can operate within clear boundaries.

6.1 *Policy implications for Rome: making micro-hubs implementable without over-designing rules*

Table 3 summarises the main practical implications for micro-hub design and implementation in Rome.

Table 3. Practical recommendations and transferability conditions for urban micro-hub deployment.

Dimension	Practical recommendation	Transferability condition
Operational definition	Define target flows, eligible users, service boundaries, and daily routines early.	Relevant wherever last-mile operations are contested or operationally heterogeneous.
Space governance	Match the micro-hub design to credible access, loading/unloading, and exception-handling rules.	Relevant where scarce space and uneven enforcement shape feasibility.
Governance configuration	Choose the governance model according to coordination burden, space regime, and monitoring feasibility.	Transferable as a selection logic, not as a universally preferred model.
Data governance	Set ex ante rules on data sharing, confidentiality, monitoring responsibilities, and feedback use.	Relevant where trust, competitive sensitivity, and adaptive monitoring affect commitment.
Piloting	Use pilots to produce minimum routines, indicators, and replicable guidance for wider deployment.	Relevant where experimentation must lead to standardisation rather than one-off demonstration.
Engagement and narrative continuity	Link engagement to traceable outputs, visible feedback translation, and, where useful, continuous storytelling.	Relevant in multi-actor settings where iterative adjustment may otherwise appear arbitrary.

6.2 *Transferability: conditions under which the toolkit travels*

The toolkit can be interpreted as a robustness device for policy design under deep uncertainty. Robust approaches focus on maintaining implementability across plausible futures and enabling adjustment through pre-defined pathways rather than ad hoc renegotiation (Kwakkel et al., 2016). The toolkit operationalises this logic at the tactical–operational interface. It specifies minimum closure gates and minimum process outputs that reduce the probability that adaptation becomes setbacks.

Transferability should be framed conservatively. The toolkit travels as a set of minimum procedural standards and governance functions, not as a guarantee that similar measures will produce similar outcomes across cities. This stance is consistent with governance research: institutional forms vary, but minimum functions recur, including coordination capacity, accountability devices, and conflict-handling routines (Emerson et al., 2012; Provan & Kenis, 2008; Sørensen & Torfing, 2009). In practical terms, the same closure logic can support other freight measures because many share the same translation problem: unclear responsibilities, weak baselines, and weak feedback routines at the point where plans become executable rules.

This also clarifies what transferability does not mean. It does not imply a single preferred governance model. It implies that governance configurations must be selected to match coordination burdens, space regimes, and monitoring feasibility, while still meeting minimum closure requirements.

6.3 *Limitations and research agenda, including structured assessment of storytelling*

Two limitations follow directly from the evidence strategy. First, the evidence is strongest on translation dynamics and procedural conditions, and weaker on long-run operational performance outcomes. Demonstrating system-level effects would require longitudinal monitoring data, enforcement traces, and behavioural indicators beyond the scope of the current corpus. Second, the stakeholder survey instruments are small-N and are used for triangulation and diagnostic interpretation, not for statistical inference.

The new storytelling module motivates a focused research agenda item rather than an inflated claim. Narrative policy research shows that actors contest policies through competing stories about causality, responsibility, and deservingness, and that these narratives shape legitimacy assessments and coalition stability (Roe, 1994; Stone, 1989; Shanahan et al., 2011). Procedural justice research suggests that perceived fairness and transparency of procedures can sustain acceptance even when outcomes involve burdens, which is critical when costs and benefits

are unevenly distributed (Tyler, 1990; de Groot & Schuitema, 2012). For micro-hubs, this matters because transition costs can concentrate on specific operators even when wider benefits accrue to the city.

Storytelling should therefore be treated as actionable only when it is anchored to governance ownership and change control. A narrative module should not be a generic communication plan. It should operate as an auditable routine that makes adjustment legible: what is fixed, what changes, why it changes, and who is affected. This is the point at which continuous storytelling reinforces, rather than replaces, governance closure. A structured assessment in Rome can test this claim by coding Living Lab artefacts for narrative continuity and distributional clarity, and by linking these patterns to stakeholder signals on clarity, trust, and feasibility across cycles (Gatta & Marcucci, 2016; Le Pira et al., 2017; Stathopoulos et al., 2012). The aim is not to "prove" storytelling effects in a causal sense. The aim is to test whether narrative continuity measurably reduces interpretive drift and lowers the risk that inevitable adaptation is interpreted as arbitrary governance.

7 Conclusions

This paper reframed urban micro-hub implementation as a translation problem under deep uncertainty, where iterative adjustment is unavoidable but does not automatically generate learning. The Rome evidence indicates that deep uncertainty becomes practically relevant when adaptation is not channelled through delivery governance. In those circumstances, adjustment surfaces as policy setbacks, including delayed closure, redesign cycles, derogations, and uneven feasibility once proposals meet street-level constraints.

For RQ1, the findings specify acceptability as conditional on implementability. Acceptability concentrates where the micro-hub is defined operationally and aligned with target flows, where space governance is credible and enforceable, where data routines are governed in a way that supports monitoring without undermining trust, and where piloting is designed to generate transferable minimum standards rather than isolated demonstrations. These conditions link attitudinal support to concrete feasibility and distributional implications.

For RQ2, the evidence indicates that no single governance configuration dominates across contexts, because preferences vary coherently with space regimes and coordination costs. However, a small set of minimum governance functions recur across viable options: an accountable public role for space and rule credibility, clear decision rights and exception governance, robust data governance, and an engagement set-up that produces decision-grade outputs with traceable feedback. Collaborative procedures reduce setbacks only when they accelerate closure on these operational gates rather than institutionalising discussion without deliverable artefacts.

The procedural toolkit is presented as a conservative contribution. It translates the mechanism account into a gated sequence of minimum outputs and monitoring routines at the tactical–operational interface. Transferability is framed as portability of procedural standards and governance functions, not as an assumption of comparable outcomes across cities or measures. Continuous storytelling is positioned as an optional module within the toolkit. It is actionable when it is anchored to governance ownership and change control and when it clarifies what is fixed, what is provisional, and why adjustments occur, thereby protecting procedural legitimacy under uncertainty.

Two limitations follow. The evidence base is strongest on translation dynamics and procedural requirements, and weaker on long-run operational performance outcomes. In addition, stakeholder surveys are used for triangulation and diagnostic interpretation rather than statistical inference. Future research should test the toolkit against later implementation stages using longitudinal monitoring evidence and should assess the storytelling module through structured coding of narrative continuity and distributional clarity across Living Lab cycles, linked to stakeholder signals on trust and feasibility.

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