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Settlement-Specific Criteria for Municipal Climate Adaptation Across Europe

Alexander Tzonis

Department of Architecture, University of Technology Delft, 108 Oude, Delft 2611, Netherlands
* Correspondence: tzonis.a@gmail.com

Abstract

While European municipalities have registered tens of thousands of adaptation measures, many measures stay outside of the administrative process leading from a listed adaptation action to its implementation. The current research explores the point at which implementation is blocked and whether the blocking point varies for different types of settlements. The empirical foundation is comprised of 18,993 actions having proper implementation status, 9,776 implemented or ongoing actions having proper timing categories, 3,640 fully observed settlements, and coefficients' signs and magnitudes for social, institutional, economic, governance role, and stakeholder field domains. The analysis uses the sequence of diagnostics of settlements gates presented in the manuscript: Scale-Lattice Evidence Balancing, the Activation-Timing Gate, observed-domain concentration, Coverage-Weighted Constraint Load, and Responsibility-Stakeholder Discordance. The results reveal the existence of a strong pre-activation barrier. Cancelled or not started actions represent 93.8% of completed or ongoing actions, while the weighted timing drag among implemented actions is 8.1%. The cities bear the highest negative load since the city profile is characterized by the economic conversion constraint. The towns have a narrow favourable pattern focusing on financial capacity and scarce stakeholder support. Small towns have one positive social signal and multiple negative institutional, economic, governance role, and stakeholder constraints. The villages have the most pronounced contrast between the positive responsibility evidence and negative stakeholder field evidence. The answer to the research question is thus settlement class-dependent: European municipal adaptation most often fails at the stage of activation, but the blockage mechanism depends on the type of the settlement.

Keywords: climate adaptation implementation; settlement size; municipal governance; activation gate; implementation friction; stakeholder discordance; European municipalities

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1. Introduction

European municipal adaptation is shifting from plan development to the more difficult challenge of implementation. Local governments are now required to demonstrate whether climate-risk measures find a way into the authorization, finance, procurement, construction, maintenance, and administrative processing work stream. A list of actions may look impressive in itself although many actions still reside beyond the work stream that gives them ownership, funding, scheduling, and jurisdiction. This is an important issue since adaptation barriers rarely originate from one technical problem only. Institutional and organisational barriers tend to combine during implementation [1]. Different barrier categories may also reinforce each other across governance scales [2]. Adaptation barriers are thus highly context-dependent [3]. Capacity of local staff, political timing, and inter-departmental collaboration are further factors shaping whether local adaptation measures advance [4]. Thus, a municipal adaptation plan may be well-developed as a piece of documentation yet fail to advance many actions through the starting gate.

Adaptation evaluation research has shown multiple times that plan presence and credibility of implementation are distinct achievements. There are many municipal adaptation plans including actions that lack details about their funding and administrative ownership [5]. Plan quality also depends on whether implementation responsibilities are clearly stated [6]. Sequencing and monitoring arrangements are other factors indicating credible implementation [7]. Recently, implementation evaluation research stresses the importance of credible delivery pathways [8]. Comparative tracking remains complicated due to differences in scope and maturity of reported actions [9]. Cross-jurisdictional comparisons are also hampered by differences in the quality of evidence [10]. Interpretability and consistency of accountability and implementation status information across reporting systems are necessary [11]. Comparative frameworks developed recently highlight the need for transparent and comparable evidence categories [12]. Implementation may include political endorsement, budget allocation, start of implementation, implementation completion, or risk reduction [14]. In this study, attention is focused on the transition from action listing to action executability,

since an action that never starts cannot implement itself, maintain itself, and affect risk reduction in any way.

Settlement class makes the above-mentioned implementation question a concrete administrative geography. Although cities normally possess specialised departments and more capital availability, their adaptation portfolio can involve costly infrastructure, land use conflicts, actor field density, and investment sequence spanning multiple years. Towns can rely on shorter decision chains but have fewer staff and lower capacity to accommodate complex reporting requirements. Small towns can be subject to the same expectations as municipalities but not possess comparable administrative depth. Villages can depend on trust, inter-municipal cooperation, regional assistance, and local recognition of responsibility whereas stakeholder procedures can differ from those operating in larger urban administrations. Comparative urban-climate research reveals that municipal capacity depends on institutional context [15]. Also, city size and governance positions affect adaptation planning [16]. Political and administrative context shapes local implementation priorities [17]. European comparisons also demonstrate the effect of population size on planning coverage and reporting [18]. Regional context determines how municipalities mainstream adaptation [19]. Recent settlement-specific research also confirms that local characteristics determine implementation progress [20].

The empirical foundation is provided by the municipal adaptation register developed by Martínez Görbig et al. The register contains 19,954 adaptation actions from 1,596 Global Covenant of Mayors European signatories located in 32 countries and distinguishes implementation-related factors among cities, towns, small towns, and villages [21]. The analysis uses a constant diagnostic procedure and focuses on its interpretation: it interprets reported counts and settlement coefficients via a gate logic that distinguishes between non-execution and delay, concentration and distribution of constraints, and administrative responsibility and stakeholder-field evidence.

The research question is: *what is the implementation gate that best distinguishes executable adaptation actions from actions stalled or fragile, and what are settlement-specific evidence profiles explaining such differentiation among European municipalities?* The question is not an overview of adaptation barriers. It tests whether the critical point of division falls before implementation or after it starts, whether negative evidence is concentrated in one area or scattered across multiple areas, and whether evidence of responsibility and stakeholder-field converge. The distinction is significant since a unified assistance programme may waste resources on the wrong point of failure. Cities with serious economic conversion problems, towns with limited financial capacity, small towns with distributed institutional weaknesses, and villages with responsibility-stakeholder separation need different instruments.

The contribution is the settlement-sensitive interpretation of municipal adaptation implementation. It connects reported counts, timing categories, settlement coverage, and coefficient signs with a policy question: where does implementation stop? The discussion extends adaptive capacity research [22]. The research also corresponds to polycentric climate governance approaches [23]. Research on mainstreaming explains the process of embedding adaptation into routine administration [24]. Urban adaptation literature also emphasises the role of planning practices [25]. Ecosystem-based adaptation represents an implementation approach as well [26]. Resilience research stresses the need to connect planning and operational capacity [27]. Recent assessment research also calls for implementation support tailored to observable local conditions [28]. Thus, European municipal adaptation should be evaluated not only according to the presence of actions in the plans but the gate that blocks the actions from being executed.

2. Evidence Record and Analytical Scope

The evidence record is comprised of the numerical counts and settlement-specific coefficient structure presented by Martínez Görbig et al. [21]. The data is used as a tabulated municipal adaptation register rather than a set of microdata. Four layers are needed for the analysis. The implementation-status layer identifies whether the actions passed the starting gate. The timing layer evaluates whether actions under implementation were implemented without delay. The settlement coverage layer provides the city, town, small-town, and village distribution for comparison. The coefficient layer provides the direction and strength of settlement-specific evidence in social, institutional, economic, governance-role, and stakeholder-field domains.

The register contains 19,954 adaptation actions. Among them, 18,993 actions have valid implementation-status information. In the status-valid layer, there are 9,801 actions that are completed or ongoing and 9,192 cancelled or not started. The timing layer includes 9,776 actions that are either implemented or ongoing and have explicit timing categories: 8,753 not delayed, 468 shortly delayed, and 555 delayed. The settlement layer includes 3,640 complete observations distributed among 975 cities, 741 towns, 821 small towns, and 1,103 villages. The difference between 18,993 status-valid actions and 18,968 actions calculated by summing up completed or ongoing and cancelled or not-started timing allocations indicates that 25 actions have valid status but no explicit timing allocation in the current table format. This difference is left unaddressed due to the use of the reported tabular evidence.

From Table 1, it can be seen that the first empirical division is the start gate. Near-equivalence of completed and canceled or not started actions indicates that implementation status is not a secondary cleaning factor but the primary result that shapes the

rest of the paper. Timing layer poses another question: how often is delay reported in actions that are already implemented? Such an approach ensures that non-start and delay are treated as separate phenomena.

Table 1. Core evidence layers.

Layer	Analytical role	Retained count
Implementation status	Separates completed or ongoing actions from cancelled or not-started actions	18,993 actions
Timing status	Separates not-delayed, shortly delayed, and delayed actions among implemented or ongoing actions	9,776 actions
Settlement coverage	Gives complete observations for cities, towns, small towns, and villages	3,640 observations
Coefficient evidence	Supplies settlement-domain signs and magnitudes for diagnostic balancing	Active settlement-domain coefficients

The evidence representation in Figure 1 depicts all four layers on one register. This approach is necessary since the same amount of actions can indicate varying implementation pressure when taking into account timing reliability, coverage of settlements and sign of coefficients associated with certain settlement categories.

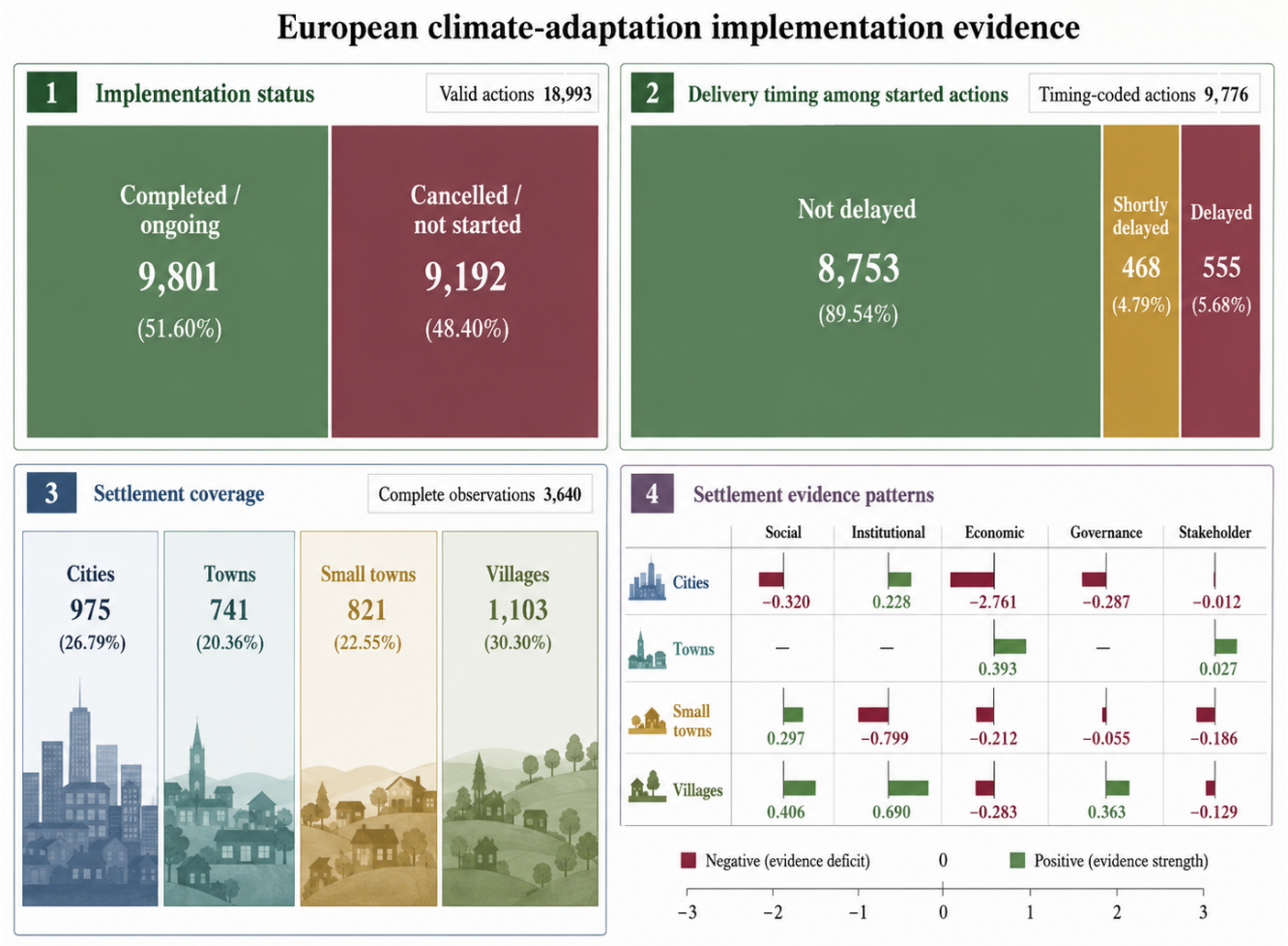

Figure 1. Evidence layers.

While the scope of the analysis is intentionally limited, its results do not produce estimates of causal effect at the action level, predictions of performance for individual municipalities and rankings of national adaptation plans. Rather, diagnostic patterns for the settlement level are found through reported tables. This scope limitation prevents overstatements and yet provides sufficient room for relevant policy implications. Adaptation research usually uses heterogeneous data sets [9]. In cross-national analysis, there is a problem of coding and evidence incompleteness [10]. Plan evaluation shows the same aggregation of implementation evidence [7]. Diagnostics based on settlement-level data remains valuable even in such cases [12].

3. Method

3.1 Scale–Lattice Evidence Balancing

Let $s \in S$ denote settlement class, where

$$S = \{\text{cities}, \text{towns}, \text{small towns}, \text{villages}\}.$$

Let k denote an implementation factor. For each factor–settlement pair, the retained coefficient is β_{ks} and the reported significance value is p_{ks}. Scale–Lattice Evidence Balancing converts this pair into a bounded directional evidence unit:

$$E_{ks} = \operatorname{sgn}(\beta_{ks}) \log(1 + |\beta_{ks}|) \min\left(1, \frac{-\log_{10}(p_{ks})}{10}\right). \tag{1}$$

$E_{ks} > 0$ means evidence related to implementation that is finished or underway, and $E_{ks} < 0$ means evidence related to implementation that has been canceled or not begun. Log makes extreme values less influential, while significance prevents insignificant estimates from being as influential as significant ones. This type of transformation is appropriate for tabular data since it keeps the sign and doesn't treat the size of the coefficient as a measure of its importance.

For each evidence domain d, the settlement-specific domain balance is

$$B_{ds} = \frac{1}{n_{ds}} \sum_{k \in d} E_{ks}, \tag{2}$$

with n_{ds} being the number of active evidential units within domain d and settlement type s. The sign of B_{ds} represents the direction of evidence for domain d, while the absolute value indicates the average weight of active evidence. A scale-reversal parameter is also introduced as:

$$R_k = 1 - \frac{|n_k^+ - n_k^-|}{n_k^+ + n_k^-}, \tag{3}$$

with n_k^+ and n_k^- being the number of settlement types for which factor k is positively and negatively significant, respectively. Such an index would be helpful where a factor facilitates implementation of an adaptation measure in one type of settlement and inhibits it in another. Adaptation barrier studies note that the role of institutional factors is different depending on context [3]. Governance and policy barriers vary depending on the administrative context as well [13]. Mainstreaming conditions may thus facilitate adaptation in one municipality and hinder it in another [24].

3.2 Activation–Timing Gate

The Activation–Timing Gate separates failure to start from delay after start. The activation friction ratio is defined as

$$F_A = \frac{N_{\text{cancelled/not started}}}{N_{\text{completed/ongoing}}}. \tag{4}$$

The implementation prevalence is

$$P_I = \frac{N_{\text{completed/ongoing}}}{N_{\text{valid status}}}, \tag{5}$$

and the pre-activation non-start prevalence is $P_N = 1 - P_I$. For timing-coded implemented or ongoing actions, the weighted timing drag is defined as

$$D_T = \frac{0.5 N_{\text{shortly delayed}} + N_{\text{delayed}}}{N_{\text{not delayed}} + N_{\text{shortly delayed}} + N_{\text{delayed}}}. \tag{6}$$

Weight 0.5 imposes a relatively lesser penalty on the short delay compared with the full delay. This kind of weighing scheme is conservative as it appreciates the fact that the short delay suggests timing friction but is not equal to the long delay. The decision rule is based on the comparison between F_A and D_T. High F_A and low D_T imply that the key implementation gap is in the pre-activation phase. Low F_A and high D_T imply that actions begin but face continued timing difficulties.

3.3 Concentration of evidence and coverage-weighted constraint load

Concentration test is used to identify whether a particular settlement profile is heavily loaded in one evidence domain or spread across multiple evidence domains. For settlement type s, the observed-domain concentration measure is

$$C_s = \frac{\max_d |B_{ds}|}{\sum_d |B_{ds}|}, \tag{7}$$

utilizing only those domains with positive evidence. High scores show that a particular domain overwhelms the settlement pattern. Low scores show that the evidence of implementation is distributed among domains. The distribution issue is important because if there is a dominance of one domain, then the tool for this case should be specialized; otherwise, it is distributed.

The coverage-weighted constraint load is defined as

$$L_s = \left(\frac{N_s}{N_{\text{complete}}} \right) \sum_d \max(0, -B_{ds}), \tag{8}$$

where N_s is the number of complete observations for settlement class s. This metric does not measure causal risk; rather, it measures how strong negative active evidence is, once the proportion of settlement class within the complete-observation layer is taken into consideration. Settlement class may exhibit very strong negative domain balance, but be low in coverage since there are not many complete observations; likewise, a settlement class may not show particularly negative balances, yet generate more weight when it forms a significant portion of complete observations.

3.4 Responsibility–stakeholder discordance

Let G_s represent governance-role domain balance and H_s represent stakeholder-field domain balance of settlement class s. The Responsibility–Stakeholder Discordance index is

$$D_s^{RS} = |G_s - H_s|. \tag{9}$$

This index is most informative where the two indexes have different signs. Positive Governance Role Balance together with Negative Stakeholder Field Balance suggest that while responsibility allocation favors implementation, stakeholder field evidence is not supportive of this process. Negative Governance Role Balance together with Negative Stakeholder Field Balance reflect a more general combination of administrative and participatory constraint. This is crucial because participation and responsibility are two different processes. Implementation requires authority and responsibility [30]. It requires cooperation and institutionalization of climate actions [31]. Most recent comparative data confirm that actor participation does not necessarily mean implementation capabilities [29].

The combination of four indexes reflects a gate-based diagnostics process. Scale–Lattice Evidence Balancing shows the direction and intensity of settlement-specific evidence. The Activation–Timing Gate shows if the deficiency is mainly pre-activation or post-activation. Evidence intensity and coverage-weighted constraint intensity show if the settlement pattern is centered at a single critical pressure point or spread across several areas. Responsibility–Stakeholder Discordance shows if the administrative responsibility and stakeholder field evidence complement each other or contradict. Each empirical display in the Results section reflects this sequence where one figure represents one diagnostics stage.

4. Results

4.1 Activation friction is greater than timing drag

The implementation-status layer tells us that 51.60% of valid actions are completed or ongoing, while 48.40% are cancelled or not started. Therefore, the activation friction ratio is 0.938, which means that cancelled or not-started actions are 93.8% of the number of completed or ongoing actions. Thus, we have a high level of pre-start friction. This tells us that the main implementation problem is at the point of action activation, when planned actions fail to be implemented.

The timing layer has a completely different pattern. Of the timing-coded completed or ongoing actions, 89.54% are not delayed, 4.79% are shortly delayed, and 5.68% are delayed. The weighted timing drag is 0.081. Once the actions are activated, there is no noticeable delay in their implementation. The empirical bottleneck is thus not the slow delivery post-activation; it is the failure to activate before the start of implementation. We cannot automatically regard the content of plans as evidence of implementation capacity [6]. For implementation credibility, we need evidence other than the mere listing of measures [8]. Monitoring studies from recent years make a similar distinction between the ambition of plans and their actual execution [32]. Adaptation tracking literature highlights the necessity of distinguishing between adoption and execution [9]. Cross-jurisdictional monitoring also needs clearly defined implementation stages [10]. Thus, observed delivery should not be mixed with the earlier administrative categories [11].

The result is that the municipality will look administratively competent as soon as the action starts, even though it misses many actions before starting them. The implementation policy must, therefore, raise the prior question: what prevents actions from entering the queue of funded, owned, scheduled, and legally authorized activities? This pre-start interpretation becomes the basis for all results below specific for each settlement.

The display of activation-timing illustrated in Figure 2 highlights the difference between the two gates. The action layer based on the status-valid actions almost equally splits actions into actions already implemented and those which are yet to be

implemented while the actions layer based on the coding of timing is predominantly made up of actions which are not delayed. The differentiation ensures that non-start is not confused for ordinary scheduling delay.

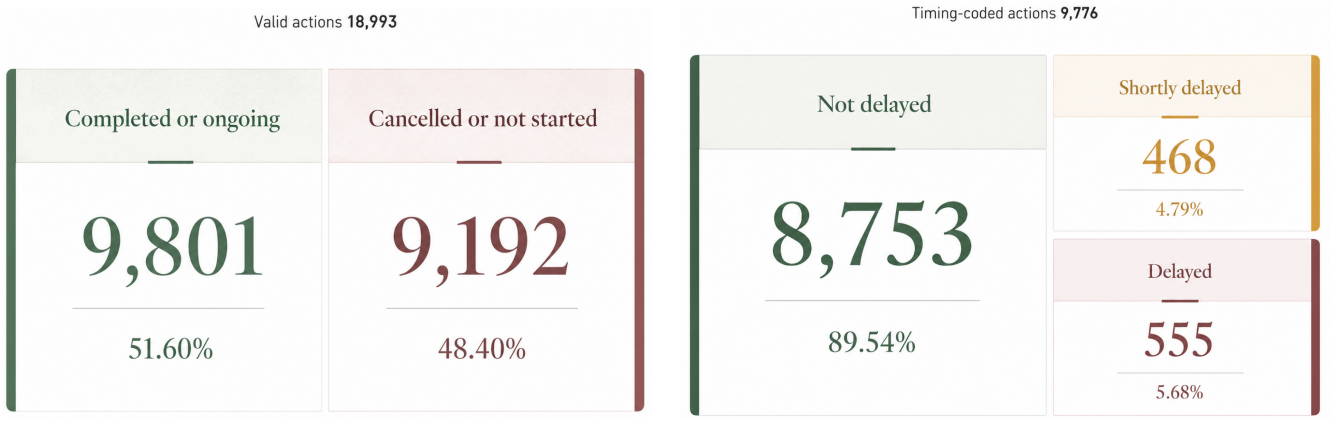

Figure 2. Activation and timing gates.

A different ratio between F_A and D_T affects the meaning of municipal assistance requirements. In case of post-start delays being the main issue, the main policy tools will be timeline management, acceleration, procurement control, or delivery control. The data, however, suggests the necessity of instruments that will help actions get past the start gates: project scoping, assigning responsibilities, budgeting, financial application, interdepartmental approval, and transforming general adaptation goals into feasible solutions. This is not saying that time is unimportant. It proves the point that time is the secondary gate for actions that have enough administrative support to get started.

Table 2. Activation gate results.

Indicator	Formula basis	Value
Implementation prevalence P_I	$9801/18993$	0.516
Non-start prevalence P_N	$9192/18993$	0.484
Activation friction F_A	$9192/9801$	0.938
Timing-coded implemented or ongoing actions	$8753+468+555$	9,776
Weighted timing drag D_T	$(0.5\times 468+555)/9776$	0.081
Share with any reported delay	$(468+555)/9776$	0.105
Status-valid actions without explicit timing allocation	$18993-18968$	25

4.2 Settlement balances show different paths of settlements

Settlement-specific balances indicate that cities, towns, small towns, and villages have their own implementation profiles. Cities have a positive institutional balance of 0.228, whereas their social, economic, governance role, and stakeholder field balances are negative. Especially negative economic balance of the city is equal to -2.761. Towns have an active economic and stakeholder domain balance of 0.393 and 0.027. The positive social balance of small towns equals 0.297; the institutional, economic, governance role, and stakeholder field balances are negative. Positive social, institutional, and governance role balances are characteristic of villages, whereas their economic and stakeholder field balances are negative.

Table 3. Settlement-domain balances.

Settlement	Social	Inst.	Econ.	Gov.	Stake.
Cities	-0.320	0.228	-2.761	-0.287	-0.012
Towns	–	–	0.393	–	0.027
Small towns	0.297	-0.799	-0.212	-0.055	-0.186
Villages	0.406	0.690	-0.283	0.363	-0.129

Inst. = institutional; Econ. = economic; Gov. = governance role; Stake. = stakeholder field. A dash indicates no active domain balance under the retained significance rule.

According to the balance table, there is evidence of qualitative difference in settlements and not just an ordinal difference. It is not the case where cities are either the strongest or the weakest class because they possess only one negative balance of economics. Villages are not just low capacity municipalities because they have positive balances of social, institutional and governance function balances along with one negative balance of stakeholders field.

Compasses in Figure 3 transform the domain balances into four specific settlement profiles. City compass is characterized by the economic deficit, towns demonstrate narrow positive profile, small towns have one positive social balance among multiple negative balances, while villages have positive governance and institutional evidence together with negative stakeholder-field balance. Visual form is useful since the profiles differ in shape, not in the balance only.

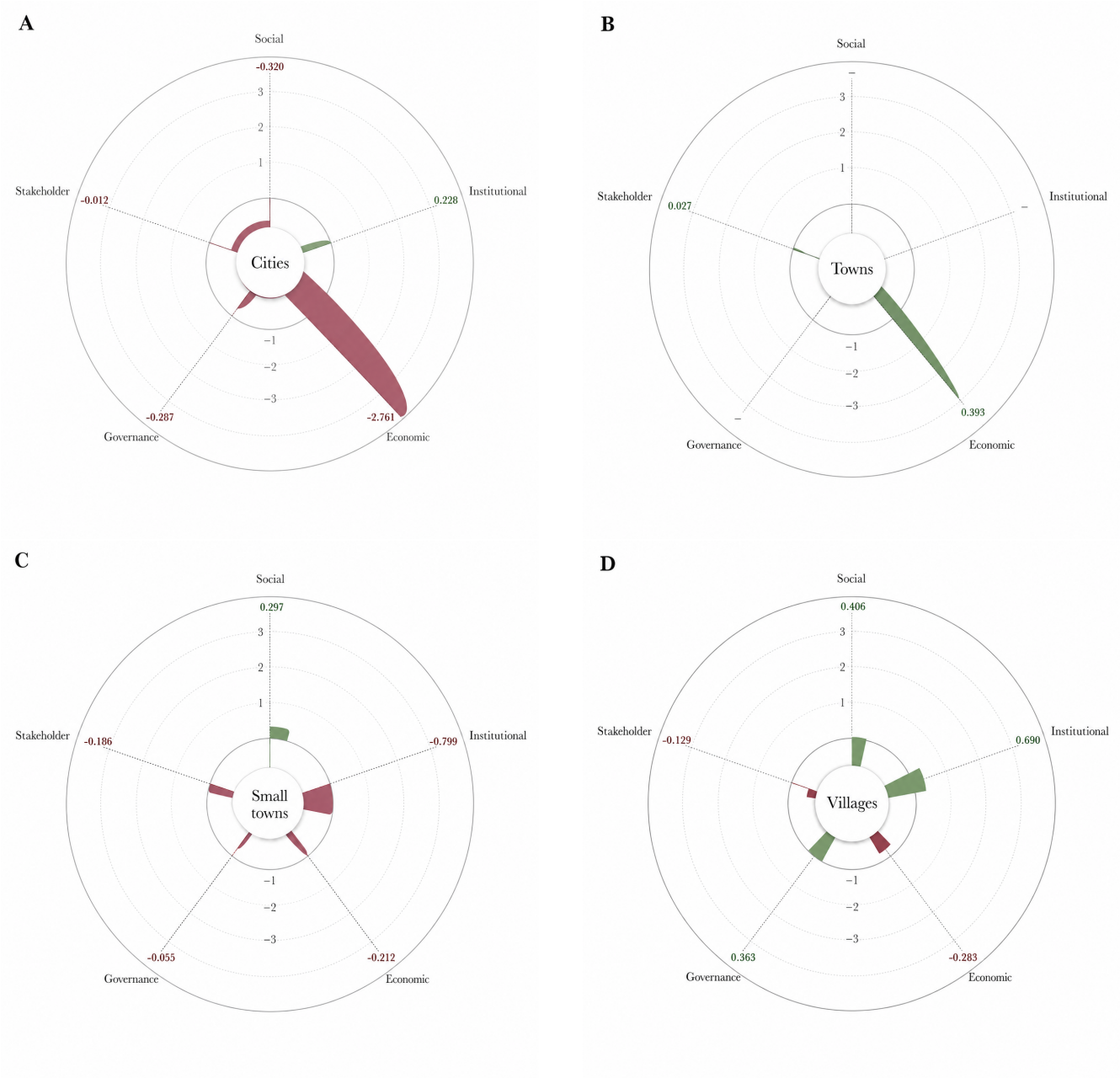

Figure 3. Settlement evidence compasses.

City outcome is far from being the evidence that money reduces implementation. Rather, it is evidence of the difficulty of turning the finance into execution in the economic domain. Big cities can have more resources and yet execute more complicated, expensive, politically significant and administratively difficult actions. Thus, negative balance in the economic domain may be caused by the difficulty of translation of financial capacity into implementation of projects which require

long-term financing, negotiation of land use, procurement packages and departmental coordination. Adaptation finance depends on investment-implementation linkages [33]. Flexible approaches are also required where decisions should be made sequentially under the conditions of uncertainty [34]. Moreover, implementation capacity is not determined by the presence of resources only [7]. Delivery and accountability are important for translating financial capacity into actions [12].

Domain balances also show why educational or awareness-raising actions cannot replace institutional delivery capacity. Positive social evidence combined with negative institutional and governance role evidence in small towns suggests that capacity to adapt can exist independently of implementation capacity. In villages we see opposite situation – responsibility seems to guarantee implementation, while stakeholder field evidence does not. Implementation of adaptation requires embedding into regular institutional practices [24]. Recent municipal data suggest that governance capacity is an implementation requirement regardless of the presence of other implementation capacities [29]. Therefore, everyday routines of planning and administration are more important than strategic aspiration alone [25].

Town profile is less wide. Active evidence is positive but restricted, which implies that towns can benefit from more direct funding options. Towns have less formalized hierarchy of decision and implementation process than cities, so the financial capacity can be a more direct capacity enabler. However, the small town profile is opposite – one positive social balance is not sufficient to overcome institutional, economic, governance role and stakeholder field constraints. Village profile is different again – it is characterized by positive governance and institutional evidence but negative stakeholder field evidence. This is how different settlement sizes can become diagnostic dimension rather than descriptive feature.

4.3 Evidence concentration distinguishes domain-dominated and diversified settlements

Concentration index allows to identify cities and towns as domain-dominated profiles. Cities have concentration of evidence in the observed domains equal to 0.765, mainly due to economic balance equal to -2.761. Towns have an even higher concentration value equal to 0.936, however, this value should be seen as narrowness rather than completeness since there are only two active observed domains. Profile of small towns is more diversified with concentration value of 0.516. Villages have most diversified profile with concentration value of 0.369.

The concentration and load scores provided in Table 4 distinguish between two problems that are usually confused. Concentration refers to the degree of dominance of one of the domains in the settlement profile, whereas the coverage-weighted load refers to the degree of residual negative evidence in consideration of the settlement share. Cities perform well in terms of both aspects, while towns provide a concentrated but positive and low-load profile.

Table 4. Concentration and constraint load.

Settlement	Share	Positive	Negative	Conc.	CwCL
Cities	0.268	0.228	3.380	0.765	0.905
Towns	0.204	0.420	0.000	0.936	0.000
Small towns	0.226	0.297	1.252	0.516	0.282
Villages	0.303	1.459	0.412	0.369	0.125

Conc. = observed-domain concentration; CwCL = coverage-weighted constraint load.

The relief diagram shown in Figure 4 illustrates the reason behind the negative-load finding regarding cities. Cities possess significant settlement coverage and concentrated negative economic load, while towns do not provide any active negative load under the retained rule. Small towns and villages produce weak but still measurable constraint load, which implies different implementation needs.

City constraint load is the largest under the coverage-weighted approach and amounts to 0.905. Small towns occupy the second place (0.282), villages take the third position (0.125), and towns demonstrate no active negative load in the observed domains. It does not imply that there are no implementation problems in towns. It just says that negative evidence is inactive in towns in terms of the retained significance rule and observed domain distribution. Hence, cities and small towns are the main sources of the negative settlement gate implementation, but each of them represents different approaches to implementation assistance. Cities require an economic-conversion approach, while small towns require a distributed institutional approach.

The concentration pattern also explains why assistance in implementing adaptive planning might be inefficient in the case of settlement-neutral adaptation planning. A concentrated economic gate should be solved with the help of instruments which will change project financing, project phases, procurement readiness, and delivery accountability. A distributed institutional gate should be dealt with the help of instruments which will provide clear responsibilities, intergovernmental assistance, staff continuity, and trust-building routines. Diversified village profile should not be regarded as a less active version of the small-town profile because villages have more positive total evidence and another responsibility–stakeholder relationship. Comparative analysis proves that the set of factors influencing adaptation plan formulation includes settlement

characteristics [20]. Governance capacities also influence the process of adaptation plan implementation [29]. Recent findings support the idea that implementation paths differ among municipalities [21].

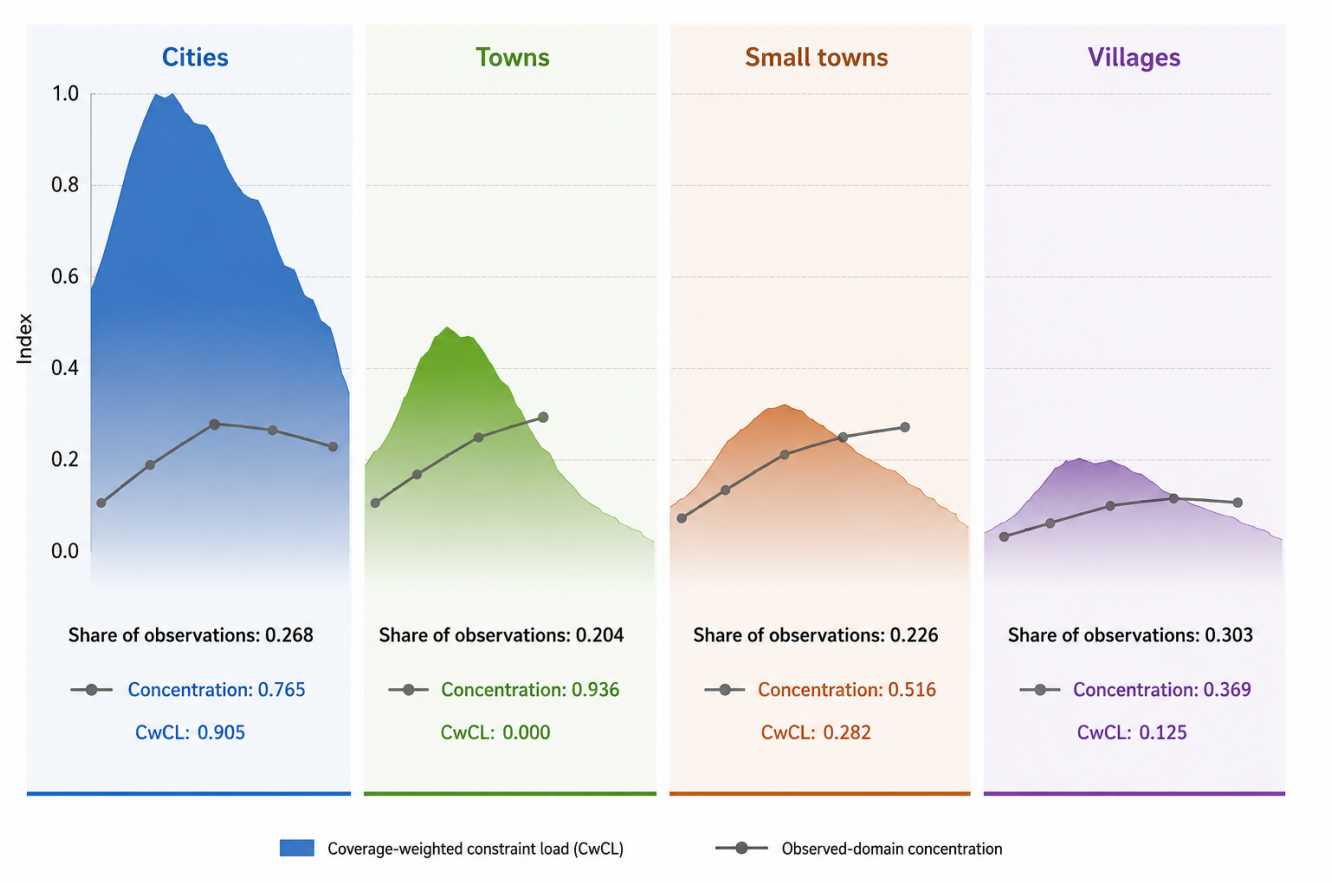

Figure 4. Constraint load by settlement class.

4.4 Responsibility–stakeholder discordance is the largest in villages

The Responsibility–Stakeholder Discordance index can be computed when both the governance-role balance and stakeholder-field balance are active. The value for cities is 0.275, since the governance-role balance is negative, while the stakeholder-field balance is negative. The value for small towns is 0.131, since both the governance-role balance and stakeholder-field balance are negative. The highest value is observed in the case of villages equal to 0.492, as the governance-role balance is positive, while the stakeholder-field balance is negative. There is no information about towns playing an active role in governance, so there is no calculation of the discordance score for them.

Since the discordance scores in Table 5 are highest in the cross-sign category, it shows that there is neither a uniformly positive nor a uniformly negative governance regime in villages. There, the maximum discordance is due to the cross-sign relationship where responsibility evidence is positive and stakeholder-field evidence is negative. The table thus provides the quantitative support to view the village implementation issue as a coordination and participation design issue.

Table 5. Responsibility–stakeholder discordance.

Settlement	Gov.	Stake.	Disc.	Interpretation
Cities	-0.287	-0.012	0.275	Administrative and stakeholder evidence are weakly negative together.
Towns	–	0.027	–	Governance-role evidence is not active, so the discordance score is not calculated.
Small towns	-0.055	-0.186	0.131	Governance and stakeholder evidence jointly constrain implementation.
Villages	0.363	-0.129	0.492	Responsibility evidence supports implementation while stakeholder evidence does not.

The paired-axis interpretation in Figure 5 highlights that responsibility and stakeholder-field evidence cannot be equated to each other. Villages shift from a positive governance-role balance to a negative stakeholder-field balance, thus resulting in the

greatest separation. The trends in cities and small towns are either weak or jointly negative. Towns exhibit the stakeholder-field evidence point alone under the retained rule.

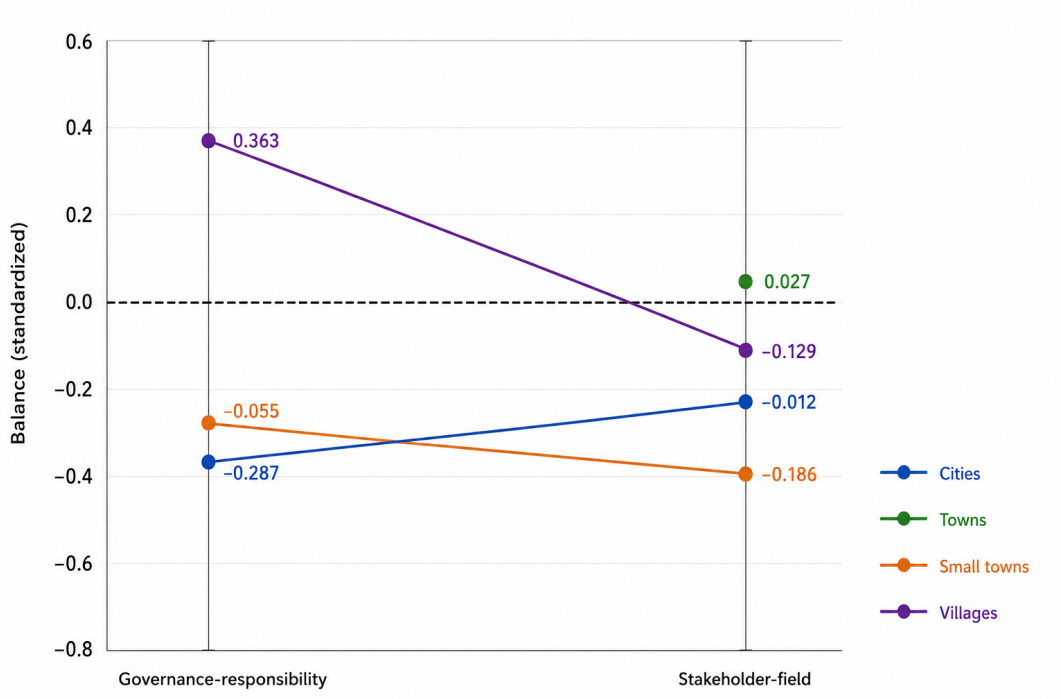

Figure 5. Responsibility–stakeholder separation.

The result is significant for villages in particular. It suggests that implementation in villages can be contingent on responsibility, authoritative powers, regional ties, and cross-boundary coordination as opposed to stakeholder evidence which is formally captured. Negative stakeholder-field balance does not necessarily mean that the locals are absent or against the implementation. It means that stakeholder evidence formally records consultation, conflict, or even the burden of capturing local participation into the categories. In villages, participation can be relational, low-cost, and rooted in local decision-making traditions instead of being articulated via stakeholder evidence formally employed in cities. Equitable adaptation requires participatory processes appropriate to local governance contexts [35]. The institutionalization process is shaped by connections among local actors and practices [31]. The recent evidence from municipalities also points in the direction of such participatory and responsibility instruments [29].

4.5 Interpretation of integrated gate

The three diagnostic layers should be understood as a chain rather than separate descriptive statistics. The first gate demonstrates that the key empirical challenge is non-activation: many actions do not fall under the scope of execution despite that actions initiated are seldom delayed. The second gate demonstrates that the evidence of non-implementation is unevenly distributed by type among settlements: cities are limited by concentrated economic evidence, small towns by a diversified institutional and stakeholders' evidence and villages by a particular mismatch between responsibility and stakeholders' evidence. Finally, the third gate demonstrates that responsibility and participation can run in opposite directions. This point is particularly important regarding villages: positive governance-role balance does not correspond to a positive stakeholder-field balance there.

With such an integrated understanding of the diagnostics one avoids two common mistakes. The first mistake is associated with a wrong belief that settlements with higher capacities necessarily have better implementation profile. Cities have higher administrative capacity in formal sense, but their evidence is defined mainly by the negative economic balance. The city problem seems to consist in transforming a complex and expensive set of actions into implementable package. The second mistake is related to a false assumption that settlements of smaller size are necessarily worse. Villages have positive evidence of institutions and governance roles, and small towns have a less stable pattern. Therefore, the settlement size determines the type of the implementation problem rather than its intensity.

The integrated interpretation of gates also allows to understand why one-dimensional adaptation indicators do not work. One number of implementation rate will conceal activation friction; one number of delay rate will conceal stalled actions; one number of domain score will conceal concentration; finally, one number of stakeholder score will conceal discordance between

responsibility and participation. Such a diagnostic chain becomes most useful as a screening mechanism, which tells what kind of implementation questions need to be asked first for each settlement class prior to municipal investigation.

4.6 Settlement-specific execution profiles

Combined diagnostics give four settlement-specific execution profiles. The cities are characterized by a high level of coverage and constraints, and domain domination. Positive institutional evidence is not enough to compensate for the strong negative economic signal. Implementation risks in cities are not the lack of general capacity but a high-load economic gate in terms of action set financeability and executability.

The towns are narrow-positive capacity-gate settlements with active evidence focused on financial capacity and stakeholder involvement, both positive. Since active domain evidence is weak in towns, they can hardly be considered strong in general. However, the town implementation process seems to have a direct link between financial capacity and implementation. Hence predictable grants, easy procedures, and fast procurement seem to be more relevant than general institutional reform.

The small towns are institutional-gate settlements, having education, negative institutional, economic, governance-role, and stakeholder balances. This profile implies that implementation failure cannot be solved by a single intervention. Role definition, institutional trust, anchoring of responsibility and stakeholder management are needed. Therefore, small towns are different from cities and villages as far as governance is concerned.

The villages are coordination-led but stakeholder-sensitive settlements having the largest positive combined evidence load, the least concentration and greatest responsibility–stakeholder discordance. It is evident that the village implementation profile is not a low capacity condition but a relational-governance condition where transboundary management, region of origin, responsibility and trust seem more important than stakeholder scope.

The execution profiles in Table 6 turn the quantitative diagnostic measures into implementation tools without altering the technique. Each entry associates a settlement class with the gate which is most likely to be blocking the process. It is the chief practical application of the findings – the same adaptation program would not solve the major barrier in all the four settlement classes.

Table 6. Settlement execution profiles.

Settlement	Main diagnostic label	Dominant evidence pattern	Recommended implementation instrument
Cities	High-load economic gate	Negative evidence is dominated by financial-capacity pressure despite positive institutional evidence	Project-finance simplification, phasing of complex actions, and administrative support for converting large action sets into executable packages
Towns	Narrow-positive capacity gate	Active evidence is limited but favourable, led by financial capacity and modest stakeholder support	Direct funding access, small-grant continuity, and rapid procurement support
Small towns	Distributed institutional gate	Educational support coexists with negative institutional, economic, responsibility, and stakeholder balances	Responsibility clarification, regional technical assistance without accountability displacement, and trust-building implementation routines
Villages	Coordination-led responsibility gate	Governance-role and institutional evidence are positive, but stakeholder-field evidence is negative	Inter-municipal coordination, locally trusted responsibility assignment, and low-burden participation formats

The graphical representation of the settlement execution profiles in Figure 6 presents the practical implication of the classes. The execution profiles remain distinct since each one calls for an alternative implementation measure - financial transformation for cities, direct finance for towns, institution embedding for small towns, and coordination-based responsibility for villages.

5. Discussion

The evidence shifts the focus of the interpretation from factor ranking to gate diagnosis. While ranking of factors may identify positive and negative variables, it cannot prove where implementation gets stuck. The Activation–Timing Gate shows that the bottleneck is not post-implementation delay. More than 40% of status-valid actions get cancelled or are not initiated, while almost 90% of timing-coded implemented actions are not delayed. This implies that many municipal action sets are pre-filtered before reaching the stage of execution. The problem of implementation is therefore related to authorization, finance, responsibility assignment, administrative preparation, and project conversion. The quality of plans relies on credible implementation arrangements, not just actions [6]. The monitoring approach should link measures and implementation

pathways [7]. There is also a need to make distinction between ambition and operational achievement in the evidence of implementation [8]. Ownership and auditable delivery are vital for credible adaptation tracking [12].

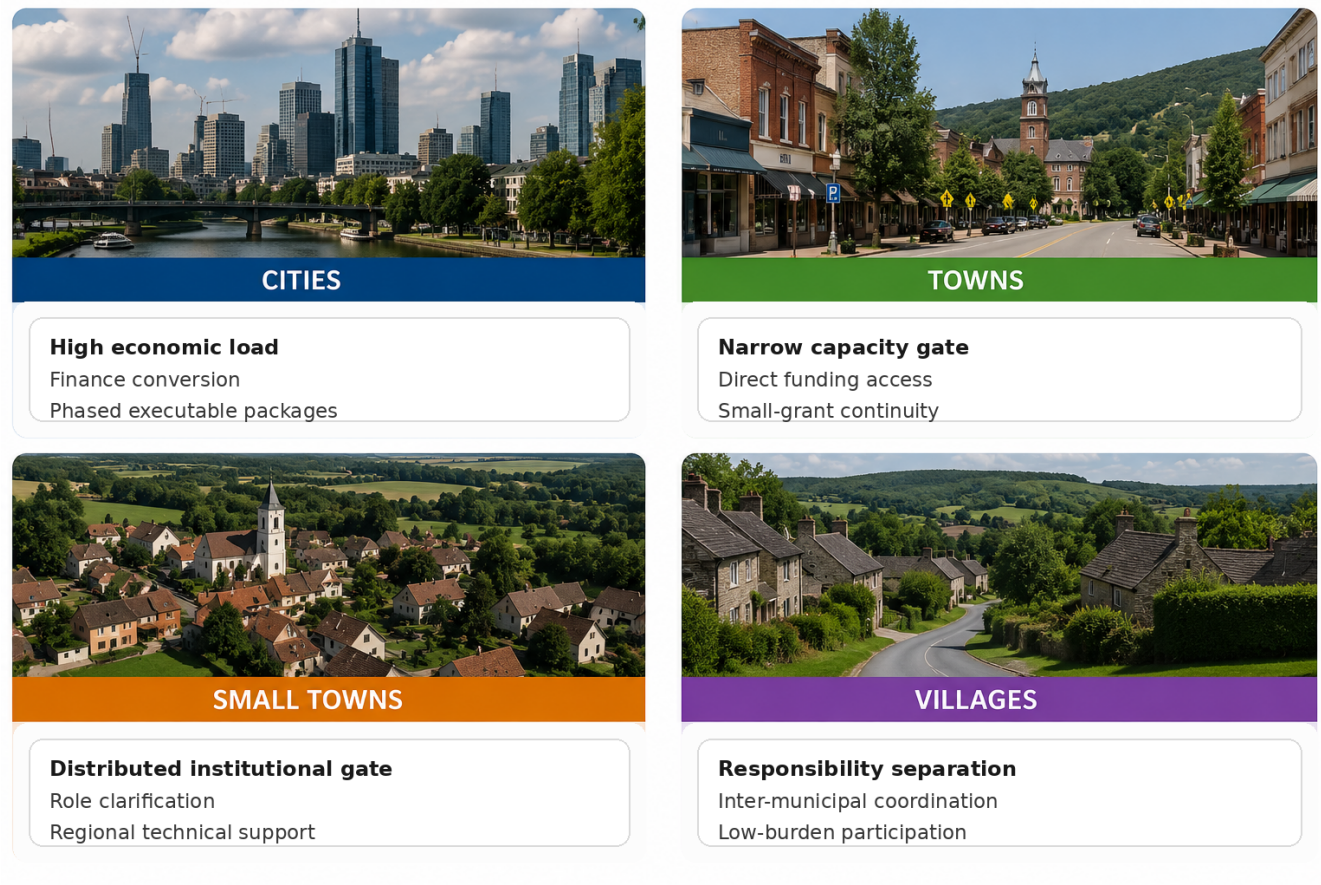

Figure 6. Settlement execution profiles.

This interpretation is also compatible with the measurement literature. The adoption of political decisions as implementation distorts the measurement of adaptation [14]. The combination of administrative preparation, spending, and project start also leads to inconsistencies [9]. Completion of risk reduction should be distinguished from other implementation stages [11]. The present evidence does not settle all the problems of measurement, but it clarifies one important distinction: the actions which were not initiated should not be lumped up analytically with actions which have been started but are delayed. This distinction modifies the policy goal from acceleration to activation.

There is also a shift of the evaluation perspective on the municipal performance with gate-based reading. A municipality which has a few delays among its actions which have been started may have a poor adaptation performance due to the fact that many of its planned actions never start. On the contrary, a municipality which has many ongoing actions with some delays may be more advanced than a municipality which has an administratively silent action set because the planned actions never passed the start gate. The implementation monitoring should, therefore, include status, activation pathway, and timing pathway. This distinction is significant for the purpose of accountability since cancelled or dormant actions are easier to remove from the political agenda compared to the actions which have been budgeted, contractually arranged, or have responsible departments. The diagnostic sequence allows making these invisible losses visible without requiring any additional precision.

The whole diagnostic sequence is summarized in the following Figure 7, which connects the evidence layers with the four interpretations and specific conclusions for settlements.

The city profile shows the need for the settlement-specific interpretation. Cities may have professional staff, higher budgets, and better planning system, but their evidence is mostly characterized by the negative economic gate. The fact that cities show such evidence cannot be interpreted as proof that finance negatively impacts implementation. Rather, it is a plausible indication of the fact that the actions in cities are more costly, complex, and procedural compared to other settlements. The network of green infrastructure, flood prevention, retrofits for heat risk, transport re-design, and big interventions in public spaces require multi-year capital planning and inter-departmental coordination. If such actions are coded using financial capacity indicators,

the coefficient may reflect the scale and complexity of the project rather than the resource deficiency. Adaptation investment decisions have to take into account the uncertainty and path dependencies [33]. Flexibility of pathways allows sequencing of projects as circumstances change [34]. The credibility of the implementation depends on the governance and monitoring of the pathways [7].

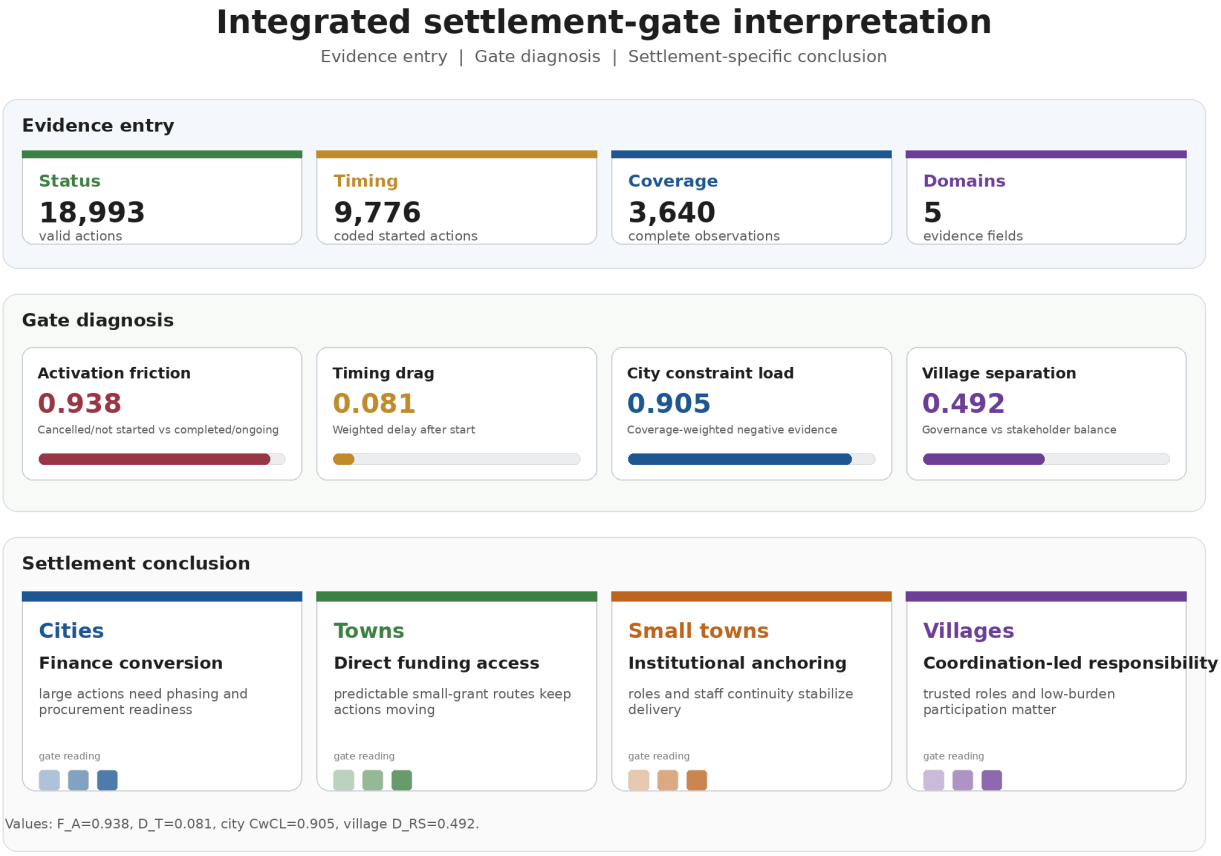

Figure 7. Integrated gate interpretation.

The town profile shows the sharpest contrast. Towns show a narrow and positive active evidence structure. The positive financial-capacity balance shows that towns can convert their financial resources and staff capacity into implementation easier than cities if the funding and stakeholders align. The conclusion which can be drawn from this evidence is that towns may not need any sophisticated redesign of governance. The small- and medium-scale predictable funding channels, simplified compliance requirements, technical templates for adaptation measures, and procurement-ready project formats may be helpful for them. This is relevant for the European adaptation policy since many adaptation programs are oriented either at big cities which have professional grant teams or at regions. Towns may fall between these program formats unless the finance mechanisms become administratively accessible.

Small towns show a challenging policy case. Their profile includes high educational support but negative institutional, economic, governance-role, and stakeholder balances. The evidence shows the presence of the distributed gate, when there is no single deficiency which causes the implementation difficulties. Education and awareness-raising may help in generating the support, but they do not guarantee the presence of the staff capacity, legal responsibility, budget continuity, and stakeholder alignment. The small towns may therefore be prone to responsibility displacement: regional or external stakeholders may initiate adaptation but operational ownership will not be clear. The regional technical assistance may be helpful, but it should not decrease local accountability. The policy tool which is required in this situation is the shared support with defined responsibility, including names of responsible units, implementation schedule, and continuity mechanisms which would survive the political and administrative changes. The mainstreaming requires managerial action in routine municipal practices [36]. Institutional learning is important for adaptation to go beyond the strategic statements [24]. Local government evidence confirms the relevance of clear and durable implementation capacity [29].

The villages show the most interesting interpretation from the governance point of view. Their profile includes the positive social, institutional, and governance-role balances, but the negative stakeholder-field evidence. It does not mean a lack of

capacity, but suggests that villages may implement adaptation if responsibility is trusted, recognized and coordinated via regional and transboundary cooperation. The formal stakeholder involvement may not predict much because the participation in villages can be informal, relational and incorporated into existing civic routines. It may also be that the formal stakeholder enumeration increases when the implementation is problematic and contested or involves external actors. The score of Responsibility–Stakeholder Discordance is useful precisely because it does not assume any automatic positive impact of participation. It checks whether the stakeholder-field evidence supports the governance role balance. In villages, it does not. The policy implication is the design of low burden participation mechanisms which would enhance the responsibility rather than expand the documentation.

The evidence also gives a clue about how adaptation equity should be handled in the diagnostic. The equity-oriented adaptation research finds that adaptation plans may replicate the social vulnerability due to unequal participation and unequal distribution of adaptation benefits [35]. Maladaptation may also distribute the costs and risks to vulnerable groups [38]. The present analysis does not give any estimate on the distribution, but it shows where the questions of adaptation equity are most likely to appear. In cities, the economic gate may be accompanied by the land use conflict and unequal access to adaptation benefits. In small towns, the institutional weaknesses may lead to inability of protecting the vulnerable residents even if they have climate awareness. In villages, the reliance on informal responsibility may be efficient, but it could exclude the less visible groups if the participation is not properly tailored. Therefore, the gate diagnostics should be accompanied by the adaptation equity review before prioritization of funding or implementation.

The present method contributes to the measurement discussion. The adaptation indicators are usually fragmentary and poorly linked to the decision needs [37]. Even existing measurement tools may remain input-oriented rather than implementation-oriented [12]. The recent research also stresses the need of alignment of the indicators with the long-term policy objectives [32]. The diagnostic sequence proposed here does not solve the entire measurement problem, but it shows how the retained counts and coefficients can be transformed into interpretable indicators without assuming more precision than the data have. The Activation–Timing Gate is an example of the simple yet powerful indicator because it splits non-start from the delay. Concentration and constraint load allow comparison of settlement profiles without reducing all evidence to a single score. Responsibility–Stakeholder Discordance shows the difference between formal involvement and responsibility. These calculations are transparent, auditable and conservative.

The results also have implications for the multilevel governance of adaptation. The European adaptation process is influenced by the autonomy of local governments, national requirements, EU policy guidance, and transnational municipal networks. The reporting mechanism established in the framework of the Global Covenant of Mayors creates the valuable evidence base, but the interpretation of reported actions is affected by the place of municipalities in the national and regional institutional context. Martínez Görbig et al. find that adaptation actions are not equally reported by different countries and settlement types, with Spain, Italy, and Belgium providing large portions of reported action counts [21]. This fact does not invalidate the diagnostic results, but it calls for the careful interpretation of settlement-gate evidence as the signal of implementation conditions and not as the universal ranking of municipal performance.

The further implication concerns maladaptation and lock-in. The adaptation actions which pass the start gate are not necessarily beneficial, equitable, and sustainable. The poorly-designed projects may shift the risk to vulnerable communities [38]. The broader climate assessments also warn that adaptation may create new risks or lock-in if the long-term consequences are overlooked [39]. Therefore, the present results should not be used for maximization of implementation counts without any qualitative assessment. The aim of gate diagnostics is identification of where action is stalled and what kind of support may be necessary. It should be combined with climate-risk assessment, equity screening, ecological evaluation, and long-term monitoring. This is especially important for cities, where big projects may create path dependencies, and for villages, where informal decision-making structures may be efficient but underrepresent the marginalized stakeholders.

6. Policy and Implementation Implications

The first implication of the empirical results is that the activation gate needs to be supported explicitly in implementation programs. Due to the similarity of the numbers of cancelled and not-started versus executed actions, municipalities need to receive support even prior to action execution. Project planning, assignment of responsibility, budget design, funding applications, procurement planning, and transformation of adaptation goals into executable actions require special attention from monitoring services reporting not only about delays in the execution of initiated actions but also about the number of planned actions that do not initiate, reasons of non-initiation, and blocking administrative step.

In Figure 8 the results are translated into the assignment map of support. Activation support is universal, while finance to execution conversion, institutional anchoring, and coordination-based responsibility depend on settlement classes. The figure thus demonstrates connection between the empirical results and implementation design without assumption that a single municipal instrument works well in all types of settlements.

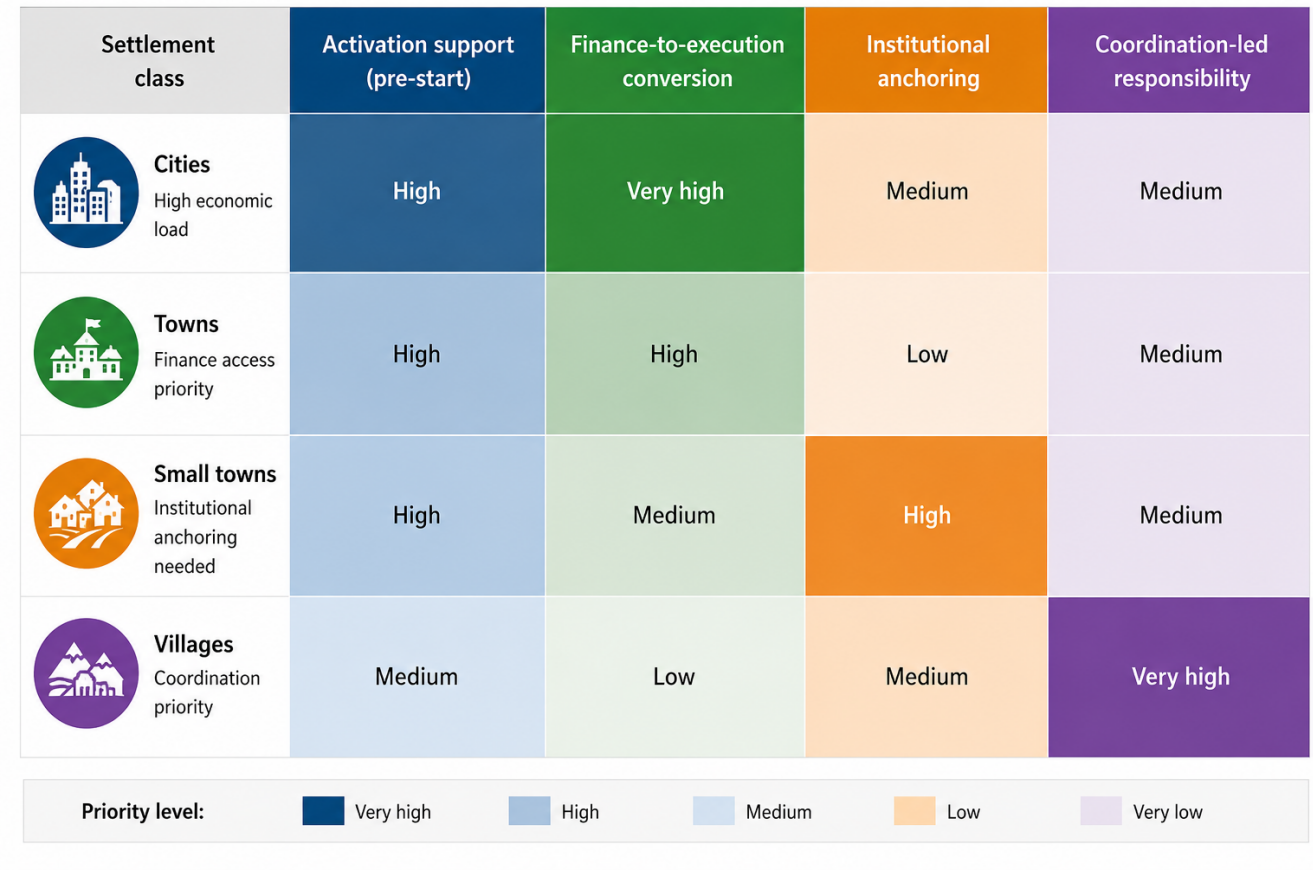

Figure 8. Gate-specific support.

The integrated board in Figure 7 closes the visual series of the empirical evidence mapping by connecting evidence layers with specific recommendations for each type of municipality. It combines activation barriers, timing effect, constraints of cities, and responsibility-stakeholder separation in villages into the policy logic traceable from the evidence.

The second implication is that cities need help in economic conversion rather than general capacity building. Even though cities demonstrate positive institutional signals, negative economic signal prevails in their profiles. City support should reduce administrative complexity in big projects, optimize finance sequences, and divide complex action set into executable parts. Adaptation activities of capital-intensive type should be bundled with the plans related to legislation, procurement, and maintenance making financial capacities deliverable and not adding additional complexity.

The third implication is that towns need predictable and administratively simple funding procedures. An active profile of the towns is positive but limited. If the town has financial capacities and stakeholder support, it will implement adaptation plan fast provided that funding procedures will not be too complicated. Grants of small amount, standard contracts, shared procurement instruments, and templates for technical documentation could help towns to implement actions without administrative burden of city-type programs.

The fourth implication is that small towns need institution anchoring. Educational support of small towns is not sufficient to compensate negative trust, responsibility, stakeholder and financing signals. Technical and financial support should be provided at regional level without accountability displacement. The goal of the support is shared support with operational responsibility. Small towns need clear responsibility assignment, continuity of municipal staff and mechanisms for the implementation continuation after completion of planning phase.

The fifth implication is that village implementation should be built upon coordination and participation without burdening administration. Positive governance and institutional signals of the villages contrast with negative stakeholder-field signals. The formal participatory procedure should be adjusted to the village decision-making culture, cooperation with other municipalities and responsibility relationship. Participation should not become an extra burden on administration; it should increase legitimacy, uncover local knowledge, and protect vulnerable groups not represented in informal networks.

7. Interpretive Boundaries

The analysis is bounded by the table-derived character of the evidence. The methodological approach does not allow detecting individual action-level causal mechanisms and cannot tell what specific municipality will take a particular step in implementation. The results can be considered as diagnostics at settlement level. They are useful for comparative policy design, hypotheses generation, and screening of implementation opportunities, but not as a substitute to in-depth case analysis of particular municipalities.

The second boundary concerns the meaning of coefficients. The transformation of evidence preserves direction and strength, but does not free from interpretative burden. The negative coefficient for financial capacity, for example, cannot be translated into a literal claim that finance reduces implementation. More appropriate interpretation is that financial capacity might be interwoven with project scale, ambition of action set, reporting practice, administrative burden, and cost structure of the implemented actions.

The third boundary concerns the sample composition. The settlement-coverage layer is unbalanced: villages contribute 30.3%, cities 26.8%, small towns 22.6%, and towns 20.4%. The coverage-weighted constraint load accounts for the sample composition, but cannot substitute the action-level analysis of nationally representative sample.

The fourth boundary concerns the meaning of stakeholder evidence. The stakeholder-field balance does not assess the quality of participation, inclusiveness of the process, or justice of outcomes. It estimates the direction of stakeholder-related signal in the evidence. The negative stakeholder evidence could be a result of conflicts, burdensome reporting, consultations fatigue, or complex actor field. Further qualitative and action-level research will be necessary to discriminate between the mechanisms.

8. Conclusion

The research question was about which implementation gate best separates executable adaptation actions from stalled or fragile actions, and which settlement-specific evidence profiles cause that separation across European municipalities. The answer is that the decisive failure takes place before actions start, and its form depends on settlement class. Cancelled or not-started actions constitute 93.8% of completed or ongoing actions, whereas the weight of timing drag among started actions is only 8.1%. Thus the evidence points to pre-start failure, and not post-start scheduling problems, as the main implementation divide.

The settlement-specific answer is not a hierarchy from big to small municipalities. The cities have the highest coverage-weighted constraint load because of the strong negative economic balance. That means the finance to execution gate, when complex action sets require better planning, budgeting, preparation of procurements, and delivery ownership. Towns show narrow favorable evidence profile based on financial capacity and stakeholder support, thus the key issue is the availability of predictable and administratively simple funding. Small towns have the distributed institutional gate: positive social evidence is compensated by institutional, economic, governance-role, and stakeholder constraints. The villages have the most distinctive discordance with positive governance-role evidence and negative stakeholder-field evidence: responsible coordination is more important than stakeholder field.

Thus, the integrated interpretation in Figure 7 allows drawing the following substantive conclusion: European municipal adaptation implementation should not be improved with the help of unified settlement-neutral support package. The same implementation rate could conceal different gates, and the same settlement size could include different combinations of responsibility, finance, stakeholder involvement, and institutional anchoring. Thus cities require economic conversion tools, towns require direct funding channels, small towns require institutional anchoring with clear delivery ownership, and villages require responsibility based on coordinated participation.

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