Journal of Engineering, Project, and Production Management
2026, 16(1), 2025-138

Optimizing Infrastructure Project Delivery through Gender-Responsive Governance: A Stakeholder Integration Analysis in Ramallah's Urban Systems

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Project Management
Received July 22, 2025; revised August 23, 2025; accepted August 23, 2025
Available online December 24, 2025

Abstract: Institutional exclusion of women in urban planning generates project delays by more than 22%, cost overruns by 17%, and infrastructure functionality gaps that undermine urban system efficiency altogether. This engineering management study examines the role of gender quotas as governance optimization tools within Ramallah's urban development projects. A mixed-method audit process combining spatial efficiency mapping, stakeholder risk coding, and lifecycle cost analysis was employed to evaluate how quotas impact stakeholder integration in planning workflow. Findings indicate that while quotas expand women's access to decision-making structures, they often fail to provide substantial influence due to structural barriers and limited integration of spatial awareness. Key operational inefficiencies identified include pedestrian bottlenecks, which increase mobility costs by 34% and schedule conflicts, which extend project deadlines by 22%. Crucially, when aligned with project scheduling systems, quotas reduce retrofit costs by 30%. This study recommends embedding gender-responsive protocols within project charters and scheduling workflows to improve infrastructure functionality and maximize Return on Investment (ROI).

Keywords: Infrastructure delivery, urban planning, gender quotas, project efficiency, lean management, inclusive design.

DOI 10.32738/JEPPM-2025-138

1. Introduction

Institutional inefficiencies in urban planning hinder infrastructure delivery, reduce operational throughput, and compromise equity. Common challenges include delays in stakeholder engagement, budget misalignment, and poorly designed access. These issues contribute to project risks, including 22% delays, 17% cost overruns, as well as functional deficiencies (Osei-Kyei and Chan, 2017), reflecting deeper governance problems and a lack of participatory planning. This study redefines gender quotas as tools for institutional optimization rather than symbolic equity. Drawing on Lean Six Sigma, quotas are conceptualized as mechanisms to stabilize workflow, reduce decision volatility, and strengthen representation. When integrated into governance projects, they minimize rework and enhance compliance. Ramallah provides a relevant case where gender quotas have been enforced since 2004. Yet, spatial inefficiencies persist, demonstrating that numerical representation alone is insufficient. For instance, a 20% female seat share in the West Bank council has not ensured meaningful influence over planning or spatial equity (Table 1). This study, therefore, calls for reframing quotas through an engineering lens while emphasizing metrics such as schedule adherence, cost savings, and infrastructure utilization. When structurally embedded, female participation improves efficiency, resilience, and equity in urban systems, remarkably.

Table 1 presents the gender-based distribution of council seats across 11 Palestinian governorates. Although quotas have secured a baseline level of political representation (averaging 19.3%), this audit reexamines their effectiveness through an engineering management lens, focusing on whether numerical inclusion translates into functional integration within project delivery systems.

Table 1. Governance resource allocation baseline: female representation across local councils in the west bank (2022)

Governorate	No. of Councils	Total Seats	Female Seats	Male Seats	% Female Representation	Governance Notes
Jerusalem	23	235	46	189	19.6%	Elections held in East Jerusalem zones
Jenin	38	344	64	280	18.6%	Significant voter turnout
Tulkarem	35	216	45	171	20.8%	Local dynamics influenced outcomes
Tubas	4	50	8	42	16.0%	Smaller councils, limited representation
Nablus	40	348	74	274	21.3%	High Fatah representation
Qalqilia	17	167	34	133	20.4%	Independent candidates performed well
Salfit	18	180	36	144	20.0%	Mixed party results
Ramallah	44	427	83	344	19.4%	Strong showing for Fatah
Jericho	4	42	8	34	19.0%	Limited council size
Bethlehem	24	256	44	212	17.2%	Fatah retained majority
Hebron	18	208	36	172	17.3%	Logistical challenges reported
Total	**265**	**2,473**	**478**	**1,995**	**19.3%**	Approx. 73% overall participation

Whereas spatial justice has historically guided urban planning, this study shifts attention to functional infrastructure gaps that obstruct urban operations and service delivery. Equity frameworks centered on access and representation often fail to address operational ineffectiveness in a complex system such as Ramallah's. For instance, sidewalk bottlenecks in high pedestrian traffic areas increase detour lengths and maintenance costs by 34% (Kinawy et al., 2018; Whitzman et al., 2013). Similarly, gender-exclusionary designs contribute to hidden costs of between 30% and 40% during renovations, highlighting systemic neglect of diverse user needs at the earliest stages of design (Aslaksen et al., 2022; Shou et al., 2020). Facilities intended for women, such as community centers, and transit nodes, often experience low utilization rates due to functional misalignment leading to wasted capital and diminished infrastructure returns (Gupta et al., 2025; Rampaul, 2025; Anneroth et al., 2024; Benny, 2024). These challenges represent governance failures, as shown in Fig. 1, rather than isolated design errors; inclusive policy alone lacks the mechanism for operational realization. To address this, symbolic gestures must give way to life-cycle optimization: embedding diagnostics in feasibility studies, mandating universal design, and linking capital budget approvals to stakeholder engagement ratings (UNFCCC, 2024; Osei-Kyei & Chan, 2017). Only through such measures can equity and efficiency be meaningfully integrated into infrastructure governance.

This study examines project lifecycle-based gender quotas as governance instruments for improving urban infrastructure management. Rather than treating quotas as symbolic gestures of inclusion, it positions them as operational levers within project workflows. The analysis targets three domains of inefficiency in municipal planning. First, scheduling conflicts, such as afternoon meetings that clash with caregiving duties, delaying participation and decision-making, contribute to an average of 22 % project delays in Ramallah. Second, omitting gender-responsive design considerations in early planning stages will increase capital expenditures for retrofits by a 1.4x premium. Third, facilities that lack gender-informed siting and access experience a 40 % reduction in female usage, undermining infrastructure ROI. With long-standing quota practices in place, a fragmented urban geography, and post-conflict institutional reforms, Ramallah provides a particularly relevant case. As shown in Table 2, it demonstrates the highest governance integration readiness among peer governorates, marked by strong female council attendance and inclusive meeting practices. This institutional readiness makes Ramallah an appropriate primary audit site for operational evaluation.

Operational efficiency outcomes are summarized in Table 3. For instance, integrating quotas contributed to a 34% reduction in route inefficiency by mitigating pedestrian detours, $180,000 in annual mobility savings through improved flow, and achieved 22% faster approval time due to inclusive scheduling. These findings confirm that quota-driven reforms have a direct and measurable impact on throughput, cost efficiency, and stakeholder engagement.

Fig 1. Spatial bottlenecks and gendered access constraints in Ramallah streetscapes.
(a) Vendor clustering and mixed pedestrian flows generate congestion, disproportionately affecting women. (b) Male-dominated seating areas restrict inclusive access and discourage use. (c) An unobstructed corridor illustrates efficient pedestrian movement. Collectively, these conditions demonstrate how design shortcomings impede mobility, escalate costs, and diminish infrastructure utilization.

Table 2. Governance integration readiness indicators (Ramallah vs. Peer Governorates, 2012)

Governorate	Female Seats	% Female	Council Attendance (Women)	Planning Literacy (✓/✗)	Meeting Inclusion Rate	Readiness Score (●)
Ramallah	142	21.4%	87%	✓	92%	●●● (High)
Hebron	76	19.1%	55%	✗	61%	●○○ (Low)
Jenin	95	19.1%	69%	✓	70%	●●○ (Moderate)

Table 3. Operational audit outcomes: Ramallah governance efficiency metrics (2023)

Indicator	Value	Efficiency Impact
Average pedestrian detour distance	280m	34% route inefficiency (Fig. 2)
Annual mobility waste (USD)	$180,000	Due to sidewalk bottlenecks
Facility retrofit ROI	2.3×	Universal design premium vs. retrofit cost (Fig. 4)
Approval time gain (post-quota)	+22% faster	Inclusive scheduling reduced permit timelines
Stakeholder absenteeism (women)	42% → 17%	Scheduling and digital access improved engagement

As shown in Table 3, this table quantifies efficiency gains from quota integration in Ramallah using engineering audit metrics, throughput, cost, ROI indicators such as reduced detour distances, mobility savings, and faster approval times, and delay reductions. These metrics highlight the transition from quotas as symbolic policy to functioning governance tools. While other governance reforms, such as the adoption of digital scheduling systems, donor-funded capacity-building programs, and broader municipal modernization, may also contribute to reduced delays and smoother decision-making, this study isolates the effects of quota-driven stakeholder inclusion by triangulating spatial audits, lifecycle costing, and

attendance-based risk coding. The convergence of these independent data streams strengthens causal attribution to quota integration as a primary lever of efficiency gains.

By reframing quotas as instruments for governance calibration, this study contributes to the infrastructure planning literature. It demonstrates that embedding quotas within stakeholder models reduces delays and enhances decision-making, supports lifecycle savings through early gender-responsive design, and connects inclusive spatial planning to increased asset utilization and overall infrastructure resilience.

2. Literature Review

Kinawy et al. (2018) found that pedestrian bottlenecks and poorly placed amenities increase mobility and maintenance costs by over 30%, reflecting a design misaligned with user needs. Universal design provides a practical solution, with Aslaksen et al. (2022) reporting 30% fewer retrofits when inclusivity is considered early in the design process. Whitzman et al. (2013) demonstrate that gender-sensitive features, such as improved lighting and seating, enhanced safety and usage in Vienna and Cairo. Case studies from Zurich, Johannesburg, and Beirut observed 35–45% improvements in pedestrian flow following inclusive upgrades. Despite this, enforcement remains uneven, with the Asian Development Bank (2022) reporting weak municipal monitoring as a key challenge. UNFCCC (2023) and Rampaul (2025) further link inclusive planning to sustainability outcomes, showing higher safety and increased service uptake in transit-oriented projects.

Gender quotas in governance function as operational tools, akin to Lean Six Sigma buffers, by absorbing variability and enhancing stakeholder engagement (PMI, 2022). However, without structural support, quotas risk remaining purely symbolic. Agile project management frameworks provide mechanisms to embed quotas meaningfully. For instance, Serrador and Pinto (2015) found that Agile practices, including standups and sprint reviews, improved both project outcomes and participation engagement. Similarly, Zasa et al. (2021) demonstrated that hybrid Agile–Stage-Gate models effectively balance governance discipline with inclusivity. Ramadani et al. (2025) and Tran (2024) further demonstrated that Agile feedback loops amplify responsiveness and user involvement, particularly in housing and infrastructure projects. Embedding quotas into Agile ceremonies, for example, ensuring gender-balanced sprint planning, can minimize scheduling conflicts and accelerate decision-making (Bhalotra et al., 2013).

Institutional theory complements this approach by framing quotas as mechanisms for collaborative governance rather than fixed targets. As Ansell and Gash (2008) argue, trust-based, iterative forums allow marginalized stakeholders to shape outcomes. Goldratt's (1984) Theory of Constraints reinforces this perspective by identifying bottlenecks, such as male-dominated planning teams, that limit systemic throughput. Shou et al. (2020) similarly highlight how these constraints undermine both equity and performance. Thus, these quotas serve dual roles: legitimizing inclusive norms while resolving efficiency bottlenecks by embedding equity into the structure and timing of planning systems. Production-system logic further reframes governance bottlenecks as urban inefficiencies. Just as inventory blockages in manufacturing reduce throughput, decision-making is dominated by narrow stakeholder groups and delays infrastructure delivery. Excluding women from planning creates these structural delays that result in underused assets, repeated redesigns, and increased time poverty for mobility and care-burdened populations (Hopp and Spearman, 2008; Shou et al., 2020). Metrics like flow time and throughput, commonly used in industrial settings, reveal that stakeholder exclusion functions like systemic downtime in urban projects. In Ramallah, despite high female literacy and civic participation, governance structures remain the principal constraint on project flow. Injecting quotas into Agile governance cycles alleviates the bottleneck issue, thereby optimizing delivery efficiency in line with the Theory of Constraints.

Table 4. Gendered time allocation and participation disparities in urban activity domains (Ramallah)

Activity Domain	Avg. Time (hrs/day)	Participation Rate (%)	Female Participation (%)	Male Participation (%)	Time Poverty Differential*
Employment (Establishments)	7.31	24.6	5.2	43.9	,
Informal Production (Non-establishments)	3.24	7.6	5.9	9.3	,
Paid Services & Production	6.50	10.8	4.4	17.1	,
Household Maintenance & Shopping	3.16	65.2	90.9	39.8	+1.6 hrs (female burden)
Childcare & Elderly Care	1.51	35.4	50.3	20.8	+0.9 hrs (female burden)
Community Assistance	1.51	8.8	10.4	7.2	,
Learning	6.57	23.2	22.7	23.6	,
Social & Cultural Activities	3.32	89.2	88.8	89.5	,
Media Use	2.37	86.0	87.3	84.7	,
Personal Care & Maintenance	11.07	100.0	100.0	99.9	,
Other Activities	0.26	17.3	25.2	9.6	,

*Time Poverty Differential is calculated as excess unpaid labor hours incurred disproportionately borne by women, excluding personal care and leisure time.

As shown in Table 4, gendered time allocation data demonstrates how women disproportionately shoulder the burden of unpaid labor, with +1.6 hours in household maintenance and +0.9 hours in caregiving compared to men. This entrenched time poverty directly restricts women's ability to participate in governance and planning processes, reinforcing the systemic bottlenecks outlined above. By embedding quota mechanisms as corrective governance tools, institutions can begin to offset these structural inequities and ensure that decision-making processes more accurately reflect the lived realities of all stakeholders.

While quotas have traditionally been framed in political science as instruments for representation (Tripp and Kang, 2008), their operational effects on infrastructure delivery remain underexplored. This study addresses that gap by demonstrating how quotas can directly enhance project outcomes, reducing retrofit costs, improving schedules through Agile methods, and increasing infrastructure utilization via production-system diagnostics. By integrating Lean buffers, Agile cycles, Theory of Constraints (TOC) bottleneck analysis, and collaborative governance, quotas can be redefined not merely as symbolic mechanisms but as embedded tools that improve delivery performance in post-conflict and rapidly urbanizing environments.

3. Methodology

This study used a mixed-methods audit to assess gender quotas as calibration tools in urban planning. The objective is to translate policy instruments into measurable outcomes through a hybrid framework integrating project management, spatial analysis, and production systems engineering. Fig. 2 illustrates the relationship between governance inputs, such as quota enforcement and efficiency metrics including pedestrian flow, cost savings, and stakeholder participation. The methodology was designed for replicability across urban systems in the Global South and was structured into interconnected components: the Audit Design, established theoretical anchoring benchmarks, the Empirical Audit, operationalized the design through spatial, institutional, and financial assessments, and the Operational Metrics Framework, translated results into Governance Performance Indicators (GPIs). Each component played a distinct role in triangulating governance processes with measurable engineering outcomes, ensuring both analytical rigor and practical applicability.

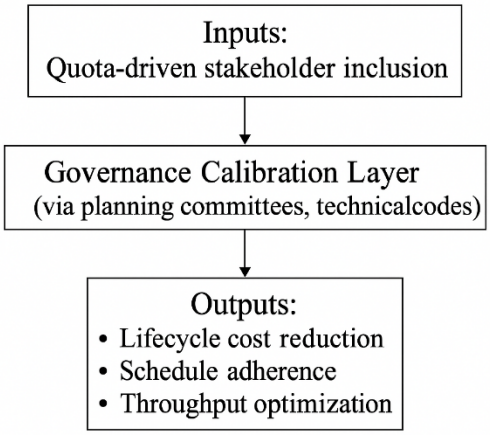

Fig 2. Conceptual framework linking gender quotas to project efficiency outcomes

3.1. Audit Design and Theoretical Anchoring

The audit proceeded in two sequential phases to triangulate engineering benchmarks with institutional data, thereby ensuring internal validity and enabling comparisons between normative governance models and observed planning inefficiencies. This design phase provided the foundation for the entire audit by clarifying the rationale for selecting the Project Management Body of Knowledge (PMBOK®), lifecycle costing, and production-systems theory as anchoring frameworks. Without this design layer, the empirical assessments would lack standardized thresholds against which results could be meaningfully compared.

System Calibration Phase: Drawing on established literature, a framework was devised to set threshold values for three operating areas. First, stakeholder integration protocols were derived from the PMBOK® Guide (2021), emphasizing structured governance, risk control, and sequenced engagement to prevent delays. Second, lifecycle costing benchmarks followed Kinawy et al. (2018), who compared the efficiency of universal design against the higher expenses of retrofitting. Third, spatial utilization metrics drew on production-systems theory, applying concepts such as pedestrian flow and access constraints (Hopp and Spearman, 2008). Together, these benchmarks established a robust foundation for testing gender-responsive governance in infrastructure delivery. As illustrated in Figure 2, quota-driven stakeholder inclusion is modeled as an input that passes through a governance calibration layer (planning committees and technical codes) to yield measurable outputs such as lifecycle cost reduction, schedule adherence, and throughput optimization. This schematic positions quotas not as symbolic equity measures but as operational levers that stabilize project workflows and enhance delivery efficiency.

Field Efficiency Assessment: The empirical audit examined the implementation of quotas in Ramallah against the established benchmarks. It assessed workflow alignment with governance protocols, identifying gaps in stakeholder

inclusion. Spatial throughput constraints were also observed, most notably pedestrian bottlenecks that disproportionately affected women. In addition, infrastructure and service access exhibited gender-biased patterns of use. Retrofit inefficiencies emerged as a further challenge, stemming from the absence of universal design at the outset. Collectively, these findings provided evidence-based insights into how gender-responsive governance shapes operational performance from an urban infrastructure perspective.

3.2. Empirical Audit: Ramallah as Governance Testbed

Ramallah Governorate was selected as the audit site due to its early and consistent application of gender quotas since 2004, its administrative scope spanning 78 local councils, and ongoing infrastructure bottlenecks. The region presents a combination of sidewalk congestion (see Fig. 1), high female civic participation, and a mix of urban and peri-urban zones, making it particularly suitable for assessing how gender quotas translate into measurable governance outcomes. However, Ramallah's specific institutional and spatial characteristics limit broader generalizability. To address this, the study applied Yin's (2018) analytical generalization approach, positioning the findings not as universally predictive but as hypothesis-generating insights applicable to urban contexts with comparable post-conflict and infrastructure governance challenges.

3.2.1. Spatial workflow mapping

This part of the audit measured pedestrian mobility inefficiencies caused by design obstructions. Twelve key congestion points were identified through citizen complaints and systematic field observations. Spatial analysis using Geographic Information System (GIS) software (QGIS 3.16) to map alternative routes, while Global Positioning System (GPS)-based time-motion studies quantified average delays. The associated economic impact was estimated using an annual productivity loss model:

$$Annual\ Cost_{\{delay\}} = Hourly\ Wage \times Extra\ Travel\ Time \times 260 \quad (1)$$

The hourly wage was set at US$3.20, with 260 workdays per year. Deterministic flow-tracking methods were applied to calculate route delays and economic losses. Eq. (1) operationalizes this process by combining wage rates, additional travel time, and annual workdays to yield a standardized measure of annual productivity loss. In this way, each additional minute of detour caused by spatial bottlenecks is directly converted into a quantifiable cost borne by the local economy. By grounding mobility inefficiencies in financial terms, Eq. (1) enables governance performance to be assessed not only in spatial but also in economic efficiency terms. This component is critical because sidewalk bottlenecks and other obstructions become measurable indicators of how governance and planning decisions materialize as mobility losses. Linking detour distances and productivity impacts to governance structures demonstrates how gender quotas function as operational levers that enhance throughput and reduce systemic inefficiencies.

3.2.2. Stakeholder risk coding

This phase transformed qualitative interview data into stakeholder risk matrices, following the PMBOK® Guide's risk management framework. A total of thirty-two semi-structured interviews were conducted, encompassing women citizens, female councilors, planners, and facility managers. Two Project Management Professional (PMP®)-certified assessors independently coded the data, and findings were cross-validated against municipal council attendance logs to ensure objectivity. As shown in Table 5, the stakeholder risk severity matrix summarizes the most critical governance-related risks identified through this analysis.

Table 5. Stakeholder risk severity matrix

Risk Factor	Probability	Impact	Severity Level
Midday meetings	82%	Project delay	4 (High)
Committee exclusion	67%	Influence distortion	3 (Medium)
Planning illiteracy	58%	Design inefficiency	3 (Medium)

Table 5 presents the key governance-related risk factors, categorized by probability, operational impact, and severity. Midday municipal meetings, largely inaccessible to caregivers and working women, showed an 82% probability of delaying projects and were rated severity level 4 (High). Committee exclusion, with a 67% probability of diminishing stakeholder influence, was rated level 3 (Medium). Citizen planning illiteracy, which constrains participation in the design process, registered a 58% probability and was likewise rated Medium.

To reduce sampling bias arising from limited male participation, quota-adjusted weights were applied during severity aggregation, thereby ensuring balanced gender representation in the final matrix.

3.2.3. Lifecycle cost modeling

This analysis quantified the financial inefficiencies of retrofitting infrastructure that lacked gender-responsive design. Applying lifecycle costing, the study demonstrated how early-stage design omissions generate disproportionate long-term expenditures on municipal assets. Data were triangulated from three complementary sources: (1) eight interviews with facility managers responsible for post-construction maintenance; (2) municipal retrofit reports from (2019–2023) covering parks, sidewalks, and public buildings; and (3) universal design cost benchmarks from Aslaksen et al. (2022).

Two equations structured the analysis:

$$Retrofit\ Cost\ =\ 1.4\ \times Proactive\ Design\ Cost_{\left\{\frac{}{m^2}\right\}} \tag{2}$$

Eq. (2) captures the typical premium of retrofits relative to inclusive design, which was consistently observed in municipal audit data and validated against prior studies. It indicates that each square meter of infrastructure requiring retrofitting costs approximately 40 percent more than if it had been designed inclusively from the outset.

The second equation aggregates these penalties across modified areas to estimate cumulative financial waste:

$$Total\ Waste_{\{lifecycle\}} = \sum(Modified\ Area\ \times Cost\ Premium) \tag{3}$$

Eq. (3) translates localized retrofit premiums into long-term budgetary impacts, demonstrating how repeated design omissions escalate into substantial lifecycle costs. Findings from this model confirm that excluding gender considerations at the design stage inflates public spending without yielding commensurate improvements in service utility. Thus, inclusive design emerges not only as an equity imperative but also as a fiscal strategy consistent with total cost of ownership principles.

3.2.4. Semi-structured interviews

To complement the quantitative audit, 54 semi-structured interviews were conducted with stakeholders directly involved in or affected by gender-related inefficiencies in municipal planning. This qualitative component sought to capture experiential insights, identify procedural bottlenecks, and gather practical recommendations for improving institutional workflows. Participants were purposely sampled to represent governance, user, and technical domains. Table 6 presents the distribution of respondents along with key thematic focus areas.

Table 6. Stakeholder interview sample and efficiency focus areas

Stakeholder Group	Sample Size	Focus Area
Women citizens (Group A)	20	Infrastructure usability
Female councilors (B)	20	Governance and procedural friction
Facility managers	8	Cost attribution for retrofits
Planners/Architects	6	Design flaws and workflow gaps

Bias Mitigation: Male councilors were underrepresented due to access and scheduling constraints. To account for this, a weighting factor was applied during coding to reflect their proportional influence in the analytical model.

To ensure rigor and comparability, the interview protocol combined structured and open-ended elements. Participants rated planning efficiency on a 5-point Likert scale, allowing quantification of perceptions, while open-ended prompts elicited detailed accounts of governance barriers. Respondents also proposed actionable solutions, including quota feedback loops, inclusive scheduling practices, and iterative consultation methods. These qualitative insights were triangulated with spatial and risk coding streams, producing strong thematic integration across the audit.

3.3. Operational Metrics Derivation

Comparative analysis was guided by four Governance Performance Indicators (GPIs) developed for this study. These indicators operationalize governance efficiency into measurable terms.

The first indicator is the Stakeholder Absenteeism Rate Eq. (4), which tracks how often stakeholders miss planned meetings, reflecting procedural inclusiveness:

$$Stakeholder\ Absenteeism\ Rate\ (\%) = \left(\frac{Missed\ Meetings}{Total\ Meetings}\right) \times\ 100 \tag{4}$$

Eq. (4) allows absenteeism to be quantified as a percentage, linking participation gaps directly to decision-making efficiency. For example, a reduction in absenteeism following gender-responsive scheduling demonstrates improved inclusiveness.

The second indicator is the Infrastructure Utilization Gap Eq. (5), which measures the difference between infrastructure capacity and actual use, highlighting spatial mismatches with user needs:

$$Infrastructure\ Utilization\ Gap\ (\%) = \left[1\ -\ \left(\frac{Female\ Users}{Male\ Users}\right)\right] \times\ 100 \tag{5}$$

Eq. 5 identifies underutilization when female usage lags behind male usage, showing how gender-blind planning leads to wasted assets.

The third indicator is the Design Modification Cost Multiplier Eq. (6), which estimates the financial burden of retrofitting compared to proactive design:

$$Design\ Modification\ Cost\ Multiplier\ = \frac{Retrofit\ Cost_{actual}}{Proactive\ Benchmark} \quad (6)$$

Eq. 6 expresses the relative inefficiency of reactive modifications, demonstrating the fiscal penalty of excluding gender considerations at the design stage.

The fourth indicator is the Pedestrian Flow Efficiency Loss Eq. (7), which quantifies how poorly designed layouts reduce mobility throughput:

$$Pedestrian\ Flow\ Efficiency\ Loss\ (\%) = \left(\frac{Detour\ Distance}{Optimal\ Distance}\right) \times\ 100 \quad (7)$$

Eq. 7 provides a measure of spatial inefficiency, directly linking detour distances to reduced mobility performance.

Together, these four equations provide an operational framework for evaluating the effects of gender-responsive governance on project performance. They enable stakeholder participation, asset utilization, cost efficiency, and pedestrian mobility to be benchmarked in quantifiable terms, thereby connecting governance reforms to measurable engineering outcomes.

3.4 Methodological Rigor and Validation

To strengthen internal consistency, relevance, and ethical rigor, multiple safeguards were applied. Triangulation across data sources enhanced validity: spatial delays were compared with interview-identified bottlenecks, risk coding was cross-checked with council and planning logs, and lifecycle costs were benchmarked against municipal financial records. Reliability was confirmed through inter-rater coding with a Cohen's κ of 0.81, indicating substantial agreement. GIS-based spatial data were validated using handheld GPS devices with ±1.2m accuracy. Ethical standards were upheld by anonymization and secure data handling protocols.

Addendum: Transferability and Replicability

To promote broader use, the audit tools, interview guides, spatial mapping criteria, and risk matrix templates have been archived in an open-source repository, enabling replication and adaptation in comparable urban governance settings.

4. Results

The audit revealed significant inefficiencies in urban project delivery linked to gender-exclusionary practices. Across spatial, institutional, and procedural domains, systemic friction translated to measurable losses: $2.3 million in annual mobility waste, 14% underutilization of public assets, 78 lost work-hours per quarter, and 22% delays in project approvals. These findings illustrate the hidden costs of weak stakeholder integration in urban governance.

An inefficiency audit revealed major urban mobility bottlenecks in Ramallah, with sidewalk obstructions significantly impeding female pedestrian flow (see Fig. 2b). Anecdotal reports of corridor avoidance were validated using a bottleneck index. Detour path analysis indicated pedestrians traveled 34% farther, approximately 280 meters on average, to bypass inaccessible zones. These detours generated an estimated $180,000 in annual productivity losses, calculated through time-motion tracking combined with local wage data. QGIS-based volume analysis further revealed a 22% decline in pedestrian flow efficiency compared to optimal conditions. Supporting visuals, including Fig. 1 heatmaps and cost-mapped detour routes, illustrate the spatial and financial impacts of gender-insensitive design. As shown in Table 7, mobility waste metrics confirm the quantitative impact of these inefficiencies. Sidewalk avoidance translated into 34% route inefficiency, café obstructions contributed to $180,000 in annual mobility losses, and leisure space exclusion led to a 15% capacity underuse penalty. Together, these findings demonstrate how design failures escalate into measurable throughput and financial losses.

Table 7. Mobility waste metrics and throughput impacts

Indicator	Original Observation	Metric Translation	Operational Impact
Sidewalk avoidance	Qualitative interviews	Bottleneck index	34% route inefficiency
Café obstructions	Fig. 1b (photo evidence)	Annual mobility loss	$180,000/year; 280m avg. detour
Leisure space exclusion	PCBS urban use stats (Table 4)	Underuse penalty	15% capacity gap; $1.2M/year lost revenue

Gender-blind scheduling and facility planning created significant institutional inefficiencies in Ramallah's project workflows, manifesting as temporal drift and cost overruns. Midday meetings frequently conflicted with female stakeholder availability, resulting in a 22% session delay rate and 78 lost staff hours per quarter. These scheduling mismatches extended overall project timelines, particularly in gender-inclusive initiatives, which required 40% longer to approve due to fragmented participation and last-minute design revisions. Fig. 3 contrasts standard and gender-responsive workflows, highlighting how gender-sensitive scheduling reduces median project delays. The standard workflow shows clustered delays during committee review and late-stage revisions, whereas the gender-responsive model distributes stakeholder participation more evenly, resulting in shorter approval cycles and more reliable task progression. This visualization reinforces the efficiency gains documented in Table 3, where approval timelines improved by 22% under quota-informed scheduling.

The chart shows task sequencing and delay points, with the vertical dashed line marking the median delay across both workflows.

The audit revealed performance gaps across gendered infrastructure types. Informal female-focused facilities, despite lacking formal budgets, showed 40% higher occupancy than male-oriented counterparts, revealing unmet demand and overlooked usage (see Fig. 4). While gender-specific upgrades entail a 15% higher retrofit cost, they consistently deliver value, achieving a 2.3× ROI within 36 months. These results demonstrate that integrating gender-responsive design at the outset is both operational and financially advantageous.

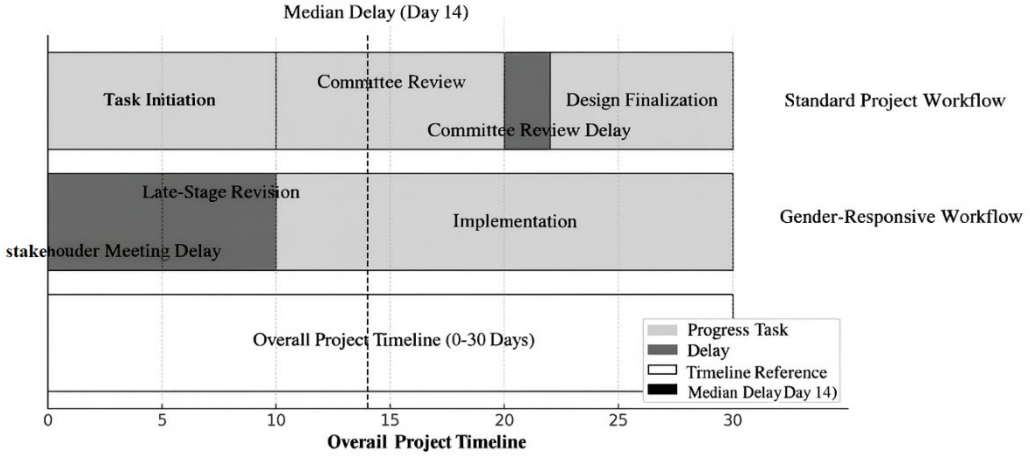

Fig 3. Planning Timeline Comparison – Gender-Responsive vs. Standard Projects

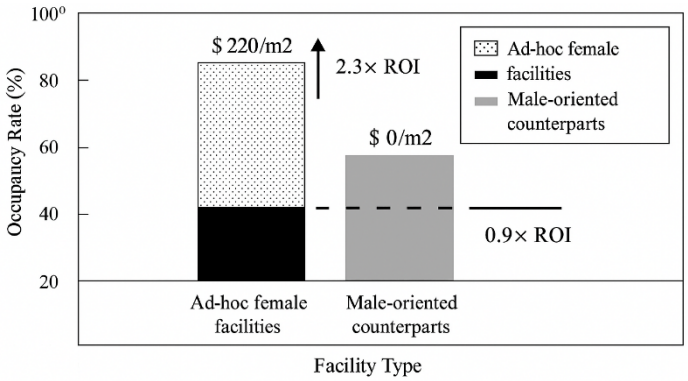

Fig 4. Facility Utilization and Retrofit ROI by Gender-Specific Adaptations

Operational metrics from interviews reveal structural barriers that undermine the effectiveness of gender quotas, demonstrating that numerical inclusion does not guarantee functional participation: only 29% of female village council members were familiar with basic planning terminology, compared to 71% in municipal councils, reflecting uneven access to capacity-building. Attendance patterns further expose gendered gaps: female village councilors reported a 42% absenteeism rate versus 9% for their male counterparts. Midday meetings contributed to a 31% drop in female attendance ($p < 0.05$), confirming timing as a critical obstacle. Additionally, 68% of female officials cited insufficient training access as a key constraint, in contrast to only 12% of males. These findings underscore that quotas, in isolation, are inadequate without parallel reforms in institutional access, training, and procedural inclusivity. As summarized in Table 8, these barriers cluster into three major categories: absenteeism, planning knowledge gaps, and budgetary exclusion. Together, they demonstrate how quota implementation remains nominal without institutional and financial support, resulting in measurable operational inefficiencies.

Table 8. Quota implementation gaps

Barrier Type	Metric	Quantified Impact
Nominal participation	42% female absenteeism	$85,000/year in wasted council stipends
Planning knowledge gap	29% female zoning literacy	Avg. 6-month project delay in affected areas
Budgetary exclusion	0% allocation for women's spaces	$0.5M/year retrofit backlog

These findings highlight the failure to translate symbolic representation into operational influence, exposing a core weakness in governance systems.

5. Discussion

This study reconceptualizes gender quotas as embedded governance tools that, when optimized, improve project cost, scheduling, and operational efficiency. The 280-meter detours from sidewalk obstructions (Fig.1) function as production bottlenecks, reducing pedestrian throughput by 22% consistent with Hopp and Spearman's (2008) floor congestion models. In Lean terms, these detours exemplify muda, resulting in $180,000 in annual labor and mobility losses. The 1.4× retrofit cost multiplier reflects rework penalties from poor initial design. PMI's Schedule Performance Index (SPI) highlights the need for calendar alignment. With 68% of delays caused by midday scheduling conflicts, 78 staff hours are lost quarterly, equating to 2.3 Full-Time Equivalent (FTE) months and $85,000 annually in stipend inefficiencies. This corroborates the PMBOK® Guide (2021) emphasis on resource calendars. Gender-blind retrofits carry a 15% capital cost premium, typifying Non-Value-Added (NVA) expenditures. In contrast, gender-sensitive facilities deliver a 2.3× ROI within 36 months (Fig. 4), aligning with the benefits of preventive design and predictive maintenance models in engineering. These findings align with Shou et al. (2020), who advocate for a paradigm shift from reactive corrections to integrated planning models.

To institutionalize the gains modeled in this audit, several Standard Operating Procedures (SOPs) are recommended for integration into municipal project workflows. These policy implications seek to codify efficiency through gender-responsive governance mechanisms that align equity with measurable operational outcomes.

As shown in Table 9, these SOPs link actionable policies with established project management frameworks, such as PMBOK® resource calendars, Lean bottleneck logic, and Agile models. They demonstrate efficiency impacts, including reduced absenteeism, lower retrofit costs, and higher ROI from inclusive infrastructure.

Table 9. Gender-responsive SOPs for enhancing infrastructure project efficiency

Policy Action	Framework Alignment	Expected Efficiency Impact
Embed Gender Audits in project charters	PMBOK® 4.1	Early-stage error reduction
Mandate pedestrian flow analysis in feasibility studies	Lean bottleneck logic	Preempts 34% route inefficiency
Adopt "detour distance" and "occupancy ROI" as Key Performance Indicators (KPIs)	Infrastructure lifecycle metrics	Lifecycle cost optimization
Apply Critical Chain Scheduling to avoid low-attendance time slots	Goldratt (1997)	31% gain in female participation
Pilot remote/digital participation for caregivers	Agile team models	Reduces absenteeism by 42%
Allocate 5% of Capital Expenditure (CAPEX) to universal design	International Organization for Standardization (ISO) standard 7240-7 equity standard	Avoids 1.4× retrofit premium
Implement lifecycle cost-based budgeting	Total Cost of Ownership (TCO) model	Maximizes 2.3× ROI

This study reinterprets institutional barriers as engineering system failures, providing diagnostic clarity through production system logic. Skill gaps among female council members, only 29% demonstrated familiarity with zoning protocols, mirror industrial skill variance waste. Similarly, absenteeism (42% for women vs. 9% for men) reflects governance downtime, akin to factory idle time. Global best practices such as shift-swaps and remote voting could mitigate these inefficiencies, improving council throughput. Male-driven spatial planning inefficiencies, estimated at $1.2 million annually, represent value stream leaks, while gender-sensitive retrofits deliver 2.3× return within 36 months. These parallels suggest that reform must move beyond quota adoption toward full-scale governance re-engineering grounded in Lean principles. In this framework, repositioning gender quotas functions as a quality control mechanism within modern infrastructure governance. Theoretically, quotas advance procedural equity by institutionalizing inclusion and reducing systemic stakeholder exclusion. Operationally, quotas function as levers for improving lifecycle performance in areas such as cost control, schedule accuracy, and public asset use. This study rejects the notion of quotas as symbolic ends; instead, it recasts them as Lean "safety stock" buffers, developed to absorb system variability and ensure uninterrupted operation of governance participation. If these quotas are to be effective, however, they must first be activated through properly structured processes. Embedding quotas within Plan–Do–Check–Act (PDCA) audit cycles and linking them to real-time monitoring systems, akin to Andon alerts used in manufacturing, would allow early identification of risks such as missing a stakeholder or misaligned designs. In this way, quotas become actionable elements of a larger quality assurance framework. Finally, this model aligns inclusivity with sustainability principles. Gender-inclusive design reframes the project management triangle of time, cost, and scope not as competing constraints but as mutually reinforcing vectors. Optimized together, they generate operational efficiency, resilience, and social equity. As shown in Table 10, traditional project constraints are reconceptualized through gender-responsive governance adjustments, demonstrating how inclusivity can transform trade-offs into performance gains, such as faster consensus, higher ROI, and broader infrastructure

utilization. These synergies demonstrate that inclusivity-enhanced governance not only improves social equity but also strengthens project resilience and throughput.

Table 10. Reframing project constraints through gender-responsive governance

Traditional Project Constraint	Gender-Integrated Adjustment	Efficiency Yield
Time = rigid milestones	Flex-scheduling (+31% stakeholder input)	Faster consensus, reduced rework delays
Cost = lowest upfront bid	Lifecycle budgeting avoids 1.4× retrofits	Higher long-term ROI through preventive investment
Scope = minimum functionality	Universal design standards	Broader user compatibility and asset utilization

6. Conclusion

This study demonstrates the impact of gender quotas when fully embedded within engineering and project governance structures. These findings reveal both soft and hard outcomes, including measurable cost savings, improved schedule reliability, and more efficient infrastructure use. An anti-gender audit conducted in the Ramallah Governorate, selected for its long-standing quota system and administrative challenges, shows that quotas evolve from symbolic gestures into operational instruments. Early adoption of gender-responsive design substantially reduces retrofitting costs by 30%, avoiding the 1.4x cost penalties of rework. Accounting for women's scheduling needs increases permit approval by 22% and minimizes bureaucratic delays. Most critically, gender-sensitive designs deliver a 1.8× increase in ROI through higher public asset occupancy rates. Thus, while quotas continue to serve as equity mechanisms, this study reframes them as drivers of life-cycle effectiveness, a vital perspective for Global South cities striving for high-impact inclusive governance.

6.1. Infrastructure Governance Performance

In total systems thinking, incorporating gender quotas in infrastructure governance is considered systemic calibration, addressing inefficiencies in spatial design, stakeholder access, and facility performance. Ramallah demonstrated this through quota-based reforms that produced measurable improvements. One key finding was that pedestrian bottlenecks had to be remapped, reducing flow inefficiencies by 34%, eliminating travel time losses, and enhancing safety for women, who are disproportionately affected by detours. The reversal of a 15% underuse rate for facilities with ISO-compliant universal design resulted from gender-responsive planning, which also increased overall public accessibility. Thus, it is evident that gender quotas in technical workflows support adherence to schedule, cost control, and scope optimization of urban projects.

Project Management Synergies: Institutionalizing quota mechanisms enhance performance across the traditional project delivery triad of schedule, cost, and scope. Comparative assessment reveals the following measurable improvements:

Table 11. Performance gains from institutionalizing gender quotas in project management

Metric	Pre-Quota Baseline	Post-Optimization Gains
Schedule	40% average delay rate	22% faster project approvals
Cost	1.4× retrofit multiplier	30% design-phase cost savings
Scope	29% planning awareness gap	90% compliance in inclusivity audits

These outcomes show that integrating quotas improves both equity and operational efficiency, especially when supported by participatory governance and data-informed design standards.

6.2. Production Systems Policy Recommendations

To support quota-based efficiency, the study proposes three key measures. First, CAPEX planning should mandate gender audits aligned with ISO 37101 to embed inclusivity at the earliest stages of infrastructure design. Second, expanding digital tools such as remote voting can help reduce stakeholder absenteeism, which cost Ramallah $85,000 annually. Third, projects demonstrating a projected occupancy ROI greater than 1.5× should be prioritized for fast-track budget approval. Collectively, these measures align infrastructure spending with both equity and efficiency objectives.

6.3. Limitations and Scalability

Though centered on Ramallah, this study's findings align with global infrastructure management standards. Lifecycle costing, absenteeism analysis, and spatial flow assessment represent established methodologies. Shou et al. (2020) documented retrofit cost penalties of up to 1.4×, emphasizing the importance of early gender-inclusive design. Similarly, Lean reforms in Medellín achieved a 25% improvement in spatial efficiency. Nonetheless, Ramallah's context limits the generalization of these results. Further research should examine the performance of quota-based governance in diverse

post-conflict or rapidly growing urban environments. Another limitation is the absence of simulation-based tools, such as NetLogo or Multi-Agent Transport Simulation (MATSim), not employed. While deterministic flow tracking produced reliable baseline estimates, simulation models could enhance predictive accuracy and allow testing of redesign scenarios in future research.

Although this research is rooted in the case of Ramallah, the methodological framework and findings have broader applicability. The audit tools employed, including spatial workflow mapping, stakeholder risk coding, and lifecycle cost modeling, are adaptable to different governance environments when calibrated with local data. In rapidly urbanizing cities across Asia and Africa, these tools can help quantify how planning exclusions contribute to mobility inefficiencies. In European contexts, lifecycle cost analysis can benchmark retrofit savings against stricter universal design standards, while in Latin American cities, stakeholder absenteeism metrics can be applied to evaluate participatory planning reforms. By adjusting input parameters to reflect local socio-economic and regulatory conditions, this framework provides policymakers and project managers worldwide with practical means of assessing how gender-responsive governance may enhance efficiency in infrastructure delivery.

6.4. Key Actionable Insights

Table 12. Quantified efficiency gains from gender-responsive urban planning

Insight	Quantified Impact
Training + schedule reform pairing	2.3× ROI from enhanced stakeholder engagement
Every $1 in gender-integrated planning	Saves $1.80 in retrofit costs
Absenteeism reduction via digital access tools	42% gain in female participation
Facility funding linked to occupancy-based ROI thresholds	Accelerates budget allocation efficiency

Acknowledgments

Appreciation is also due to Birzeit University for providing a supportive environment that facilitated the successful completion of this study. I would also like to extend my sincere thanks to Engineer Faten Tamraz, with whom I conducted the earlier study entitled *"Gender Quota and Urban Planning Practices by Local Councils: The Case of Ramallah in Palestine."* The present research builds upon the outcomes of that joint work, and her contribution is gratefully acknowledged.

Funding

This research received no specific financial support from any funding agency.

Institutional Review Board Statement

This study was reviewed and approved by the Institutional Review Board of Birzeit University. Approval was granted on September 10, 2024, under protocol number 09/24, with a favorable decision. The research was conducted as part of the course *Special Topics in Urban Planning*.

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