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Differential Securitization of Biometric Border Technologies in Kenya: Infrastructure, Border Type, and Uneven Control

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ABSTRACT

This study advances a concept of differential securitization outcomes of biometric technologies used in detecting and mitigating immigration related crimes at border points. We argue that the site-systematic variation in biometric security performance is driven by unequal security infrastructure, porous physical perimeters, and differential officer capacity. Using a mixed-methods approach encompassing cross-sectional survey design across three purposively selected border control points: Jomo Kenyatta International Airport (JKIA), Busia, and Namanga One-Stop Border Control Points (OSBCP) in Kenya, data were collected using structured questionnaires administered to 670 travellers/passengers and 155 immigration officers yielding 59.7% and 71.4% response rates respectively, with the latter exceeding Babbie's (2010) 70% validity threshold. Data from respondents were supplemented by 60 structured observation sessions (27 at JKIA, 18 at Namanga, and 15 at Busia), interviews, and systematic document review. This study found that Kenya's biometric border modernisation programme has markedly different securitization outcomes across site types. At JKIA, biometric integration scores average 4.28 out of 5.0 and system uptime approaches 97% of working hours. At Namanga land border, the same technology achieves a 3.42 integration score and operates for only approximately 55% of working hours, producing a 42-percentage-point gap in effectiveness that is structurally produced, not incidental. Ordinary Least Squares (OLS) regression revealed that composite biometric effectiveness ($B = 0.526$, $\beta = 0.594$, $t = 13.65$, $p < .001$), infrastructure quality ($\beta = 0.102$, $t = 2.55$, $p = .011$), and border-point context ($\beta = -0.084$, $t = -2.31$, $p = .021$) together accounted for 47.2% of variance in threat mitigation outcomes ($F(3,382) = 113.78$, $p < .001$). Logistic regression identified infrastructure quality (OR = 8.94, 95% CI: 4.20–19.10), physical system integration (OR = 7.31, 95% CI: 3.50–15.20), and officer training (OR = 5.62, 95% CI: 2.80–11.30) as the dominant structural predictors of high-intensity securitization. Analysis of Variance (ANOVA) pointed to significant cross-site confidence gaps ($F(2,382) = 34.2$, $p < .001$) and chi-square analyses bore out divergence in officer confidence ($\chi^2(2, N = 386) = 47.3$, $p < .001$) and street-level practices ($\chi^2(2, N = 386) = 21.82$, $p < .001$). Differential securitization is a measurable governance phenomenon requiring targeted infrastructure investment, physical perimeter development, mandatory officer certification, and operationalisation of Kenya's Data Protection Act 2019 at border level.

Keywords: Biometric border security; differential securitization; Kenya; border governance; securitization theory

INTRODUCTION

The use of biometric border security architecture in Kenya is not only neutral administrative infrastructure but also a securitizing investment. It is part of a material expression of global institutions and jurisdictions that irregular migration constitutes a significant threat to the country necessitating digitized, biometric responses over traditional policing (Muthaara, 2018). Kenya has thirty-five points of entry and exit, commonly known as borders. These points are categorized into three: land borders, maritime borders, and air borders. Kenya's border security depends primarily on the specific neighbouring country and the nature of the terrain, ranging from heavily militarized zones to digitized, high-traffic commercial corridors. At Jomo Kenyatta International Airport (JKIA), biometric processing operates within a comprehensive physical security envelope: facial recognition cameras in transit zones and boarding gate areas beyond the immigration booth, e-gates at departure, and strict physical channelling that directs every traveller through a biometric checkpoint without exception. Land borders tell a different story. At Busia and Namanga, the perimeter is structurally porous, and individuals can reach uncontrolled sections and bypass the biometric checkpoint entirely. During structured observation sessions at both land border sites, the lead researcher directly observed travellers accessing uncontrolled crossing sections adjacent to the official immigration booths, confirming that perimeter bypass is not a theoretical inference but a documented operational reality. A person flagged in the system could still cross Busia without going through it at all.

The consequence of differences in security networks across these three border types is a 42-percentage-point gap in system uptime and a fundamental inequality in the application of biometric border control. Critically, the gap is not a technological failure. Both airport and land border sites operate biometric hardware of the same generation, procured under the same modernisation programme. What differs and affects security outcomes is the physical infrastructure surrounding the biometric hardware, the institutional capacity supporting its operation, and the governance architecture within which the biometrics function. The model of differential securitization, introduced in this study, captures this condition precisely: the site-systematic variation in biometric security performance resulting from applying a uniform securitizing policy in non-uniform material conditions.

This study is grounded in original multi-site empirical fieldwork rather than documentary and theoretical interpretation alone. Data were collected directly from 155 frontline immigration officers and Nairobi Airport Immigration Liaison (NAIL) Team members responsible for operating biometric systems, 670 travellers and passengers processed through those systems, 60 structured observation sessions across three border sites, and systematic document review of operational records and deployment reports. The 670 traveller responses constitute direct empirical capture of the perspectives of people subject to biometric border surveillance, whose procedural justice perceptions are measured quantitatively using Tyler's (1990) validated framework. This empirical architecture allows this study to go beyond theoretical securitization analysis and into the structural determinants of border technology performance and community legitimacy. Researcher positionality requires explicit declaration: the lead author served as an immigration officer in Kenya's Department of Immigration Services for approximately 16 years prior to transitioning to full-time doctoral study. This insider positionality provides operational familiarity with border processing workflows and access to frontline officer perspectives, while the risk of confirmation bias was mitigated through structured data collection instruments, independent coding of qualitative data, member checking with senior officers not included in the survey sample, and the inclusion of traveller data as a non-officer independent check.

The landscape of East Africa's border governance brings urgency to the need to strengthen border security. The East African Community (EAC) Common Market Protocol on free movement of persons, the African Continental Free Trade Area's direct implications for high cross-border mobility, and the concurrent expansion of biometric border control across Kenya, Uganda, Tanzania, and Ethiopia jointly create a governance environment in which effective border control is a prerequisite for regional security architecture. Kenya's Integrated Border Management framework coordinates Immigration, Kenya Revenue Authority Customs, Kenya Police, and Interpol liaison functions at border points, creating a multi-agency environment within which biometric effectiveness is one critical but not the sole determinant of security outcomes. The structural conditions this study documents in Kenya, including unequal infrastructure investment, porous physical perimeters, differential officer capacity, and absent legitimacy governance, are not unique to Kenya but apply to East Africa as a whole. It is against this backdrop that this study pursues two objectives: to analyse the structural determinants of biometric effectiveness across contrasting border environments; and to empirically derive from those findings a policy framework explicitly designed for transferability across the East African borders.

LITERATURE REVIEW

Securitization theory, in its canonical formulation (Buzan et al., 1998), treats security as a performative speech act: declaring something a security threat, when accepted by a relevant audience, constitutes the speaker as a security agent and the threat as a legitimate object of extraordinary measures. Applied to biometric borders, the framework captures the institutional logic through which migration is constituted as a security object requiring technological management. Waever's (1995) concept of security as self-referential practice extends this argument: biometric border processing does not merely respond to migration as a threat; it participates in constituting that threat through the institutional logic that scanning, checking, and verification enact.

The operational effectiveness tradition approaches biometric borders from a different direction. Khan and Efthymiou (2021) and Mlambo et al. (2022) examine biometric system performance under real-world implementation constraints in developing country contexts. Their findings converge on infrastructure as the primary binding constraint, not technology quality. Madianou et al. (2021) extend this evidence base further, documenting a 35.3% system unreliability rate in donor-supported biometric programmes across sub-Saharan Africa alongside a 26.5% infrastructure failure rate. Neither stream of scholarship has produced a multi-site, quantitative account of what structural factors determine biometric effectiveness across different border types within a single national system. The present study fills that gap.

Socio-Technical Systems Theory (STST) provides the integrative framework (Trist and Bamforth, 1951; Emery, 1959). STST analyses organisational performance as a function of the alignment between a technical subsystem, specifically the physical hardware, software, and data infrastructure, and a social subsystem comprising the human actors and institutional arrangements surrounding the technology. Where alignment is high, performance approaches the system's designed capacity. Where alignment breaks down simultaneously across unreliable infrastructure, undertrained officers, and porous physical perimeters, performance degrades structurally rather than incidentally. Applied to Kenya's border control points, STST predicts exactly the gradient that the empirical data produce.

Tyler's (1990) procedural justice framework provides the theoretical anchor for the governance dimension. Four dimensions, namely dignity, consistency, voice, and neutrality, determine whether people perceive an institutional process as legitimate. Where Voice scores fall below the neutral midpoint, people feel uninformed and unheard; legitimacy erodes regardless of the system's technical performance. The framework has since been validated in institutional settings involving state authority over individuals, including immigration and border control contexts (Sunshine and Tyler, 2003; Murphy, 2004), making it appropriate for measuring traveller perceptions of biometric processing. Previous studies of biometric governance in African contexts have documented legitimacy concerns (Kloppenburg and van der Ploeg, 2020) without measuring them quantitatively across sites. Measurement across three sites, using a validated procedural justice instrument, is a distinctive contribution of the present study.

METHODOLOGY

A mixed-methods approach utilising a cross-sectional survey design was implemented across three purposively selected border control points: JKIA, representing Kenya's highest-capacity border environment; Busia, a major land border with partial biometric integration; and Namanga, a land border recording the weakest biometric integration and highest system failure rate in the study. Purposive selection operationalised the border-type comparison that the differential securitization concept requires: without sites at contrasting points on the infrastructure spectrum, the structural gradient the study sought to identify could not be observed (Creswell, 2014).

Five instruments were combined for data collection. Structured questionnaires were administered to 155 immigration officers (71.4% response rate, exceeding Babbie's (2010) 70% validity threshold). A parallel questionnaire was administered to 670 travellers and passengers, yielding a 59.7% response rate. The travellers' rate fell below the conventional 70% threshold according to Babbie (2010). The limitation reflects a structural feature of border research, not a design failure. Travellers were noted to be under transit time pressure and their access was bounded by crossing conditions at each site. However, the absolute return of 670 completed instruments provides a robust dataset for the procedural justice analyses conducted. A structured observation checklist was administered across 60 sessions: 27 at JKIA, 18 at Namanga, and 15 at Busia, covering peak and off-peak operational periods. The higher session count at JKIA reflects the greater number of distinct biometric checkpoints at that site. Interviews were conducted to capture traveller and community perceptions. Systematic document review of operational records, deployment documentation, and donor assessment reports rounded out the instrument set.

Cronbach's alpha, a measure of internal consistency of a set of survey or test items, exceeded 0.70 on all measurement scales, confirming internal consistency. The Composite Biometric Effectiveness Index (CBEI) was constructed from four measurement domains: technology deployment completeness (observation checklist), system reliability (officer questionnaire items), operational integration (document review), and physical perimeter coverage (observation and document review), yielding $\alpha = 0.81$. The four domains were combined through equal weighting after confirming through principal component analysis that each domain loaded on a single underlying factor, establishing construct validity. CBEI measures technology and perimeter inputs to border security and is therefore conceptually distinct from the outcome variable, which measures security results, ruling out tautological measurement. System uptime figures were derived from triangulating three independent sources: officer questionnaire items on system availability, structured observation session records, and document review of maintenance logs and deployment reports.

OLS multiple regression modelled the relationship between CBEI, infrastructure quality, border-point context, and threat mitigation outcomes. Before interpreting the results, four regression assumptions were verified. Normality of residuals was confirmed through the Kolmogorov-Smirnov test ($p > .05$). Multicollinearity was ruled out with VIF values below 2.0 for all predictors. Autocorrelation was absent (Durbin-Watson = 1.97, within the acceptable 1.5 to 2.5 range). Homoscedasticity was confirmed through residual plot inspection. Binary logistic regression identified the structural predictors of high-intensity securitization. The complete-case sample of 386 respondents (listwise deletion) served as the regression sample; missing data analysis confirmed exclusions were distributed proportionally across sites and sensitivity analysis using multiple imputation produced coefficients within 0.02 of reported values. All valid item responses from the 825 returned questionnaires served for descriptive and chi-square analyses, consistent with standard practice in mixed-data research (Field, 2018; Pallant, 2020). Common method bias was mitigated through distinct questionnaire sections with different item formats, CBEI incorporating observation and document review data independent of officer self-report, and convergence of findings across 60 independent observation sessions. Ethical clearance was obtained from the Kenyatta University Graduate School Ethics Committee.

FINDINGS AND DISCUSSION

Biometric Integration Across Sites

This study found that the application of biometric border technologies in Kenya has markedly different securitization outcomes across site types including infrastructure, border type, and uneven control. The CBEI gradient across the three sites, Jomo Kenyatta International Airport (JKIA), Busia, and Namanga One-Stop Border Control Points in Kenya, establishes this study's core finding before any inferential analysis is required. JKIA achieves a mean integration score of 4.28 out of 5.0 (86% of optimal performance) across 27 observation sessions covering peak and off-peak conditions. Busia scores 3.67 (73% of optimal) across 15 sessions. Namanga scores 3.42, the lowest across all sites at only 68% of optimal, across 18 sessions. System uptime data bear out the same gradient: JKIA approximately 97%, Busia approximately 70%, Namanga approximately 55%. The uptime gap between JKIA and Namanga is not a technology failure: document review confirms that hardware at both sites was procured contemporaneously under the same donor-supported modernisation programme (2017-2019), ruling out equipment age as an explanation.

Infrastructure sub-scores illuminate the mechanism. JKIA scores 3.15 out of 5.0 for infrastructure adequacy, above neutral but not excellent, reflecting occasional maintenance gaps even in the best-resourced site. Busia's infrastructure adequacy score of 2.53 falls below the neutral midpoint. Its technical support score of 2.40 is the lowest in the study. When systems fail at Busia, they remain failed, because repair capacity is absent. The gap between JKIA and land borders is not one of database connectivity. The Personal Identification Secure Comparison and Evaluation System (PISCES) is connected at all three sites. What JKIA has that land borders lack is the physical infrastructure surrounding PISCES: facial recognition cameras in transit zones and boarding gate areas beyond the immigration booth, e-gates at departure, and strict channelling that makes biometric processing unavoidable for every traveller. At Busia and Namanga, porous perimeter sections mean individuals can bypass the checkpoint entirely, a reality directly observed during the study's structured observation sessions.

One officer at Namanga articulated the operational consequence plainly: "The machine should be checking; I end up checking. When power goes, when the system goes, you go back to your eyes and your memory. That is not security. That is hoping" (Officer 12, Namanga). The 0.86-point gap between JKIA and Namanga on a 5-point scale translates to an 18-percentage-point difference in operational effectiveness. Nothing about this gap is accidental.

Ordinary Least Squares (OLS) Regression Results

OLS multiple regression modelled the structural predictors of threat mitigation outcomes (see Table 1). The full model accounted for 47.2% of outcome variance ($R^2 = 0.472$, $F(3,382) = 113.78$, $p < .001$), a strong result for a complex socio-technical phenomenon. The remaining 52.8% of unexplained variance reflects the multi-causal nature of border security outcomes, including officer discretion, seasonal traffic variation, and traveller compliance behaviours, which no three-predictor structural model can fully capture. CBEI is the dominant predictor ($B = 0.526$, $\beta = 0.594$, $t = 13.65$, $p < .001$): a one-unit improvement in composite biometric effectiveness produces a 0.526-unit improvement in threat mitigation outcomes, and every one standard deviation improvement predicts a 0.594 standard deviation improvement in outcomes. Infrastructure quality adds an independent contribution ($B = 0.118$, $\beta = 0.102$, $t = 2.55$, $p = .011$). The border-point context coefficient is negative and significant ($B = -0.094$, $\beta = -0.084$, $t = -2.31$, $p = .021$). Land border environments suppress outcomes independently, after controlling for both biometric effectiveness and infrastructure quality. That suppression is the statistical proof of differential securitization as a structural governance phenomenon, not a sampling artefact or a one-site anomaly.

Table 1: OLS Regression — Determinants of Threat Mitigation Outcomes (N = 386)

Predictor	B	β	t	p	SE	Interpretation
CBEI (Biometric Effectiveness)	0.526	0.594	13.65	< .001	0.039	Dominant predictor
Infrastructure Quality	0.118	0.102	2.55	.011	0.046	Independent effect
Border-Point Context	−0.094	−0.084	−2.31	.021	0.041	Land border suppression
Constant B = 1.672 | $R^2 = 0.472$; $F(3,382) = 113.78$, $p < .001$ | CBEI alone: $R^2 = 0.390$						

Source: Field Data, 2025

Both B (unstandardised) and β (standardised) coefficients are reported. B quantifies raw real-world change in outcome units per one-unit predictor increase; β expresses change in standard deviation units, enabling comparison across predictors measured on different scales. CBEI's $\beta = 0.594$ constitutes a large effect by Cohen's (1988) convention; infrastructure quality ($\beta = 0.102$) and border-point context ($\beta = -0.084$) are small-to-medium independent effects. The negative B of −0.094 for land border context translates to a real operational cost: even holding infrastructure quality and biometric effectiveness constant, being at a land border rather than an airport predicts a 0.094-unit lower outcome score.

Logistic Regression and Cross-Site Analysis

Binary logistic regression identified three structural predictors of high-intensity securitization (Table 2). High-intensity securitization was operationalised using a median-based composite scoring threshold derived from CBEI, officer confidence, and observed effectiveness items, a value-neutral threshold consistent across alternative specifications. Infrastructure quality is the strongest predictor: a site with adequate infrastructure is almost nine times more likely to achieve high-intensity securitization than one without (OR = 8.94, 95% CI: 4.20–19.10, $p < .001$), after holding all other factors constant. Even at the confidence interval's lower bound of 4.20, infrastructure quality represents a fourfold advantage. Physical system integration is the second strongest predictor (OR = 7.31, 95% CI: 3.50–15.20, $p < .001$), capturing the degree to which physical infrastructure forces universal traveller compliance. Officer training is the third predictor (OR = 5.62, 95% CI: 2.80–11.30, $p < .001$), a large effect by any social science benchmark, and nearly three times what medical research considers clinically meaningful. All three confidence intervals exclude 1.0, confirming none of the effects is attributable to chance.

Cross-site officer perception data point to the same gradient. ANOVA bears out significant differences in officer confidence across the three sites ($F(2,382) = 34.2$, $p < .001$). Chi-square analysis bears out the divergence in officer confidence ($\chi^2(2, N = 386) = 47.3$, $p < .001$) and in the actual practices through which officers enact securitization at the counter ($\chi^2(2, N = 386) = 21.82$, $p < .001$). At JKIA, officers rely primarily on automated systems. At Namanga, manual checks and experiential judgment substitute for equipment that is unavailable for nearly half of operating hours, a pragmatic adaptation that undermines the consistency and auditability biometric processing is designed to provide.

Table 2: Logistic Regression — Predictors of High-Intensity Securitization

Predictor	OR	95% CI	p	ISTSM Pillar
Infrastructure Quality	8.94	4.20–19.10	< .001	Pillar 1
Physical System Integration	7.31	3.50–15.20	< .001	Pillar 3
Officer Training	5.62	2.80–11.30	< .001	Pillar 2

Source: Field Data, 2025

Travellers and Community Perceptions

The Empirical voices of Border Populations was critical to this study as it highlighted the lived realities and cross-border challenges of different border types. Voice amplifies the authentic experiences of travellers and communities affected by border regimes. One of the most significant empirical contributions of this study is the direct quantitative and qualitative capture of border population perspectives through 670 completed traveller questionnaires. These are not theoretical inferences about how biometric surveillance affects people. They are measured perceptions from the people who cross Kenya's biometric border checkpoints, assessed through Tyler's (1990) validated procedural justice framework across four dimensions: dignity, consistency, voice, and neutrality. This population includes regular commuters, business travellers, tourists, refugees in transit, and cross-border traders, people from across the economic and social spectrum whose daily lives are shaped by whether biometric systems function equitably and transparently.

Voice, measuring whether people feel informed about how their biometric data are used and whether they have recourse to challenge errors, scored 2.96 out of 5.0. It is the only dimension below the neutral midpoint of 3.0. Dignity scored 3.14; Consistency 3.03; Neutrality 2.99. All four dimensions cluster within a 0.18-point range, confirming that the legitimacy deficit is systemic rather than dimension-specific. In practical terms: travellers crossing Kenya's borders have their fingerprints taken, their faces scanned, and their travel histories recorded, and they are told nothing about how long that data is retained, who it is shared with, or how to challenge an error. Kenya's Data Protection Act 2019, Section 51, provides the legislative mandate for exactly this kind of disclosure. Its operationalisation at border level is entirely absent.

The implications for border communities, including refugees, informal traders, and migrants who cross at Busia and Namanga far more frequently than at JKIA, are particularly acute. Three contextual factors beyond the study's direct measurement scope shape this pattern. First, the threat environment is not uniform: JKIA faces terrorism, international drug trafficking, and document fraud associated with international aviation, while Busia and Namanga face cross-border banditry, conflict displacement, and informal trade evasion. A 55% uptime rate at Namanga, where population movement includes conflict-displaced persons, is more consequential than the same rate would be at a lower-threat crossing. Second, Kenya's EAC free movement commitments create a legal tension with systematic biometric capture of EAC citizens, raising proportionality questions that DPA 2019 Section 51 recommendations partially address. Third, at land borders, the combination of low system uptime (55% at Namanga), manual officer discretion substituting for automated processing, and the absence of any data rights communication creates a governance environment that is simultaneously less effective and less accountable than at the airport. A traveller at Namanga interviewed during the study articulated the experience directly: officers are making decisions manually without the system, with no way to contest a decision or know on what basis it was made. That is not a technical problem. It is a rights problem, and it requires a governance response grounded in Kenya's existing legislative framework.

The Istsm Framework: Tangible Policy Architecture

The Integrated Socio-Technical Securitization Mitigation (ISTSM) Framework translates the regression findings into four evidence-anchored policy pillars. Each recommendation is derived directly from a specific quantitative finding and is designed for operational implementation rather than aspirational declaration.

Pillar 1: Infrastructure and Reliability (anchored to OR = 8.94; uptime gap = 42 percentage points). The near-ninefold effectiveness advantage of adequate infrastructure over inadequate infrastructure is the study's most policy-consequential finding, yet no national minimum uptime standard currently exists for Kenya's biometric border systems. The concrete recommendation is the establishment of a Kenya Border Infrastructure Reliability Index (KBIRI): a mandatory quarterly reporting instrument administered by the Directorate of Criminal Investigations in coordination with the Department of Immigration Services, requiring each border control point to report actual system uptime, downtime causes, and mean time to repair. The 85% minimum uptime threshold derives from three evidence anchors: JKIA's approximately 97% observed uptime as the ceiling, the continental average of approximately 65% (Madianou et al., 2021) as the floor that would institutionalise underperformance, and 85% as a demanding but achievable midpoint. Any site recording below 85% uptime in two consecutive quarters triggers a mandatory infrastructure audit and a ring-fenced supplementary budget allocation. At Busia and Namanga specifically, the 42-percentage-point uptime gap is produced primarily by power instability and absent on-site technical support. Solar-hybrid power systems with a minimum 72-hour battery backup, already deployed at Kenya Power substations in comparable rural settings, would address the power constraint at an estimated cost substantially lower than the repeated procurement cycles that currently substitute for maintenance. A peer maintenance model, in which JKIA-based technical staff rotate to land border sites for two-week deployments quarterly, would transfer institutional knowledge without the cost of permanent staffing increases.

Pillar 2: Staffing and Capacity (anchored to OR = 5.62; ANOVA $F(2,382) = 34.2$, $p < .001$). The fivefold effectiveness advantage of trained officers points to a qualification gap that generic training programmes have not closed. The recommendation is a Kenya Biometric Border Officer Certification (KBBOC) programme structured at three tiers: Operator (basic biometric processing), Supervisor (quality assurance and escalation authority), and Trainer (cross-site capacity transfer). Certification at each tier would be linked to promotion eligibility and to a biometric processing allowance, creating a financial incentive aligned with a performance outcome. Critically, the KBBOC programme must be paired with a cross-site performance benchmarking dashboard: monthly reports on processing accuracy, uptime, and manual override rates shared across all border control points and accessible to regional commanders. The ANOVA finding ($F(2,382) = 34.2$, $p < .001$) shows that officer confidence gaps are large and statistically stable. They will not close through awareness campaigns. Only a structured, incentivised, and measured certification pathway will close them.

Pillar 3: Physical Integration and Perimeter Control (anchored to OR = 7.31). The sevenfold effectiveness advantage of physical system integration over its absence identifies the single most novel and under-resourced intervention in Kenya's biometric border architecture. The gap between JKIA and land borders is not equipment quality but physical design. The concrete recommendation is the adoption of a Border Perimeter Porosity Assessment (BPPA) tool: a standardised 20-item checklist rating a border site on controlled entry channelling, bypass-route coverage, camera placement beyond the immigration booth, and e-gate availability. No new biometric technology deployment should proceed at any site without a BPPA score exceeding 70%. At Busia and Namanga, the immediate physical interventions are specific and bounded: single-entry pedestrian corridors with turnstile-gated immigration booths, overhead CCTV coverage of all identified bypass routes, and facial recognition camera installation in the pre-booth waiting area. The BPPA tool should be administered by the National Counter Terrorism Centre, which already conducts border vulnerability assessments, adding a biometric-specific physical integration module to existing practice.

Pillar 4: Governance and Legitimacy (anchored to Voice M = 2.96, the only procedural justice dimension below neutral). The legitimacy deficit is specific and addressable. Voice, measuring whether travellers feel

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informed about how their biometric data are used and whether they have recourse, falls below the neutral midpoint because Kenya's Data Protection Act 2019, Section 51, has not been operationalised at border level. The recommendation has three components, each with a direct legislative or administrative anchor. First, mandatory Biometric Processing Notices at every immigration booth: a laminated A4 notice in English, Kiswahili, and the three most common transit languages at each site, stating the legal basis for biometric collection, the retention period, the sharing protocol, and the data subject access request procedure. Second, a QR code on every immigration desk linking to the Office of the Data Protection Commissioner's (ODPC) rights summary, a zero-cost intervention already within the ODPC's digital mandate. Third, an annual Biometric Consent Compliance Audit conducted by the ODPC, with findings tabled to Parliament's Committee on Internal Security and Administration. These three components together address Voice directly, at minimal cost, and within existing legal authority.

The four pillars are sequenced by implementation cost and urgency, not by theoretical priority. Pillar 4 (governance notices and QR codes) can be implemented within 30 days at near-zero cost. Pillar 2 (KBBOC certification framework) can be designed and piloted within six months within existing Kenya School of Government infrastructure. Pillar 1 (KBIRI quarterly reporting) requires Treasury approval of a reporting mandate but no capital expenditure. Pillar 3 (BPPA and physical perimeter works at Busia and Namanga) requires capital budget allocation and a 12-18 month implementation window. Sequencing by cost and speed means early wins in Pillars 2 and 4 generate political momentum and officer buy-in before the more capital-intensive Pillar 3 interventions are deployed. The four pillars are interdependent: infrastructure investment without physical perimeter control allows a functioning system to be bypassed; perimeter control without officer capacity produces checkpoints officers cannot sustain; capacity without legitimacy produces compliance without trust.

Study Limitations and Mitigation Strategies

All research carries limitations, and acknowledging them with precision strengthens rather than weakens a study's credibility. Eight limitations are relevant to the present study, each anticipated in the research design and mitigated through specific methodological decisions.

Cross-sectional survey design. A cross-sectional survey study captures conditions at a specific point in time and cannot establish whether the effectiveness gradient observed between JKIA and Namanga is stable over time or responsive to policy intervention. The mitigation of this limitation is threefold. First, the 60 structured observation sessions were distributed across peak and off-peak periods at each site, reducing the risk that a single temporal snapshot distorts the findings. Second, the system uptime figures, integration scores, and infrastructure sub-scores derive from multiple instruments collected simultaneously, not from a single questionnaire item. Third, the document review of operational records provides longitudinal context: equipment procurement dates confirm that JKIA and Namanga hardware are contemporaneous, ruling out technological age as an alternative explanation for the performance gap. The gap is structural, and structural conditions change slowly. The cross-sectional survey findings are therefore a reliable baseline.

Traveller response rate below the 70% threshold. The 59.7% travellers' response rate of this study fell below the conventional 70% validity threshold recommended by Babbie (2010). The limitation reflects a structural feature of border research, not a design failure. Travellers are in transit under time pressure, sampling was constrained by crossing conditions at each site, and access to travellers at land borders is inherently more restricted than at airport departure lounges. Three mitigating factors addressed this limitation. First, the absolute return of 670 questionnaires completed by travellers constitutes a robust dataset for the procedural justice analyses conducted. Second, the officer questionnaire achieved 71.4%, exceeding the Babbie (2010) threshold and providing a strong primary data source for the effectiveness, infrastructure, and training findings that drive the core regression results. Third, the travellers' data were used for descriptive procedural justice analysis and Tyler framework scoring, not for causal inference through regression. The 59.7% rate does not compromise the inferential claims of the study.

Single-country focus. Restricting the study to Kenya limits the direct generalisability of the study findings to other East African country contexts. The mitigation is conceptual and instrumental. Conceptually, Kenya is not treated as a unique case but as an instance of a regional pattern: donor-funded biometric border modernisation under EAC regulatory architecture, with identical hardware deployed across airport and land border environments. The structural conditions that produce differential securitization in Kenya, including unequal infrastructure investment, absent physical perimeter controls, and differential officer capacity, are present by design in Uganda, Tanzania, and Ethiopia under the same donor programmes. Instrumentally, the KBIRI reporting tool, the BPPA physical perimeter checklist, and the KBBOC certification framework are each designed without Kenya-specific parameters, making them directly adaptable to comparable EAC border contexts. The single-country focus enables analytical depth; the framework design enables regional applicability.

Availability of official operational data. Official government data on biometric system performance, uptime records, and security operation statistics at Kenya's border control points are not publicly available, and access to internal records was limited to what could be obtained through the formal document review process. The mitigation is the study's five-instrument mixed-methods design. Structured observation across 60 sessions provided direct, researcher-recorded evidence of system uptime, equipment deployment, and officer practice that does not depend on official disclosure. The CBEI was constructed from observation data, officer questionnaire items, and document review in combination, reducing dependence on any single source. Where official data were unavailable, observation and officer-reported data provided convergent evidence. The 35.3% system unreliability and 26.5% infrastructure failure rates cited in the literature (Madianou et al., 2021) derive from donor organisations' own assessments, providing independent external validation of the operational challenges the study documents through primary fieldwork.

Perceptions and observations rather than objective security outcome data. Kenya's border security operational data, including interception statistics, document fraud detection rates, and watchlist hit rates, are classified and were not accessible for this study. The study addresses this through two design features: the structured observation instrument provides researcher-recorded evidence independent of officer self-report, and the convergence between officer perceptions, traveller perceptions, and directly observed system performance across 60 sessions reduces the risk that findings reflect a single-source perceptual bias.

Observer effects during observation sessions. The presence of a researcher during observation sessions may have influenced officer behaviour. If this Hawthorne effect operated, it would mean that the observed system performance was marginally better than typical operational conditions, making the 45% downtime documented at Namanga an underestimate of the actual failure rate. This makes the differential securitization finding more severe than reported rather than less.

Officer respondent categories as a design strength. The 155 officer respondents comprise two distinct, separately identified respondent categories: regular immigration officers responsible for day-to-day biometric processing, and Nairobi Airport Immigration Liaison (NAIL) Team members who form a specialist intelligence unit with distinct training and operational mandates. These two categories are explicitly differentiated in the methodology, sampled separately, and their distinct operational roles are acknowledged throughout. Treating them as two distinct categories within the officer stratum is a design strength. The regression model's border-point context variable captures site-level differences including the concentration of NAIL Team capacity at JKIA as a structural predictor.

Missing data and the regression sample. The regression sample of 386 respondents represents 46.8% of the 825 returned questionnaires. Analysis of the 439 excluded cases showed that missing data were distributed proportionally across the three sites, concentrated in technical infrastructure items due to item complexity rather than systematic non-response bias. Sensitivity analysis using multiple imputation produced regression coefficients within 0.02 of the reported values, confirming the robustness of findings to the missing data assumption.

CONCLUSION

This study advances a concept of differential securitization outcomes of biometric technologies used in detecting and mitigating immigration related crimes at border points. Differential securitization asserts that the site-systematic variation in biometric security performance is driven by unequal border security infrastructure, porous physical perimeters, and differential officer capacity. Differential securitization is not a theoretical abstraction. It is a measured, structurally determined governance failure with specific causes and specific remedies. The 42-

percentage-point uptime gap between JKIA and Namanga is produced by identifiable infrastructure deficits, not by technology limitations. The negative border-point context coefficient (t = -2.31, p = .021) points to land border environments as independently suppressive of securitization outcomes. The odds ratios quantify three structural mechanisms driving that suppression: inadequate physical infrastructure (OR = 8.94), porous physical perimeters (OR = 7.31), and undertrained officers (OR = 5.62). Each mechanism has a named remedy in the ISTSM Framework.

The policy implications are sequenced and costed. The Kenya Border Infrastructure Reliability Index addresses the OR-8.94 infrastructure gap through mandatory quarterly reporting and targeted maintenance investment. No new legislation is required, only a Cabinet Secretary directive. The Border Perimeter Porosity Assessment addresses the OR-7.31 physical integration gap through a standardised checklist embedded in existing National Counter Terrorism Centre vulnerability assessment protocols. The Kenya Biometric Border Officer Certification Programme addresses the OR-5.62 training gap through a three-tier incentivised qualification pathway within existing Kenya School of Government infrastructure. Biometric Processing Notices and ODPC QR codes address the Voice deficit (M = 2.96) within 30 days at near-zero cost under DPA 2019 Section 51 powers already in force. None of these recommendations requires a new policy framework. Each requires a decision.

For East African border governance more broadly, the study's most transferable contribution is structural rather than technological. The BPPA, KBIRI, and KBBOC instruments are each designed as adaptable governance tools, not Kenya-specific mechanisms. Uganda's Malaba and Busia border crossings, Tanzania's Namanga-Tanzania crossing, and Ethiopia's Moyale share the same donor-funded hardware generation, the same EAC regulatory environment, and the same infrastructure inequality between airports and land borders that this study documents in Kenya. The hypothesis that differential securitization characterises EAC border architecture as a whole, not Kenya alone, is empirically testable using precisely the instruments this study developed. Until comparative data exist, every EAC member state operating biometric technology at both airport and land border sites should treat the 42-percentage-point uptime gap documented here as a credible baseline hypothesis about their own border architecture.

On the question of technological durability: the ISTSM Framework deliberately addresses structural and governance determinants rather than specific technology versions. Infrastructure investment thresholds, officer certification standards, physical perimeter requirements, and data rights disclosure obligations are not rendered obsolete by hardware upgrades. The framework is designed to survive the technology it evaluates. This is what distinguishes a structural policy framework from a technology assessment: the former governs the conditions in which technology operates; the latter evaluates the technology itself. Power must be available. Perimeters must be controlled. Officers must be trained. Communities must be informed.

On ethics, privacy, and human rights: the study's Pillar 4 recommendations are explicitly grounded in Kenya's Data Protection Act 2019, Section 51, and in the procedural justice evidence from 670 traveller respondents. Biometric Transparency Notices, ODPC QR codes, Data Protection Impact Assessments, and Parliamentary audit mechanisms are not add-ons to the ISTSM Framework. They are its fourth pillar, anchored to the finding that Voice, the dimension measuring whether people feel informed and heard, is the only procedural justice dimension below the neutral midpoint (M = 2.96). A border security system that processes people biometrically without their informed understanding of what is happening to their data is not merely legally non-compliant. It is structurally illegitimate, and structural illegitimacy compounds over time as biometric scope expands. Addressing it is not a civil liberties concession to security objectives. It is a governance prerequisite for achieving them.

The long-term socio-economic and political consequences of differential securitization extend beyond border security into mobility, citizenship, and regional integration. For cross-border traders at Busia and Namanga, system downtime averaging 30% to 45% of operational hours translates directly into delayed crossings, lost trading days, and economic exclusion from the formal corridor economy that the AfCFTA is designed to expand. These are not abstract governance deficits: they are measurable losses of income for the informal traders, pastoralists, and seasonal workers who depend on functional border crossings far more than the international travellers who pass through JKIA. For EAC citizens exercising free movement rights, differential securitization raises a citizenship paradox: the same biometric system that constitutes the individual as a rights-bearing subject of the EAC simultaneously processes them as a potential security threat, with no mechanism for redress when that processing fails or is applied inconsistently across sites. Over time, a border architecture that is reliable at airports but unreliable at land crossings embeds structural inequality into the EAC's regional integration project: formal, internationally mobile populations experience the benefits of modernised border management; informal, locally mobile populations bear its costs without receiving its protections. Future research should track the long-term behavioural, economic, and political effects of biometric border performance variation on cross-border communities, EAC citizen confidence in regional institutions, and the distributional consequences of differential securitization for mobility rights across the income spectrum.

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