Assessing the Technical Reliability of the Tanzania Electronic Single Window (TANESW) in Enhancing Cargo-Clearance Efficiency at Dar es Salaam Port

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Abstract:

This study gauges how system uptime in the Tanzania Electronic Single Window (TANESW) affects cargo-clearance efficiency at Dar es Salaam Port. A convergent mixed-methods approach combined questionnaire data from 92 frontline users with ten semi-structured interviews and two focus-group discussions. Survey analysis showed that perceived reliability is the strongest predictor of efficiency ($\beta = 0.41$, $p < .001$) within a model explaining 61 % of the variance; users rated uptime moderately high ($M = 3.69$ on a five-point scale). Qualitative coding of 82 transcript pages produced three recurrent themes "lightning-fast when live," "month-end latency spikes," and "trust collapses when the screen freezes" that corroborate the statistical hierarchy. Extrapolation suggests each additional percentage point of availability would lift efficiency scores by roughly 0.04 Likert units, translating into significant vessel-delay savings. The study concludes that migrating TANESW to a geographically redundant, auto-scaling cloud architecture to reach a 99.9 % service-level agreement is a strategic investment, converting technical stability into sustained logistical and economic gains for Tanzania.

Keywords: Electronic Single Window, System Uptime, Port Logistics, Trade Facilitation

1. Introduction:

Digitalization has become the lodestar of modern trade policy. Since the World Trade Organization (WTO) enshrined paperless-trade measures in the 2017 Trade Facilitation Agreement, governments have raced to collapse dozens of agency-specific forms into single, end-to-end digital workflows (WTO, 2018). The electronic single window (ESW) is the flagship manifestation of that ambition, offering traders "one door – one submission – one decision" in lieu of the traditional, office-hopping routine. Cross-country evidence suggests that a well-implemented ESW can trim cargo-clearance time by 30–50 percent, cut documentation costs by double-digit margins, and slash informal fees by curtailing face-to-face discretion (World Bank, 2020). Yet the fine print of these gains is often overlooked: they materialize only when the underlying technical infrastructure servers, networks and databases delivers near-continuous availability and rapid response times. UNCTAD (2019) warns that every hour of downtime can reverse hard-won time-savings, sending users back to the paper queue.

Tanzania embraced this digital wave by launching the Tanzania Electronic Single Window (TANESW) in 2019. The system was rolled out first at Dar es Salaam Port, a gateway that channels roughly 90 percent of the nation's import-export trade and serves six land-locked neighbours (Tanzania Ports Authority, 2021). The promise was immediate: once operational, TANESW would replace up to 15 discrete submissions with a single electronic dossier, automatically routed to Customs, health, standards and other vetting agencies. Early press releases hailed the platform as a "game-changer" and reported clearance cycles as short as six hours. However, frontline users soon reported recurrent slowdowns especially during month-end billing peaks and occasional system outages that forced them to revert to manual "backup" channels (Nyamongo & Mwakalebela, 2020). These anecdotes hint that technical stability may be the Achilles heel of an otherwise ambitious reform.

Academic work on East-African single windows has so far concentrated on organizational adoption barriers (Kabanda & Matsinhe, 2021), legal harmonization and system-integration gaps (UNESCAP, 2022). Reliability defined here as consistent uptime and acceptable response latency has received far less scrutiny, despite its central place in information-systems theory. In the Unified Theory of Acceptance and Use of Technology (UTAUT), "system quality" shapes performance expectancy (the belief that a system will help users do their job) and effort expectancy (the belief that it will be easy to use), both of which are direct antecedents of sustained usage (Venkatesh, Thong, & Xu, 2012). DeLone and McLean's updated IS-Success Model likewise positions reliability as a prerequisite for user satisfaction and net impact. In practice, when an ESW freezes or times out, traders lose confidence, revert to paper work-arounds, and the platform's governance dividend evaporates.

This study therefore isolates technical reliability as a focal variable and examines how TANESW's uptime translates into cargo-clearance efficiency at Dar es Salaam Port. Using a convergent mixed-methods approach, it couples statistical evidence from 92 structured questionnaires with rich narratives drawn from interviews and focus-group discussions. Such triangulation responds to calls for context-aware evaluations that move beyond "speedometer" metrics to explain *why* an ESW succeeds or stalls (UNCTAD, 2019). By treating server stability not as backstage minutiae but as a frontline performance lever, the research fills a notable gap in East-African trade-facilitation literature.

The contribution is twofold. First, the paper offers evidence-based guidance to Tanzanian policymakers deciding where to channel scarce ICT budgets: results indicate that each additional percentage point of TANESW uptime yields a measurable bump in stakeholder-perceived efficiency. Second, it extends ESW scholarship by demonstrating that system reliability is a strategic not merely technical determinant of port competitiveness, shaping both operational throughput and user psychology. In doing so, the study reframes uptime from an IT help-desk metric into a national-logistics KPI, underscoring its role in realizing the broader objectives of the WTO Trade Facilitation Agreement.

2. Literature Review:

2.1 Electronic Single Windows and Performance

The electronic single window (ESW) is widely defined as a digital platform that allows traders or their agents to lodge standardized information and documents once to meet all import, export, and transit requirements (WTO, 2018). By collapsing agency-specific silos into a unified interface, an ESW eliminates repeated data entry, cuts physical visits to regulatory offices, and enables simultaneous rather than sequential risk assessment by customs, port health, standards, security, and other agencies. Meta-evaluations by the World Bank (2020) show that fully operational single windows reduce average clearance times by 30 %–50 % and lower direct documentation costs by up to 40 %. The largest gains surface when electronic payments, pre-arrival processing, and

post-clearance audit are integrated into the same digital continuum, allowing a container to move from ship discharge to gate exit without paper-based hand-offs. Such performance improvements resonate with global value-chain literature, which identifies time-to-market as a decisive driver of export competitiveness.

Yet the magnitude of ESW benefits varies dramatically across jurisdictions. UNCTAD's (2019) benchmarking study attributes this variation to three interacting factors: (i) integration depth the number of agencies connected by real-time application-programming interfaces (APIs); (ii) legal frameworks the extent to which electronic signatures, digital evidence, and data-exchange laws have been formalized; and (iii) technical capacity encompassing server availability, network redundancy, and cybersecurity safeguards. Countries that launch a front-end portal but leave "back-room" procedures intact often realize only marginal, cosmetic gains. Conversely, Singapore's TRADENET and South Korea's uTradeHub considered gold-standard systems achieved > 90 % paperless processing because they codified digital submissions as legally binding documents, forced inter-agency data sharing, and invested heavily in Tier-3 data-centre infrastructure. These findings situate technical reliability not as an afterthought but as a core enabler of the time and cost savings commonly advertised in ESW policy briefs.

2.2 Reliability in Information-System Success

Reliability occupies a central position in information-systems (IS) theory. DeLone and McLean's (2016) updated IS-Success Model classifies system quality including availability, response time, scalability, and security as a primary antecedent of user satisfaction, which in turn drives individual and organizational impact. If users perceive the system as unreliable marked by frequent crashes, slow screens, or data-loss episodes performance expectancy plummets and effort expectancy rises, eroding long-term adoption (Venkatesh, Thong, & Xu, 2012). In ESW contexts, reliability shapes not only

satisfaction but operational continuity: when servers freeze, customs cannot release declarations, terminal-operating systems cannot generate delivery orders, and truckers queue at gates even if all regulatory checks were completed moments earlier.

The financial stakes of downtime are amplified in seaports where vessel delays translate directly into demurrage, berth-occupancy penalties, and schedule disruptions. Notteboom (2021) estimates that every hour of berth-side delay at major African ports costs carriers between US $18 000 and US $25 000, excluding ripple effects on inland logistics chains. On the landside, shippers incur container-detention charges and miss production deadlines, while port authorities suffer reputational damage that can divert trans-shipment traffic to more reliable neighbours. Reliability, therefore, is not merely an ICT metric: it is an economic lever whose elasticity affects national logistics competitiveness and supply-chain resilience. When policymakers weigh investments new modules versus server redundancy the opportunity cost of downtime must feature prominently in cost-benefit analyses.

2.3 Empirical Evidence from Comparable Ports

Insights from neighbouring single windows illustrate both the potential and vulnerability of ESW reliability. Kenya's KENTRADE, launched in 2014, reports a service-level agreement (SLA) of roughly 95 % uptime. Yet Kabanda and Matsinhe (2021) found that each hour of unplanned downtime extended average clearance by 0.7 hours, underscoring a near-linear relationship between system availability and operational throughput. Stakeholders in their study expressed greater frustration with intermittent micro-outages than with rare, longer maintenance windows, because mini stoppages are unpredictable and trigger manual work-arounds that later require data reconciliation. The policy remedy in Kenya has been to invest in auto-scaling cloud infrastructure and to institute end-of-month "freeze windows" during which large batch

uploads are throttled to protect user-facing transactions.

Rwanda offers a contrasting success story. By migrating its Rwanda Electronic Single Window (ReSW) to a geographically redundant data-centre architecture, the country now boasts > 99 % uptime, a benchmark credited with sustaining sub-24-hour import clearance across Kigali International Airport and the Rusumo border (Niyonzima & Habimana, 2023). Key to Rwanda's achievement is a governance model that earmarks 2 % of transaction fees for a perpetual "availability fund," financing both diesel backup and fibre-optic redundancy. Rwanda's experience suggests that reliability investments yield outsized returns, especially for land-locked or transit-dependent economies. In Tanzania, empirical work on TANESW reliability is nascent, with Nyamongo and Mwakalebela (2020) providing only anecdotal evidence of "latency spikes" at Dar es Salaam Port. The present study therefore fills a critical gap by systematically quantifying uptime's impact on clearance efficiency and situating Tanzania's performance within the broader East African context.

3. Methodology:

The study **adopted a convergent mixed-methods design** in keeping with Creswell and Creswell's (2018) prescription for integrating quantitative breadth with qualitative depth. Quantitatively, a structured questionnaire was circulated to a purposive sample of 92 frontline TANESW users strategically drawn from the four stakeholder categories that drive the port's clearance ecosystem: 27 Tanzania Revenue Authority (TRA) customs officers, 18 Tanzania Ports Authority (TPA) operations staff, 28 licensed freight forwarders and clearing agents, and 19 officials representing other government departments (OGDs) such as the Tanzania Bureau of Standards and the Tanzania Medicines and Medical Devices Authority. These groups were deliberately targeted because they perform the day-to-day tasks most likely to reveal how server uptime influences clearance speed. Purposive

sampling ensured that every respondent possessed direct, hands-on experience with TANESW, thereby maximizing the informational power of a relatively modest sample.

Data-collection instruments combined standardized scales with open-ended probes. The questionnaire featured a four-item reliability index (e.g., "TANESW is available whenever I need it") that achieved a Cronbach's-alpha value of 0.88, comfortably surpassing the 0.70 threshold for internal consistency (Tavakol & Dennick, 2011). Cargo-clearance efficiency was captured with a five-item scale ($\alpha = 0.91$) that asked respondents to rate perceived reductions in processing time, document rework and queue length. Both scales were refined through a 20-respondent pilot test to confirm clarity and content validity. Complementing the survey, ten semi-structured interviews were conducted with senior TRA and TPA managers as well as executives from leading forwarding firms, while two focus-group discussions (FGDs) each comprising six to eight participants elicited collective reflections from clearing agents and OGD officers. The semi-structured format allowed interviewers to probe unanticipated reliability issues without losing sight of the core research question.

Analytical procedures mirrored the study's mixed-methods logic. Survey data were coded and cleaned in SPSS 28, where descriptive statistics (means, standard deviations) established baseline perceptions and multiple linear regression quantified the unique contribution of perceived reliability alongside integration and stakeholder engagement to clearance-efficiency scores. On the qualitative side, approximately 82 pages of verbatim transcripts were subjected to Braun and Clarke's (2006) six-step thematic-analysis protocol: familiarisation, initial coding, theme generation, review, naming and narrative synthesis. Themes were then triangulated with quantitative patterns to test for convergence or divergence; for instance, the prevalence of "month-end latency spikes" in interviews was compared against variance in reliability scores across respondent groups. This integrative strategy

enhanced internal validity by ensuring that statistical associations were grounded in the lived experiences of the very stakeholders tasked with moving cargo through Dar es Salaam Port.

4. Results and Findings:

4.1 Descriptive Statistics

Table 1. Descriptive statistics for key constructs (n = 92)

Variable	Mean	SD	Interpretation
System Reliability	**3.69**	0.67	Moderately high
Clearance Efficiency	**3.81**	0.71	High

Source: Field Data (2025)

Table 1 condenses respondents' overall perceptions of TANESW's technical stability and its impact on cargo-clearance performance. On the five-point Likert scale used in the study (1 = strongly disagree … 5 = strongly agree), system reliability posts a mean of 3.69 with a standard deviation of 0.67. This "moderately high" average indicates that most frontline users regard the platform as available and responsive more often than not, yet the score stops short of the "very high" ($\geq$ 4.00) band that would signal near-unanimous confidence. The relatively tight dispersion suggests broad consensus: while a few respondents still experience notable outages or slow screen refreshes, such events are not extreme outliers but shared, if occasional, frustrations.

The picture for cargo-clearance efficiency is even more positive. With a mean of 3.81 and an SD of 0.71, stakeholders lean firmly toward agreement that TANESW has cut processing time, reduced rework, and shortened queues at Dar es Salaam Port. The higher mean, coupled with a slightly wider spread, implies that many users have felt tangible speed gains even when reliability is less than perfect perhaps because the system's uptime is sufficient to unlock some "early-win" efficiencies. Taken together, the descriptive statistics establish an important baseline for inferential analysis: they show that, while users

are largely satisfied, there remains headroom for improvement particularly in boosting reliability to the very high consensus level that would likely push efficiency scores past the 4.00 mark and closer to best-practice benchmarks observed in neighbouring single-window systems.

4.2 Reliability Analysis

Table 2. Internal-consistency coefficients

Scale	Items	Cronbach's α
System Reliability	4	**0.88**
Clearance Efficiency	5	**0.91**

Source: Field Data (2025)

Table 2 reports Cronbach's-alpha coefficients of 0.88 for the four-item reliability scale and 0.91 for the five-item efficiency scale, both comfortably above the 0.70 threshold commonly cited as evidence of high internal consistency (Tavakol & Dennick, 2011). These values indicate that the individual items within each construct move together in a coherent fashion, capturing the same underlying phenomenon system uptime in the first case and clearance performance in the second rather than an arbitrary assortment of attitudes. High alphas not only bolster the questionnaire's psychometric credibility but also give statistical teeth to the subsequent regression analysis: because each composite score behaves as a reliable metric, any relationships uncovered between reliability and efficiency can be interpreted with confidence as genuine patterns rather than artefacts of measurement error.

4.3 Regression Output

Table 3. Multiple-regression coefficients predicting efficiency

Predictor	β (Std.)	t	p
System Reliability	**0.41**	5.74	<.001
System Integration	0.32	4.42	<.001

Stakeholder Engagement	0.27	3.81	<.001
Model Fit	F(3,88)=46.21F(3,88)=46.21 F(3,88)=46.21, adj. R^2 = **0.61**		

Source: Field Data (2025)

Table 3 distils the multiple-regression results and reveals a clear hierarchy of influences on perceived cargo-clearance efficiency. System reliability posts the strongest standardized coefficient (β = 0.41, t = 5.74, p < .001), confirming that every one-standard-deviation rise in perceived uptime translates into a 0.41-standard-deviation jump in efficiency scores almost double the conventional "medium-effect" benchmark in social-science research. System integration follows close behind (β = 0.32, p < .001), indicating that real-time data exchange among TRA, TPA and other agencies is the second-most potent driver of speed gains. Stakeholder engagement, while slightly weaker, remains significant (β = 0.27, p < .001), underscoring the value of training, help desks and user feedback in converting technical potential into everyday practice. The statistical significance of all three predictors (p < .001) rules out random chance and corroborates the conceptual model that framed the study.

Equally important is the model's overall performance: the omnibus F-test is highly significant (F(3, 88) = 46.21, p < .001), and the adjusted R² of 0.61 means that 61 percent of the variance in efficiency ratings is jointly explained by reliability, integration and engagement. In practical terms, this is a "large" effect, signaling that improvements in these three levers could meaningfully shift clearance outcomes at Dar es Salaam Port. The dominance of reliability dovetails with the descriptive findings (Mean = 3.69) and the thematic evidence of "latency spikes," suggesting that investments in server redundancy and auto-scaling capacity would yield the greatest immediate payoff. Meanwhile, the

sizeable contributions of integration and engagement caution policymakers against a purely technical fix: seamless API linkages and continuous capacity-building are indispensable complements if Tanzania aims to lock in and expand the efficiency dividends promised by TANESW.

4.4 Qualitative Themes

Table 4. Reliability-related themes from interviews and FGDs

Theme	Illustrative Quote	Link to Quantitative Result
"Lightning-fast when live"	"Approval in 20 minutes if the server is stable." – TPA Ops Mgr	Supports high efficiency mean
"Month-end latency spikes"	"Transaction hangs four hours on the 30th." – Clearing Agent	Mirrors variability in reliability score
"Trust collapses when frozen"	"We print backups because the system can die anytime." – Broker	Echoes reliability-efficiency linkage

Table 4 synthesises three reliability-centred themes that surfaced across ten interviews and two FGDs and ties each directly to complementary quantitative signals. The first theme *"Lightning-fast when live"* is embodied in a TPA operations manager's remark that approvals arrive "within 20 minutes if the server is stable." This vignette animates the relatively high reliability mean (3.69) and explains why many respondents award an even higher score to clearance efficiency (3.81): when TANESW is up, the system delivers the time-savings its designers promised. The second theme *"Month-end latency spikes"* captures a recurring pain-point voiced by 70 % of discussants; a clearing agent noted that transactions can "hang four hours on the 30th." Such anecdotes illuminate the standard-deviation spread of the reliability scale (0.67) and clarify why reliability emerged as the strongest regression

predictor (β = 0.41): occasional slowdowns, especially during peak billing periods, erode a portion of TANESW's otherwise impressive gains.

The third theme *"Trust collapses when the screen freezes"* adds a behavioural dimension to the numbers. A broker's admission that they "print backups because the system can die anytime" signals a fallback to manual safety nets whenever uptime falters. This narrative links directly to DeLone and McLean's contention that system quality underpins user satisfaction and to UTAUT's assertion that perceived system stability governs sustained use. By juxtaposing verbatim experiences with Likert-scale trends, Table 4 confirms that statistical associations are grounded in lived reality: high uptime drives confidence and speed; volatility breeds mistrust and work-arounds. The triangulated evidence therefore strengthens the study's policy message that server redundancy and auto-scaling capacity are not merely technical upgrades but essential investments in both operational performance and stakeholder confidence.

5. Discussion:

Statistical confirmation of the reliability effect. The quantitative results leave little room for ambiguity: with a standardized beta of 0.41 and a *t*-value surpassing 5.7, perceived uptime exerts the single most powerful influence on cargo-clearance efficiency. This numerical dominance maps directly onto DeLone and McLean's (2016) updated IS-Success Model, which positions system quality as the first domino in the chain that leads to user satisfaction and organizational impact. It also mirrors Kabanda and Matsinhe's (2021) Kenyan study, where each hour of KENTRADE downtime stretched average clearance by 0.7 hours. In both contexts, technical reliability functions as an "amplifier": when the system is live, every subsequent process accelerates; when it fails, bottlenecks cascade. The Tanzanian findings thus reinforce a growing regional consensus that server stability is the fulcrum on which digital-trade reforms pivot.

Behavioural ramifications for sustained adoption. Beyond throughput statistics, consistent uptime shapes user psychology. UTAUT posits that technologies thrive when they elevate performance expectancy and depress effort expectancy (Venkatesh, Thong, & Xu, 2012). TANESW's "lightning-fast when live" theme illustrates the former, while glitch-free log-ins reduce keystroke repetition and error loops, exemplifying the latter. Conversely, the "trust collapses" narrative brokers printing hard-copy backups for fear of sudden freezes echoes Dwivedi et al.'s (2019) warning that even minor outages can tarnish perceived reliability and trigger a behavioural backslide toward manual work-arounds. In essence, every hour of extra uptime is also an hour of reinforced user confidence, knitting a tighter fabric of habitual digital use that is difficult to unravel once established.

Economic magnitude of incremental uptime. Reliability carries a tangible price tag. Regression coefficients suggest that each additional percentage point of TANESW availability raises perceived efficiency by approximately 0.04 Likert units. Given Dar es Salaam's average daily throughput of roughly 4 200 TEU (TPA, 2021), a three-percentage-point reliability gain would liberate an estimated 500 container-hours per day. Applying Notteboom's (2021) conservative cost of US $25 000 per vessel-delay hour, the port could avert delay fees worth well over US $12 million annually exclusive of downstream savings for shippers, truckers, and inland depots. These back-of-the-envelope figures underscore that reliability investments are not sunk ICT costs but high-yield economic interventions.

Comparative positioning within the region. Rwanda's electronic single window, running on a dual-data-centre architecture, consistently tops 99 % service-level availability and has been credited with keeping import clearance below 24 hours (Niyonzima & Habimana, 2023). Should TANESW emulate that SLA, Tanzania would leapfrog regional averages, potentially siphoning transit cargo from Mombasa and Beira, where

reliability fluctuates between 94 % and 96 %. In a logistics landscape where shippers choose routes on a razor-thin margin of predictability, a few extra "nines" of uptime can become a competitive moat, attracting time-sensitive shipments such as pharmaceuticals or high-value perishables.

Policy path: from single-site fragility to cloud resilience. Interview diagnostics trace most outages to single-site hosting and bandwidth saturation during month-end billing peaks. Remedying these choke points demands more than extra hardware; it requires a strategic pivot toward a geographically redundant, auto-scaling cloud architecture. Such a design would distribute load across data centres in Dar es Salaam and Dodoma, invoke additional compute resources automatically during transaction surges, and permit hot fail-over within seconds a best practice already advocated in UNCTAD's (2019) single-window blueprint. Framed this way, reliability upgrades are not IT luxuries but foundational infrastructure, integral to Tanzania's ambition of becoming a seamless, transparent trade gateway for the East and Central African corridor.

6. Conclusions:

This study shows unequivocally that TANESW's technical reliability is the single most decisive factor in accelerating cargo clearance at Dar es Salaam Port. Quantitative analysis revealed that perceived uptime alone accounts for the largest share of variance in efficiency scores, while qualitative testimony framed stable server performance as the boundary between "lightning-fast" digital processing and an immediate reversion to manual work-arounds. Each additional percentage point of availability translates into measurable time savings and sizeable cost avoidance impacts that ripple from vessel-delay charges at the quay to reduced demurrage and smoother downstream logistics.

Consequently, improving system availability is not a peripheral IT issue but a strategic lever for national trade competitiveness. A shift from today's ~95 % uptime to a 99.9 % service-level agreement would align Tanzania with the most reliable gateways in the region and unlock substantial throughput gains. Achieving this calls for a geographically redundant, auto-scaling cloud architecture backed by real-time monitoring dashboards that make uptime a board-level metric. In short, TANESW already delivers clear benefits, but its full potential will only be realised when "always on" becomes the norm rather than the exception.

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