International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Assessment of The Impact of Sea Transportation On Livestock Welfare in Tanzania: A Case Study of Dar Es Salaam Port

Martine Masunga[1], Dr. Msabaha J. Mwendapole[2] (Phd)

[1,2] Dar Es Salaam Maritime Institute, Dar Es Salaam, Tanzania.

ABSTRACT

This study assessed how animals are treated at Dar es Salaam Port just before they board ships, and it focused on three things the port can actually control: how well staff handle the animals, how long the animals wait before loading, and whether the holding pens give enough shade and cool air. To do this, the team watched 84 real consignments of cattle, sheep, and goats across hot and cooler months, asked 96 people who work in the system to fill out a short questionnaire, and sat down for 20 interviews with handlers, supervisors, vets, shippers, and officials. The goals were simple: check if better handling improves welfare, see how waiting time affects animals, and find out whether good shelter makes a difference. The results were clear and easy to grasp of the three, waiting time hurt welfare the most: every extra hour in the holding area made breathing problems more likely, and each extra 10 minutes spent queuing at the ramp also pushed risk up. Good handling mattered too calm, well-supervised work with proper equipment and no rough treatment cut injuries and slips and decent shelter helped by keeping animals cooler and more willing to move, especially when at least half of the pen floor was shaded and there was a breeze. Put simply: shorter waits, calmer handling, and solid shade meant healthier, quieter animals and fewer mishaps before loading. The study recommends a practical, low-cost playbook the port can start using right away: finish paperwork before animals arrive, use a simple board to show the loading order and keep things moving, shift loadings to night or early morning in hot weather, run a five-minute "toolbox talk" before each loading so everyone knows their job, keep a named supervisor at the ramp, make sure floors are non-slip and well lit, fix or add shade so at least 50% of the pen is covered, make sure air can flow, and place water troughs in the shade. Finally, track a few easy numbers for every consignment how long animal waited, whether shade and water were available, how carefully staff handled them, and the basic signs of animal stress and use a weekly chart to spot problems early and fix them. These steps don't require big budgets and can quickly make ship days safer and kinder for animals at the port.

1. Introduction

Livestock transportation by sea involves the movement of live animals most commonly cattle, sheep, and goats across maritime routes using vessels specially built or retrofitted to accommodate their physiological and behavioural needs. These livestock carriers are fitted with reinforced pens to prevent injury, automated ventilation systems to regulate airflow and temperature, and integrated feeding and watering stations that allow continuous access to nutrition throughout the voyage (FOUR PAWS International, 2023).

International standards governing sea transport of livestock are anchored in the Five Freedoms framework freedom from hunger and thirst; discomfort; pain, injury or disease; fear and distress; and the ability to express normal behaviour. The World Organization for Animal Health (WOAH) Terrestrial Animal Health Code specifies requirements for vessel stability, stocking densities, and journey planning, while the Food and Agriculture Organization (FAO) provides practical guidelines on contingency planning, personnel training, and veterinary supervision (WOAH, 2021; FAO, 2023). Together, these instruments seek to ensure that every stage from pre-boarding health checks to post-disembarkation handling is conducted with animal welfare as the paramount consideration.

In Tanzania, livestock production underpins both rural livelihoods and national food security. The sector contributes roughly 5 percent of GDP and supports the livelihoods of over 70 percent of rural households, while also generating export earnings through sales to neighboring countries and island markets (FAO, 2023). Although road networks facilitate most domestic movements, maritime routes are indispensable for connecting Dar es Salaam to Zanzibar, Pemba, and external markets in the Comoros and Middle East. These sea links offer economies of scale for bulk movements, but introduce distinct risks to animal welfare that demand dedicated investigation.

This research therefore concentrates on key welfare determinants at Dar es Salaam Port. Pre-transport handling will be examined through observations of holding pen design, hygiene protocols, and frequency of veterinary inspections. Loading procedures will be analyzed in terms of ramp gradients, personnel training, and handling equipment to identify injury hotspots. On-board conditions encompassing space allowance per animal, air exchange rates, ambient temperature and humidity monitoring, and feed/water delivery systems will be measured against WOAH benchmarks (WOAH, 2021). Voyage durations to principal destinations will be logged to assess cumulative stress exposure.

2. Statement of the problem

Sea transportation is indispensable to Tanzania's livestock sector, providing a cost-effective link between production areas and both domestic and international markets. Major ports such as Dar es Salaam, Tanga, and Mtwara serve as critical nodes where animals are received from hinterland regions, assembled, and loaded onto specialized vessels bound for destinations like the Comoros Islands and beyond (Tanzania Ports Authority, 2025). Farmers and traders depend on these maritime routes to move large herds efficiently, taking advantage of economies of scale that road or air transport cannot match. Yet the very attributes that make sea transport attractive bulk capacity and extended voyage durations also introduce unique welfare risks for live animals.

Crucially, there is a dearth of empirical research examining how these maritime stressors specifically affect Tanzania's livestock trade. While international guidelines prescribe minimum standards for space allowance, ventilation, and journey planning, little is known about the extent to which local operators comply with or diverge from these benchmarks.

2.0 Literature review

The literature review examines the current status of livestock transportation globally, regionally and locally context to study the impact on animal welfare and the potential of solutions recommendations to make good condition.

2.1 Staff Care Quality

In the study, staff care quality was defined as the standard of human–animal interaction and handling competence demonstrated by port personnel during holding and loading, encompassing calm, low-stress handling, correct use of equipment, compliance with standard procedures, and evidence of relevant training. This conceptualization reflected stockmanship research linking handler attitudes and skills to animal fear responses, stress physiology, and welfare outcomes (Ceballos et al., 2018; Acharya et al., 2022), and drew on validated observational tools (e.g., the Stockman's Scorecard) to indicate correct movement, pressure–release, and avoidance of aversive stimuli (Yost et al., 2020).

2.2 Waiting Time Before Loading

In this study, waiting time before loading was defined as the elapsed duration between consignment arrival at the port holding area and the commencement of vessel loading. Conceptually, lairage time influences welfare via a balance between rest/recovery and cumulative stress, dehydration, and thermal load; both very short and prolonged durations can compromise welfare depending on environmental conditions and management (Nicolaisen et al., 2023). Indicators considered under this construct included behavioral agitation, panting or respiratory distress, injuries, and mortality recorded at pen level.

2.3 Holding-pen Shelter Availability

In this study, holding-pen shelter availability was defined as the presence and extent of effective shade or roofing that reduced direct solar load, mitigated radiant heat, and protected animals from precipitation over the occupied pen area. Evidence from recent reviews and trials associated access to shade with lower respiration rates, body temperatures, and panting scores core indicators of reduced heat stress and with improved performance outcomes (Edwards-Callaway et al., 2020; Chauhan et al., 2023). Measurement included a categorical record (present/absent) and an aerial estimate of coverage (e.g., ≥50% of pen surface).

2.4 Theoretical Review

Five Domains Model of Animal Welfare

The study drew on the Five Domains Model as its core welfare theory, because it systematically links physical/functional states to animals' affective (mental) experiences. Recent updates emphasise that welfare assessment should integrate nutrition, physical environment, health, and behavioural interactions to infer likely mental states, thereby offering a coherent lens for interpreting welfare risks and enhancements in real-world supply chains. This framing provided the study with a scientifically current and integrative account of welfare relevant to port settings. (Mellor, 2017).

Job Demands–Resources (JD-R) Theory

The study also applied Job Demands–Resources (JD-R) theory to explain variation in staff care quality as a proximal driver of animal welfare. JD-R posits two pathways: a health-impairment process whereby excessive demands deplete workers' physical and psychological resources, and a motivational process whereby sufficient resources (e.g., training, equipment, supportive climate) foster engagement and performance. This dual-process view offered a rigorous mechanism linking operational context to the quality of handling observed in the port. (Bakker & Demerouti, 2017).

2.5 Empirical review

Global Perspectives on Livestock Transport

Global animal-welfare governance for transport is anchored in the World Organization for Animal Health (WOAH) Terrestrial Animal Health Code, which codifies guiding principles derived from the Five Freedoms and sets minimum standards recognized by Member Countries. The Code contains dedicated chapters for transport by sea, land, and air, specifying expectations for planning, fitness to travel, competent personnel, monitoring, and contingencies (WOAH, 2021). These chapters function as a common baseline that national authorities and industries align with or build upon through their own regulatory instruments and audit schemes, thereby promoting a measure of international consistency. The maritime chapter is particularly pertinent for ruminants moved through export gateways, where long journeys and variable climates elevate risk. The Code's language emphasizes animal-based measures alongside resource-based requirements, reinforcing outcome-focused compliance. Because the Code is updated periodically, it remains a living reference that incorporates advances in science and practice (WOAH, 2021).

Regional Insights: Africa

Regional policy attention to animal movements in Africa has grown as cross-border trade intensifies and disease risks persist. Notably, during the 82nd General Session of the World Organization for Animal Health (WOAH, formerly OIE), the WOAH Regional Commission for Africa selected "Cross-border movements of animals and animal products and their relevance to the epidemiology of animal diseases in Africa" as a technical item for its 2015 Rabat conference, signalling that mobility, controls, and welfare during movements are inseparable from transboundary animal disease management (Bouslikhane, 2015).

Local Studies: Tanzania Insights

Recent reporting highlighted a practical bottleneck for Tanzania–Comoros trade: the temporary absence of regular shipping services between the two countries, which constrained flows and exposed knowledge gaps among traders regarding maritime rules and documentation (Daily News, 2024b). During a diaspora clinic held at the Parliament grounds in Moroni, Tanzania's Ambassador to Comoros, Saidi Yakubu, underscored the twin needs of restoring reliable sailings and raising regulatory awareness, noting interim steps including assurances that, once repaired, MV *Mapinduzi* would operate on the route (Daily News, 2024b). The same report quantified the commercial stakes for Tanzania, citing TZS 148 billion worth of exports to Comoros in 2023, predominantly foodstuffs and live animals an indicator of both demand and

the vulnerability of perishable cargoes to delay (Daily News, 2024b). Together, these developments situated port-side handling and pre-embarkation practices as a welfare-relevant concern when schedules slip or services are irregular.

3.0 Methodology

This study adopted a non-experimental, observational research design with a convergent mixed-methods approach. Quantitatively, it implemented a cross-sectional design with repeated measurements across wet and dry seasons at Dar es Salaam Port to capture climatic variation relevant to welfare outcomes. Qualitatively, it incorporated structured interviews to contextualize operational practices and enforcement. The unit of analysis was the consignment and its associated holding/loading event, aligning directly with the fixed specific objectives: staff care quality, waiting time before loading, and holding-pen shelter availability as determinants of livestock welfare.

Area of Research, this study focused on Dar es Salaam Port in the United Republic of Tanzania, specifically the livestock handling (lairage) and loading areas where consignments are staged immediately prior to embarkation. Observations and measurements were taken at holding pens, staging lanes, and ramps across wet and dry seasons to capture climatic variation relevant to welfare outcomes. The inquiry concentrated on three determinants staff care quality during handling, waiting time before loading as experienced in lairage queues, and holding-pen shelter availability and linked these to animal-based welfare indicators recorded at pen exit and on the ramp. Environmental readings (e.g., heat-index differentials between shaded and unshaded zones), time-motion logs, and structured behavior checklists were used to characterize site conditions and practices. The operational context included national animal-welfare and maritime-transport requirements and the roles of exporters, shipping agents/operators, port authorities, veterinary services, and other competent agencies responsible for inspections and clearance.

Sampling, the study employed a multi-stage sampling strategy aligned to its convergent mixed-methods design. Quantitatively, consecutive sampling captured all eligible export consignments processed at Dar es Salaam Port on scheduled vessel-call days within the study window, with explicit stratification by season (wet/dry) and loading window (morning/afternoon/night) to reflect operational variability; where throughput exceeded observer capacity, a fixed systematic interval (e.g., every second consignment) was applied to minimize selection bias. Within each selected consignment, animals were drawn using systematic random sampling at pen exit (e.g., every 10th head) for welfare scoring, with minimum within-lot targets set to stabilize estimates (cattle ≥30; small ruminants ≥50) and replacements taken only for non-ambulatory or withdrawn animals.

4. Results, findings and discussion

Effect of staff care quality on livestock welfare

This section examines how Staff Care Quality (SCQ) constructed from observed low-stress handling behaviors, SOP compliance, equipment checks, supervisor presence, PPE use, and reverse-scored rough-handling incidents relates to pre-embarkation livestock welfare at Dar es Salaam Port.

Table 4. 1 **Welfare Outcomes By Staff Care Quality Quartile**

Outcome	Q1 (SCQ ≤ 58)	Q2 (59–67)	Q3 (68–76)	Q4 (≥77)
Welfare Index (0–100)	66.9 ± 10.9	71.8 ± 9.8	76.3 ± 9.2	79.6 ± 8.5
Injury prevalence (%)	6.9	5.4	3.9	3.2
Slips/trips/falls (/100 head)	6.1	4.7	3.5	3.0
Respiratory distress (%)	9.4	7.9	6.2	5.3
Dehydration signs (%)	8.5	7.1	5.3	4.6
Downers (/1,000)	1.6	1.2	0.8	0.7

Source: Field Data (2025)

Table 4.4 displays a clear dose–response pattern: higher Staff Care Quality (SCQ) aligns with progressively better welfare. The Welfare Index (WI) rises steadily from 66.9 in the lowest SCQ quartile (Q1) to 79.6 in the highest (Q4) a gain of about +12.7 points (~19%). Adverse events fall in tandem. Compared with Q1, Q4 shows roughly half the slips/trips/falls (3.0 vs. 6.1 per 100 head) and a marked reduction in injury prevalence (3.2% vs. 6.9%). Heat-related signs also ease as SCQ improves: respiratory distress drops from 9.4% to 5.3%, and dehydration signs from 8.5% to 4.6%. Even rare outcomes move in the right direction, with downer cases decreasing from 1.6 to 0.7 per 1,000 head across the gradient.

Impact of waiting time before loading on livestock welfare

This section evaluates how waiting time before loading influences pre-embarkation livestock welfare at Dar es Salaam Port. Waiting exposure is operationalized through the Waiting-Time Index (WTI) a 0–100 composite where higher values indicate shorter, better-managed waits built from lairage duration, ramp-queue minutes, reschedules, within-port moves, and a time-of-day penalty for hot afternoon loading. The analysis first profiles unadjusted waiting patterns by loading window and season (Table 4.7), then estimates adjusted associations between waiting exposures and outcomes using multivariable models (Table 4.8) that control for species, consignment size, season, loading window, and staff care quality. Conceptually, longer lairage and queues are expected to elevate thermal load, thirst, and crowding stress, thereby increasing respiratory distress, dehydration, and handling incidents, while higher WTI should correspond to improved welfare.

Table 4. 2 **Waiting Exposures By Loading Window And Season**

Metric	Night (Wet)	Night (Dry)	Morning (Wet)	Morning (Dry)	Afternoon (Wet)	Afternoon (Dry)
Lairage duration (h)	3.1 ± 1.9	3.8 ± 2.1	3.5 ± 1.8	4.2 ± 2.2	4.6 ± 2.3	5.2 ± 2.5
Ramp queue (min)	22 ± 14	27 ± 16	29 ± 18	34 ± 20	35 ± 21	43 ± 24
Reschedules (count)	0.4 ± 0.7	0.7 ± 0.9	0.6 ± 0.9	0.9 ± 1.1	0.8 ± 1.0	1.2 ± 1.2

Source: Field Data (2025)

Table 4.7 shows a consistent exposure gradient: afternoon–dry season loadings have the longest waits, while night–wet season loadings have the shortest. Lairage rises from 3.1 h at night in the wet season to 5.2 h in the dry-afternoon slot an increase of +2.1 h (~68%). Ramp queues follow the same pattern, nearly

doubling from 22 min (night–wet) to 43 min (afternoon–dry, +21 min ~95%). Reschedules also peak in the afternoon–dry window (1.2 vs 0.4 in night–wet), indicating greater schedule slippage when ambient heat and daytime congestion coincide. Morning values sit between these extremes, but still lengthen in the dry season (e.g., lairage 4.2 h, queue 34 min), suggesting a general seasonal effect with a strong time-of-day overlay.

Effect of holding-pen shelter availability on livestock welfare

This section investigates how holding-pen shelter availability shapes pre-embarkation welfare at Dar es Salaam Port. Shelter performance is operationalized via the Shelter Availability Index (SAI; 0–100), combining shelter presence, shade coverage at peak sun, structural condition, air-movement adequacy, water access, and the shaded–unshaded heat-index differential (reverse-scored so greater cooling improves SAI). The analysis first presents unadjusted patterns by shade-coverage category against heat-linked indicators (Table 4.9), then estimates adjusted associations between SAI (and its components) and welfare outcomes using multivariable models that control for species, consignment size, season, loading window, and staff care quality (Table 4.10). Conceptually, higher SAI is expected to moderate thermal load and thirst by providing effective shade, airflow, and shaded water access, thereby reducing respiratory distress, visible heat-stress signs, dehydration, and related adverse events prior to loading.

Table 4. 3 **Shade Coverage and Heat-Related Outcomes**

Shade coverage at peak sun	Respiratory distress (%)	Heat-stress signs (%)	Dehydration signs (%)	Δ Heat index (unshaded − shaded)
<25%	10.5	22.8	9.7	0.9
25–49%	8.9	18.6	8.1	2.1
50–74%	6.3	13.2	5.7	3.2
≥75%	5.2	11.6	4.9	3.8

Source: Field Data (2025)

Table 4.9 shows a strong, graded relationship between shade coverage in holding pens and heat-related welfare signs. When coverage is <25%, respiratory distress averages 10.5%, heat-stress signs 22.8%, and dehydration signs 9.7%. Each step up in coverage improves outcomes, with the largest gains appearing once pens reach ≥50% shade: at 50–74%, respiratory distress falls to 6.3% and heat-stress signs to 13.2%. At ≥75% coverage the best-performing category respiratory distress drops to 5.2%, heat-stress signs to 11.6%, and dehydration signs to 4.9%. The Δ heat index (unshaded − shaded) also widens with better coverage, from 0.9 where shade is minimal to 3.8 where coverage is extensive, confirming a real micro-climate benefit rather than a nominal structural change.

Integrated Model: Relative Contributions of the Three Determinants

To compare determinants directly, the study estimated an integrated model with WI as the dependent variable and all three indices (SCQ, WTI, SAI) included simultaneously, plus the standard controls. The study also tested interactions (SCQ × WTI; SAI × WTI) to examine whether good handling or shelter moderates the effect of waiting.

Table 4. 4 **Integrated Model of Welfare (OLS With Robust SE)**

Variable	Coefficient (SE)
Staff Care Quality (per 10-pt ↑)	**+1.74*** (0.49)
Waiting-Time Index (per 10-pt ↑)	**+2.01*** (0.53)
Shelter Availability Index (per 10-pt ↑)	**+0.91** (0.39) *
Interaction: SCQ × WTI (centred)	**+0.06** (0.02) **
Interaction: SAI × WTI (centred)	+0.03 (0.02)
Cattle (ref: small ruminants)	−1.11 (0.94)
Consignment size (per 100 head)	−0.38* (0.18)
Dry season (ref: wet)	−1.54* (0.77)
Afternoon loading (ref: night)	−1.82** (0.70)
Constant	66.8*** (2.7)
N consignments	84
R^2	0.47

Source: Field Data (2025)

Table 4.11 ranks the three determinants by their independent contribution to welfare when considered together. A 10-point increase in the Waiting-Time Index (WTI) is associated with +2.01 WI points ($p<0.001$), a 10-point rise in Staff Care Quality (SCQ) with +1.74 WI points ($p<0.001$), and a 10-point rise in the Shelter Availability Index (SAI) with +0.91 WI points ($p<0.05$). Thus, flow/time management exerts the largest marginal effect, followed closely by handling quality, with shelter providing an additional, meaningful buffer. The positive SCQ × WTI interaction (+0.06, $p<0.01$) indicates that good handling partly offsets the harm of longer waits; the SAI × WTI term is smaller and not significant, suggesting shelter helps mainly in an additive way rather than changing the slope of the waiting–welfare link. Controls behave as expected: afternoon loading (−1.82) and dry season (−1.54) depress welfare, while larger consignments reduce WI modestly (−0.38 per additional 100 head); species differences are negligible once context is controlled. Model fit ($R^2 = 0.47$) is strong for operational field data, implying that the three determinants explain a substantial share of welfare variation.

Species-Specific Patterns

Species differences were secondary to the main questions but are relevant for application. Table 4.12 summarizes core indicators by species. Cattle consignments had higher slips/falls and vocalizations but comparable injury prevalence to small ruminants. Goats showed the lowest downer rates; sheep displayed slightly higher respiratory distress in hot afternoons.

Table 4. 5 **Selected Indicators By Species**

Indicator	Cattle (n=48)	Sheep (n=14)	Goats (n=22)
Welfare Index (0–100)	72.5 ± 10.9	74.1 ± 10.2	74.0 ± 11.1

Slips/trips/falls (/100 head)	4.8	3.6	3.2
Injury prevalence (%)	4.9	5.1	4.3
Respiratory distress (%)	7.1	8.0	6.6
Downers (/1,000)	1.4	0.9	0.7

Source: Field Data (2025)

Table 4.12 indicates broadly similar welfare levels across species, with the Welfare Index clustering near the low–mid 70s for cattle (72.5), sheep (74.1), and goats (74.0). Differences emerge in specific indicators consistent with species ergonomics and handling dynamics: cattle exhibit the highest slips/trips/falls (4.8/100 head) and slightly higher downer rates (1.4/1,000), reflecting greater body mass and the higher consequences of pace errors or poor footing on the ramp. Sheep show the highest respiratory distress (8.0%) under hot conditions, aligning with their sensitivity to heat and bunching, while goats post the lowest downer incidence (0.7/1,000) and a marginally lower injury prevalence (4.3%). Overall, the spread is modest, and species means overlap enough that they do not by themselves explain welfare variation observed elsewhere in the chapter.

Findings on the Perceptions and Self-Reported Practice

Perception data provide a parallel view of the port context. Table 4.13 summarizes key questionnaire items aligned to the three determinants. A majority agreed that SOPs exist and are generally followed (71%), but only 58% reported formal low-stress handling training in the past 12 months. On waiting, most respondents cited documentation and vessel scheduling as the primary sources of delay; 62% recommended night or early-morning loading as a welfare measure. For shelter, 54% perceived coverage ≥50% in pens they typically used, and 61% rated ventilation as adequate; however, open comments frequently referenced “hot pockets” and “stagnant corners.”

Table 4. 6 **Selected Questionnaire Results Aligned To Determinants (N = 96)**

Item (percent agreeing/endorsing)	**%**
Handlers received formal low-stress training in last 12 months	58
Supervisors present and active during loading	67
SOPs known and followed in lairage and ramp	71
Average lairage duration ≥4 h in typical operations	49
Average ramp queue time ≥30 min in typical operations	46
Main causes of delay: docs/approvals; vessel timing	64; 57
Preferred loading windows to reduce heat: night/early morning	62
Shelter coverage in pens ≥50%	54
Ventilation adequate (no strong ammonia/stagnant heat)	61
Water points accessible/working during holding	69

Source: Field Data (2025)

Table 4.13 shows respondents' perceptions lining up with the observational data on all three determinants. A majority report SOPs are known and followed (71%) and supervisors are active (67%), yet only 58% confirm formal low-stress handling training in the past year revealing a coverage gap within Staff Care Quality. Nearly half say lairage ≥4 hours (49%) and queues ≥30 minutes (46%), while the top-cited delay drivers are documentation/approvals (64%) and vessel timing (57%), mirroring the longer waits recorded in the dry season and afternoons. On shelter, 54% perceive ≥50% shade and 61% rate ventilation as adequate, but open-ended feedback flags "hot pockets," suggesting uneven airflow across pens despite nominal coverage. The preferred loading windows cluster in night/early morning (62%), consistent with lower heat load and shorter waits observed in those periods.

Discussion: Synthesis of Findings

The findings show that three controllable, port-level determinants staff care quality, waiting time before loading, and holding-pen shelter shape livestock welfare in distinct yet complementary ways immediately prior to embarkation. Waiting time exerts the largest marginal effect on the composite welfare index, reflecting how prolonged lairage and ramp queues accumulate heat load, thirst, and crowding pressure. Staff care quality follows closely, reducing both mechanical risks (injuries, slips/falls) and physiologic strain by keeping movement calm and paced under clear supervision. Shelter contributes an environmental buffer that moderates the local micro-climate, with benefits strongest once shaded floor area reaches at least half of the occupied pen space and airflow remains unobstructed. Importantly, interaction results indicate partial buffering: high-quality handling softens the welfare penalty of unavoidable waits, while adequate shelter stabilizes conditions when queues overlap with hot afternoon periods.

Practical Implications for Dar es Salaam Port

Dar es Salaam Port can translate the evidence into a simple, accountable routine: (i) Scheduling & flow use heat-index triggers to reserve night/early-morning windows in hot months; pre-clear documents before animals arrive; run a visible pen-release board and a live dashboard tracking lairage hours and ramp-queue minutes with alert thresholds (e.g., lairage >4 h or queue >30 min ⇒ re-sequence or re-time). (ii) Briefings & supervision conduct a 5-minute toolbox talk before each loading block, designate a named supervisor at the ramp (pace, signals, incident response), and record rough-handling incidents per 100 head as a standing KPI. (iii) Shelter & micro-climate achieve ≥50% shaded floor area at peak sun, keep covers intact, clear obstructions for airflow, and relocate water troughs into shade; check shade and ventilation daily between 11:00–15:00. (iv) Footing & equipment maintain non-slip, dry lanes, confirm lighting for night loads, and pre-position gates, mats, and radios; add ramp-condition checks to the SOP sign-off. (v) Monitoring & feedback log SCQ, WTI, SAI, and WI per consignment, plot weekly run-charts, and trigger immediate corrective actions when metrics breach thresholds.

4. Summary of the Study

This study assessed pre-embarkation livestock welfare at Dar es Salaam Port with a focus on three controllable determinants within port influence: staff care quality, waiting time before loading, and holding-pen shelter availability. A non-experimental, observational design with a convergent mixed-methods approach generated complementary quantitative and qualitative evidence. Quantitatively,

structured field observations covered 84 consignments of cattle, sheep, and goats across wet and dry seasons; a structured questionnaire was completed by 96 role-holders (ship operators/agents, exporters, government/authority personnel, consultants/technical); and 20 semi-structured interviews were conducted with handlers and supervisors, transport representatives, ship agents, port/authority officers, and official veterinarians. The consignment + loading event served as the unit of analysis to align directly with the study objectives and the operational setting of lairage and ramp work.

Findings show that all three determinants exert independent and complementary effects on welfare immediately before embarkation. Waiting time displayed the largest marginal association with WI, followed by staff care quality, then shelter. Interaction analysis indicated that high-quality handling partly buffers welfare losses when waits cannot be avoided, while adequate shelter provides a foundational environmental cushion especially during hot afternoon periods when queues lengthen.

5.0 Conclusions

The evidence demonstrates that livestock welfare at Dar es Salaam Port immediately before embarkation is materially and measurably shaped by three determinants that lie squarely within port influence: how people handle animals, how long animals wait, and the micro-climate of the holding pens. Among these, time in system (lairage and ramp queues) exerts the largest single effect on welfare, underscoring the centrality of scheduling discipline, pre-clearance of documents, and predictable pen-release sequencing. Staff care quality follows closely, reducing both mechanical risks (injuries, slips/falls) and physiological strain by keeping movement calm, coordinated, and well supervised. Shelter functions as an environmental buffer that reduces heat load and dehydration, with the most notable improvements once shaded floor area reaches at least half of the occupied pen space and airflow is unobstructed.

The determinants are independent and complementary. When waits cannot be eliminated for example, during congestion or fixed vessel windows high-quality handling provides partial protection; when heat peaks in the afternoon, effective shelter keeps local conditions within tolerable bounds. Seasonal and time-of-day patterns (dry season, afternoon loading) amplify risks in predictable ways, reinforcing that tactical scheduling changes can produce outsized benefits. Importantly, observed associations were robust to multiple specifications, and qualitative accounts explained why the changes work in practice. Taken together, the conclusions support a stacked strategy optimize flow, elevate handling, and secure shelter as the most effective and achievable route to sustained welfare improvement at the port's land–sea interface.

5.1 Recommendations

Prioritize flow optimization as the first lever, then lock in people-and-place improvements.

The port should institutionalize pre-arrival document verification and operate a visible, real-time pen-release board to sequence consignments, thereby shortening lairage and ramp queues. During hot months, adopt heat-index triggers that shift loads to night or early-morning windows, protecting animals from peak thermal stress without waiting for major infrastructure upgrades. These organizational steps are low cost, rapidly deployable, and based on the study's estimates likely to deliver immediate gains in the welfare index while reducing the odds of respiratory distress and dehydration.

Embed high-quality handling through routine briefings and visible supervision.
Implement a five-minute toolbox talk before each loading block to set pace, roles, and signals, and assign a named supervisor at the ramp who is accountable for calm flow, SOP adherence, and incident response. Enforce equipment and footing checks (non-slip mats, dry lanes, intact rails, functional lighting) as part of SOP sign-off. These practices lift Staff Care Quality scores and translate into fewer slips/falls and injuries. Make training in low-stress handling recurrent, close documented gaps in coverage, and use simple event KPIs (e.g., rough-handling incidents per 100 head) to maintain standards over time.

Achieve a practical shelter threshold and improve micro-Climate where animals actually stand
Aim for ≥50% shaded floor area in occupied pens at peak sun, maintain roofing and shade sails, and clear obstructions to airflow to eliminate heat pockets. Relocate water points under shade so animals can drink without standing in hot zones. These low-to-moderate cost upgrades produce measurable reductions in heat-stress and dehydration indicators and are especially valuable when afternoon queues are unavoidable. Check shade coverage and ventilation daily (11:00–15:00) and repair defects promptly.

Institutionalize measurement and feedback to sustain gains
Track the study's indices as operational KPIs WTI (flow), SCQ (handling), SAI (shelter), and WI (outcomes) for every consignment or loading block. Display weekly run-charts to detect regression early; set alert thresholds (e.g., lairage >4 h, queue >30 min) that trigger re-sequencing or re-timing; and assign named owners (operations lead, lairage supervisor, veterinary officer) to close the loop. Periodic spot observations and short refresher briefings keep behaviors aligned with SOPs and national welfare obligations. By treating flow, handling, and shelter as measurable processes rather than one-off fixes, the port can embed welfare improvements into everyday practice and deliver a more reliable, humane export interface.

REFERENCES

1. Akman, S. (2023). Sampling frame.
2. Animal Welfare Institute. (2020). Monitoring international transport of farm animals. Animal Welfare Institute.
3. Australian Maritime Safety Authority. (2018). Marine Order 43: Cargo and cargo handling Livestock (2018). Australian Government.
4. Bouslikhane, M. (2015). Cross-border movements of animals and animal products and their relevance to the epidemiology of animal diseases in Africa. World Organisation for Animal Health (WOAH).
5. Carnovale, F., & Phillips, C. J. C. (2020). The effects of heat stress on sheep welfare during live export voyages from Australia to the Middle East.
6. Daily News. (2024, August 9). Lack of ships between Tanzania, Comoros disrupts trade. https://dailynews.co.tz/lack-of-ships-between-tanzania-comoros-disrupts-trade/
7. Food and Agriculture Organization of the United Nations. (2023). Livestock transportation and slaughter practices: Practical guidelines for Asia and the Pacific region. FAO.
8. FOUR PAWS International. (2023, September 27). Live animal transport by sea. https://www.four-paws.org/campaigns-topics/campaigns/live-animal-transport/live-animal-transport-by-sea

9. Galanakis, C. M. (2019). Saving food: Production, supply chain, food waste and food consumption. Academic Press. https://www.sciencedirect.com/
10. Garrigus, W. P., & Holden, P. J. (2025). Livestock farming. In Encyclopaedia Britannica. https://www.britannica.com
11. Goodloading. (2024, June 24). What is sea transport? https://www.goodloading.com/en/blog/containers/what-is-sea-transport/
12. International Chamber of Shipping. (2024). Common guidance on the presentation and loading. International Chamber of Shipping.
13. Jain, N. (2023, September 8). What is a research design? IdeaScale. https://ideascale.com/about-ideascale
14. Karthick, S. (2022). Sample size determination for single-proportion studies: A practical note.
15. Menczer, K. (2008). Long-distance transport and welfare of farm animals.
16. Merriam-Webster. (2025, February 22). Questionnaire. https://www.merriam-webster.com/dictionary/questionnaire
17. NSPCA (National Council of SPCAs, South Africa). (2024). Position and updates on sea shipments to Mauritius. NSPCA.
18. Senturtun, E. (2020). The welfare of livestock transported by ship. The Veterinary Journal, 310–314.
19. Takáčová, D., & Kaluža, M. (2022). Animal welfare during transport: Comparison of mortality during transport. Italian Journal of Animal Science.
20. Tanzania Ports Authority. (2025, January). Official website. https://www.ports.go.tz/index.php/en
21. Tanzania Shipping Agencies Corporation (TASAC). (2024). Public advisory on using registered shipping agents for livestock cargo. TASAC.
22. United States Department of Agriculture. (2020). Animal welfare considerations during livestock transport. USDA.
23. WOAH (World Organization for Animal Health). (2021). Terrestrial Animal Health Code (2021 ed.). WOAH. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code/
24. WOAH (World Organization for Animal Health). (2024). Regional trainings on animal transport and slaughter Africa programme. WOAH.