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Kenya Dry Port Design Requirements:
The Case Study of Inland Container Depot Nairobi

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Abstract

This study investigated the design requirements for dry ports in Kenya, focusing on the Inland Container Depot Nairobi (ICDN), and specifically examined how logistics requirements and design considerations impact ICD operations. The study applied ICD and Queueing Theories and adopted a mixed-methods approach to understand the research problem. Stratified random sampling ensured representation across ICDN departments. Primary data was collected using a structured-questionnaire, and both descriptive and inferential analyses were conducted. Hypothesis testing accepted the alternative hypothesis. Regression results showed that design considerations and appropriate design requirements had a positive and significant impact on ICDN operations. The study concluded that ICDN's operational efficiency is significantly influenced by logistics requirements and design considerations. Key factors include seamless container flow, dwell time management, and alignment of infrastructure with customs policies. Design considerations had the greatest impact, underscoring the need for strategic infrastructure planning, enhanced rail integration, and improved stakeholder coordination.

Keywords: Design requirements, ICD operations, logistics requirements

INTRODUCTION

Globalization has significantly increased cargo volumes at ports, expanded containerized transport, caused supply chain delays, raised operational costs, congested terminal access routes, and elevated pollution levels. Container ports, including Inland Container Depots (ICDs), are vital hubs in global supply chains and key to economic growth strategies in developing countries. According to Qi (2021), inland ports primarily serve in container storage and distribution, transport linkages, customs clearance, inspections, and support for both rail and maritime systems. Wan et al. (2022) reported that establishing dry ports led to a 31.5% rise in container volumes between cities and ports.

Poor performance at a single port can disrupt fixed shipping schedules, affecting other ports along the route. This disruption increases trade costs, weakens national and regional competitiveness, and negatively impacts economic growth and poverty reduction (World Bank, 2022). Ports often face disruptions that hinder operations and challenge overall resilience (Rodrigue & Notteboom, 2023).

The Economic and Social Commission for Asia and the Pacific (ESCAP, 2018) outlines key principles for dry port development: design layout, infrastructure and capacity, equipment and facilities, and the institutional, administrative, and regulatory framework. Dry port efficiency and effectiveness depend heavily on the implementation of these principles. Failure to adhere leads to congestion and operational bottlenecks.

Hervas-Peralta et al. (2019) emphasized that modeling and simulation tools can improve infrastructure use and reduce congestion. Similarly, Ha et al. (2017) found that automation enhanced TEU management and increased terminal capacity in Hong Kong.

Roso (2013) found that integrating dry ports with seaports improves overall competitiveness. In

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Malaysia, Jeevan and Roso (2019) demonstrated that linking dry ports with transport networks enhanced seaport competitiveness and supported operations of larger vessels in international trade. However, this restructuring introduced challenges such as congestion, reduced efficiency, capacity limits, inadequate infrastructure funding, and outdated policy frameworks. In Vietnam, Nguyen (2021) identified four dimensions of dry port–seaport integration, information, operational, relational, and geographical, which collectively improved integration and performance.

In Africa, Cronje et al. (2009) identified infrastructure challenges at City Deep in South Africa, including daily truck and train congestion, and recommended prioritizing rail connectivity to encourage multimodal transport. In Nigeria, ICDs face issues such as underfunded container handling equipment, weak intermodal links, inconsistent government policies, outdated MIS systems, and a lack of modern transport units like piggyback and double-stacking wagons (Adejumo, 2020). Tanzania's ports also struggle with bureaucratic delays and outdated cargo handling equipment (Mapunda, 2016).

In Kenya, ICDs are managed by the Kenya Ports Authority (KPA) and accessed via railways, pipelines, and roads, ensuring continuous movement of large container volumes. ICDs are located in Naivasha, Nairobi, Eldoret, and Kisumu and are linked to the Port of Mombasa by rail. According to World Bank (2022), the global port performance index ranked the Port of Mombasa 293rd with a score of -27.174 for vessel and call size, and 296th in statistical indexing with -12.177.

As container trade grows—boosted by cargo on the Standard Gauge Railway (SGR)—ICDs are increasingly crucial for logistics operations and serving landlocked countries. This study focuses on ICDN, currently operating at an optimal capacity of 450,000 TEUs annually. Despite infrastructure upgrades, port logistics and trade performance in 2021 declined, with import cargo dwell time averaging 109 hours—well above the international standard of under 24 hours (NCTTCA, 2021). Although systems like the Integrated Customs Management System (iCMS) were introduced, delays persisted due to limited skilled personnel, affecting cargo transfer and dwell times.

The primary objective of this study was to examine how logistics requirements and design considerations influence the operational efficiency of the ICDN. Specifically, the study investigated the following research questions: (1) What is the impact of logistics requirements on ICDN operations? (2) How do design considerations affect the efficiency of ICDN? Corresponding hypotheses were tested to determine the significance and strength of these relationships.

THEORY

This study is primarily anchored on the Inland Container Depot (ICD) Theory, supported by Queueing Theory, as described below:

Inland Container Depot (ICD) Theory

Terminals that serve seaports but are located inland were initially referred to as dry ports and later commonly termed Inland Container Depots (ICDs). For consistency, this study uses the term ICD. The ICD theory is central to understanding the integration of maritime systems with inland logistics networks. According to Varese et al. (2020), ICDs encompass a range of logistics functions, including manufacturing operations, warehousing, customs processing, and both retail and wholesale distribution. Key success factors for ICDs include strong railway connectivity, efficient transport systems, and the development of value-added services.

Fatimazahra et al. (2016) conceptualized ICD development through the lens of the Product Life Cycle (PLC), which includes five stages: development, introduction, growth, maturity, and decline. These stages provide a framework for designing and improving ICDs by anticipating changes over time and guiding strategic decisions. For this study, the ICD design concept is interpreted as a means of extending the operational life cycle of the depot, forecasting its evolution, and assessing the impact of each phase. Thus, the application of ICD theory in this context helps to understand the design and development requirements of dry ports.

Queueing Theory

Queueing Theory, a branch of applied mathematics, deals with systems involving waiting lines or queues (Ragapriya, 2019). It provides mathematical models that aid in resource planning and decision-making in service operations. According to Ragapriya, queueing approach entail the arrival of units (e.g., customers or cargo), waiting for servicing, and exiting the que after servive. In this study, the theory is applied to the flow and processing of containers within ICDs.

Borthakur and Borthakur (2021) note that queueing models help predict the performance of service systems when arrival and service times are variable. The core characteristics of a queueing system include arrival patterns, service mechanisms, capacity of the system, queue discipline, service stages and number of service channels.

El-Naggar (2010) emphasized that queueing theory supports infrastructure planning at seaports by estimating future demand and determining the optimal number of service points, such as docks. Similarly, Cuadrat (2018) applied the theory to analyze vessel waiting times at Portcemen Terminal, optimizing operational parameters and minimizing system costs. Queueing theory thus offers valuable predictive insights for designing more efficient port and ICD operations. In this study, it is used to understand the service flow within ICDs and inform design principles that reduce congestion and improve operational efficiency.

Variables

The independent variables were Logistics Requirements and Design Considerations, while the dependent variable was ICDN Operational Efficiency.

ICDN Operational Efficiency referred to the effectiveness and productivity of operations at the ICDN, including cargo handling speed, container dwell time, gate control processes, and overall service delivery. It was measured using indicators such as container flow rates, turnaround times, dwell time management, congestion levels, and stakeholder perceptions.

Logistics Requirements represented the systems and practices related to the transportation, handling, tracking, and clearance of cargo and containers within and around the ICDN, including freight movement, documentation processes, and tracking infrastructure. It was measured through aspects such as container flow, gate control efficiency, dwell time management, and section-based cargo segregation.

Design Considerations encompassed the physical and functional layout of ICDN, including infrastructure design, facility zoning, IT systems, and compliance with regulatory standards such as customs policies and rail connectivity. It was assessed by evaluating conformity with customs regulations, capacity of rail and road systems, and the effectiveness of supporting infrastructure and equipment.

Figure 1 presents the relationship between the independent variables and the dependent variable. The independent variables represent the key factors under investigation, each hypothesized to

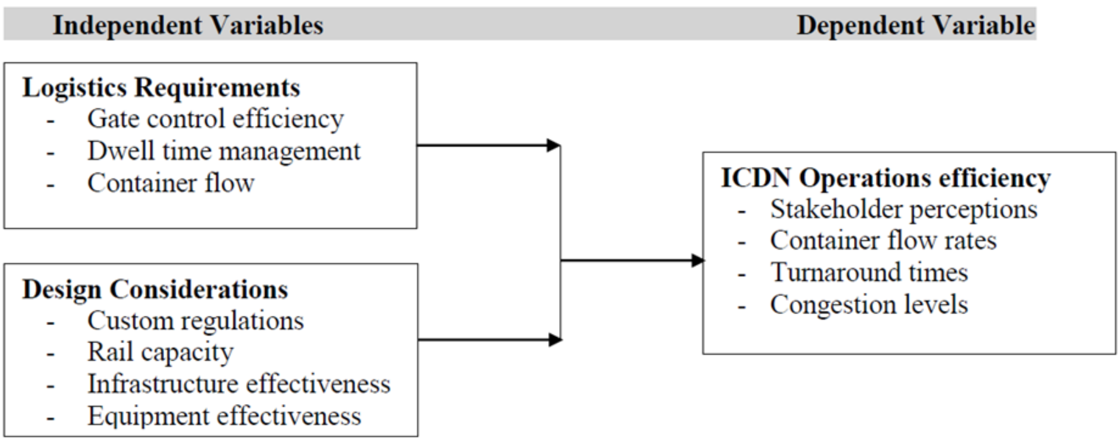

FIGURE 1
Conceptual Framework
Source: Field survey, 2025

influence the outcome measured by the dependent variable.

EMPIRICAL LITERATURE

This study reviewed existing literature on logistics requirements and design considerations related to ICDs.

Logistics Requirements

An effective logistics management platform, covering freight, container, and port logistics, is essential for optimal ICD performance. Poor planning, inefficient design, and weak container transport systems can significantly hinder operations. This section examines logistics performance, dwell time, and supporting technologies.

Song (2021) analyzed the Container Shipping Supply Chain (CSSC), identifying key value-adding elements such as vessels, containers, freight, terminals, and inland logistics. Major challenges included digitalization, decarbonization, ICD location and design, network layout, container storage, demurrage and detention, and inefficiencies in cargo handling. Although these issues were well-documented, the study offered few solutions and called for further evaluation of digital and green technologies to improve CSSC efficiency.

Anwar et al. (2019) examined the adoption of emerging technologies in logistics and terminal operations. Most respondents prioritized AI (94%), followed by cloud computing (29%) and IoT, while blockchain remained under-researched. UNCTAD (2022) projected global smart port market growth from USD 1.9 billion in 2022 to USD 5.7 billion by 2027, emphasizing the need for digital infrastructure investments to address IT security risks. However, developing countries still face barriers such as low connectivity, poor integration, and limited funding.

Ndwiga (2017) evaluated technologies like electronic cargo tracking, scanners, and the single window system, finding that they significantly improved logistics performance. Based on a sample of 171 using stratified random sampling, the study recommended regular IT updates, AI adoption, and alignment with e-government standards.

Dwell time, an indicator of port efficiency, is largely shaped by dry port layout, particularly container yards. Alli (2015) categorized dwell time into operational, transactional, and discretionary types. Using data from Tanzania Ports Authority (TPA) and Revenue Authority (TRA), the study found most cargo was cleared just before the end of the free storage period, with minimal time spent on customs clearance. Recommendations included reducing the free period from 14 to 7 days and imposing stricter demurrage penalties to deter delays.

Similarly, Okwong et al. (2020) assessed cargo dwell time at Onne Seaport, Nigeria, revealing strong links between dwell time, cargo throughput, and equipment availability. Prolonged documentation processes also contributed to delays, with turnaround times consistently exceeding the 2.4-day benchmark, except in 2016.

Design Considerations

The success of an ICD depends not on a universal design but on its ability to ensure operational effectiveness, efficiency, and high-quality service delivery.

Rodrigue et al. (2021) studied dry port objectives in Brazil and identified essential infrastructure components, including rail sidings, container freight stations, yards, boundary walls, gate complexes, roads, maintenance areas, and office buildings. The study emphasized the need for sufficient space to allow container handling equipment to operate efficiently.

Czermanski et al. (2021) conducted a comparative analysis of combined transport (CT) terminals across the Baltic Sea Region, covering nine countries and 150 terminals. They examined parameters such as spatial distribution, operational models, service range, infrastructure, and equipment. The study concluded that access to multimodal transport infrastructure is crucial and that efficient transshipment equipment plays a key role in determining terminal capacity.

Bichou (2021) evaluated South African container terminals' performance and proposed a strategic improvement plan. The study linked performance deterioration to limited technology adoption and inadequate infrastructure. It recommended a phased approach: short-term measures such as improved operational efficiency, performance-based licensing, and pricing strategies; and long-term reforms focusing on institutional restructuring, intermodal integration, and policy realignment.

At the Port of Mombasa, Talam (2021) investigated service delivery determinants using the SERVQUAL model and queuing theory. The study found infrastructure development to be the most significant factor, followed by staff competence, information systems, and customs processes. Recommendations included continuous infrastructure investment, automation to reduce bureaucracy, and ongoing personnel training to improve service delivery.

Inland Container Depot Nairobi

ICDN is located west of the Nairobi Terminal along the Mombasa–Nairobi Standard Gauge SGR, approximately 3.5 kilometers from Nairobi Station. Covering an area of 29 hectares, the depot has a container yard capacity of about 450,000 Twenty-foot Equivalent Units (TEUs) (KRC, 2022).

The facility features a SGR loading and unloading area comprising five railway lines, four for loading and unloading, and one for locomotive movement, with effective track lengths ranging from 900 to 1,005 meters. The container yard is equipped with a 30-meter rail-mounted gantry (RMG) track gauge, supporting the simultaneous handling of three container trains stacked up to five layers high. Below the gantry span are two railway lines and two truck operation lanes, while an additional locomotive line is located between adjacent RMGs. Four rubber-tyred gantry (RTG) crane operation lines support the movement of six container trains (also stacked five high), along with a truck access lane (NCTTCA, 2019).

The depot is equipped with a total of 12 forklifts, including 2 standards and 10 electric models along with 16 specialized forklifts, for container handling, the facility features 4 front cranes specifically for loaded containers, alongside 2 stackers dedicated to empty containers. Additionally, the depot has 8 RTG cranes and 10 reach stackers, to manage large volumes of containerized cargo. Ground transport within the depot is supported by a fleet of 67 trailers and 30 terminal tractors, allowing for smooth internal logistics. Further, the depot is outfitted with 4 RMG cranes, enabling seamless integration with rail transport and facilitating the transfer of containers between different modes of freight (QPCC, 2019).

In terms of layout, ICDN comprises approximately 46,000 m² of container yard space on both sides of the new SGR line, and an auxiliary container yard covering about 70,000 m² **Figure 2**. Two intelligent container gates are located at the east and west ends of the depot, each with its own

FIGURE 2
ICDN location
Source: Google Earth, 2025

gate control and security rooms. Key functional zones include the customs and national inspection warehouse (located west of the east gate), a comprehensive office complex, a police station, a customs inspection area, equipment maintenance zones, a container freight station (CFS), a truck parking lot, and a container security inspection area.

This sophisticated infrastructure enables ICDN to serve as a vital logistics hub, supporting efficient rail and road connectivity for both domestic and regional cargo movement.

RESEARCH METHODS

To evaluate the impact of design and logistics on ICD operations, this study utilized a mixed-methods approach, combining qualitative and quantitative research methods for data collection, analysis, and interpretation. Qualitative methods were used to explore the underlying reasons behind the research questions, providing context and depth. Meanwhile, quantitative methods offered measurable insights into the design requirements of the ICDs in Kenya, with a particular emphasis on the ICDN as a case study.

The research targeted a population of 350 individuals, including 60 Kenya Ports Authority (KPA) officials, 60 ICDN operators, 40 Kenya Revenue Authority (KRA) officials, 100 transport operators, and 120 shippers and freight forwarders (KPA, 2025). From this population, a sample size of 35 respondents was selected. Mugenda and Mugenda (2003) postulate that a sample size of 10 percent to 30 percent of the targeted population is sufficiently representative for drawing valid conclusions. A stratified random sampling technique was employed by categorising the population into relevant subgroups. The subgroups included KPA officials, ICDN operators, KRA officials, transport operators, shippers, and freight forwarders. The respondents were then randomly selected from each subgroup to ensure comprehensive representation of all stakeholder groups.

Both qualitative and quantitative data were collected through structured questionnaires and direct observations of stakeholders at the ICDN, serving as the primary sources of data. The questionnaires, which included a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), were administered electronically. Secondary data, including official reports, publications, and statistical records related to ICDN, were also reviewed.
Statements contained in the 5-point Likert scale were;

Logistics
i. There is a smooth flow of containers in and out of ICDN
ii. Dwell time is managed by reducing free storage time and implementing smooth flow in and outside ICDN
iii. Consignments of exports and imports are managed in distinct sections
iv. The Gate Complex controls the entry and exit of vehicles

Design
i. The design of ICDN adheres to the existing custom regulations and policies
ii. The rail gauge accommodates the required traffic intensity
iii. The information technology infrastructure is regularly updated

ICDN Operations
i. The operations at ICDN enhance customer satisfaction
ii. The dwell time has been significantly reduced
iii. The operations at ICDN contribute to higher revenue collection for government agencies

A pilot study was conducted using online questionnaires with 10 participants. Internal reliability was assessed using Cronbach's alpha, yielding values of 0.824 for design considerations and 0.846 for suitable design requirements, indicating strong consistency (Raykova et al., 2024). Validity was evaluated through expert review by two academic supervisors, whose feedback guided the refinement of the questionnaire (Madhuwanthia et al., 2024).

Collected data were cleaned before analysis. Both descriptive and inferential statistics were used, with results presented in tables. Descriptive analysis involved means and standard deviations, while inferential analysis used Pearson correlation and regression to examine relationships among design considerations, design requirements, and ICDN operational efficiency. Correlation assessed the strength and direction of relationships (Ele et al., 2023), and multiple regression evaluated the combined effect of design considerations and logistics requirements on ICDN efficiency.

FINDINGS

All the questionnaires distributed electronically were 35, out of which, 33 were received back fully completed and suitable for analysis, resulting in a response rate of 94.3%. A 70 percent feedback rate or higher is considered very good for analytical purposes.

Demographic analyses of the respondents showed that participants 22(66.7%) comprised of male while 11(33.3%) were female. Regarding educational background, the highest level of education attained by the respondents was as follows: 20 respondents (60.6%) had a university-level education, 7 respondents (21.2%) had attained tertiary or college-level education, and 6 respondents (18.2%) held professional certifications.

In terms of work experience at ICDN, 13 respondents (39.4%) had less than 5 years of experience, 14 respondents (42.4%) had between 5 and 9 years of experience, 5 respondents (15.2%) had between 10 and 14 years of experience, while only 1 respondent (3%) had 15 or more years of experience.

Descriptive Analysis

The first objective attempted to examine how logistics requirements influences efficiency of the ICDN's operations. The response of the respondents was synthesized descriptively and the outcome were presented in **Table 1**.

Table 1 findings indicate that respondents generally agreed with the statements related to logistics requirements at ICDN. The statement "*There is a smooth flow of containers in and out of ICDN*" had mean (3.69) and standard deviation (0.93), suggesting that most responders agreed that there is a smooth flow of containers in and out of ICDN. The statement on managing dwell time by reducing free storage time and ensuring smooth inbound and outbound flow recorded mean (3.49) and a standard deviation (0.89), thus indicating general agreement among responders.

Similarly, the statement "*Consignments of exports and imports are managed in distinct sections*" had mean (3.60) alongside 0.95 standard deviation, reflecting a positive perception of the management of cargo segregation. Lastly, the statement regarding the Gate Complex's role in controlling vehicle entry and exit attracted mean of 3.69 and 1.05 standard deviation, further showing agreement among the majority of participants.

One respondent emphasized the importance of minimizing system downtime, stating:
"*There is a need to enhance efforts to reduce system downtime. Since the port gates are fully automated, any downtime leads to congestion within the port, affecting trucks that need to enter to return empty containers or drop off export consignments.*"

To improve loading and unloading efficiency at ICDN, one respondent recommended the deployment of advanced handling equipment and better yard organization, stating:

"*High-capacity gantry cranes, reach stackers, and forklifts are needed for faster loading and unloading. There should also be dedicated stacking*

TABLE 1
Descriptive statistics on logistics requirements

Statement	Mean	Standard Deviation
There is a smooth flow of containers in and out of ICDN	3.6857	.93215
Dwell time is managed by reducing free storage time and implementing smooth flow in and outside ICDN	3.4857	.88688
Consignments of exports and imports are managed in distinct sections	3.6000	.94558
The Gate Complex controls the entry and exit of vehicles	3.6857	1.05081

Source: Field survey, 2025

zones for import, export, empty, and transshipment containers, along with automated container tracking systems integrated with both the KPA and KRA systems."

In addition, to enhance cargo movement, another respondent emphasized the importance of improved rail connectivity:

"*Optimized rail connectivity, seamless integration with both the SGR and conventional rail, is essential for efficient cargo movement.*"

The other study objective assessed the impact of design considerations on the operational efficiency of ICDN. Respondents' feedback on Likert scale statements related to design considerations was analyzed using descriptive statistics. The results are presented in **Table 2**.

Table 2 presents the results related to design considerations at ICDN. The statement "*The design of ICDN adheres to existing customs regulations and policies*" received a mean score of 2.91, indicating that most respondents disagreed with the statement. This suggests that the current design of ICDN does not fully align with customs regulations and policies.

The statement "*The rail gauge accommodates the required traffic intensity*" had a mean score of 3.00, reflecting a neutral to slightly positive response, suggesting that respondents generally agreed the rail infrastructure is adequate for current traffic demands.

The statement "*The information technology infrastructure is regularly updated*" scored a mean of 3.46, indicating agreement among respondents, who believe that the IT infrastructure at ICDN is frequently updated.

In addition to the structured responses, participants also offered recommendations for enhancing ICDN's design. One respondent suggested the following:

"*Create green spaces for operations teams and drivers. Explore scalability within the available space. Identify a designated truck parking area to support the truck appointment system and improve queuing efficiency.*"

Another respondent emphasized the importance of specialized zones and reliable infrastructure:
"*Install reefer container zones with reliable power backup and temperature monitoring. Designate areas for hazardous cargo, complete with safety signage and appropriate material handling protocols.*"

A third respondent highlighted the need for expanded parking facilities:
"*Ensure adequate parking and holding areas to accommodate trucks awaiting clearance, thereby minimizing congestion within the ICD.*"

Correlational Analysis

Pearson correlation analysis was conducted to determine the strength as well as the direction of the interrelationship between design requirements and ICDN operation efficiency. Analyses output were as conveyed in **Table 3.**

Table 3 shows that logistics requirements have a strong, positive, and statistically significant relationship with ICDN operations, as revealed by (r) of 0.756 alongside the p-value (0.000). This outcome justifies rejecting the null hypothesis (H01) in favor of accepting the alternative hypothesis:

H_1: There exist a positive and statistically significant interrelationship between logistics requirements

TABLE 2
Descriptive statistics on design considerations

Statement	Mean	Standard Deviation
The design of ICDN adheres to the existing custom regulations and policies	2.9143	1.01087
The rail gauge accommodates the required traffic intensity	3.0000	1.00000
The information technology infrastructure is regularly updated	3.4571	1.09391

Source: Field survey, 2025

TABLE 3
Pearson correlational analysis

		Logistics Requirements	Design Considerations	ICDN Operations
Logistics Requirements	Pearson Correlation	1	.624**	.756**
	Sig. (2-tailed)		.000	.000
	N	33	33	33
Design Considerations	Pearson Correlation	.624**	1	.784**
	Sig. (2-tailed)	.000		.000
	N	33	33	33
ICDN Operations	Pearson Correlation	.756**	.784**	1
	Sig. (2-tailed)	.000	.000	
	N	33	33	33

Source: Field survey, 2025

and ICDN operations.

Similarly, design considerations demonstrated a strong, positive, and statistically significant correlation with ICDN operational efficiency, with an r-value of 0.784 and a p-value of 0.000. As a result, the null hypothesis (H02) rejected, and accepting the alternative hypothesis as follows:

H_2: There is an existing positive and statistically significant interconnection between design considerations and the efficiency of ICDN operations.

Multiple Linear Regression Analysis

Before conducting multiple regression analysis, multicollinearity among the logistics and design variables was assessed using the Variance Inflation Factor (VIF) and Tolerance values. The analysis yielded a Tolerance of 0.611 and a VIF of 1.637 for both variables. Since the Tolerance value was greater than 0.1 and the VIF was below 10, the results indicated no evidence of multicollinearity in the dataset (Meyers et al., 2014).

Table 4 shows an R of 0.855, indicating a strong positive interconnection between the design requirements studied and the predicted values of ICDN operations. The R-squared value of 0.731 indicates that logistics requirements and design considerations together explain 73.1% of the variation in ICDN operational efficiency. This suggests that the regression model used is a good fit for explaining the changes in ICDN operations.

However, 26.9% of the variation in ICDN efficiency is attributed to factors not included in this study. Additionally, the standard error of the estimate was 1.50753, meaning that, on average, the predicted values differ from the actual observed values by approximately 1.51 units. This reflects the model's reasonable accuracy in forecasting ICDN operational efficiency.

Table 5 shows an F-value of 40.856 and p-value (0.000) below the 0.05 level of significance. This indicates that the regression model used in the study is statistically significant and can reliably be used to predict how dry port design requirements influence the operational efficiency of ICDN.

Table 6 presents the regression coefficient results.

TABLE 4
Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.855[a]	.731	.714	1.50753

Source: Field survey, 2025

TABLE 5
ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	185.700	2	92.850	40.856	.000[b]
Residual	68.179	30	2.273		
Total	253.879	32			

Source: Field survey, 2025

TABLE 6
Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.402	1.217		-.330	.744
Logistics requirements	.365	.101	.437	3.612	.001
Design considerations	.547	.129	.511	4.224	.000

Source: Field survey, 2025

The constant term was -0.402, indicating that when both logistics requirements and design considerations are held at zero, the efficiency of ICDN operations would be at -0.402.

The unstandardized coefficient (B) for logistics requirements was 0.365 and a p-value=0.01, while design considerations had a B of 0.547 and a p-value=0.00. Both coefficients are positive, and their corresponding p-values are below the 0.05 significance level, indicating that both logistics requirements and design considerations had a positive and significant influence on the operational efficiency of ICDN.

Based on these results, the regression model was expressed as:

$$Y = -0.402 + 0.365X_1 + 0.547X_2 + \varepsilon$$

Where:
- Y = ICDN operational efficiency
- X_1 = Logistics requirements
- X_2 = Design considerations
- ε = Error term

DISCUSSION

The analysis showed a strong, positive, and statistically significant relationship between logistics requirements and ICDN operations ($r = 0.756$, $p < 0.001$). Respondents generally agreed that there is a smooth flow of containers in and out of the facility, and that dwell time is being managed through improved logistics processes. However, issues such as system downtime and inadequate handling equipment were cited as constraints to optimal logistics performance.

Design considerations demonstrated an even stronger correlation with operational efficiency ($r = 0.784$, $p < 0.001$), underscoring their critical role in ICDN performance. The low mean score (2.91) on the alignment of ICDN's design with customs regulations indicates a significant gap in regulatory compliance. Additionally, stakeholder feedback highlighted the need for enhanced infrastructure, such as designated zones for specific cargo types, improved rail integration, and expanded truck parking areas.

These findings align with existing literature, which emphasizes the importance of infrastructure design, intermodal connectivity, and technological integration in improving port and inland terminal efficiency. The study reinforces the view that a systems-based approach, linking logistics, infrastructure, and regulatory frameworks, is essential for optimizing operational outcomes at inland container depots

CONCLUSION

This study explored the impact of logistics requirements and design considerations on the operational efficiency of the ICDN. Results showed both factors had a statistically significant, positive effect, with design considerations having the strongest correlation. Key operational challenges included misalignment with customs regulations, limited truck holding space, poor rail connectivity, outdated equipment, and intermittent IT system failures. The study concludes that enhancing ICDN's design and infrastructure—especially in regulatory compliance, transport integration, and modernization of equipment and technology—is vital for improving efficiency. Targeted interventions will enhance cargo flow, reduce congestion, and reinforce ICDN's role as a key logistics hub in Kenya and the East African region.

RECOMMENDATIONS

Based on the findings and analysis presented in this study, a series of recommendations have been developed to address the key issues identified. These recommendations are intended to provide practical guidance for stakeholders, inform future policy or practice, and support further research in this area. The following are the specific recommendations:

i. *Align Infrastructure Design with Customs Regulations*: The study found a low compliance score (mean = 2.91) for design adherence to customs policies. Since design considerations had the strongest correlation with operational efficiency (r = 0.784), aligning ICDN infrastructure with customs requirements is critical to streamline clearance processes and reduce delays.

ii. *Improve Rail Connectivity (SGR and Conventional):* Stakeholders emphasized the importance of seamless integration between rail systems. Optimized rail connectivity is essential for efficient cargo flow and reducing reliance on road transport, which contributes to congestion and inefficiency.

iii. *Expand Truck Parking and Holding Areas:* A recurring issue identified was congestion at ICDN due to insufficient space for trucks awaiting clearance. Expanding and organizing these areas is a practical step to immediately reduce bottlenecks and improve overall flow within the depot.

iv. *Modernize Information Technology Systems:* Ensure regular updates and maintenance of IT infrastructure to minimize system downtime and improve the efficiency of automated processes like gate control.

v. *Expand Truck Parking and Holding Areas:* Develop adequate and well-organized parking zones for trucks awaiting clearance to ease queuing and reduce internal congestion at ICDN.

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