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MEASURING THE SERVICE DELIVERY GAP IN INDIAN DRY PORTS: A USER-CENTRIC PERSPECTIVE

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1. Introduction:

The efficiency and effectiveness of dry ports' services in India have emerged as a significant element within the nation's logistics framework. In any nation's dream of emerging as a developed nation with enhanced share of international trade, accelerated economic activities and cost-competitive supply of goods and services, the streamlined and unwavering logistics network complemented by a transparent mechanism for facilitating cross-border trade, remains indispensable for enhancing export competitiveness (Nazia, Javed, Misbah, & Mark, 2023). Hence, the quality of services delivered by trade logistics systems serves as a decisive enabler of international trade. India's policymakers are not oblivious of these systems as enablers and correspondingly are vying for improved quality of logistical services. Some recent initiatives such as GATI Shakti Mission, National Logistics Policy-2022 and National Infrastructure Pipeline are steps in this direction, aiming to not only cut the cost and time of logistics services but improve the quality of services to internationally benchmarked standards (NLP, 2022). These imperatives are further fueled by India's ambitions of emerging as 3rd largest economy of the world by 2027, having already posited as 5th largest economy in 2023.

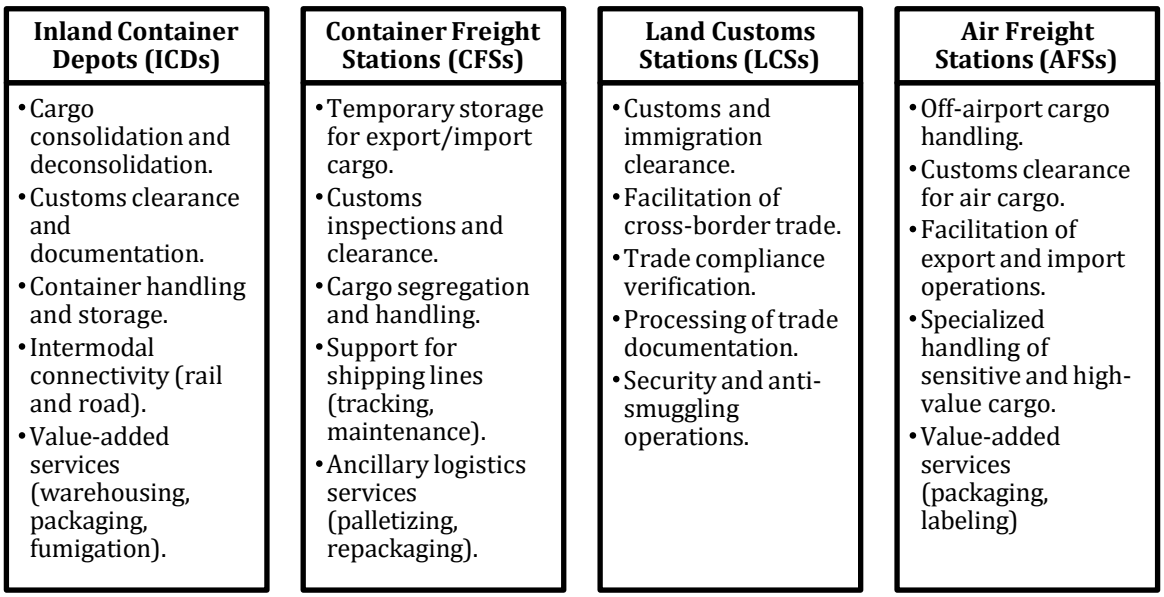
In reference to the above, dry ports have emerged as an important node in strengthening the service quality of internationally traded goods. Moreover, given India's vast geography coupled with presence of small scale enterprises having largely; less than container (LCL) load, along with pronounced regional imbalances highlight the strategic significance of dry ports as inland hubs for cargo consolidation and distribution, crucial for fostering export-driven economic growth (Haralambides & Gujar, 2012). Correspondingly, the dry port infrastructure and service quality has been on the radar of the union government, earmarking USD 82 billion for port infrastructure development by 2035[1]. Complementing this, several state governments have rolled out an array of incentives to promote the establishment of dry ports within their territories. This coordinated policy and investment impetus from the federal and state administrations highlights the sector's criticality. However, the service quality at these dry ports remains an underexplored area, constrained by the complexity of stakeholder interactions and the extensive geographic scope of the dry port network.

Operationally, there are various types of dry ports, inland container depot (ICDs) usually for full container load, container freight stations (CFSs) for less than container load, air freight stations (AFSs) for low volume and high value air transport and land customs

[1] Press Note Details: Press Information Bureau

stations, always locate at international frontier, offering logistics services to India's adjoining nations. Dry ports offer a series of logistics services (figure 1) and correspondingly their defined role is not strict, and the focus is on cutting the cost and time of logistics services and improving the services quality with occasional role reversal among them. Dry ports, fundamentally conceptualized as inland logistical nodes, are equipped with sophisticated cargo-handling infrastructure facilitating a spectrum of services that include cargo consolidation and distribution, temporary storage of containers, customs documentation and clearance, and seamless intermodal transport connectivity. Beyond their logistical functions, these ports act as convergence points for private entities and public institutions, fostering dynamic synergies among diverse stakeholders across the supply chain. Additionally, they provide ancillary services such as warehousing, value-added logistics, and trade facilitation, highlighting their key role in augmenting economic integration and streamlining trade operations.

Figure 1: Specific functions of each type of dry port



Source: (Singh, 2015)

The foundational work on dry port concepts by (Cullinane, Bergqvist, & Wilmsmeier, 2012). They define them as inland terminals where shipping lines issue bills of lading, originally conceived to encompass all cargo types (UNCTAD, 1982). Over time, the concept has evolved, aligning closely with the rise of containerization and innovations in cargo handling (UNCTAD, 1991). As (Cullinane & Wilmsmeier, 2011) note, dry ports replicate seaport operations but are located inland, functioning as critical extensions of seaport lifecycles. (Wilmsmeier & Monios, 2020) argue that when conventional ports reach capacity limits, causing congestion and operational challenges, dry ports alleviate these issues, extending the lifecycle of existing ports. Beyond cargo distribution, dry ports now

serve multifaceted purposes: driving hinterland development, reducing congestion and pollution, promoting modal shifts from road to rail, and functioning as integrated logistics hubs that enhance trade efficiency and connect maritime and inland networks seamlessly. Recounting India's surging economic growth, (Haralambides & Gujar, 2012) underlined the critical need for efficient dry port logistics but elaborate on the inefficiencies that have remained pervasive across the country. This study further elucidates how the Indian government reconciled the dichotomy between fostering foreign private investment and safeguarding domestic operators, illustrating the profound impact of political imperatives on industry competitiveness in developing economies.

Similarly, (Chakrabartty & Sinha, 2022) explore the services aspect of dry port and introduce a Performance Index for Dry Ports (PIDP), a non-parametric method that quantifies dry port performance without scaling or weights, ideal for skewed data. PIDP follows composite index properties, aiding in identifying performance gaps and improving dry ports efficiency over time. (Gudisa, 2016) and (BEKELE, 2019) also highlight the critical role of service quality in the efficacy of dry ports, particularly within landlocked economies like Ethiopia. (Gudisa, 2016) Comparative study of Modjo and Kaliti dry ports employs the SERVQUAL model to assess customer perceptions, identifying gaps in service dimensions such as reliability and responsiveness. Similarly, (BEKELE, 2019) evaluation of Modjo emphasizes the medium-level performance of factors like infrastructure and human capital, recommending strategic leadership to enhance service quality and port functionality. Correspondingly, the assessment of service quality at dry ports, framed through the SERVQUAL model's dimensions—reliability, responsiveness, assurance, empathy, and tangibles—offers a nuanced understanding of their vital role in enhancing international trade competitiveness (Agarwal & Yadav, 2015). Given India’s rising economic aspirations, dry ports must exemplify reliability through reduced processing time and costs, enhancing operational efficiency and stakeholder trust. Similarly, their responsiveness to global trade shifts can improve throughput and customer satisfaction and assurance, backed by skilled personnel, ensures cargo security (Shah, 2013). Lastly, as argued by (Adolf & Cetin, 2012), empathy, through its tailored services, strengthens client relationships, while advanced infrastructure and technology elevate logistics efficiency, reducing costs and improving India's global trade competitiveness.

Reliability in ports, as articulated by (Yeo, Thai, & Roh, 2015), hinges on minimizing delays and costs through seamless operations, even amidst fluctuating demands. By employing robust scheduling, precise inventory management, and efficient customs processes, these ports ensure smooth cargo handling. For example, automated tracking systems and streamlined workflows enhance transparency, cultivating trust among stakeholders, while measures like scheduled pickup appointments reduce idle truck times. Similarly, responsiveness emphasizes the ability of dry ports to manage sudden shifts in trade volumes or regulatory changes, supporting diverse product lines and sustaining

customer satisfaction in dynamic environments. The SERVQUAL model emphasizes empathy as a crucial driver in improving the service quality of Indian dry ports. loyalty (Kamal, Salam, & Elnakib, 2021) suggest that by addressing the varying needs of clients, empathy facilitates tailored services like personalized solutions for smaller firms and expedited processing for larger corporations. In India, empathy extends to understanding the cultural, linguistic, and trade-specific nuances of stakeholders, strengthening client loyalty. This personalized approach fosters deeper client engagement, ensuring users feel valued and encouraging long-term relationships with the ports.

Furthermore, tangibles—modern infrastructure and digital systems—are essential for enhancing service quality in Indian dry ports. (Moldabekova, Beifert, & Sabden, 2019). argue that high-quality facilities and state-of-the-art technology reflect professionalism, enabling dry ports to manage substantial trade volumes efficiently. Investing in such infrastructure enhances responsiveness, minimizes processing times, and elevates the customer experience, thereby instilling confidence among traders. These SERVQUAL dimensions—empathy and tangibles—create a synergistic effect that bolsters the reputation and service standards of Indian dry ports, making service quality a critical determinant of logistics performance. In a volatile global landscape, flexibility in operations is paramount, as evidenced during disruptions like pandemics or geopolitical crises. (Nguyen, Ngo, Huynh, Quoc, & Hoang, 2022) highlight the importance of scaling resources, adapting IT systems, and responding swiftly to seaport closures, demonstrating the resilience of dry ports. Assurance, rooted in clear communication, adherence to protocols, and expert personnel, further builds trust among stakeholders, reinforcing long-term partnerships and ensuring regulatory compliance in a complex global trade environment.

In reference to above, the improved service quality at Indian ports exerts considerable influence on facilitating international trade, enhancing connectivity, alleviating congestion, and fostering cross-border commerce. These benefits ultimately spur economic growth and employment however, the service quality at dry ports—manifested in reduced operational time and costs, alongside superior cargo handling—remains an area often underappreciated in logistics discourse in India. Moreover, the service quality is integral, encompassing facets such as form, place, possession, and price, all of which are indispensable in logistics functions. For trading firms, service quality transcends mere operational service delivery, emerging as a fundamental component of the logistics solution itself. Given the escalating demand for efficient and timely delivery in India, a dissection of the service quality paradigm is imperative, especially considering the discrepancy between user expectations and actual service outcomes. Addressing this gap is critical, as it offers an opportunity to enhance the operational efficacy of dry ports and bolster their competitiveness in an increasingly dynamic trade environment. This study, therefore, delves into the literature of the service delivery gap at dry ports, offering insights that can significantly augment

performance and fortify these vital logistics hubs' standing in the global marketplace. Correspondingly, the research objectives are:

RO1: To adopt a user-centric perspective in identifying critical areas for improvement in service quality and operational efficiency.

RO2: To evaluate and comprehend the service delivery gap in Indian dry ports by analyzing user expectations versus actual performance across key service quality dimensions.

RO3: To suggest the policymakers on stakeholder needs and limitations of existing service quality frameworks in the context of Indian dry ports.

2. Literature Review:

Several well-established models offer structured approaches for assessing and enhancing service quality, providing organizations with frameworks to measure performance and implement improvement strategies. The SERVQUAL model, developed by (Parasuram & et.al, 1985), evaluates service quality across five core dimensions—tangibles, reliability, responsiveness, assurance, and empathy—using gap analysis to compare customer expectations with actual service delivery, yielding actionable insights. In contrast, SERVPERF, introduced by (Cronin & Taylor, 1992), simplifies this by focusing exclusively on service performance, deeming customer evaluations sufficient for quality assessment. The RATER model, akin to SERVQUAL, consolidates these dimensions into a practical framework, emphasizing customer evaluation. Meanwhile, Total Quality Management (TQM) is a comprehensive philosophy stressing continuous improvement across organizational processes, fostering customer satisfaction, employee engagement, and data-driven decision-making. Likewise, ISO 9001 offers a systematic approach to maintaining high-quality service through customer satisfaction, continual improvement, and employee participation. In parallel, Six Sigma leverages statistical tools to minimize defects and process variability, optimize service efficiency and ensure consistent, high-quality outcomes. Each model, while distinct in its focus and methodology, narrate and document the essential role of service quality in organizational success, facilitating enhanced customer experiences and operational excellence across diverse sectors.

Additionally, research on customer satisfaction underlines that cultivating robust customer relationships by delivering exceptional services is indispensable for firms striving to surpass competitors (Kotler, Wong, Saunders, & Armstrong, 2002).. To achieve this, firms must consistently provide superior value that outshines rival offerings. Crucial to this endeavor is customer feedback, which serves as a vital tool in assessing service quality. Elevated service quality frequently correlates with enhanced customer satisfaction, reinforcing the symbiotic relationship between these two elements (Kotler & Keller, 2009). Previous studies have identified two primary determinants of customer satisfaction: the

nature and extent of the service provided (Lee, Lee, & Yoo, 2000). Service quality is universally recognized as a pivotal driver of customer satisfaction (Wilson, Zeithaml, Bitner, & Gremler, 2008). As articulated by (Parasuraman, Zeithaml, & Berry, SERVQAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality, 1988), perceived service quality emerges from customers comparing their expectations with the actual service performance, reflecting an overarching assessment of excellence. This perceived quality, though intrinsically linked to satisfaction, is not synonymous with it. Satisfaction tends to be associated with specific transactions, whereas perceived service quality signifies a more generalized evaluative judgment. Moreover, expectations play an integral role in both customer satisfaction and service quality. In the domain of satisfaction, expectations are regarded as predictions of what is likely to occur during a service encounter. In terms of service quality, they represent the ideal outcomes or aspirations of customers regarding service delivery. These expectations are categorized into three distinct forms: desired service, adequate service, and predicted service, with the latter serving as a benchmark to assess service performance (Zeithaml, Berry, & Parasuraman, 1993).. Customers' perceptions of service quality are shaped during and after service interactions. These perceptions, which are derived from the actual service delivery experiences, play a decisive role in determining satisfaction. If service performance exceeds expectations, it results in satisfaction, and when performance significantly surpasses expectations, it can lead to delight. Conversely, failure to meet expectations invariably results in dissatisfaction (Parasuraman, Zeithaml, & Berry, 1991).

In the specific context of Indian dry ports, service quality plays a crucial role in fostering customer satisfaction and loyalty within a service-centric framework. This quality is gauged by how well the services meet or exceed customer expectations, significantly influencing satisfaction with logistical operations. Service quality at dry ports is a multidimensional construct, encompassing aspects such as tangibles, reliability, responsiveness, assurance, and empathy, as delineated in established service quality models (Yarimoglu, 2014). A review of service quality models reveals a nuanced and comprehensive framework that highlights various dimensions vital for enhancing the customer experience. For instance, (Grönroos, 1984) Technical and Functional Quality Model introduces the "service quality gap," which annotates the importance of aligning technical quality, functional quality, and corporate image to meet customer expectations and ensure effective service delivery. Complementing this, (Parasuram & et.al, 1985) SERVQUAL Gap Model outlines five core dimensions—tangibles, reliability, responsiveness, assurance, and empathy—that capture customer perceptions and highlight discrepancies between expectations and actual service performance. The (Haywood-Farmer, 1988) Attribute Service Quality Model adds another layer of complexity by emphasizing the intangible nature of services and the critical role of customer participation, while also highlighting essential elements such as physical infrastructure, staff behavior, and professional judgment in the quality management process. Similarly, (Brogowicz &

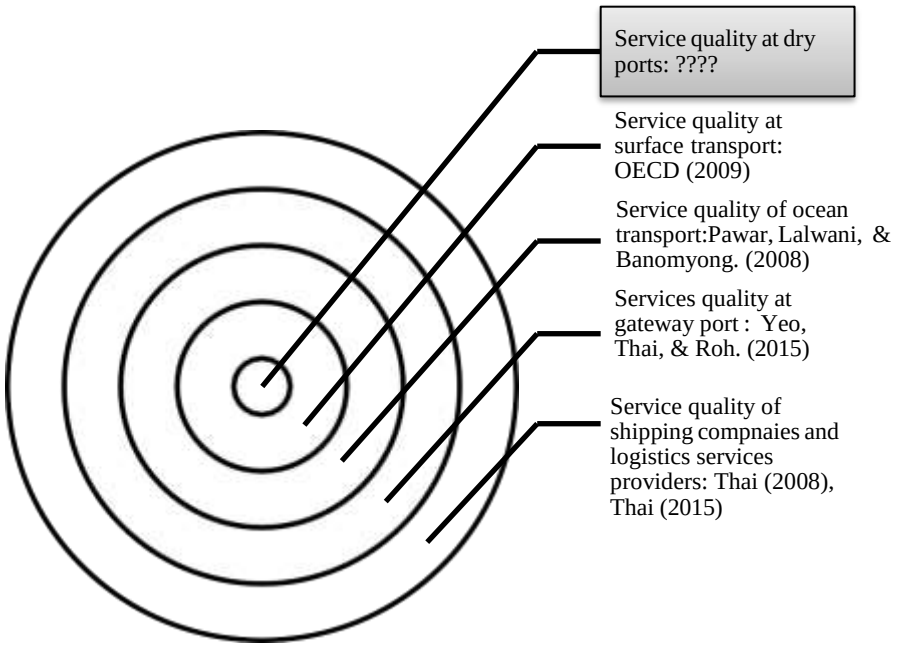
et.al, 1990) stress the alignment of managerial strategies with customer expectations. (Cronin & Taylor, 1992) Performance-Only Model challenges conventional frameworks by centering customer satisfaction as the key metric for evaluating service quality.

Building on these perspectives, (Mattsson, 1992) introduces an ideal standard for measuring service performance, addressing the gaps inherent in traditional metrics. (Teas, 1993) Evaluated Performance and Normed Quality Model critiques reliance on expectations, advocating for alternative methods to provide a more refined and accurate assessment of service quality. Additionally, (Berkley & Gupta, 1994) IT Alignment Model explores the integration of technology with service quality dimensions, equipping organizations with the tools necessary to enhance service delivery. (Dabholkar, 1996) investigation into Technology-Based Self-Service Options stresses the importance of assessing specific service attributes, rather than generalized perceptions, in evaluating service quality. (Philip & Hazlett, 1997) P-C-P Attributes Model categorizes service attributes into pivotal, core, and peripheral, offering a structured framework for understanding customer preferences and expectations. Finally, (Oh, 1999) Integrative Model of Service Quality explores the interrelated dynamics between customer value, satisfaction, and repurchase intentions, providing a comprehensive perspective on the drivers of service excellence. Together, these models constitute a robust and multifaceted framework for improving service quality across various sectors, illustrating the crucial role of understanding customer expectations, aligning managerial efforts, and leveraging technological advancements to ensure superior service delivery.

In examining service quality models within the logistics sector, various academic frameworks accentuate critical, interconnected dimensions that drive effective service delivery in logistics and supply chain operations. (Seth, Vrat, & Deshmukh, 2005) provide a detailed analysis highlighting the significance of service quality models across multiple sectors, particularly in the logistics and transportation domains, including dry ports. Indian dry ports utilize techniques such as customer surveys, feedback systems, and compliance with established quality standards to assess service quality effectively. These methods offer valuable real-time insight into customer experience, enabling operators to pinpoint areas needing improvement. Concurrently, adherence to service quality standards ensures consistent service delivery that meets the diverse expectations of customers, helping Indian dry ports secure a competitive edge in an ever-evolving logistics landscape. (Thai, 2008) The ROPMIS model categorizes port service quality into six dimensions: resources, outcomes, processes, management, image, and social responsibility, underscoring the multifaceted nature of port services, particularly the importance of resource availability and process management. Building on this foundation, (Yeo, Vinh, Thai, & Roh, 2015) developed the Port Service Quality (PSQ) model, incorporating feedback from 313 port users, which highlights the influence of management effectiveness and image on customer satisfaction. The model stresses the roles of operational efficiency and reputation in

delivering quality port services. Further expanding this understanding, (Nguyen, Ngo, Huynh, Quoc, & Hoang, 2022) identified empathy as the most critical service quality criterion among 29 factors, alongside tangibles, assurance, reliability, responsiveness, and service diversity, as determined through expert consultations. In the context of strategic frameworks like the Sultanate of Oman Logistics Strategy 2040, (Balasa, Othman, & Alemu, 2023) emphasize the need to enhance ROPMIS dimensions to elevate port service quality from "satisfactory" to "very satisfactory," stressing the importance of improving resource utilization, managerial capabilities, and social responsibility to achieve future-oriented service excellence. Additionally, (Dua & Sinha, 2018) analyzed India's multimodal transport system, uncovering challenges such as communication gaps, procedural ambiguities, and delays that negatively impact user experience and reduce customer satisfaction. Collectively, these models highlight the intricate dimensions of service quality contributing to operational efficiency, customer satisfaction, and competitive advantage in logistics. Given the absence of specific studies on service quality at Indian dry ports, this research aims to address this gap by investigating whether users in India perceive a gap in service quality when utilizing dry port services.

Figure 2:
Literature review and research gaps identification



Source: Author's

This academic study aims to identify key elements of service quality within the SERVQUAL model, which categorizes service quality into five core dimensions: Tangibles, Reliability, Responsiveness, Assurance, and Empathy, as proposed by (Parasuraman, Zeithaml, & Berry, 1988). In the context of dry ports, these dimensions are

redefined as follows: Tangibles encompass infrastructure, technology, and safety measures critical for fostering an efficient, secure operational environment. Reliability pertains to operational efficiency, timeliness, and accuracy, ensuring services consistently meet user expectations. Responsiveness emphasizes customer service, problem resolution, and communication, highlighting timely and effective interactions. Assurance involves legal compliance, safety protocol adherence, and staff competence, ensuring reliable and skilled operation. Empathy focuses on accessibility, customer engagement, and stakeholder management, underscoring a user-centric approach to address diverse needs. The SERVQUAL framework proves valuable due to its integration of both outcome-based and process-oriented dimensions, making it well-suited for the multifaceted operations of Indian dry ports. Furthermore, alternative models like the ROPMIS (Thai, 2008) and PSQ (Yeo, Thai, & Roh, 2015) emphasize user and operator perspectives, focusing on operational outcomes, processes, management, and social responsibility. While these models effectively analyze user satisfaction, they neglect government stakeholders, a critical omission in the Indian context where government actively supports dry port development. Thus, while insightful, these models fall short in capturing the broader policymaker perspective essential for a holistic service quality assessment. Based on this the hypotheses are:

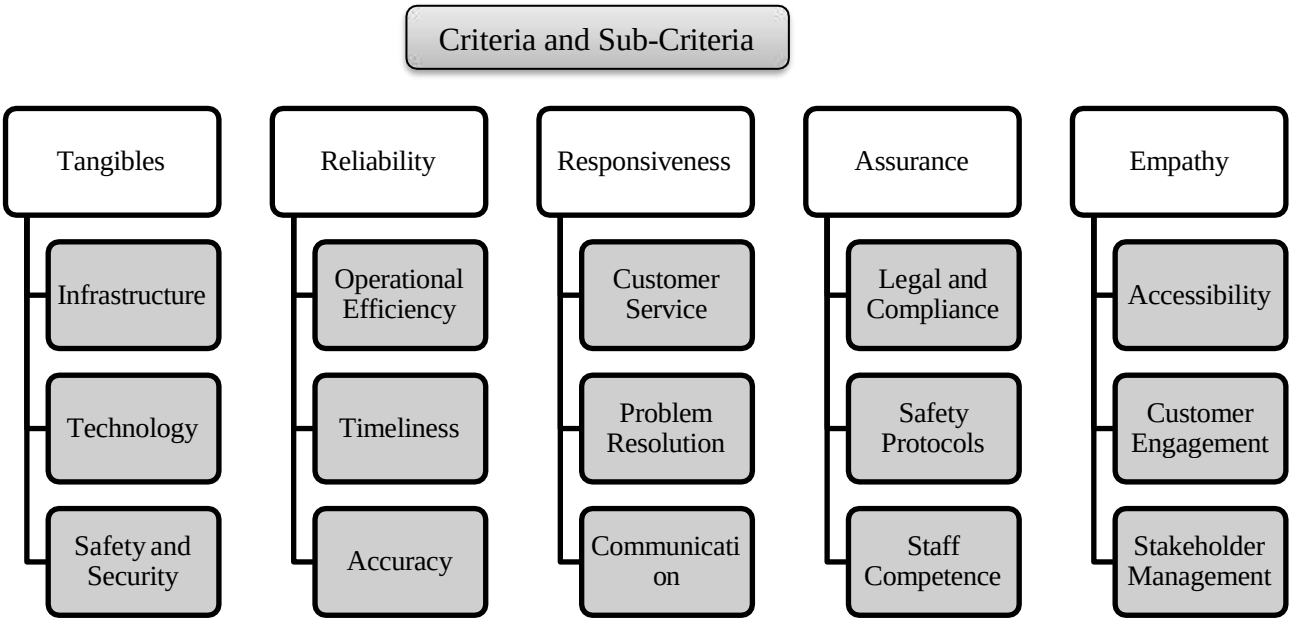
HO-0: All the variables of SERVQUAL model equally impact the perception of service quality amongst port users.

HO-1: All the variables of SERVQUAL model differently impact the perception of service quality amongst port users.

3. Data and Methodology

This paper adopts the SERVQUAL Model proposed by (Parasuram & et.al, 1985) and conducts Structural Equation Modeling (SEM) to evaluate the service quality dimensions of Indian dry port users.

Figure 3:
Variables Influencing Service Quality in India's Dry Ports



Based on above, a questionnaire is designed (appendices 1) to collect the data from the users of the dry port in India.

SEM is an advanced statistical technique that combines factor analysis and multiple regression to analyze complex relationships between observed and latent variables, enabling the evaluation of theoretical models with multiple dependent relationships and the Fit indices in SEM are crucial as they offer quantitative metrics to evaluate model adequacy, helping to refine models for a more accurate representation of theoretical constructs confirmatory factor analysis is employed to validate measurement instruments and assess construct validity, with fit indices used to evaluate model-data fit and guide necessary adjustments. As a fundamental part of SEM, confirmatory factor analysis plays a critical role in validating measurement models for path or structural analyses (Schumacker & Lomax, 2016). Generally, SEM consists of two models namely, measurement model and structural model and before developing structural model it is required to assess a measurement model of latent constructs to measure reliability and validity following a Confirmatory factor analysis.

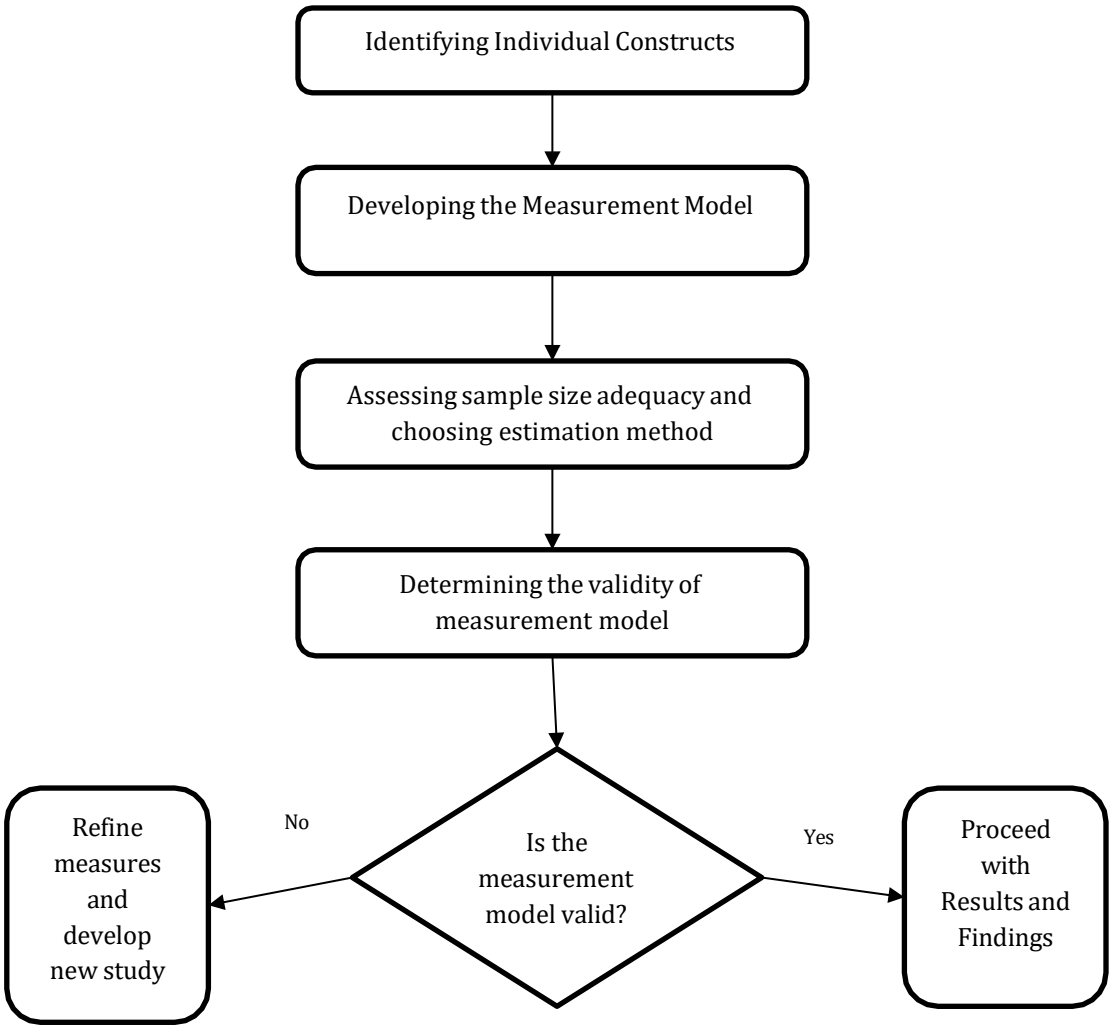
Therefore, Covariance based SEM in AMOS was favored for the analysis to determine a measurement model for validating the constructs. For this purpose, individual constructs namely, Tangibles, Reliability, Responsiveness, Assurance, and Empathy were defined using extant literature and items for specific variables were established to be used as measured variables. Further, measurement model was developed by connecting the constructs with their respective items to draw a path diagram for the measurement model. Construct validity of the measurement model is tested and measures are refined in case of deviations in the study. Finally, the values obtained from the model are assessed and substantive conclusions and recommendations are drawn to support the analysis (Fadhali, 2024). Standardized Regression Weights provide information about the relative strength and the direction of the relationships between the items and the constructs, i.e., more positive weights have greater explanatory power.

When testing Structural Equation Modeling in AMOS, threshold values are commonly referred to evaluate model fit and determine whether the model is acceptable. If thresholds are not met, the model must be refined by examining modification indices or re-specifying paths and most importantly, the acceptable thresholds may vary depending on the field of study, data characteristics, and sample size.

Also, in the case of identifying the absolute fit indices for model fit, several key criteria must be considered such as, the Root Mean Square of Approximation (RMSEA) value to be less than 0.08 while a value less than 0.1 is also acceptable. The Goodness of Fit (GFI) statistics must be greater than 0.95. If the sample size is low the value of Adjusted Goodness of Fit (AGFI) must be greater than 0.8. The results obtained for the measurement model are established based on the threshold values where the RMSEA value is 0.94. Minimum was achieved for the measurement model where the Chi-square value is 608.166, the degree of freedom is 289, and the probability level is 0.000.

Figure 1 depicts the flow for validating a measurement model involving developing the model, assessing sample size and estimation methods, and determining validity. If valid, results are analyzed, if not, measures are refined for a new study. The decision to proceed depends on the model's validity assessment conforming with the reliability of the constructs and items.

Figure 4:
Flow Diagram of the Structural Equation Modeling



3.1 Sampling:

The sampling framework was designed to capture the perspectives of service quality amongst users of dry port across India. A stratified sampling approach was adopted to ensure a comprehensive representation of key dry port facilities, including Inland ICDs, CFSs, and AFSs. This stratification facilitates a holistic understanding of service quality variations across different dry port types and regions.

Data was collected from 156 facilities, which include 90 ICDs, 37 CFSs, and 29 AFSs spread across 15 states and union territories in India. (Table 1) illustrates the distribution of facilities by state and type. States with higher dry port densities, such as Gujarat, Tamil Nadu, and New Delhi, were specifically targeted to account for their pivotal role in India's logistics network. The significance of logistics network can be found in (Roso, Woxenius, & Lumsden, 2008). Conversely, states with fewer facilities, such as Himachal Pradesh and West Bengal, were also included to ensure geographical diversity.

This sample is considered sufficient for conducting Structural Equation Modeling (Hair, Black, Babin, & Anderson, 2010) given that the recommended minimum sample size for such analyses ranges between 100 to 200 observations (Kline, 2015). The distribution of facilities aligns with the broader objective of understanding regional and operational variations in service quality.

The selection of facilities was also guided by their functional relevance and operational scale, leveraging district-level exports and consultations with logistics professionals. The sample ensures proportional representation, reflecting the relative distribution of dry port facilities across different states. The surveys were conducted both virtually and physically.

Table 1. Descriptive statistics of data collected

State	ICD	CFS	AFS	Grand Total
Andhra Pradesh	2	1		3
Gujarat	9	6	3	18
Haryana	16	1		17
Himachal Pradesh	1			1
Karnataka	6		5	11
Kerala	2	2	1	5
Madhya Pradesh	5	2		7
Maharashtra	6	3	3	12
New Delhi	12		8	20
Punjab	9	5		14
Tamil Nadu	9	8	5	22
Telangana	5		3	8
Uttar Pradesh	7	8		15
West Bengal	1	1	1	3

Grand Total	**90**	**37**	**29**	**156**

Measurement Model Equations

Each observed variable (X_i) is related to its latent construct (ξ_j) through the equation:

$$X_i = \lambda_{ij} \xi_j + \delta_i$$

where:
- X_i: Observed variables.
- λ_{ij}: Factor loading representing the strength of the relationship between X_i and ξ_j.
- ξ_j: Latent variable (e.g., Tangibles, Reliability, Responsiveness, Assurance, Empathy).
- δ_i: Measurement error for X_i.

Structural Model Equations

The relationships between latent constructs (ξ_j) are represented as:

$$\xi_j = \Sigma \beta_{jk} \xi_k + \zeta_j$$

where:
- β_{jk}: Path coefficients showing causal relationships between latent constructs.
- ζ_j: Structural error term.

Model Fit Indices

These evaluate how well the hypothesized model fits the data:

1. Root Mean Square Error of Approximation (RMSEA):
$RMSEA = sqrt[(\chi^2 / df) - 1] / (N - 1)$

2. Goodness of Fit Index (GFI):
GFI = 1 - (Residual Sum of Squares / Total Sum of Squares)

3. Adjusted Goodness of Fit Index (AGFI):
AGFI adjusts GFI based on degrees of freedom.

Latent Construct Relationships

Each latent construct is defined by multiple observed variables. For instance:

Tangibles = f(T1, T2, T3, T4, T5)

with corresponding standardized regression weights (λ).

Reliability and Validity Metrics

1. Composite Reliability (CR):
$CR = [(\Sigma \lambda\_i)^2] / [(\Sigma \lambda\_i)^2 + \Sigma \delta\_i]$

2. Average Variance Extracted (AVE):
$AVE = \Sigma \lambda\_i^2 / [\Sigma \lambda\_i^2 + \Sigma \delta\_i]$

3. Discriminant Validity:
Verified if AVE for each construct exceeds inter-construct correlations.

Standardized Regression Weights

Denote the strength of observed variables in reflecting the latent construct:

Loading Factor = $Cov(X\_i, \xi\_j) / sqrt[Var(X\_i) * Var(\xi\_j)]$

Hypotheses Testing

Null (H_0) and alternative (H_1) hypotheses relate to the impact of SERVQUAL dimensions:

1. H_0: All SERVQUAL variables equally impact service quality perception.
2. H_1: SERVQUAL variables impact service quality perception differently.

Variables and Constructs

1. Latent Constructs (SERVQUAL Dimensions): Tangibles, Reliability, Responsiveness, Assurance, Empathy.
2. Observed Variables: Specific items like T1, T2 (Tangibles), R1, R2 (Reliability), etc.,

measured through survey responses.

3. Measurement Errors: Unique variances associated with each observed variable.
4. Fit Indices: RMSEA, GFI, AGFI, Chi-Square (χ^2), Degrees of Freedom (df).

Figure 4 illustrates the relationships between latent constructs and their observed items. Each latent construct namely, Tangibles, Reliability, Responsiveness, Assurance, and Empathy is measured using individual items with arrows indicating their factor loading. Also, the strength of correlations between each construct is shown using the curved double headed arrows. Therefore, the model assesses how well indicators reflect latent variables, aiding in confirmatory factor analysis (CFA) (Brown, 2015)for measurement validity and reliability.

Figure 5:
Covariance based SEM Model

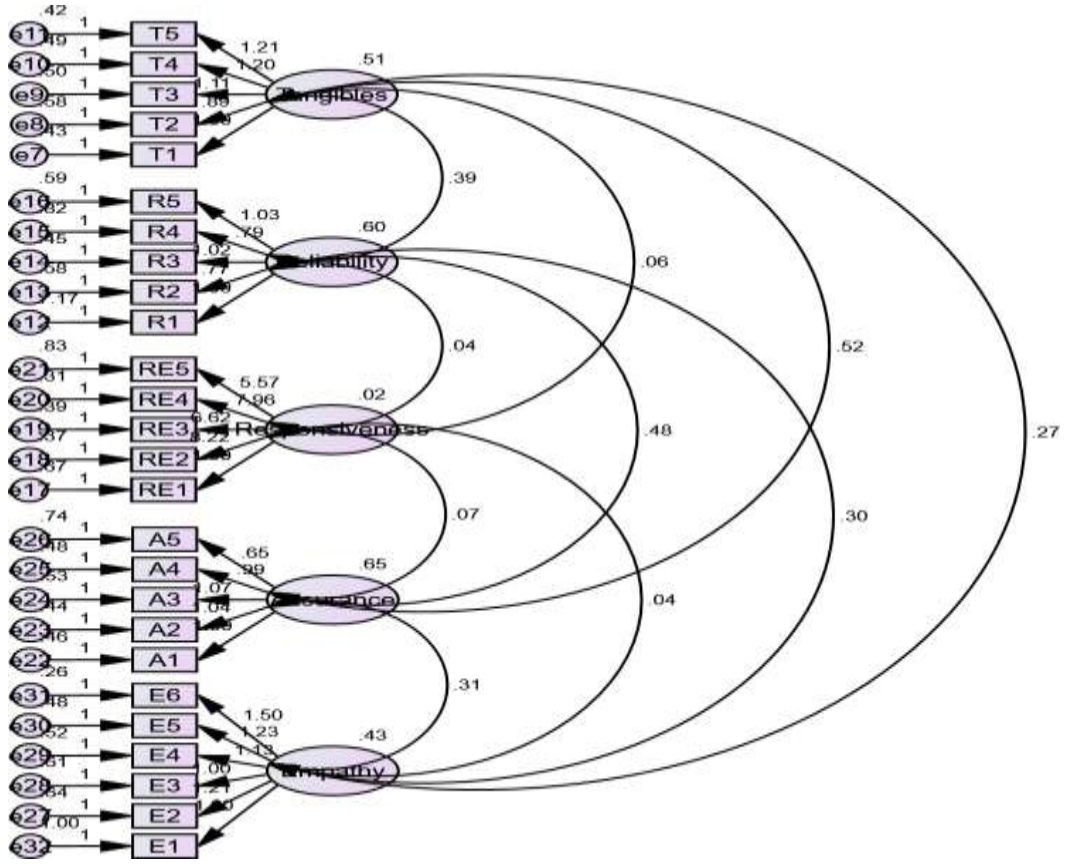


Table 2 presents standardized estimates, standard errors (S.E.), critical ratios (C.R.), and significance values (P) for items measuring latent constructs (**Tangibles, Reliability, Responsiveness, Assurance,** and **Empathy**). The C.R. values (Estimate/S.E.) are greater than 1.96 and **P-values < 0.05** (marked ***), indicate significant factor loadings for most items. Items T1-T5 for Tangibles, R1-R5 for Reliability, and A1-A5 for Assurance show strong loadings. However, Responsiveness items (RE2-RE5) have low C.R. and insignificant P-values, suggesting weaker loadings. Empathy items demonstrate significant loadings, particularly **E6** (1.497), showing strong construct representation. These results assess item reliability and construct validity.

Table 2:
Regression Weights of the Model

Items/Constructs			Estimate	S.E.	C.R.	P	Label
T1	<---	Tangibles	1.000				
T2	<---	Tangibles	.889	.127	7.008	***	
T3	<---	Tangibles	1.108	.135	8.210	***	
T4	<---	Tangibles	1.203	.141	8.546	***	
T5	<---	Tangibles	1.209	.137	8.851	***	
R1	<---	Reliability	1.000				
R2	<---	Reliability	.771	.279	2.762	.006	
R3	<---	Reliability	1.015	.356	2.853	.004	
R4	<---	Reliability	.792	.293	2.708	.007	
R5	<---	Reliability	1.028	.363	2.832	.005	
RE1	<---	Responsiveness	1.000				
RE2	<---	Responsiveness	8.220	5.111	1.608	.108	
RE3	<---	Responsiveness	6.622	4.127	1.605	.109	
RE4	<---	Responsiveness	7.955	4.944	1.609	.108	
RE5	<---	Responsiveness	5.570	3.516	1.584	.113	
A1	<---	Assurance	1.000				
A2	<---	Assurance	1.044	.115	9.108	***	
A3	<---	Assurance	1.066	.121	8.811	***	
A4	<---	Assurance	.993	.114	8.718	***	
A5	<---	Assurance	.652	.113	5.791	***	
E2	<---	Empathy	1.211	.209	5.785	***	
E3	<---	Empathy	.998	.183	5.464	***	
E4	<---	Empathy	1.131	.193	5.847	***	
E5	<---	Empathy	1.232	.204	6.040	**s*	
E6	<---	Empathy	1.497	.230	6.497	***	

Items/Constructs			Estimate	S.E.	C.R.	P	Label
E1	<---	Empathy	1.000				

Further, Table 3 shows standardized factor loadings for five constructs where most items show strong loadings (>0.5), reflecting good construct representation. However, R1 (.278) and RE1 (.150) have weak loadings, indicating poor representation. E6 (.889) and T5 (.801) demonstrate the strongest contributions.

Table 3:
Standardized Regression Weights

Variables/Factors			Estimate
T1	<---	Tangibles	.736
T2	<---	Tangibles	.641
T3	<---	Tangibles	.745
T4	<---	Tangibles	.774
T5	<---	Tangibles	.801
R1	<---	Reliability	.278
R2	<---	Reliability	.617
R3	<---	Reliability	.761
R4	<---	Reliability	.560
R5	<---	Reliability	.719
RE1	<---	Responsiveness	.150
RE2	<---	Responsiveness	.858
RE3	<---	Responsiveness	.798
RE4	<---	Responsiveness	.871
RE5	<---	Responsiveness	.606
A1	<---	Assurance	.765
A2	<---	Assurance	.787
A3	<---	Assurance	.764
A4	<---	Assurance	.757
A5	<---	Assurance	.523
E2	<---	Empathy	.705
E3	<---	Empathy	.642
E4	<---	Empathy	.718
E5	<---	Empathy	.761
E6	<---	Empathy	.889
E1	<---	Empathy	.549

Additionally, Table 4 showcases construct-wise correlations among Tangibles, Reliability, Responsiveness, Assurance, and Empathy. Tangibles highly correlate with Assurance (.904), indicating strong association. Reliability and Empathy (.581) share moderate correlation. The lowest correlation is between Reliability and Responsiveness (.437), suggesting weaker relationships.

Table 4:
Construct wise Correlation

Construct wise Correlation			**Estimate**
Tangibles	<-->	Reliability	.706
Tangibles	<-->	Responsiveness	.728
Tangibles	<-->	Assurance	.904
Tangibles	<-->	Empathy	.581
Reliability	<-->	Responsiveness	.437
Reliability	<-->	Assurance	.765
Reliability	<-->	Empathy	.581
Responsiveness	<-->	Assurance	.695
Responsiveness	<-->	Empathy	.488
Assurance	<-->	Empathy	.587

Table 5 presents reliability and validity metrics for five constructs namely, Assurance, Tangibles, Reliability, Responsiveness, and Empathy. CR (Composite Reliability) values exceed 0.7, indicating good internal consistency. AVE (Average Variance Extracted) values are above 0.5 for most constructs, confirming convergent validity. MSV (Maximum Shared Variance) shows the highest shared variance among constructs, while MaxR(H) indicates the maximum reliability for each construct that is also high. Diagonal values represent square roots of AVE, showing discriminant validity as they exceed off-diagonal correlations, confirming constructs are distinct and valid for further analysis.

Table 5:
Analysis of Model Fit Validity

	CR	**AVE**	**MSV**	**Max R(H)**	**Assurance**	**Tangibles**	**Reliability**	**Responsiveness**	**Empathy**
Assurance	0.845	0.527	0.817	0.860	0.726				
Tangibles	0.859	0.550	0.817	0.865	0.904	0.741			
Reliability	0.733	0.374	0.585	0.783	0.765	0.706	0.611		
Responsiveness	0.813	0.504	0.530	0.892	0.695	0.728	0.437	0.710	

Empathy	0.862	0.516	0.345	0.893	0.587	0.581	0.581	0.488	0.718

4. Conclusion

The service quality of dry ports in India has emerged as a cornerstone in the country's efforts to enhance export competitiveness, align with global trade practices, and strengthen logistics efficiency. This study explored the gap between user expectations and the actual service delivered, shedding light on the critical areas of improvement for the dry port sector. The findings offer a user-centric perspective that combines theoretical models, empirical analysis, and practical implications to contribute meaningfully to the discourse on dry port service quality.

The evaluation, rooted in the SERVQUAL framework, undergirds that the five dimensions—Tangibles, Reliability, Responsiveness, Assurance, and Empathy—are not equally perceived by users. Tangibles, encompassing infrastructure and technology, stood out as the most influential factor shaping user satisfaction. Modern infrastructure, seamless digital systems, and efficient cargo handling not only enhance operational efficiency but also build confidence among users. Investments in robust infrastructure and cutting-edge technology, therefore, must remain a priority for stakeholders aiming to align service quality with global standards.

Reliability, defined by operational consistency and timeliness, was another critical determinant of service quality. Users expect dry ports to deliver consistent and dependable services that minimize delays and cost overruns. The study revealed significant gaps in this dimension, pointing to the need for improved scheduling, inventory management, and coordination between different transport modes. Addressing these reliability concerns will ensure smooth cargo movement and elevate user trust.

Responsiveness, or the ability to adapt to dynamic trade demands, was found to be a mixed bag. While certain ports demonstrated agility in handling urgent shipments and responding to regulatory changes, others lagged, leaving users dissatisfied. Customized problem-solving approaches, real-time communication, and efficient grievance redress mechanisms are essential for fostering a responsive service culture. These measures would not only improve user experiences but also enhance the reputation of Indian dry ports as adaptive and user-friendly logistics hubs.

The Assurance dimension, which reflects the expertise and professionalism of staff, revealed a moderately positive perception. Users value clear communication, adherence to safety protocols, and the ability of logistics personnel to handle complex operations. However, gaps in training and inconsistencies in service delivery emerged as barriers. Continuous skill development programs and adherence to global best practices in service delivery can bolster assurance levels and foster long-term user trust.

Empathy, the provision of personalized and stakeholder-focused services, was identified as the weakest dimension in the SERVQUAL assessment. This indicates a pressing need for dry ports to adopt a more user-centric approach. Understanding the diverse needs of stakeholders, particularly small and medium enterprises, small traders, and offering tailored solutions can significantly enhance user satisfaction. Such initiatives could include multilingual support, cultural sensitivity training, and the adoption of user feedback mechanisms to refine service offerings continuously.

The study also highlighted the broader implications of service quality on India's logistics ecosystem. Enhanced service quality at dry ports can lead to faster cargo processing, reduced costs, and improved export competitiveness. These outcomes directly contribute to India's economic aspirations, including the goal of achieving $2 trillion in exports by 2030. Furthermore, superior service quality can alleviate congestion at seaports, reduce environmental externalities, and promote sustainable logistics practices.

From a policy perspective, the findings call for a holistic approach that integrates infrastructure development, regulatory reforms, and stakeholder engagement. The substantial investments planned in India's dry port infrastructure must be complemented by policies that prioritize service quality. Collaboration between government bodies, private operators, and port users can drive this agenda forward. Regular audits, user satisfaction surveys, and compliance with global quality standards should be institutionalized to ensure continuous improvement.

The use of Structural Equation Modeling in this study provided nuanced insights into the interrelationships between the SERVQUAL dimensions. The findings revealed that while tangibles and reliability had the highest impact on user perceptions, responsiveness and empathy required more focused attention. This reinforces the need for a balanced approach that addresses both operational and experiential aspects of service delivery.

Another significant takeaway is the role of user feedback in shaping service quality. Dry ports must adopt mechanisms for real-time feedback collection and analysis, enabling them to address user concerns promptly. This aligns with global trends in logistics, where user-centric strategies are becoming increasingly critical for competitive differentiation.

The study's findings also have implications for the broader logistics and supply chain industry. By addressing the service quality gaps identified in this research, Indian dry ports can set benchmarks for other logistics hubs, fostering a culture of excellence. This can catalyze India's integration into global value chains, enhancing its positioning in international trade.

The service delivery gap at Indian dry ports presents both challenges and opportunities. By addressing these gaps through targeted interventions, India can not only enhance the performance of its dry ports but also achieve broader economic and strategic objectives. The insights provided by this study serve as a roadmap for stakeholders committed to

elevating the service quality of Indian dry ports, thereby contributing to the nation's trade and economic growth. Ultimately, the pursuit of excellence in service quality is not just a logistical imperative but a strategic necessity in today's interconnected and competitive global landscape.

5. Research Limitations and Future Directions:

The focus on a specific set of user groups (mostly customs house agents and freight forwarders) may limit the generalizability of the findings. Future research could expand the scope to include a broader range of dry ports users (including big exporters and big traders) and stakeholders, including policymakers, and operators. Additionally, longitudinal studies could provide insights into the long-term impact of service quality improvements on user satisfaction and trade performance. Furthermore, the reliance on the SERVQUAL framework, while comprehensive, may not capture all the nuances of service quality in the unique operational and regulatory environment of Indian dry ports. Incorporating alternative models, such as ROPMIS or hybrid frameworks, could yield more holistic insights. Similarly, the study primarily relied on user perceptions, which may introduce biases or subjective interpretations. Future research could integrate objective performance metrics, such as cargo throughput, processing times, and compliance rates, to complement user feedback and offer a more balanced assessment.

Additionally, this study did not deeply explore the impact of external factors, such as policy changes, global supply chain disruptions, and technological advancements, on service quality perceptions. Addressing these dimensions in future research could provide a richer understanding of the dynamic nature of service delivery at dry ports. For example, the role of digital transformation and emerging technologies, such as blockchain and IoT, in enhancing service quality remains an unexplored area with significant potential.

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Appendix 1

Survey on Dry Port Services

Background:

Dear Participant, I am grateful to you for taking part in our survey to study the Service Qualityof Dry Ports in India. I assure you that the data you provide will be used anonymously for research purposes only.

Objective: To study the service quality provided in dry ports

General Information

Q1) Name?

Q2) State?

Q3) Name of the dry port that you mostly do business in?

Q4) Type of Dry Port? (please tick)

- ICD
- CFS
- AFS
- Other: _____(please specify)

Q5) What is your role in the Port? (please tick)

- Importer
- Exporter
- Customs House Agent
- Freight Forwarder
- Other: _____(please specify)

Q6) Type of Dry port?

a) Private b) Public

Instructions: Read before continuing with the survey

Thank you for participating in our service quality survey. Your feedback is crucial in enhancing the service delivery in Indian dry ports. Kindly rate your level of agreement with the following statementson a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).

Rating	Meaning
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

The following survey tries to under the aspect of service quality from below five pillars

1. Tangibles (Physical facilities, equipment, and location.)
2. Reliability (Ability to perform the promised service dependably and accurately)
3. Responsiveness (Willingness to help customers and provide prompt service.)
4. Assurance (Knowledge and courtesy of employees and their ability to convey trust and confidence)
5. Empathy (Caring, individualized attention the firm provides to its customers)

Section 1. Tangibles: Please tick the option that you agree with ✓

T1) The dry port you use is located in a geographically accessible location				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
T2) The dry port you use has modern cargo handling facilities and equipment's				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
T3) The dry port you use has Safe Storage space for cargo				

1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
T4) The dry port you use has provisions for further connectivity (rail, sea port, land way)				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
T5) The dry port you use has good Information technology ability (Comprehensive applications of ICT in customer service)				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)

Section 2. Reliability: Please tick the option that you agree with ✓

R1) The dry port you use consistently delivers services as promised.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
R2) The dry port you use has accurate and reliable cargo handling records. (schedule)				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
R3) The dry port you use effectively communicates Delays and keep disruptions to Minium				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
R4) The dry port you use does documentation related to cargo and operations in accurate and error-free manner.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
R5) The dry port you use manages and handles cargo with precision and care. (safety)				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)

Section 3. Responsiveness: Please tick the option that you agree with ✓

RE1) The dry port you use handles Customer inquiries and complaints efficiently and effectively.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
RE2) In the dry port you use, the port staff are always ready and willing to assist customers.				

1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
RE3) In the dry port you use Issues and problems are resolved promptly and satisfactorily.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
RE4) The dry port you use actively take steps to prevent recurring issues.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
RE5) The dry port you use always keeps you well-informed about relevant developments and changes.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)

Section 4. Assurance: Please tick the option that you agree with ✓

A1) The dry port you use adheres to all legal and regulatory requirements.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
A2) The dry port you use ensures strict and effective safety and security measures.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
A3) The dry port you use has its Personnel adequately trained in safety protocols and procedures.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
A4) The dry port you use staff are confident and competent in providing services.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
A5) The dry port you use provides its services in a manner that instills confidence.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)

Section 5. Empathy: Please tick the option that you agree with ✓

E1) The dry port you use gives personal attention to its customers.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
E2) The dry port you use has offers personalized services to customers.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
E3) The dry port you use seeks Customer feedback, value it, and act upon it.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
E4) The dry port you use has ensures Stakeholder relationships are managed with diligence and care.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
E5) The dry port you use understands the specific needs of its customers.				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)
E6) The dry port you use contains provision for special cargo-related services				
1 (Strongly disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly agree)

Conclusion

Dear participant, thank you very much for your time and answers.

Q7) Did you understand all the questions?

Yes ( ) No ( )

Q8) Please provide any suggestions that could help improve the services at dry ports.