A Study on Air and Sea Consolidation in Logistics Operations: Evidence from Seven Stars Logistics, Chennai

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ABSTRACT

With global trade becoming more complex, air and sea freight consolidation has become a key strategic tool to exporters, importers and logistics service providers. The present study deals with the role and effectiveness of air and sea consolidation in reducing logistics costs and enhancing supply chain performance with special reference to Seven Stars Logistics, a freight forwarding company at Chennai. Data were collected from 60 logistics professionals using a descriptive research design with structured questionnaires. Secondary data were collected from academic journals, industry reports and government portals. The study evaluates the significant variables of consolidation such as volume of shipment, type of cargo, cost efficiency, mode selection of transport, customs coordination, adequacy of infrastructure and digital technology adoption. Statistical analysis such as Cronbach's Alpha reliability testing, Pearson correlation, one-way ANOVA and Chi-Square tests.

Keywords: Freight Consolidation, Air Freight, Sea Freight, Logistics Efficiency, Supply Chain Management, LCL, Freight Forwarding, Chennai, Digital Logistics, Cost Reduction

INTRODUCTION

Logistics is the backbone of international trade and commerce, helping to make sure that goods flow smoothly across geographic borders. Freight forwarding is a specialized arm of logistics and has become a sophisticated service that includes transport management, customs compliance, documentation, cargo insurance and supply chain coordination. There are many different approaches taken by freight forwarders, but one that has been proven to be an effective way to reduce costs and increase reliability of service is consolidation, that is, combining multiple small shipments from a variety of clients into one larger shipment. The global logistics and freight forwarding industry has transformed dramatically with the expansion of e- commerce, technological advancements, and the increase in globalisation. Companies everywhere need to find cost effective and efficient transportation solutions if they are to remain competitive. Here it is cargo consolidation. This is for

the optimization of the usage of container space, to reduce the freight costs per unit and to reduce the operating costs. Air freight consolidation (for time-sensitive and high-value goods) and sea freight consolidation (for bulk and cost-sensitive goods) are essential tools in modern supply chain management.

Given India is one of the fastest growing logistics markets globally, it provides a particularly fertile context for studying consolidation practices. India's logistics industry caters to a wide range of sectors such as manufacturing, pharma, auto, textiles and retail. Chennai, the "Gateway of South India" has strategic location, well developed port, airport, rail and road infrastructure. The Chennai Port, Kamarajar Port and Chennai International Airport handle large amounts of cargo, both exports and imports, together making the city a majorhub for consolidating air and sea freigh Consolidation is of practical relevance, but little academic research exists on air and sea consolidation practices in emerging markets. Most of the current studies are theoretical, based on cost-reduction models and not enough on real operational dynamics, especially for small and medium exporters, the main beneficiaries of consolidation services. This study attempts to fill this void by studying the consolidation practices in Seven Stars Logistics, a professionally managed freight forwarding company, based in Chennai. This study thus adds to the scholarly literature with its region specific, practice driven focus .

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OBJECTIVES OF THE STUDY

Primary Objective

To analyse the role and efficiency of air and sea freight consolidation in reducing logistics costs and improving supply chain performance at Seven Stars Logistics, Chennai.

Secondary Objectives

- To examine the entire process of cargo consolidation in air freight and sea freight modes of transport.
- To assess the effect of consolidation on the reduction of transportation costs for small and medium shipments.
- To examine the related documentation like House Air Waybill (HAWB), Master Air Waybill (MAWB), House Bill of Lading (HBL) and Master Bill of Lading (MBL).

To study the effect of consolidation on lead time and shipment planning.

- To study the role of digital systems such as Electronic Data Interchange (EDI) and ICEGATE in enhancing the efficiency of consolidation.
- To detect the major operational issues faced by freight forwarders at consolidation and deconsolidation stages.

NEED FOR THE STUDY

The model of air and sea consolidation, is important in today's world of globalized trade as logistics efficiency is a key to business competitiveness. The increase in international trade has created a need for efficient and reliable transportation for companies, especially small and medium sized companies with no need to book a full container or just book space on a charter. Consolidation is the process of combining a number of smaller shipments into one shipment. This allows a number of shippers to share the freight cost and also increases space utilisation.

Chennai logistics ecosystem has large clusters of exporters, importers, container freight stations (CFS) and freight forwarding agents. These clusters provide opportunities as well as challenges for consolidation management. Knowing how organisations such as Seven Stars Logistics manage these dynamics is key to identifying best practice and operational improvements. The rapid rollout of digital platforms, customs automation systems and e-documentation tools also necessitates a review of the impact of technology adoption

on consolidation efficiency. This study responds to these practical and academic needs by providing an empirical-based analysis of consolidation operations specific to the region

REVIEW OF LITERATURE

The academic literature on freight consolidation encompasses theoretical optimisation models, operational case studies and technological analyses. The following review summarizes major contributions relevant to this study .

Min and Cooper (1990) provided some of the basic understanding on consolidation as a cost reduction strategy. They showed that consolidation of small shipments into larger loads considerably reduces transportation costs and increases vehicle utilization. They too indicated a need for better route planning and better use of resources, especially in deregulated transport markets.

The role of logistics and freight forwarding in the management of flow of goods from point of origin to point of consumption was discussed by Alapati and Greeshma (2016). They said consolidation is particularly helpful for smaller companies that don't have enough cargo to fill a full container or airplane. Their research underlined consolidation as a mechanism for the inclusion of SME's in international trade.

Yençak (2015) studied the consolidation of air cargo to reduce the handling and holding costs in international cargo hubs. The study shows that optimal consolidation decisions are sensitive to the network structure, gateway capacity and routing strategies. "Good planning can optimize cost saving while guaranteeing delivery reliability."

Feng, Li and Shen (2015) reviewed air cargo operations in detail and found that most studies are on airline operations instead of the role of the forwarder in consolidation. They called for greater attention to operational aspects of consolidation, such as demand uncertainty and real-time decision-making.

Zhu, Wu, Smith and Luo (2022) studied the hub-based air cargo consolidation and showed that the uncertainty in cargo demand and decision of advance booking have significant impact on the consolidation efficiency and cost optimisation. Their work showed the importance of demand forecast in developing effective consolidation plans.

Sahoo, Bhowmick and Tiwari (2021) formulated mathematical optimization models for consolidated air freight costs and demonstrated the importance of quantitative methods for better decision making in the face of uncertainty of demand and shipment volumes. Their work brought methodological rigor to the literature on consolidation planning .

The work of Angelelli, Archetti, and Peirano (2022) on the air transport unit consolidation problem shows that consolidating several packages into transport units reduces operational costs, improves cargo safety and reduces handling operations, which are directly applicable to the processes of freight forwarders .

Hanbazazah et al. (2018) propose the large-scale consolidation of freight in transit. When considering consolidating, think about: multiple consolidation points, due dates, and when shipments are to be made. The main contribution to the field is the use of advanced optimization models to solve complex multi-points consolidation problems.

The profitability of freight consolidation facilities was researched by Aljohani and Thompson (2021) and the main factors affecting the feasibility of consolidation systems were found to be labour and infrastructure costs. Their study emphasizes the importance of financial planning and demand forecasting for sustainable consolidation operations.

In their paper, Cheng et al. (2025) propose machine learning and optimisation for freight consolidation. They demonstrated how data-driven techniques applied to traditional models can significantly reduce transportation costs and increase planning efficiency, underscoring the increasing importance of artificial intelligence in modern logistics

Recent maritime research (2026) also confirms benefits such as reductions in carbon emissions through the use of AI-based systems to optimise consolidation processes. This body of work reflects a growing alignment

between sustainability goals and operational efficiency within the consolidation space.
Consolidation is a well-known strategy to reduce costs and improve efficiency of the supply chain in the literature in general. There is a serious lack of empirical studies on consolidation practices in South Asian Emerging markets specific to the region especially in view of the fast growing logistics sector of India. This study aims to address this gap.

CONCEPTUAL FRAMEWORK

The conceptual framework of this study is structured around four variable categories that capture the complete consolidation process:

Input Factors	Consolidation Process	Moderating Factors	Outcomes & Impact
• Shipment Volume • Cargo Type • Cost Considerations • Mode Selection	• Cargo Collection • CFS Handling • Grouping & Loading • Documentation	• Regulatory Compliance • Infrastructure Quality • Digital Technology • Forwarder Efficiency	• Cost Reduction • Delivery Performance • Customer Satisfaction • Supply Chain Efficiency

RESEARCH METHODOLOGY

3.1 Research Design

The research design used in this study is descriptive in nature to systematically describe the characteristics, behaviours and relationships of air and sea freight consolidation in logistics operations. As this study is descriptive in nature, it is best suited for this type of research since it allows for a detailed assessment of the current practices without the manipulation of the variables under study. It is a common technique in logistics and supply chain research for modelling operational realities within a specific point of time .

3.2 Data Collection

For primary data collection structured questionnaires were distributed to 60 respondents from the supervisors, managers, executives and other operational staff of Seven Stars Logistics and other logistics organisations in Chennai. The questionnaire consisted of 35 items on a five- point Likert scale (Strongly Agree to Strongly Disagree) and incorporated dimensions such as volume of shipments, cargo type, cost efficiency, mode selection, CFS handling, documentation, regulatory compliance, infrastructure, and digital technology. Convenience sampling was employed, targeting professionals directly involved in consolidation activities. The secondary data were collected from academic journals, logistics industry reports, government portals (including ICEGATE and DGFT) and international organisations like IATA and IMO. These sources provided contextual depth, theoretical foundations and comparative points of reference for the main findings. 3.3

Sample Profile

Designation	Number of Respondents
Supervisor	15
Manager	15
Executive	15

Other	15
Total	**60**

Respondent experience ranged from less than 2 years (33%) to over 10 years (8%), with 42% having 2–5 years of experience. This distribution ensures a reasonable blend of practitioner perspectives across experience levels.

3.4 Analytical Tools

The data were analysed using SPSS. Analytical Techniques Used: (a) Percentage analysis and frequency distribution for descriptive insights (b) Cronbach's Alpha for reliability assessment (c) Descriptive statistics (mean, standard deviation and variance) for variable analysis (d) Chi-Square test for association between categorical variables (e) One-way ANOVA for comparison of group means (f) Pearson correlation analysis for relationships between study variables**.**

DATAANALYSIS AND FINDINGS

4.1 Reliability Analysis

The internal consistency of the 30-item questionnaire scale was tested using Cronbach's Alpha. The calculated value of $\alpha = 0.867$ is considerably higher than the generally accepted value of 0.70, confirming that the measuring tool has high reliability. This is further supported by the standardised alpha value of 0.871. Thus, the null hypothesis of unacceptable internal consistency (H_0: $\alpha < 0.70$) is rejected and the scale is considered appropriate for robust statistical analysis

4.2 Descriptive Statistics — Key Variables

Mean scores for the five central study variables reveal consistently positive perceptions among respondents:

Variable	N	Mean	Std. Dev.	Variance
Consolidation reduces transportation costs	50	4.08	0.748	0.565
CFS handling supports smooth cargo movement	50	4.02	0.714	0.510
Digital documentation improves efficiency	50	4.10	0.700	0.490
EDI systems reduce paperwork and delays	50	3.94	0.770	0.590
Consolidation improves supply chain coordination	50	4.16	0.680	0.462

The mean scores of 3.94 to 4.16 on a 5-point Likert scale show that the respondents are generally agreed with all statements. Supply chain coordination had the highest mean (4.16) denoting the strategic importance of consolidation beyond cost savings. EDI systems had the lowest mean (3.94), perhaps indicating awareness of implementation barriers or partial adoption in practice

4.3 Pearson Correlation Analysis

The Pearson correlation analysis was applied to explore the interrelationships between the five dimensions of the study variable: Input Factors, Consolidation Process, Moderating Factors, Outcomes and Impact. All correlations were statistically significant at the 0.01 level (two-tailed) ranging from $r = 0.571$ to $r = 0.721$.
The strongest correlation was between Outcomes and Impact ($r = 0.721$) confirming that better operational consolidation outcomes, e.g. cost reduction and delivery reliability, translate directly into broader positive

supply chain impact. The high inter-variable correlations are collectively endorsing the structural integrity of the conceptual framework and confirming the systematic interrelationship of the inputs, processes, and moderators of consolidation. Thus, the null hypothesis of no significant correlation (H_0) is rejected.

4.4 Chi-Square Test — Gender and Trade Facilitation Perception

The association between the respondent's gender and the perception of the role of CHA firms in facilitating international trade was examined by using a Chi-Square test. The Pearson Chi-Square value of 7.000 (df = 4, p = 0.136) is greater than the significance threshold of 0.05, indicating no statistically significant association between gender and perception of trade facilitation. The result indicates that the perceptions of service quality with regard to consolidation are similar across gender groups and hence, supports the universality of the study's findings.

4.5 One-Way ANOVA — Age Group and Consolidation Efficiency Perception

A one-way ANOVA was conducted to explore the difference in mean perceptions of consolidation efficiency among the four age groups (18-25, 26-35, 36-45 and above 45 years). The F-value of 1.121 (p = 0.350) shows no statistically significant differences among the groups with age group means between 3.75 and 4.29. The positive assessment of consolidation is valid for all age groups, so that the assessment does not depend on age but rather on professional experience with consolidation processes.

4.6 Selected Survey Findings

The responses to the 35 Likert-scale items in the survey revealed many interesting patterns:

- Almost 67% of respondents either agreed or strongly agreed that shipment volume is a major factor in consolidation planning, reiterating volume as a key driver of consolidation decisions.
- 65% Thought that the method of consolidation depends on the type of cargo. This indicates the importance of the cargo classification in the logistics planning.
- 67% agreed that consolidation reduces transportation costs, which supports the cited rationale of the literature of cost efficiency .

66% agreed that air freight is the choice for urgent shipments. Sea consolidation was the natural mode for large volume, cost sensitive cargo.

- 65% thought digital documentation positively impacted operational efficiency. Sixty-five percent said EDI systems reduce paperwork and delays – showing widespread awareness of the benefits of technology.
- 65% said coordination with customs authorities is effective ▸ 66% said consolidation operations are affected by government regulations ▸ 65% agreed that port and airport infrastructure supports efficient cargo handling. ▸ Infrastructure constraints also induce operation delays for 65%.

OVERALL FINDINGS

All empirical and analytical findings of the study indicate a significant positive association between consolidation practices and logistics performance outcomes. The key findings below summarise the evidence across all dimensions of the investigation: ▸ Freight consolidation is a proven and efficient means of reducing transport costs, particularly for small and medium exporters who cannot fill entire containers or charter exclusive air cargo space.

The two most relevant input factors for decisions on consolidation planning are shipment volume and cargo type. Higher volumes mean better space utilization, economies of scale and thus an increase in efficiency.

The preferred mode of transport for bulk and non-urgent cargoes is sea consolidation (LCL) and we always ship urgent, time-sensitive and high value cargoes by air consolidation. ▸ Digital technologies such as EDI systems, ICEGATE and digital tracking platforms are key to enhancing the speed of the customs processing,

minimizing documentation errors and enhancing operational transparency.
Coordination between freight forwarders, customs authorities, CFS operators and transport providers is identified as a critical success factor in consolidation efficiency.
The quality of infrastructure in ports and airports is a significant factor in the performance of consolidation. Delays in handling and operational bottlenecks are caused by poor facilities, especially in peak seasons.
The quality of consolidation directly affects the customer satisfaction as it influences the delivery speed, safety of cargo and shipment tracking visibility.
The statistical analysis revealed high internal consistency of the measurement instrument ($\alpha = 0.867$) and statistically significant positive correlations of all study variables, thus supporting the conceptual framework.

ECOMMENDATIONS

The empirical results of the study give rise to the following recommendations for the logistics companies, policy makers and freight forwarding professionals involved in air and sea consolidation:

Companies in the logistics sector must invest in full digital tracking systems and automatic documentation platforms to minimize manual errors, improve shipment visibility and expedite customs clearance. Measuring the difference in satisfaction results can be made possible by real-time cargo tracking and proactive customer communication.

- Freight forwarders should focus on better co-ordination mechanisms between transport operators, CFS managers, customs authorities and destination agents. Standardized digital platforms and formalized communication protocols can help mitigate coordination failures and variability in transit times.
- Staff involved in the preparation of documentation and customs compliance need to be trained to reduce clearance delays and avoid costly mistakes. Investment in human capital development provides direct benefits on operations.
- Companies have to develop sophisticated logistics management software including route planning, cargo distribution, schedule management and communication with stakeholders. Technology should be adopted in phased manner and as per capacity of the organisation.
- Adopt a standard approach to contingency planning for peak season demand spikes, port congestion and unexpected transportation disruptions. “Proactive scenario planning reduces the cost of reactive decision making.”
- Shippers should select the mode that is best suited to the cargo type: air consolidation for time-sensitive, high-value cargo and sea consolidation (LCL) for larger, cost-sensitive and non-urgent cargo. Choice of mode for optimal cost-service trade-off. ‣ Policymakers and port authorities must concentrate on infrastructure upgrades, such as improved CFS facilities, berth availability and digital single-window systems, to resolve structural bottlenecks in cargo consolidation and customs processing.

CONCLUSION

The present study has examined the role and effectiveness of air and sea freight consolidation carried out by Seven Stars Logistics, Chennai using a combination of primary survey data, statistical analysis and secondary literature review. The results strongly support the value of consolidation as a strategy to reduce transportation costs, improve the utilization of container and aircraft space, improve coordination across the supply chain, and enhance customer satisfaction. These results corroborate the broader global literature, but also indicate India-specific aspects of regulatory compliance, infrastructure bottlenecks, and patterns of digital adoption. The empirical analysis is consistent with the conceptual framework and supported by Cronbach's Alpha reliability testing, Pearson correlation, one way ANOVA and Chi Square testing. The

systematic interrelation of input factors, processes of consolidation, moderating conditions and performance outcomes is validated. In particular, the high correlation between Outcomes and Impact (r = 0.721) emphasizes the strategic importance of well-implemented consolidation processes.

But the study also points to persistent challenges, including peak-season congestion, infrastructure constraints, regulatory complexity and uneven digital adoption. Both are areas for operational improvement and opportunities for policy intervention. The results indicate more technology integration, more stakeholder collaboration and a more proactive management of risk and complianc as the cornerstones of future consolidation excellence. This study also contributes to the consolidation literature by providing empirical evidence from an under-explored geographical and organisational context, and adds ground-level insights from the logistics sector in South India. This work may be extended in future studies through longitudinal studies, multi-firm comparisons or quantitative modelling of the carbon footprint benefits of consolidation – issues of growing importance in an era of sustainability-driven supply chain transformation

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