Optimization of Container Space Utilization in Full Container Load (FCL) Shipping to Reduce Logistics Costs

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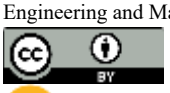

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ABSTRACT

Full Container Load (FCL) transportation is an integral aspect of logistics that can make a great difference to the performance of international companies in the current business environment. Although it is a well-known practice, the issue of underutilized containers poses a considerable concern which results in higher transportation expenses. The purpose of this study was to explore the problem of underutilization of FCL containers, determine the main causes of underutilization, and find out how much money it affects logistics expenses of Wingman Freight Express Pvt. Ltd., a freight forwarding company based in Chennai. The research was conducted using a descriptive and analytical approach, involving a structured questionnaire of 31 people who work in logistics. Results show that FCL containers are underutilized, reaching their total capacity by only 80–85%, with another 15–20% of space wasted during each transportation. The reasons include lack of coordination between departments, the absence of special software for creating load plans, last-minute changes in shipments, and cargo sizes that do not correspond to the standards. Based on a multiple regression analysis, it is stated that the variable representing even as loading planning and technology usage are positively directional, yet individually insignificant statistically. The regression equation accounts for 84.17% of variation ($R^2 = 0.8417$, $F = 47.86$, $p < 0.001$) and is thus validated as having robust predictive capability. Practical suggestions include usage of container space optimization software, standardization of packing techniques, staff training, and cross-functional integration tools. The results offer concrete suggestions to logistics firms seeking to implement cost leadership strategy in managing FCL space.

Efficiency, Supply chain management, Container space management, Logistics technology, Worldtron logistics international private limited

INTRODUCTION

International business transactions make up the cornerstone of growth in the world's economy today. Logistics in shipping plays a vital part in making sure that these transactions are handled efficiently and economically. Full Container Load is one of the widely used methods for carrying goods in international shipping transactions. FCL shipping refers to a process where only a single shipper uses an entire container. It brings several advantages in terms of security, protection from damage during transport, and time efficiency. Nevertheless, one major drawback continues to plague this efficient system – inefficient use of container space.

OBJECTIVES OF THE STUDY

Main Objective:

➜ Analyze and optimize the use of Full Container Load (FCL) shipments at Wingman Freight Express Pvt. Ltd., Chennai for better cost efficiency and improved logistics management.

Secondary Objectives:

➜ Analyze existing methods of container loading at Wingman Freight Express Pvt. Ltd. and identify the inefficiencies of space use in these processes.

➜ Analyze past FCL shipment data including space used in containers, density of load, frequency of shipment and patterns of freight costs.

➜ Analyze the savings and benefits that may be realized by optimizing container usage in FCL operations.

➜ Identify strategies to optimize space usage in shipping containers using modern technological capabilities.

NEED FOR THE STUDY

The logistics industry worldwide is currently operating under a scenario of increasing cost pressures, whereby all aspects of logistics expenditure are under scrutiny for ways of improving efficiency. For logistics organizations handling FCL shipments, the container becomes not only the unit of cost but also the unit of possible improvements to efficiency. It has been found that on an average of 15 to 25 percent of the space within ocean containers remains unused globally, which constitutes a definite loss of money for both the shipper and logistics provider.In the Indian logistics context, this challenge is particularly pronounced. Infrastructure bottlenecks, fragmented supply Chain coordination, technology constraints, and the variety of cargo categories that Indian domestic freight forwarders handle are reasons behind the poor container utilization levels. As an important industrial state in India with regard to the production of cars, textiles, engineering materials, and leather goods, Tamil Nadu is a source of high FCL traffic at the ports of Chennai, Ennore, and Tuticorin. Companies in this market will benefit immensely from even slight increases in container utilization because of the large number of containers shipped each year.

The need for this research arises as a result of the difference between current practice and what is achievable. In this way, this research hopes to help logistics professionals understand how they can increase container utilization levels by presenting them with concrete examples and practical ways of doing so.

REVIEW OF LITERATURE

The initial research on the topic of containerized transport done by Ghaderi & Wang (2007) pointed out that inefficient container loading became the core reason for the increased costs and higher fuel expenses during the transportation of goods. The importance of utilizing systematic planning techniques to increase efficiency and reduce costs of the shipment units has been highlighted within the scope of this research. Thus, this particular study became the foundation of subsequent research on the topic.

Moreover, according to Kumar & Saini (2015), the inefficient logistical performance of freight forwarding companies operating in India is connected to the inefficiency of cargo consolidation and, thus, poor load factors due to non-transparency of the whole process. As a part of the comparison between international logistics operations and those of Indian freight forwarding companies, the researchers proposed that cargo profiling and

visibility could be the first step towards more efficient usage of containers in export-oriented regions.Notteboom & Rodrigue (2009) explored the relationship between port efficiency, inland logistical operations, and efficient use of containers. The authors claimed that inefficiencies in container loading generate secondary consequences, which include increased port congestion due to vessel delays resulting in much higher system

According to Sahin et al. (2014), there are formal mathematical frameworks for optimizing container loading, whereby computer simulations have shown that the use of software solutions can lead to a considerable reduction in empty spaces within FCL shipments especially where the cargoes are irregularly configured. The authors' work provides a quantitative justification of the benefits of using load planning software tools.

On his part, Kaushik & Sharma (2017) studied cost-saving measures in India-based manufacturers and logistics companies and concluded that better container loading can directly translate into cost savings of between 10 and 15 percent per shipment. It is quite notable that this result would be of significance to the local exporters operating out of Tamil Nadu because of the large volumes of their shipments.

According to UNCTAD (2021), in its review on maritime transport, around 20 percent of the total container movements worldwide are caused by repositioning, which is largely attributed to load imbalance. UNCTAD advocated the adoption of digitalization as well as data-based optimization as the core strategies to address this structural problem, arguing that the adoption of algorithms in freight forwarding was highly achievable and economically viable.

Chopra & Meindl (2020) offer a supply chain management model within which container utilization optimization would constitute a critical factor that not only impacts transportation costs but inventory management and even logistics service delivery. This model strengthens the importance of improving the management of container space from the aspect of the economic benefit beyond merely reducing the cost of freight transport.

The internal reports by Wingman Freight Express Pvt. Ltd. showed that the utilization rate of FCL containers had been around 80 to 85 percent on average based on the internal operational evaluation conducted by the company. This internal evidence, on which the current research is based, suggests that underutilization has become a repetitive phenomenon.

RESEARCH METHODOLOGY

3.1 Research Design

This study employs a descriptive and analytical research design in order to comprehensively describe the nature and degree of under-utilization of FCL containers in freight forwarding, as well as to pinpoint the causes behind such under-utilization. The nature of descriptive research design provides an opportunity to study the state of affairs based on the existing practices, without manipulating any variable experimentally, thus being highly appropriate for investigating real-life logistic issues. Meanwhile, the analytical component of the research design allows using statistical methods to discover patterns and correlations within the collected information.

3.2 Sample Size and Sampling Technique

A structured questionnaire survey was conducted among 31 logistics practitioners consisting of freight forwarders, customs brokers, logistics managers, as well as importers/exporters with practical knowledge of freight forwarding services and operations involving FCLs. A non-probability sampling technique known as purposive sampling was applied to make sure that all respondents have enough operational knowledge of the subject matter to be able to answer the survey questions adequately.

3.3 Data Collection Methods

Primary Data:

The primary data was gathered via a structured questionnaire of 26 questions arranged along six different thematic dimensions: container usage, cost management, technology use, compliance with regulations, sustainability issues, and risk management. The answers to these questions were gathered using Likert type and categorical scale responses. Secondary information regarding the research was also collected using direct observation of logistics activities and discussions with employees of Wingman Freight Express Pvt. Ltd., Chennai.

Secondary Data:

The secondary data was collected from various academic papers, industry articles, government publications, and internal company documentation. The major secondary sources for this study include Review of Maritime Transport published by UNCTAD, India's Maritime India Vision 2030, annual statistical data of Chennai Port Trust, and operational reports of Wingman Freight Express Pvt. Ltd.

3.4 Statistics Analysis

Analysis of data included percentage statistics in analyzing data for categorical questions in the survey questionnaire, chi-square tests in evaluating associations between categorical data, and regression analysis in measuring the relationships between organizational and operational variables and outcomes in container loading. Regression analysis involved load planning practice (X1), coordination among departments (X2), and technology use (X3) as independent variables, while container loading success and efficiency were dependent variables.

DATA ANALYSIS AND CONCLUSIONS

4.1 Respondent Profile

The complete sample of 31 respondents belonged to the age group between 20 to 30 years old, indicating an early career professional demographic. The survey was conducted among males only, which might be due to the prevalent gender dynamics of the operational logistics position within the freight forwarding business at Chennai. Survey respondents were postgraduates in logistics or similar fields, and about 87 percent had more than five years of experience in foreign trade, giving them substantial expertise pertaining to the survey content.

4.2 Container Utilization Practices

Based on survey results, it can be concluded that container underutilization within FCL is quite common. In the case of 22 percent of respondents, they claimed to load their FCL container fully all the time; however, 45 percent of respondents mentioned that they sometimes managed to load their containers to capacity. In line with the internal operational statistics of Wingman Freight Express, the average utilization rate of containers is between 80 and 85 percent, thus resulting in 15 to 20 percent wastage.

Manually planned container loading is still the most widespread approach, utilized by more than 50 percent of the surveyed companies. Software-based freight planning accounts for less than 30 percent of container loading approaches used in this sector, illustrating the large gap in technological adoption. In terms of container sizes, both 40-foot and 40-foot high-cube containers are widely used. Mixed cargo with different-sized containers depending on shipment characteristics comes as the third most frequently used option. Reactive void space management is another issue in this context – the most common method after inefficient loading is dunnage/filler use.

4.3 Cost Assessment and Its Implications

Freight costs constitute the highest cost factor influencing FCL performance. Next come loading/unloading, custom duties, and warehouse charges. Most of the participants perform their container utilization cost analysis annually or quarterly. There is no continuous monitoring involved here, which means that no prompt steps can be taken. Nearly one-third of the surveyees do not assess cost per cubic meter and cost per kilogram. This constitutes another problem, making it impossible to calculate the actual financial impact of poor container usage on the business. Therefore, management cannot base its decisions on the figures.

4.4 Technology Adoption

The use of advanced technological solutions in the process of container loading is still low. As many as 32 percent of the participants use manual spreadsheet methods to plan the loading, while 22 percent do not use any software in this process, whereas just 19 percent use advanced software to optimize container loading. The most important features in load planning software include three-dimensional visualization of cargo placement, ERP system integration, and real-time updating. A very large proportion of the survey participants plans to invest in modern logistics technologies during the next twelve months.

4.5 Risk and Sustainability Considerations

Delayed deliveries (reported by 54.8 percent of the survey participants) are viewed as the major risk related to container underutilization; financial losses come second (19.4 percent); legal non-compliance is third (12.9 percent); and damages fourth (12.9 percent). What is particularly interesting is that all 100 percent of respondents have encountered the problem of damages/losses due to the improper loading of containers, with 71 percent of them stating they encounter such incidents either often or occasionally. In terms of sustainability considerations, 93.5 percent of respondents consider carbon footprints of container shipping operations, but just 38.7 percent monitor than operationally embedded.

4.6 Regression Analysis

A multiple regression analysis was performed to investigate the predictive relationship between load planning (X1), interdepartmental coordination (X2), and adoption of technology (X3) on the one hand and container utilization outcome on the other hand. The output of the analysis is presented in the table below:

Predictor	Coefficients	p-value	Significance
Constant	1.3991	1.03E-08	Highly Significant
X1 – Load Planning	0.1908	0.2929	Not Significant
X2 – Coordination	0.5029	0.0004	Significant
X3 – Technology Adoption	0.0624	0.7645	Not Significant

In the above model, the Multiple R is 0.9175, while the R-Square value is 0.8417. Hence, 84.17 percent of the variance in the outcome of the container utilization is explained through these predictor variables. The Adjusted R-Square is 0.8241. The significance of the entire model can be confirmed from the F-

statistic value, which is 47.86, p<0.001 in the ANOVA table. In terms of individual predictors, only interdepartmental coordination (X2) achieves statistical significance at the 5 percent level (coefficient 0.5029, p=0.0004).

COMPREHENSIVE RESULTS

- **FCL containers used at Wingman Freight Express Pvt. Ltd. are generally only used to their 80-85 percent of capacity, with 15-20 percent always left unused per trip.**

- **The common obstacles preventing full capacity in operation involve cargo inconsistency in shape and packaging.**

- **More than half of respondents manually perform calculations when preparing loads, while fewer than 30 percent employ digital methods.**

- **Late changes in shipping plans and a lack of coordination among departments involved in load preparation are mentioned as disruptive factors at the process level.**

- **The most prevalent risk in under-utilizing container space is delivery delay (54.8 percent), while all respondents reported having damaged their containers because of improper load preparation.**

- **Departmental coordination (X2) proves the sole predictor with statistical significance for container utilization (β = 0.5029, p = 0.0004).**

- **The regression model explains 84.17 percent of variance in container utilization performance, validating the multi-faceted and measurable aspect of the challenge.**

- **Sustainable practices are recognized well, although the actual measurements of container-specific carbon footprint have been performed by only 38.7 percent of respondents.**

- RECOMMENDATIONS AND PROPOSALS
- • Leverage Container Load Optimization Software: Modern software solutions like CubeIQ or LoadPlanner or similar 3D cargo modeling systems should be implemented. The software automatically analyzes cargo arrangements and generates designs for optimal packing, ensuring that all the cargo is optimally packed, adhering to weight, stacking, and alignment limitations. A gradual introduction may be considered initially in busy or complicated cargo routes.
- • Synchronize Cargo Packing Procedures: Implementing and disseminating standardized cargo packing practices among clients and suppliers, emphasizing the use of compatible and stackable cargo, simplifies the cargo loading process and ensures minimal wastage. Providing guidance on cargo packing and organizing client workshops can expedite the process.
- • Incorporate Comprehensive Employee Training Programs: Systematic employee training sessions on cargo loading methods, weight distribution strategies, and cargo planning software utilization should be implemented periodically. Employee training must be seen as an ongoing operational activity, not a one-time measure.

- **Promote Interdepartmental Coordination: As X2 (coordination) is the single statistically significant variable in the regression equation, efforts towards improving inter-departmental coordination are essential. The implementation of structured communication processes between the planning, storage, and operations departments will go a long way towards mitigating last-minute loading issues.**

- **Initiate Constant Cost Monitoring: The monitoring of costs associated with freight per cubic meter or per kilogram will allow for immediate understanding of the financial implications of underutilization and will facilitate more informed decision making regarding containers.**

- **Educate Clients: Discussions about the benefits of improved container utilization both economically and environmentally, together with the inclusion of clients in decision-making process regarding packaging and cargo configuration standards, may result in higher utilization of space from the very first stage of the cargo handling process.**

- **Add Carbon Footprint Measures: Given increased awareness among regulators and consumers regarding the environmental aspects of the international logistics industry, it is time for freight forwarding companies to start monitoring their carbon footprint and the efficiency of space utilization as one of the main indicators.**

CONCLUSION

This paper reveals that FCL underfilling is a tangible, quantifiable and operationally feasible problem faced by freight forwarding companies in India's dynamic logistics industry environment. The empirical investigation conducted into practices of Wingman Freight Express Pvt. Ltd., Chennai has proven that there are instances where FCLs are loaded with only 80% – 85% of their capacity being used—an avoidable cost which increases depending on the yearly volume of cargo carried by the company. There are a variety of factors affecting fill rate, from operational inefficiencies, technological constraints to organizational limitations, and all together have a tendency to reduce fill rates below possible maximum values.

The results of the regression analysis reveal that organizational processes such as interdepartmental cooperation are the most influential factor affecting container fill rates and account for much of variance regardless of whether the technology was used or not. This result implies that it is possible to make great progress in terms of increasing FCL fill rates without significant investments in technological development.

Conclusion

The research makes an important contribution to the existing empirical knowledge regarding logistics cost reduction and optimization in the Indian and South Asian freight forwarding sector, given the logistical challenges and opportunities posed by the inadequacy of the infrastructure, lack of technological innovations, and the failure to coordinate effectively. With the use of the suggested measures such as the use of digital planning systems, proper standardization in packaging, appropriate training programs, and cross-departmental communication systems, logistics companies such as Wingman Freight Express can effectively optimize FCL containers and minimize costs per shipment, thereby gaining competitive advantage.

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