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EMPTY INTERMODAL CONTAINER MANAGEMENT

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16. Abstract

This research analyzes the empty marine container accumulation problem specific to the region of NY/NJ. An elaborate literature review is performed. Critical factual documentation is presented and subsequently the empty container logistics are presented. The factors affecting accumulation and the complex relationships between players and stakeholders involved are discussed. A mapping of the movement of containers at a global, regional and local level, with a focus on the movement and accumulation of empty containers is presented. The relative merits and limitations of addressing the problem at a regional and local level are critically discussed and analyzed. A conceptual decision making procedure based on empirical goal setting is presented. Key efforts and projects, which if implemented have the potential to increase the efficiency of the current system and reduce the overall costs associated with moving and storing empty containers are outlined.

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EXECUTIVE SUMMARY

Problem Context

Over the last four decades total seaborne trade estimates have nearly quadrupled, from less than 6,000 billion ton-miles in 1965 to over 25,000 billion ton-miles in 2003. During this period of time a complex global network of shipping routes connecting 2,867 commercial seaports across 133 countries has been developed. In 2001 the global container population was approaching 16 million TEUs and the global container moves exceeded the 236 million TEUs. This inventory has been substantially augmented by the massive number of containers built in the subsequent years as a result of the tremendous trade increase in the East – West routes. The number of containers has reached 18.8 million TEU in year 2004 and it is expected to climb to 21million TEU in year 2005 and 23.2 in 2006. Research by carrier focus groups in 2001 estimated that about $16.8 billion is spent by the industry each year to deal with inefficiencies in container operations, including repositioning empty equipment. A decade ago it was estimated that empty boxes accounted for 20% of the ocean container movements, at a cost to the industry of $3.5 billion a year. In 2003 the percentage of empty movements was about the same, but the estimated cost has escalated to more than $11 billion, not counting overland repositioning and costs of idle containers at depots. The constant increase in the container population has been adding a few million empty containers every year in the U.S. Imports are growing faster than exports increasing the trade imbalance, which along with the low price for new containers overseas in the past, resulted in empty containers accumulating in some major port regions. In early 2004, there was an unpredicted and unforeseen hike in steel prices all over the world. Container manufacturers in China were able to fill only half of the carrier's orders. Carriers started reporting difficulty in obtaining enough new containers to replace the boxes they retire, and the containers they were purchasing started costing them about 40% more than they did in the previous year. Shipping lines in a struggle to overcome the equipment shortage began repositioning empty containers from areas with surplus, such as the U.S. and Europe, to areas with shortage, primarily in Asia, spending about $1,000 for each container. Currently, it is reported that intensive manufacturing of containers in China, in combination with a slack in trade increase and the massive repositioning of empties has led to a surplus container stock in China.

To accommodate trade and maintain the efficiencies that currently exist in the freight transportation and logistics industry, temporary storage of empty containers is inevitable. Movement and storage of empty intermodal containers, which are part of the operating procedures but are often described as inefficiencies of the freight transportation system, cost the industry billions of dollars each year and have raised environmental, social and economic concerns. This report examines the root causes of the empty container accumulation, the state-of-practice in dealing with related issues around the world and synthesizes factual data to develop a detailed mapping of how containers move at a global, regional and local level, including moving and accumulation of empty intermodal containers with a focus on the New York New Jersey region. The study identifies and presents various key efforts which, if fully developed and implemented have the potential to bring a better understanding, and increase the knowledge base of the industry, facilitating the decision making process.

Major Players and their Interactions

There are two main types of owners of empty marine containers, who are key players in the empty intermodal container management problem, carriers, including global and niche carriers, and container leasing companies. Depot enterprises handle, store, and repair empty containers and may own a small share of them. Some major shippers may also own a relatively small amount of containers for their dedicated use. Ocean carriers and other transport operators own about 55% of all box equipment while leasing companies own about 43%.

A substantial structural change has taken place in the shipping liners world in the past decade with carriers integrating their resources, forming alliances and groups, mergers and acquisitions, cooperation agreements regarding slot exchange and ocean carrier consortia and joint services. Carrier firms charter each other's capacity, often known as 'slot chartering', which results in more container movements and fewer ship miles, and which also translates to lesser capacity available to move empties. The container leasing business was developed as a result of the economic benefit and flexibility they offer to carriers, especially during periods of high demand for containers.

Interactions between players are extremely complex. Ocean carriers use extensively the flexibility of leasing arrangements and tend to off hire containers in surplus areas and on hire containers in areas of high demand. Since carriers are handling containers as transportation equipment, while leasing companies consider them as assets, seeking to cover depreciation and make profit out of their leasing, it is obvious that these two major players have normally conflicting goals and interests.

Patterns of Empty Container Movement

Container movement is governed by a different set of factors at each level and comprises of different set of stakeholders. To better understand the flow of containers at each level, three different case scenarios should be examined: container movement on a global, regional and local level. At a global level, containers move between surplus and deficit regions with main actor the shipping line. With reference to a Major Coastal Economic Activity Center, if the inflow of containers is greater than outflow (import center) then the area shows a surplus of empty containers. When outflow is greater than inflow there is demand for empty containers in the area. In each case, ocean carriers are faced with a set of options on how to move containers. Depending on these carrier choices as well as level activity and operations, the empty container movement and accumulation conditions are defined on a regional and local level.

Causes of Empty Container Accumulation

The major cause of the empty container accumulation problem is the fundamental global imbalance of trade between the East and the West and the associated trade imbalance in the US. Other causes of empty container accumulation are associated with tariff imbalances and the related cost of repositioning empty containers from surplus to deficit areas, cost of inland transportation, marginal and volatile profitability of the leasing industry, cost of manufacturing and purchasing new boxes in relation to the cost of leasing containers, terms of leasing contracts between leasing companies and ocean carriers and cost of inspection and maintenance for aged containers.

State-of-Practice in Dealing with Empty Containers

As the efficiency of the intermodal transportation system lies on having the right equipment in the right place when needed, several options have been explored by the industry in trying to deal with the accumulation of empty intermodal containers in places where there is not demand for them. These options are classified in three main categories, including keeping containers into to transportation system, converting them into attractive commodities, and reuse or recycle them. Keeping containers into the transportation system requires managerial, policy, logistics, and/or technology solutions, which are very often interrelated.

Addressing the problem in the NY/NJ region

Empty container logistics is a global issue, greatly influenced by international transportation practices, governed by global trade patterns and mostly dictated by major ocean carriers' interests. To this end, complete and direct control of empty container accumulation at a regional and local level falls far beyond the ability of local and regional authorities and other interested stakeholders. Institutional, fiscal or regulatory measures can be proved inefficient in lessening the accumulation problem and even detrimental to the competitive position of transportation resources of this region in the international marketplace if the global environment is not considered in formulating them. Measures taken at a regional level should be taken cautiously, bearing in mind the broader trade environment, the operational conditions and constraints of the industry, and its influence in the competitive position of the region. Both the external environment and the structure of the transportation industry in the said region should be taken into account when formulating policies seeking to alleviate the empty container accumulation problem. Any policies to be adopted should be taken bearing in mind the very dynamic nature of the maritime transportation industry.

During the course of this study, the container accumulation in New Jersey has dropped significantly. Variations in container inventories in the region are attributed to seasonal variations as anticipated, but also due to the increase in steel prices which drew down container inventories in the U.S. From its traditional role as an area with demand for empty containers, China has become a surplus area. Production of new containers has decreased substantially for the purpose of easing the overplus.

Strategic, Policy and Operational Measures Considered in the Region

Policy guidelines, stakeholder strategies and managerial and operating measures may be devised to address the empty container accumulation at a regional level. *Policy guidelines* may include objectives for overall annual reduction rate for long-term stored containers, redistribution objectives for these containers, developing or using an existing auditing mechanism for the reduction of the total number of long term stored containers in the state. *Stakeholder strategies* may address matters specifically associated with a certain stakeholder and a certain type of empty containers (eg. promoting the immediate relocation of containers as soon as they are entering the state and being emptied) or promoting synergies between representatives of the same stakeholder (eg. networking depots) or promoting cooperation and synergies between stakeholders with conflicting interests. Finally, a set of *managerial and operating* *measures* of tactical nature can be effectively applied by individual players in order to support success of stakeholder strategies and policy objectives.

Caution should be exercised, in selecting and proposing to implement these measures to ensure in depth understanding of the behaviour of the industry and its dynamics, as well as the potential broader impacts of each measure.

A Decision Support Tool

To facilitate dialogue among various stakeholders and facilitate the decision making process, a Decision Support Tool is being proposed. The decision support tool is based on the idea of a continuous monitoring system, which would provide information on the empty container inventory in the region. The tool is based on empirical goal setting and what-if scenario inference procedure.

This tool is not intended as a solution to the empty container accumulation problem. It is meant to be used as a means to facilitate the decision making process in determining the most promising measures in terms of achieving desirable levels of empty container accumulation, while considering other direct and secondary impacts that implementation of these measures may have.

Recommendations and Proposed Future Actions

A set of recommendations and future actions including development of a monitoring system; study of the behavior of key players in the empty container industry; a systems approach, which will investigate the optimal location of empty container depots in the region and which may be part of a broader effort; and a systems approach to the study of the secondary marketare are proposed as part of this project. Each of these efforts could bring a better understanding and increase the knowledge base of the industry, facilitating the decision making process.

Monitoring System

A monitoring system aims at answering questions that came up frequently during the various presentations of this study to industry stakeholders, such as: ”how many empty containers are stored, where, and for how long”. Although some information may be available, it is rather aggregate and often outdated, as it represents a rough estimate of an overall empty accumulation in the region during some past period of time. To answer the questions mentioned above, a monitoring system, mapping the conditions prevailing in empty container accumulation over time, could be implemented. Such a monitoring system could be part of a broader system for equipment tracking and tracing, used to improve productivity, efficiency and security of facilities and services. Information about ownership and location of containers as they move from origin to destination is said to be crucial in reducing the vulnerability of the freight transportation network and related infrastructure.

Behavioral Models for key Industry Players

Another question that needs to be answered relates to the potential behavior of the key industry players in choosing the best option from within a set of alternatives, as they react to changes in current policies and strategies. A study that will identify the factors affecting decision and, based on these factors, develop and calibrate behavioral models is required. Model sensitivity to variations in the values of the factors should be established. Industry players usually have several options available to them. Proposed policies and strategies should not lead to industry actions that may have a negative overall impact to the region. Models based on industry input may assist in better understanding the behavior of key players.

Strategically Located Depots

Trade imbalance and seasonal variations in demand make the need for empty container storage inevitable. To reduce the number of empty vehicle miles traveled from delivering the goods to inland destinations and then hauling the containers empty back to the port area, several efforts have been proposed including a Virtual Container Yard (VCY) effort currently underway in the New York / New Jersey region. Along with this effort, a set of optimal locations for temporary storage of empties may be determined, so that empty containers are available at satellite locations and along the Port Inland Distribution Network, when an export load becomes available. This would help ease congestion at marine terminals and depots near by these terminals. It may also facilitate selling of these containers in the secondary market, an effort that is described in the following section.

Systems Approach to the Secondary Market

It has been estimated that about 8% of the over 16 million containers that exist today are taken out of the transportation system and into the secondary market each year. Containers that are stored at or nearby marine terminals are most susceptible to the economic swings of market demand. Furthermore, if containers are located nearby a high demand area, they typically sell at higher prices in larger quantities. The secondary market for marine containers is not fixed in either size or location. Nevertheless, the size of this market is significant and requires further attention. A systems approach to this market may assist in determining the regions in which older containers should be moved to, to sell to the secondary market easier, in higher volumes and at better prices.

INTRODUCTION

The first ocean borne containerized shipment sailed from Newark, New Jersey to Houston, Texas in 1956. Ten years later, in 1966, a new era of world trade began with the maiden voyage of a Sea-Land container ship in the first transatlantic trip of containers from Newark, New Jersey to Rotterdam, Holland [(1)]. Since then, with the 'Intermodalism' enabled by the 1980's deregulation of the U.S. transportation industry and the improved infrastructure and technological innovations, there has been a dramatic increase in freight transportation by water. Introduction of containers - large, standardized steel and aluminum boxes – especially the original 20-foot unit (TEU) and their adoption by the various modes of transportation such as ship, train and truck further resulted in successful freight intermodal operations since the 1980's.

Globalization of the world economy has tremendously increased the exchange of goods all around the world. In search of economical and competitive manufacturing, production centers of most industries have rapidly shifted their basis beyond national borders. As globalization has developed, world trade and in particular sea borne trade has grown rapidly in the past few decades and is predicted to grow even faster in the future years. Over the last four decades total seaborne trade estimates have nearly quadrupled, from less than 6,000 billion ton-miles in 1965 to over 25,000 billion ton-miles in 2003. In 1970, estimates say that around 2.7 billion tons of goods was transported by sea whereas in 2000 nearly 5.9 billion tons was shipped, making it more than double since 1970. [(2)] The overall world trade volume never declined over the past years, despite the currency crisis in Asian countries in 1997 and the subsequent global economic turmoil. As for container traffic, the present world throughput of 188 million TEUs is expected to grow to between 417 and 491 million TEUs by 2012. [(3)]

To cope with such an ever-growing world trade, ports will no doubt continue to play a critical and indispensable role. More advanced and efficient infrastructure is necessary to improve port productivity and keep the goods moving. With the support of modern information technology and the use of the Internet, a complex global network of shipping routes, connecting 2,867 commercial seaports across 133 countries has been developed. Over 90% of the world trade is carried by the international shipping industry. There are around 50,000 merchant ships trading internationally, transporting every kind of cargo. The world fleet is registered in over 150 nations.(4) United Nations Conference on Trade and Development (UNCTAD) estimates that the operation of merchant ships contributes about US$380 billion in freight rates in the global economy, equivalent to about 5% of the total world trade.

Increasing industrialization and liberalization of national economies have fuelled free trade and a growing demand for consumer products. Advances in technology have also made shipping an increasingly efficient and swift method of transportation. Over the last four decades total seaborne trade estimates have nearly quadrupled, from less than 6,000 billion ton-miles in 1965 to over 25,000 billion ton-miles in 2003.

Challenges facing the ports around the world today are related not only to the amount of traffic, but also to the quality of services. The continuous progress of globalization of shipping and trade business is resulting in increased pressure on ports to reduce terminal costs and improve operational efficiency. Ports are required to play a more active role in the integration of logistics, while, at the same time, continued efforts are needed to provide better terminal services at lower cost.

Despite the increase in productivity, efficiency, safety and the reduction in cost and service time, due to trade imbalances across the globe, a major problem has emerged; the problem of empty container accumulation at ports world over.

According to a certain source of information, it was estimated that the global container population is approaching 16 million TEU and the global container moves per year are more than 236 million TEU (year 2001) [5] out of which around 9 million TEU is exported into the ports of the US every year. The joint total inventory of boxes is estimated to have reached 18.8 million TEU in year 2004 and it is expected to climb to 21million TEU in year 2005 and 23.2 in 2006.[6] A few years ago in 1997, PIERS trade statistics stated that 8.7 million loaded containers were imported into the US and just 6.4 million of them were exported. This indicated that some millions of empty boxes stayed back in the yards and depots around the country, waiting to be repatriated. [7] Since 1998 the problem has worsened. There has been a constant increase in the container population, adding a few million empty containers every year in the U.S. From year 2001 production of new containers has followed an upward trend in line with the expansion of the world container vessel fleet and for the first time in year 2003 worldwide annual production was over 2 million TEUs. The standard freight container made up about 90% of worldwide production [8]. Figure 1 provides data on annual container production worldwide between 1999 and 2003.

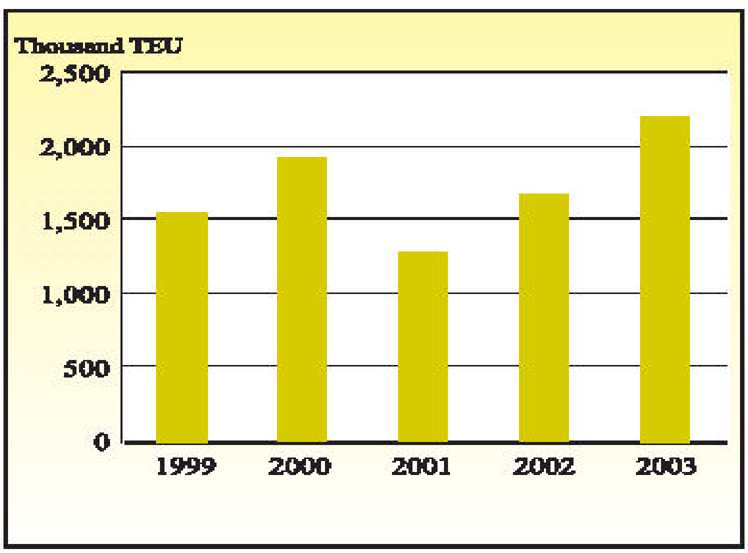


Figure 1: Annual Container Production

(Source: UNCTAD/Review of Maritime Transport 2004)

Figure 2 below shows the growth in container throughput in the US since year 2003 and forecasts this growth until year 2007. (*Dyna Liners, 27/04*). In year 2004, the total US containerized import grew by 13.2% as compared to the 8.4%

increase in exports. This led to an all time high container flow imbalance, which is estimated to reach the amount of 7.7 million TEUs

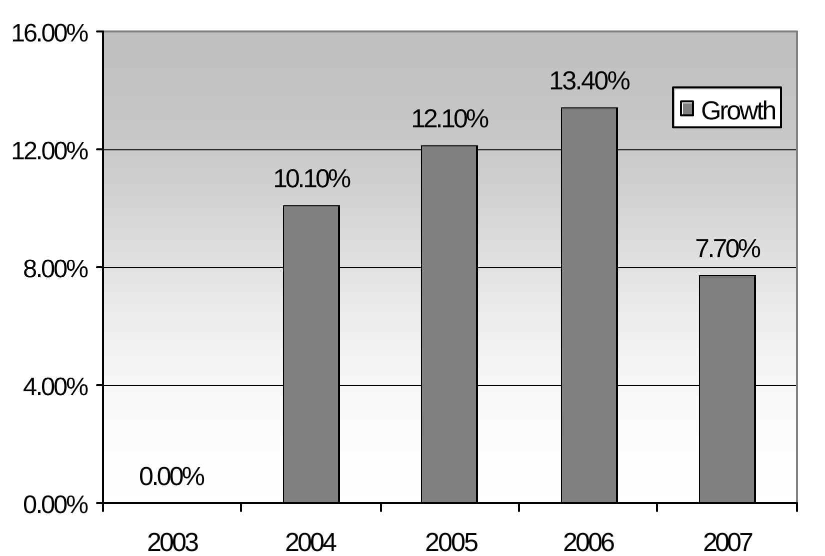


Figure 2: Growth in Container Throughput US, Base Year 2003

The anticipated traffic growth is steadily verified by the even higher real trade growth between Asia and the US during year 2004, which is shown in table 1 below.

Table 1: Far East/US Full Container Trades-First half 2004

	To the US		From the US	
Month	**Growth (%)**	**Eastbound ***	**Growth (%)**	**Westbound ***
June	23	915	5	393
May	14	927	8	322
April	16	888	11	344
March	19	847	13	382
February	2	683	10	324
January	18	854	4	325
Total	**17**	**5,113**	**10**	**2,090**

Source: Dyna Liners Report, Issue 45, 2004 (* 1,000 TEU)

In the eyes of port operators, shippers and carriers, the number of empty boxes sitting directly at the terminal should ideally be nil or very few. Given the fact that empty boxes have to go somewhere, storage and repair depots represent an essential ingredient in containerization. As ports have expanded and residential areas behind the ports have gobbled up more land for housing, storing empty containers has become an increasingly serious problem, requiring special attention.

Research by carrier focus groups in 2001 estimated that almost US $110 billion per year is spent to manage shipments globally. Of this total, about 15% ($16.8 billion) is believed to be associated with inefficiencies in container operations, including repositioning empty equipment to meet cargo demand. While this percentage is high, it only reflects the percentage of 'idle time' in a container's life cycle. In terms of moving empty containers, a decade ago, Drewry Shipping Consultants of London estimated that empty boxes accounted for 20% of the ocean container movements, at a cost to the industry of $3.5 billion a year. Today the percentage of empty movements is about the same, but the estimated cost is more than $11 billion, not counting overland repositioning and costs of idle containers at depots. [(9)]

The recent shipping industry White Paper 'Profit Optimisation for Container Carriers', published by the ROI Container Cargo Alliance, found that only 20% of a container's time is spent at sea, while 56% is unproductive. Given the endemic imbalances in the major east-west trade lanes, shipping empties around the world is unavoidable. However, while these imbalances are outside the carriers' control, more efficient container management is said not to be.

Stacking the containers at the port terminals or at its nearby areas could be advantageous economically. This, however, would be a very short-term view as this stockpiling can adversely affect the environment, traffic conditions and employment in the area. Furthermore, land around the port consumed for storing empty containers is rather valuable and potentially prime location for other uses, such as distribution facilities.

The next section presents a thorough review of pertinent literature from both scientific and trade journals, as well as industry reports and articles. The following section presents background information on the types of container leases and rate terminology used in the shipping industry. Key players and their interactions are discussed next, followed by the mapping of container movement, which illustrates how containers move at a global, regional and local level. The next section looks at the empty container accumulation in various parts of the world, concluding with the situation in the state of New Jersey. Root causes of empty container accumulation and the state-of-practice in responding to issues related to empty containers are discussed next. The following section presents an approach to address the problem in the New York New Jersey region, looking into the recent global developments that have affected the situation, and into strategic, policy and operational measures that have either been discussed or implemented in the region. A decision support tool, which, if developed and used properly may facilitate collaborative approaches to the problem is presented next, followed by recommendations and proposed future actions.

LITERATURE REVIEW

Substantial scientific literature has been produced so far related to the empty equipment management problem, focusing primarily on the equipment transportation optimization problem. Issues that have been treated extensively in the literature include the empty equipment allocation and distribution problem and the balancing of demand and supply between terminals to meet future demands; the effect of the planning horizon length on empty container distribution management; the dynamic equipment allocation and reuse problem; and the empty balancing strategies within the context of a network design problem. The issues of optimal amount of storage space in container terminals; the empty container management problem in a port as an equilibrium inventory problem; the depot location problem using network design formulations; and models analyzing stakeholder operational activities have also been studied.

Practical industry related and oriented reports and articles represent also a very interesting source of reference and information. This kind of literature substantially contributes to the development of a broad understanding concerning practices adopted in the US and other parts of the world in dealing with empty marine container management and the supply and demand dynamics.

Empty equipment allocation and distribution problem

Allocation and distribution are defined as the processes of assigning activities, (costs, equipment or facilities) and ensuring the availability of them in the desired quality, quantity, place and time for the customer. Efficient allocation and distribution of empty containers is a major problem in the real world and several studies have been performed in order to understand the complexities.

Dejax and Crainic, 1987 [(10)] surveyed the literature on fleet management models in freight transportation and they noted that relatively little effort was directed, by that time, toward developing models aimed specifically at land container transportation issues, with the bulk of the work in the area being dedicated to the maritime aspects of the problem. Efforts in this area addressed mainly the problem of the empty container distribution as that of allocating containers available in surplus at a terminal, from earlier loaded shipments, to demanding terminals (marine terminals, customers' warehouses, rail yards).

Crainic et. al., 1993 [(11)] describe the problem of dispatching empty containers of various types in response to requests by export customers to storage depots or ports in anticipation of future demands. They identify the basic structures and the main characteristics of the problem. They introduce two dynamic deterministic formulations for the single and the multicommodity cases, offering a general modeling framework for this class of problems. These formulations account for the problem's special characteristics: the space and time dependency of events, substitutions among container types, relationships with partner companies, imports and exports, massive equilibrium flows etc. They provide finally a mathematical formulation for handling, in the single commodity case, the uncertainty of demand and supply data that is characteristic of container allocation and distribution problems. Various modeling choices, data requirements and algorithmic considerations related to the implementation of the models are handled in this paper.

Gendron and Crainic, 1995 [(12)] treat the multicommodity location problem with balancing requirements, which is related to one of the major logistics issues faced by distribution and transportation firms: the management of a fleet of vehicles over a medium to long term planning horizon. To solve this problem, they present a branch-and-bound algorithm in which bounds are computed by a dual-ascent procedure. They particularly emphasize the design of efficient branching and pre-processing rules. The algorithm was tested on a wide variety of randomly generated problems, and on a large-scale application to the planning of the land operations of a heterogeneous container fleet. Results show that the algorithm is highly efficient, and outperforms other existing methods. In the particular context of the land transportation management of a heterogeneous fleet of containers by an international maritime shipping company, savings of up to 40 % of the total transportation cost of empty containers have been identified by finding approximate solutions to the model. Furthermore, in the same context, both algorithmic and solution efficiencies are of prime importance, since this logistics problem has to be solved regularly due to variations in patterns of demands, transportation costs, space availability and costs for container warehousing.

Shen and Khoong, 1995 [(13)], presented a decision support system to solve a large-scale planning problem concerning the multiperiod distribution of empty containers for a shipping company. The system proposed uses network optimization models. Besides optimizing on container positioning across ports, the system is also able to recommend cost-effective container leasing-in and off-leasing decisions. Furthermore, the system incorporates constraint relaxation techniques that minimize perturbations to the existing planning decisions in response to ad-hoc changes in demand and supply of empty containers. The paper takes a business process perspective, with emphasis on the shipping industry, providing a detailed treatment of leasing considerations.

Spieckermann and Voss, 1995 [(14)], treat the class of empty railcar distribution problems with particular reference to a case study dealing with a German railcar rental company and the need to provide reasonable algorithmic support for a specific empty railcar distribution problem. The paper compares a simple heuristic approach with one of the older network flow approaches.

An analysis of the Chinese mainland's container distribution network is presented in Cullinane, 2002 [(15)]. It analyzes China’s inland distribution network that has become a bottleneck impeding the fast development of its container throughput. They apply a multi-objective programming approach to optimize the network configuration and flow. The approach focuses on import of laden containers and avoids the complexity caused by having to export empty containers.

Smilowitz, 2003 [16], introduced an application of a Multi-Resource Routing Problem (MRRP) in drayage operations. Drayage involves the movement of loaded and empty equipment between rail yards, shippers, consignees and equipment yards. The problem is modeled as a MRRP with flexible tasks, since the origins and destinations of some movements can be chosen from a set of possible nodes. The complexities added by routing choice are studied. A set partitioning formulation of the problem is presented along with a column generation solution methodology. Using this methodology, efficient operating plans are designed for a series of test cases in Chicago. The approach can be used as an efficient operational tool in minimizing empty drayage trips.

Erera et. al. 2004 [17] focuses on asset management problems faced by tank container operators and formulates an operational tank container management problem as a large-scale multi-commodity flow problem on a network. By integrating container routing and repositioning decisions in a single model, total operating costs and fleet sizes are reduced. A computational study is presented verifying this hypothesis.

Coslovitch et al., 2004 [18], focus on a fleet management problem that arises in container trucking industry. From the container transportation company perspective, the present and future operating costs to minimize can be divided in three components: the routing costs, the resource (i.e., driver and truck) assignment costs and the container repositioning costs (i.e., the costs of restoring a given container .fleet distribution over the serviced territory, as requested by the shippers that own the containers). This real-world problem has been modeled as an integer programming problem. The proposed solution approach is based on the decomposition of this problem in three simpler sub-problems associated to each of the costs considered above. Numerical experiments on randomly generated instances, as well as on a real-world data set of an Italian container trucking company, are presented.

Perez and Holguin-Veras, 2005 [19], propose a multiperiod programming approach to model the empty containers distribution problem and gain insights into the effectiveness of alternative policies to mitigate the situation. The proposed model - a simplification of the real life system - reflects the operational and planning complexity of the container distribution problem. An example used to demonstrate the formulation suggested that, under current policies, the amount of empty containers stored in urban areas is fairly insensitive to taxes and other fees, suggesting that land use regulation may be the most efficient way to deal with this problem.

Tan et al., 2005 [20], considered a transportation problem for moving empty or laden containers for a logistic company. Owing to the limited resource of its vehicles (trucks and trailers), the company often needs to sub-contract certain job orders to outsourced companies. A model for this truck and trailer vehicle routing problem (TTVRP) is first constructed in the paper. The solution to the TTVRP consists of finding a complete routing schedule for serving the jobs with minimum routing distance and number of trucks, subject to a number of constraints such as time windows and availability of trailers. To solve such a multi-objective and multi-modal combinatorial optimization problem, a hybrid multi-objective evolutionary algorithm (HMOEA) featured with specialized genetic operators, variable-length representation and local search heuristic is applied to find the Pareto optimal routing solutions for the TTVRP. Detailed analysis is performed to extract useful decision-making information from the multi-objective optimization results as well as to examine the correlations among different variables, such as the number of trucks and trailers, the trailer exchange points, and the utilization of trucks in the routing solutions. It has been shown that the HMOEA is effective in solving multi-objective combinatorial optimization problems, such as finding useful trade-off solutions for the TTVRP routing problem.

Cheang et. al, 2005 [21] discusses the imbalances of an international shipping company's empty containers in ports all over the world, and study the problem of the dynamic distribution of empty containers with and without the third party leasing from another company. It develops a decision support system to solve the empty container distribution problem.

Roop et. al., 1998 [22] develop a general simulation model of ship-to-rail intermodal container movements to provide analytical support to operations and facility design personnel. They describe the “container revolution” of the last forty years and how containerized freight is continuing to increase with ever larger ships, double stack train service, and trucking companies dedicated to intermodal container movements. A “seamless” interaction between modes is desired to reduce container dwell times at facilities, thus improving the productivity and profitability. The paper presents a simulation model for the design of intermodal container terminals, the selection of appropriate lift equipment, and manpower allocation to increase facility productivity.

Davies, 2006 [23] estimates the impact of establishing off-dock container storages in the lower mainland of British Columbia. Off-dock storage locations were initially planned and developed here as a response to short-term congestion problems at the terminals, but when operational, they imposed additional costs on shipping lines, trucking companies and drivers. The introduction of off-dock storage introduced a non-revenue “third leg” to truck trip patterns. This paper aims to discuss the institutional factors, which hindered the adaptation of industry operating and contractual practices to accommodate the change. The paper underlines the importance of considering institutional factors in trying to implement change to complex logistics systems by this case study and example.

Planning Horizon

Choong et al., 2001 [24] present a computational analysis of the effect of planning horizon length on empty container management for intermodal transportation networks. The distinction in the analysis here lies on the fact that tree different modes explicitly truck, rail and barge are considered in the analysis. The analysis is based on an integer program that seeks to minimize total costs related to moving empty containers, subject to meeting requirements for moving loaded containers. A case study of potential container-on-barge operations within the Mississippi River basin illustrates the effects of planning horizon length on mode selection. The study concludes that a longer planning horizon can encourage the use of inexpensive, slow transportation modes, such as barge.

In another paper by Choong, 2002 [(25)], computational analysis of the planning horizon effects on empty container management for intermodal transportation networks is presented and the analysis is based on an integer program that may minimize the costs related to moving empty containers.

Jansen et al., 2004 [(26)], describe the operational planning system POP developed for Danzas Euronet, a merger of Deutsche Post Transport and Danzas NTO. As of November 1997, the system has been used daily for the transportation planning of on average 4000 container-orders a day on trains and trucks in Germany. An important feature is that the future has to be taken into account: trucks have to return home within a couple of days, and empty containers have to be available at the right time and the right place. These repositioning aspects are taken into account integrally with the planning of the orders with a view to get a cost efficient solution. In addition, practical constraints play an important role, and the system has to be flexible for new and modified constraints. The system has not only been used heavily for daily planning, but also for many simulation studies, thereby supporting operations as well as commerce.

Dynamic equipment allocation and reuse problem

Containerized liner trades have been growing since globalization of world economies in the early 1990s. However, these trades are typically imbalanced in terms of the numbers of inbound and outbound containers. As a result, the relocation of empty containers has become one of the major problems faced by liner operators.

In a paper by Cheung, 1998, [27] considered the dynamic empty container allocation problem addressing the need to reposition empty containers and to determine the number of leased containers to meet customers' demand over time. They formulate the problem as a two-stage stochastic netrwork. In stage one the parameters such as supplies, demands and ship capacities for empty containers are deterministic. In stage two these parameters are random variables. They make decisions at stage one such as the total of the stage one cost and the stage two cost are minimized. They show how a stochastic quasi-gradient method and a stochastic hybrid approximation procedure can be applied to solve the problem, by taking advantage of the network structure. Numerical tests were conducted to evaluate the value of the two-stage stochastic model over a rolling horizon environment and to investigate the behaviour of the solution methods with different implementation scenarios.

Powell, 1998 [28] proposed a dynamic model for optimizing the flows of flatcars that considers explicitly the broad range of complex constraints that govern the assignment of trailers and containers to a flatcar. The problem is formulated as a logistics queuing network which can handle a wide range of equipment types and complex operating rules. The problem is formulated as a logistics queuing network which can handle a wide range of equipment types and complex operating rules. The authors formulate a global model with the specific goal of providing network information to local decision makers, regardless of whether they are using optimization models at the yard level. Experiments suggest that a flatcar fleet that is managed locally, without the benefit of the research network information, can achieve the same demand coverage as a fleet that is 10 percent smaller but is managed locally with the research network information.

Abrache et. al, 1999 [29] proposed a new decomposition approach to solve a dynamic model for the deterministic problem of empty containers allocation, already proposed in the literature. The proposed approach was based on the classical restriction framework that takes into account the specificities of the model, particularly the substitution property between the different container types. Several variants of a generic algorithm were implemented in sequential and parallel environments and led to interesting comparative results. In the corresponding mathematical model several categories of constraints were considered, including customer demand and supply, stocks at nonport depots, stocks at ports, availability of empty containers for allocation at depots, upper and lower bounds on volumes of flow on interdepot balancing links, upper bounds on the substitution flow over links and non-negativity of flow variables.

Jula et al., 2006 [(30)], studied empty container movements in the Los Angeles and Long Beach (LA/LB) port area in an effort to reduce congestion by optimizing the empty container reuse. The dynamic empty container reuse is modeled analytically, and techniques are developed to optimize empty container operations. Several case studies based on current and projected demand in the LA/LB port area are used to evaluate the proposed techniques. Simulation results demonstrate that significant cost and congestion reductions can be achieved in the area, through reuse of empty containers. The authors considered the operational issues that appear in dynamic empty container reuse. They modeled the dynamic empty container reuse analytically, and developed an optimization technique to minimize the number and the cost of truck trips. Based on current and projected data for the next 20 years, they developed several realistic case studies in the Los Angeles and Long Beach port area. Experimental results showed that the empty container reuse reduces costs and congestion significantly. They showed that with a careful selection of the reuse cost function, weights can be adjusted to put more emphasis on either the street-turn or depot-direct handling methodologies. Basically, when time is critical, empty reuse is shifted towards depot-direct, since the waiting time is minimal in this methodology. On the other hand, when the traveling cost and traffic congestion are the important factors, street-turn methodology provides the best match between supply and demand of empties.

Crinks, 2000 [31], emphasizes on the importance and need for increasing the equipment visibility among the ocean carriers. Author describes that due to the information gaps or 'blind spots', carriers, shippers and vendors find it difficult to manage their assets effectively. He says that out of the $100billion that is spent in container handling and asset management, some $16billion is attributable to the cost of repositioning empty containers only. The author concludes that the greatest opportunity for reducing the costs is by increasing the equipment visibility on the landside when the assets leave the ocean carrier's network.

In Chang et. al, 2006 [32] a deterministic and stochastic problem is considered, dealing with empty container reuse. The authors explain that in most cases, empty containers are handled twice; once they are recycled from importers and the second time they are trucked to exporters. They propose and analytically demonstrate that a system, which may facilitate interchange of empty containers outside the ports, by facilitating 'street-turns', and help reduce the traffic congestion and emissions around the ports, is not only a desirable but a necessary solution to the current congestion problems in the Los Angeles/Long Beach Port Area. The authors also investigate multi-commodity empty container substitution problem, in which one type of containers can be substituted with another container. The authors conclude that a cost reduction in the range of 5% to 46% is attainable, if a combination of the container types in the supply and demand nodes is found.

Empty container balancing strategies within the context of a network design problem

Transportation is a complex field with several players and levels of decision, where investments are capital-intensive and usually require long implementation phases. Furthermore, freight transportation has to adapt to rapidly changing political, social and economic conditions and trends. It is thus an area where accurate and efficient methods and tools are required to assist and enhance the analysis of planning and decision-making processes.

Crainic and Laporte, 1997 [33] and Crainic, 1998 [34], treat the problem as a tactical planning problem within the context of Service Network design to generate empty balancing strategies, indicating how to reposition empty vehicles to meet the forecast needs of the next planning period. As stated in their work moving vehicles empty does not directly contribute to the profit of the vehicle operating firm, but it is essential for the sustainability of its activity. The authors identify two very important methodological steps in modelling empty balancing operations, those associated with the explicit consideration of the time perspective and the uncertainties in empty vehicle distribution.

Crainic, 2000 [35] treats the problem of empty vehicle repositioning in the overall context of service network design. Imbalances associated with trade flows result in discrepancies between the supply and demand of vehicles at the terminals of the system. As noted the decision of how many vehicles and where to send them is complicated by the numerous possibilities for movement and the uncertainties of future supplies and demands. The search for the most economic strategy is a significant problem in itself.

Gendron and Crainic, 1997 and Bourbeau et al., 2000 [36], proposed branch-and-bound parallelization strategies applied to the location/allocation problem with balancing requirements. This formulation is representative of a larger class of discrete network design and location problems arising in many transportation logistics and telecommunications applications: it displays a multicommodity network flow structure and a complex objective function comprising fixed and variable flow costs. As for many problems of this class, the bounding procedure embedded in the branch-and-bound algorithm is complex and time-consuming. The authors report and analyze experimental results, on a distributed network of workstations, which aim to compare different implementations of these strategies. To test their parallelization strategies, they chose a representative location/network design formulation, the multicommodity location/allocation problem with balancing requirements (MLB). The general goal is to locate depots for empty containers in order to collect the supplies available at customers' sites and to satisfy customer requests, while minimizing the total operating costs. These costs comprise fixed costs for opening and operating the depots, and transportation costs generated by customer-depot traffic and by inter-depot movements. These inter-depot balancing flows differentiate the problem from classical location/allocation applications.

Shintani et. al, 2005 [37], address the design of container liner shipping service networks by explicitly taking into account empty container repositioning. The paper addresses two key and interrelated issues; deploying ships and containers on a shipping network design simultaneously, which the author describes as being unique to this study. The problem is formulated as a two-stage problem and a genetic algorithm-based heuristic is developed to solve it. Through a number of numerical experiments it is shown that the problem with the consideration of empty container repositioning provides a more insightful solution for the container liner shipping service network design than the one without considering it.

Shintani et. al, 2004, [38] propose a design method of containership routing networks. It explains that most liner shipping companies make an effort to select calling ports, in particular taking into account effective plans of an efficient repositioning of equipment in use based on a prediction of when and where imbalance in equipment quantities will occur, to maximize the company's profit. They design the routing networks as the shuttle type of the location routing problem on the set partitioning problem basis. The proposed method gives the solution as a set of calling ports, shipping routes, the number ships by ship's speed and size. An application of the problem to container transportation in Southeast Asia is presented. By numerical simulation studies, they evaluated routing alternatives of several ship sizes and examined the effect of consideration of equipment imbalance in composing the shipping routes.

Song et. al, 2005 [39], presents a simple formulation in the form of a pipe network for modeling the global container-shipping network. The cost-efficiency and movement-patterns of the current container-shipping network have been investigated using heuristic methods. The model reproduces the overall financials and container movement-patterns for the industry as well as for the individual shipping lines and ports. The authors concludes with the findings that the cost of repositioning empties is 27% of the total world fleet running cost and that overcapacity will continue to be a problem.

Optimal amount of storage space in container terminals problem

Focusing on the operational aspects of container terminals, Kim and Kim, 2002[40] discuss a method of determining the amount of storage space and the optimal number of transfer cranes for handling import containers. They develop a cost model for the decision making, which consists of the space cost, investment cost of transfer cranes and the operating cost of transfer cranes and trucks.

Li et al., 2004 [41], approached the empty container management problem in a port as an equipment inventory problem. The empty container allocation problem in a port is related to one of the major logistics issues faced by distribution and transportation companies: the management of importing empty containers in anticipation of future shortage of empty containers or exporting empty containers in response to reduce the redundancy of empty containers in this port. They considered the problem to be a nonstandard inventory problem with positive and negative demands at the same time under a general holding-penalty cost function and one-time period delay availability for full containers just arriving at the port. The main result is that there exists an optimal pair of critical policies for the discounted infinite-horizon problem via a finite-horizon problem, say (U, D). That is, importing empty containers up to U when the number of empty containers in the port is less than U, or exporting the empty containers down to D when the number of empty containers is more than D, doing nothing otherwise. They obtained a similar result over the average infinite horizon.

Ogonowski and Hart 2004 [42], present a preliminary assessment of the key ideas behind an inland port in South Carolina such as positioning container staging facilities at noncongested interior locations with easy truck and rail access, and at the same time improving the transportation network and land use conflicts in established urban and transportation centers, co supporting deep water port volume and facility expansion needs, while enhancing economic development opportunities in less developed localities. This preliminary assessment of an inland port in South Carolina finds that the concept may only be market-driven and financially viable when the combined truck drayage costs, including demurrage, gate delay charge, etc., begin to converge and exceed the cost of short-haul rail. An inland port can generate a number of operating and social benefits that may merit public investment. These include land use improvements, emission, and congestion savings, as well as economic development. These findings suggest that an inland port warrants further exploring and should become part of long-term strategic transportation planning in South Carolina, and quite possibly in other states. Inland ports play an important role in managing empty container distribution both at a strategic and tactical level, while they provide input also at the operational level of empty container balancing.

Lai et. al 1995 [(43)] treat the empty logistic distribution problem of a major shipping company in Hong Kong. A simulation model of the shipping company's operational activities was developed. Heuristic search was employed to identify the policies that yield the lowest operating cost in terms of leasing, storage, pick-up, drop-off and other changes. The authors stress the fact that the forecasts of future export movement and the demand for empty containers change continually, thus making the company to face the possibility to lose sales if containers are not available when requested by the customers. Four decision parameters were adopted to formulate a stepwise simulation approach. The four parameters were as follows: safety stocks or reserves, allocation factors, critical allocation point and priority for port allocation reduction. To determine reasonable values for these parameters, one year's data from the Far East agents' projection reports were collected and analyzed. The container inventory simulation model was designed to track the inventory level of the containers at each port. The inventory level is associated with the initial inventory, the probability distribution of customer demands for containers-which is equal to the distribution of the number of containers to be loaded to the next departing vessel, the probability distribution of the number of containers discharged by the previous arriving vessel and the number of short-term leased containers returned to, or picked up from the leasing company. A two-step heuristic search was employed. The authors state that the study provided insights that resulted in substantial savings to the shipping company while increasing customers' satisfaction.

Lopez, 2003 [(44)] studied the organizational choice that ocean carriers use to reposition their empty containers in USA. The paper deals with the four options that carriers have in order to relocate their empty containers: the spot organization and the adoption of three different renewable contracts to frame the externalization. The author analyzes the various stakeholder relationships and concludes that ocean carriers choose the organization form to frame the externalization of the reposition of empty containers' activity by looking at their production costs and the characteristics of the service (distance and volume). It seems that ocean carriers do not think about transaction costs, however, they adopt some mechanisms to control and to adjust their transaction in order to reduce those costs. Following factual analysis the author concludes that spot contract and the rigid relation with rail companies are two organizations that provide no mechanism to control and to adjust the reposition transactions. On the contrary, subcontracting with road companies and contracting with IMCs are two governance structures that ensure to ocean carriers that their providers will achieve their commitments even if they have to face some transaction costs.

Related industry reports and articles

Mallon and Maggadino, 2001 [(45)] studied the local container traffic in the LA/LB region. Although the study mainly focuses on the traffic implications of container movements, including those referring to empty container movements, it provides interesting information on the practices adopted by the stakeholders involved in the exchange of empty containers.

The Tioga Group Study, 2002 [46] provides an excellent source of reference on the logistics of empty marine containers. The study covers issues such as empty container logistics and flows, the potential for empty container reuse, off-dock empty return depots and depot-direct off-hires. The study, moreover, evaluates the Internet-based systems with capabilities to address equipment matching needs and critically reviews institutional and risk management issues. Finally, the study proposes a Container Logistics Strategy with the adoption of a Virtual Container Yard, an equipment matching shared information Internet platform, as a focal point. The study is not intended towards addressing the empty container accumulation problem, but rather seeks to investigate viable methods to reduce VMTs (Vehicle Miles traveled) by empty containers.

Prozzi et al., 2003 [47], studied the system of containerized cargo transportation in Texas. They have examined practices broadly followed in managing marine intermodal and they analyzed the impact of repositioning cost, as well as the factors associated with them.

The Study dealing with process mapping of container moves in the port of Melbourne, Australia, 2003 [48] revealed some interesting findings. According to the Study, shipping lines have significant influence over movement patterns of containers, particularly in relation to movements of empty containers. Typically, shipping lines own containers or lease them, and make them available to shippers as part of a package to ship freight, a practice common to that followed in other parts of the world There are some instances of importers and exporters owning their own containers however this is not generally industry practice as it creates problems with having to return containers. They found that at any one time 65% of a shipping lines container fleet is typically unused and will be in a container depot incurring storage fees. Container repair and upgrade costs are also a significant cost of container management for shipping lines.. Shipping lines typically have contracts with one to three container depots (called container parks) in metropolitan Melbourne and they require all empty containers to be returned to the container depot that they nominate. Importers pay for the container to be transported back to the container depot and received by the container depot. With regards to exports the exporter will be notified as to which container depot to collect the box from. They will then pay to collect the box and transport it to their premises.

The logistics of empty marine containers with special reference to Southern California Region are examined in the report by Van Duin, 2003 [(49).] The report examines the market structure, the relationships of the stakeholders involved and the logistic practices adopted in marine container empty container management and concludes that current international logistic practices adopted by ocean carriers represent a barrier in rationalizing the regional movement of empty containers. Nevertheless, the author examined the merits and applicability of certain strategies in dealing with reducing the empty container movements in the region under consideration.

The bi-state (NY/ NJ) port plans to expand reach through rail and barge transshipment to regional feeder ports is presented by Mottley, 2001 [(50)]. The plan increases the potential to reduce container accumulation in the area of the port of NY/NJ.

Konings, 2004 [(51)], analyzed the opportunities for commercial application of foldable containers. For this purpose a cost-benefit analysis was adopted in which four logistic concepts to use foldable containers were presented as a framework for analysis. The costs and benefits of using foldable containers in these logistic concepts were calculated and compared with the situation in which standard containers are used. It was shown that the use of foldable containers can lead to substantial net benefits in the total chain of container transport. However, much depends on the additional costs that foldable containers cause, i.e. the cost of folding and unfolding, additional exploitation costs and any additional transport to places where folding and unfolding can take place. The logistic concept plays a part in it, but there is a major challenge for designers and container producers to develop a foldable container that can be operated within the financial margins which are available for these additional costs.

Yahalom and Guan, 2004 [52], deal with empty container accumulation in North Jersey and indicate some broad possible solutions. They examine the empty container flow logistics globally and the container flow logistics of East Coast and they analyze the factors affecting the container flow pattern. They examine the regional economic characteristics and the trade imbalance for Northern N. Jersey and they provide factual information on empty container movement and accumulation in the Region. Finally they examine the important implications associated with empty container accumulation, including those associated with depot location, land needs and competition for land use.

Ferguson et. al, 2005 [53], summarizes a feasibility assessment of automated container handling within and between rail ramps (yards) in Chicago. The assessment is conducted by a class, Automated Shipping Container Transportation System Design, at the Illinois Institute of Technology. They examine the core functions of container handling in the Chicago region, which involve: (a) receipting of containers arriving at a rail terminal (ramp), inbound or for outbound (b) performing a triage on containers and separating them into classes for onward movement or for intermediate yard storage; (c) moving the first of those classes between two specific ramps, and (d) moving the second into/out of yard storage. The paper presents preliminary conclusions on economic feasibility for either moving and storing containers within ramps, or, transferring containers between ramps. The system solution aims at reducing the waiting time and the variability in waiting time for the movement or exchange of containerized cargo within and between ramps in the Chicago regional "gateway".

Hanh, 2003, [54] describes existing logistics practices with respect to empty containers, and considers the economic and institutional circumstances that direct the movement of empty containers within the SCAG (Southern California

Association of Governments) region. The work explores the regional problems posed by empty containers in the context of existing international trading structures and international marine carriers. A key objective of this project is to understand the current logistics of empty containers related to the movement of cargo through the ports of Los Angeles and Long Beach. This project deals with two aspects of the existing logistics system for handling empty containers: (1) the physical movement of empty containers, and (2) institutional arrangements and practices. The methodology of this study includes field surveys and interviews with local and international carriers, container leasing firms, trucking companies, intermodal transport operators, freight forwarders, and marine container logistics specialists. Findings of this research suggest that, although these operators are cognizant of the efficiencies that could be gained through a rationalization of empty container movements, the business opportunity costs associated with an inadequate supply of empty containers for customers in Asia far outweighs the likely gains of rationalized empty container movements in the SCAG region.

Based on this review, it may be concluded that the empty container accumulation problem is well recognized in the scientific and industry literature. Most of the current articles, however, isolate components of the problem and try to solve them separately, or treat this problem as a side issue. The empty container accumulation problem has multiple dimensions in terms of its causes, stakeholders, and potential solutions and an efficient approach to dealing with it needs to consider all dimensions and examine it within its whole environment. This report identifies the causes of the problem, taking a closer look in the port of NY/NJ, review the state-of-practice and examine alternative solutions, finally proposing a framework on how to approach this problem considering all its components and the possible strategies.

BACKGROUND

This section provides an overview of background information in terms of types of lease contracts and rate terminologies used in the shipping world. This background information is important in developing a basic understanding of the terms that are used in this report.

Types of Container Leases

There are a variety of container leases, falling under three general categories: spot, term, and master.

Spot Leases: In spot leases, also known as "short-term" or "trip leases," users request one or more containers for a short period of time or for a specific trip or purpose. Prices for spot leases fluctuate widely, depending on market conditions at the time of request. Users may get low prices by shopping the market, but should not depend on the spot market for major requirements because of the market's vulnerability to sudden upward price fluctuations. Similarly, leasing companies try to keep their spot leasing activities to a minimum in order not to be caught in a low-rate period with too many unemployed containers.

Term Leases: A term lease is sometimes used for prolonged possession of containers by the lessee. This type of lease is usually a "dry" lease without the lessor providing any service except buying the container from the manufacturer and leasing it. In a term lease, the leasing company is almost wholly in the financial end of the business, in direct competition with banks and other financial institutions.

Master Leases: Master leases, also known as "pool management plans" or "full-service leases," are long-term leases where the leasing company undertakes full management of the container fleet, including maintenance, repair, repositioning, and all other services to fit the user's needs. Master leases are quite complicated, involving debits and credits between the parties according to the condition of the containers at time of interchange and service. Each lease is separately negotiated to fit the user's specific requirements.

Rate Terminologies in the Shipping World

The following definitions present a typology of rate and tariff terms used in the shipping industry.

Freight Rates: Indicate the rates applicable for export shipments obtained by directly contacting the carriers' agent or the freight forwarders.

Tariff: A tariff is a freight rate published by the ocean carriers in a rate book called *The Tariff,* which gives the rates for different kinds of cargo between specific ports worldwide. The freight conferences publish these ocean cargo rates.

Applicable Tariff Rates: The carrier, or the carrier's agent often refers to *The Tariff* for applicable freight rates. These are the freight rates that are influenced by the volume of traffic on a given route. When an exporter contacts the carrier or the carrier's agent for the freight rate, the information normally required of the exporter is the kind of cargo and its intended destination, the gross weight and total cube of the consignment, the expected date of shipment, and whether the freight will be prepaid or collected. Based on this information the applicable tariff rate is determined.

General Cargo Rates: The general cargo rate applies to a shipment of mixed products.

Specific Commodity Rates: The specific commodity rate applies to a shipment of a specific product between specified ports. It is lower than the general cargo rate. In practice, most export goods are transported under the specific commodity rate.

NES Rates: The NES rate (Not Elsewhere Specified rate) or the NOS rate (Not Otherwise Specified rate), sometimes referred to incorrectly as the FAK rate (Freight All Kinds rate), applies to a product that is not specifically listed in the tariff for a given route, that is, a product not found under the specific commodity or the general cargo classifications. The NES rate is higher than the specific commodity and the general cargo rates.

Box Rates: Most ocean freight in modern shipping is containerized. Hence, there is a trend towards the flat rate per container for FCL (Full Container Load) shipments, known as box rate, at times also referred to as FAK rate (Freight All Kinds rate), instead of a weight based rate or measure that is commonly applied in the LCL (Less than Container Load) shipments. The box rate is convenient in simplifying the freight cost calculation in consignments consisting of a wide range of products.

Through Freight Rates: The through freight rate is used in multimodal transport and transshipment. It covers the specified route and mode of transportation to the final destination.

Conference and Non-Conference Rates: The term conference rate refers to the rate of the conference carrier. The term non-conference rate refers to the rate of the independent or non-conference carrier. The freight rate from members of a conference is uniform, but it may differ between the conferences. The non-conference rate varies among the independent carriers. The non-conference rate is lower than the conference rate.

Charter Rates: The charter rate used in the charter industry varies greatly among the charter operators. It is the lowest rate per weight or measure. The operator may offer a very low rate on a return trip in order to secure the cargo, for example, in the return trip from a voyage charter.

UNDERSTANDING THE INDUSTRY AND ITS PLAYERS

This chapter discusses the interactions among key players. Container movement comprises of different set of people, links and nodes. The owners of containers are primarily ocean carriers, leasing companies and depot operators. Direct and indirect stakeholders involved in the container transportation process include ocean carriers, shippers, consignees, trucking companies, depot operators and various transportation intermediaries (NVOCCs, IMCs etc). The process is extremely complex and dynamic in nature and the often conflicting interests of the various stakeholders need to be well understood if an efficient management is to be attained.

Key players in the empty intermodal container management problem are the owners of these containers. There are three main types of container owners. Carriers, including global and niche carriers, and container leasing companies are the primary owners of the container fleet including empties. Depot enterprises handle, store, and repair empty containers and may own a small share of them.

It is essential to understand the dynamics between these groups, to better understand the causes and potential solutions of the empty intermodal container accumulation problem. Constant rate pressures are a fact of life in the container business. Shipping lines have freight rate pressures, which flow through to leasing company rates, and both shipping lines and leasing companies apply rate demands on depots.

The balance that a depot operator must achieve in its customer mix has been complicated by a change in leasing companies' portfolios. For many years through the 1990s, the master lease represented a major portion of most leasing company business. But persistent and significant trade imbalances convinced leasing companies that trying to move containers back to areas of demand, usually Asia, from North America and Europe, was akin to pushing water uphill and the fee revenue that could be earned from their shipping line customers was insufficient.

The global container leasing industry endured a tough year during 2001, when the slowdown in world box traffic growth cut demand for rental equipment and caused a huge redelivery of units. The situation in 2001 was made worse by the earlier optimism of 2000, which prompted lessors and ocean carriers to invest heavily in new box equipment. That year holds the record for container production, with almost 2 million TEUs built in total, of which about 850,000 TEUs were ordered by leasing firms. The increase in box disposal and transfer into carrier ownership outstripped the lessors' new build deliveries by a sizeable margin. It reduced the share of TEUs owned by lessors by several percentage points, from its high of 47.5% owned in 1999 to just over 43% in 2002. Ocean carriers and other transport operators thus own over 55% of all box equipment, which is their largest proportional holding in many years.

Many leasing companies have now moved more towards long-term leases. When ocean carriers have been faced previously with a combination of strengthening demand, rising container prices, lengthening delivery lead times, and shortfalls in immediately available stocks, they have tended to switch to leasing in greater amounts. The current market is proving no different and a number of top carriers have already opted to take a substantial number of new containers on long-term rental, with a wide range of lessors benefiting. Long-term leases also have a significant impact on the throughput volume in depots. Lower gate volumes from leasing companies mean lower repair revenues to depots. A container depot is at the end of a complex chain of supply and demand issues. In the US there is a major change in the attitude of shipping lines to their use of inland depots. The imbalance of containerized trade in the US is legendary. For many years, the attitude of lines with surplus equipment from imported loads was to put the boxes in local depots and hope that a load would be found to move it back to Asia. Now, the lines know that this is a remote prospect, so as soon as the box is unloaded it is shipped back to the coast, usually the west coast.

Lloyd's List International in April 2004, reported that there is a tremendous container shortage in Asia. An acute shortage of containers in Asia is forcing shipping lines to take desperate measures as they make every effort to keep cargo moving. Ocean carriers are quite literally scouring the world for empty and idle boxes, and moving the equipment back to the Far East themselves rather than rely on leasing companies. In more normal times, it is the lessors that replenish supplies, shouldering the cost of returning their containers to the export markets of Asia. But market leader GE SeaCo said that it has now stopped repositioning equipment, with the container lines prepared to take over this expensive exercise in order to make sure they have sufficient stocks in place as fast as possible.

Carrier Collaborations

A substantial structural change has taken place in the shipping liners world, in the past decade. Shipping lines seek to expand their business by expanding the geographic region of their services, integrate the logistics services offered to customers and finally seek to reduce cost by economies of scale. In a desperate call to survive in the depressed market times, these liners and small container carriers integrate the resources of each other by forming alliances and groups, mergers and acquisitions, cooperation agreements regarding slot exchange and ocean carrier consortia and joint services. Carrier firms charter each other's capacity, often known as 'slot chartering', which results in more container movements and fewer ship miles. Consortia and alliances are the most acceptable and preferable form of co-operation between ship owners. They work closely with each other and make every effort to accommodate each other's shipping needs and preferences. Reports say that strategic alliances among liner shipping companies started in the mid-1994. These alliances generally share vessels, terminals and equipment, and work with joint scheduling, slot chartering etc., but do not set prices and follow prices only prepared and agreed by the conferences they belong to.

The maritime industry has been facing many developments in recent years. These developments have led the shipping companies to get involved in horizontal and vertical integrations with the other organizations. The carriers and shippers integrate their activities vertically in port operations, freight forwarding, logistic services and inland transportation. By consolidating operations and sharing each other's assets, carriers believe they are better able to fulfill their promises to customers. Technological solutions and high performance Information Technology (IT) has also gone a long way in making these collaborations a success.

The Container Leasing Industry

The container leasing business was developed as a result of the economic benefit they offer to carriers, especially during periods of high demand for containers. Overall, about 43% of the world's ocean container fleet is owned by container leasing companies, while the remaining is owned mostly by carriers.

The first real player in the container leasing business appears to be Container Transport International, which started operating in the early 1960s. Several other companies entered this business by the end of the 1960s. In 1997 10 of the largest leasing companies owned more than 90% of the worlds leased containers (4.5 million TEUs out of a total of 5.0 million TEUs), and 4 of these collectively controlled about 62% of those containers.

Large container leasing companies capitalize on the convenience of their worldwide facilities and container availability. Their corporate objective is usually continual expansion, because expansion, as well as financial and operating acumen, usually equates to more sustained and/or higher profits in their business approach. Smaller container leasing companies capitalize in areas where they can provide close personal service to selected customers. Like other businesses, container leasing is beginning to use the Internet for online booking, billing, and other cost-saving analytical tools. It is necessary to run a very tight operation in the container leasing business. Furthermore, competition among leasing companies, especially in times of light demand, causes the price of master leases to fall, making carriers very happy.

MAPPING CONTAINER MOVEMENT

Container movement is governed by a different set of factors at each level, global, regional and local. To better understand flow of containers at each level, three different case scenarios are shown below: Container movement on a global basis, on a regional basis and finally at a local level.

The global container flow is shown in reference with a major coastal economic activity center. The flow diagram (figure 3) begins with an inflow of containers and considers two different cases within it. Case I: Inflow is greater than outflow, which may depict a surplus of containers in the area like United States and Case II: where Inflow is less than outflow, showing a deficit area as Far East. In both the cases, changes in carrier decisions are shown and explained. The regional level figure (figure 4) considers the case for the region of New York/New Jersey and shows its links, nodes and modes for its linkage with other East Coast ports, West coast ports and global destinations. In the local area figure (figure 5), container movement is shown after it has arrived at the port terminal and what different places does it travel to before reaching the destination and its repositioning back to the terminal or in a depot.

Figures 3, 4 and 5, present this complex process at a global, regional and local level respectively. In figure 3, the global movement of marine containers is considered, with reference to a Major Coastal Economic Activity Center. If the inflow of containers to that area is greater than outflow (import center) then the area shows a surplus of empty containers. Therefore ocean carriers are faced with one of the following options: to reposition empty containers to areas of high equipment demand at their own expenses, to off-hire the surplus containers and allow lessors to take the appropriate decision about their availability, to temporarily store them in depot at the surplus area, to allow some time before taking decision, to sell out them to secondary market-particularly if their age (greater than ten years and their condition substantiates such a decision, to match their needs with other carriers' needs, although this decision is rather rare and normally it happens only between members of the same alliance.

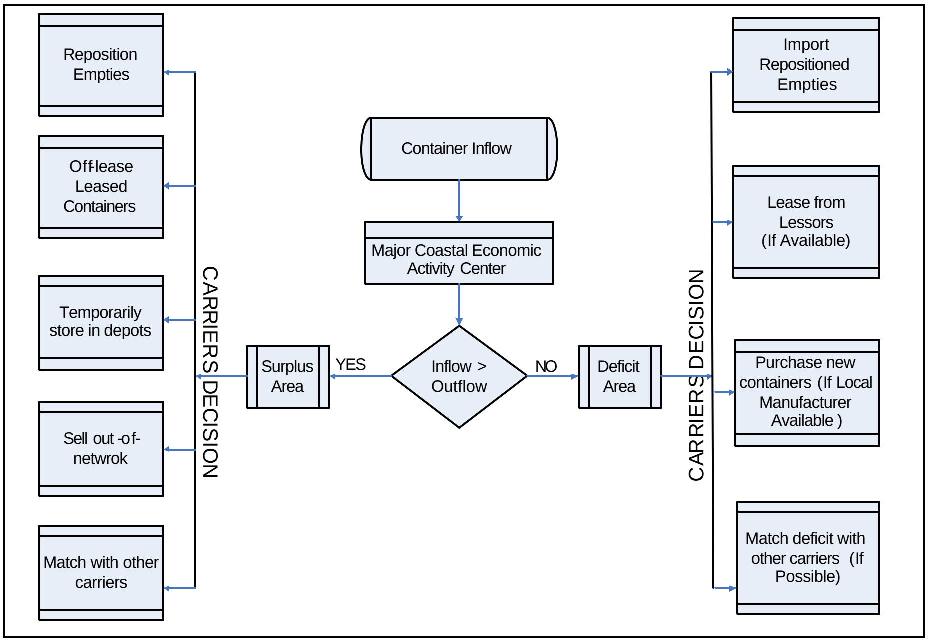


Figure 3: Carriers' Decision Making for Empty Container Flow – Global Level

On the other hand, when outflow is greater than inflow (demand area) the Ocean Carrier is faced with the following options: to import repositioned empty containers from surplus areas, to lease containers from lessors (either locally available or to be repositioned from other areas), to purchase containers (particularly when available at the local market (a case common in Far East, since the area is a container making area and a high demand area at the same time) or to match the needs with other carriers.

Figure 4 shows the relative position of NY-NJ in relation to other competing East Coast ports, the West Coast ports and global destinations.

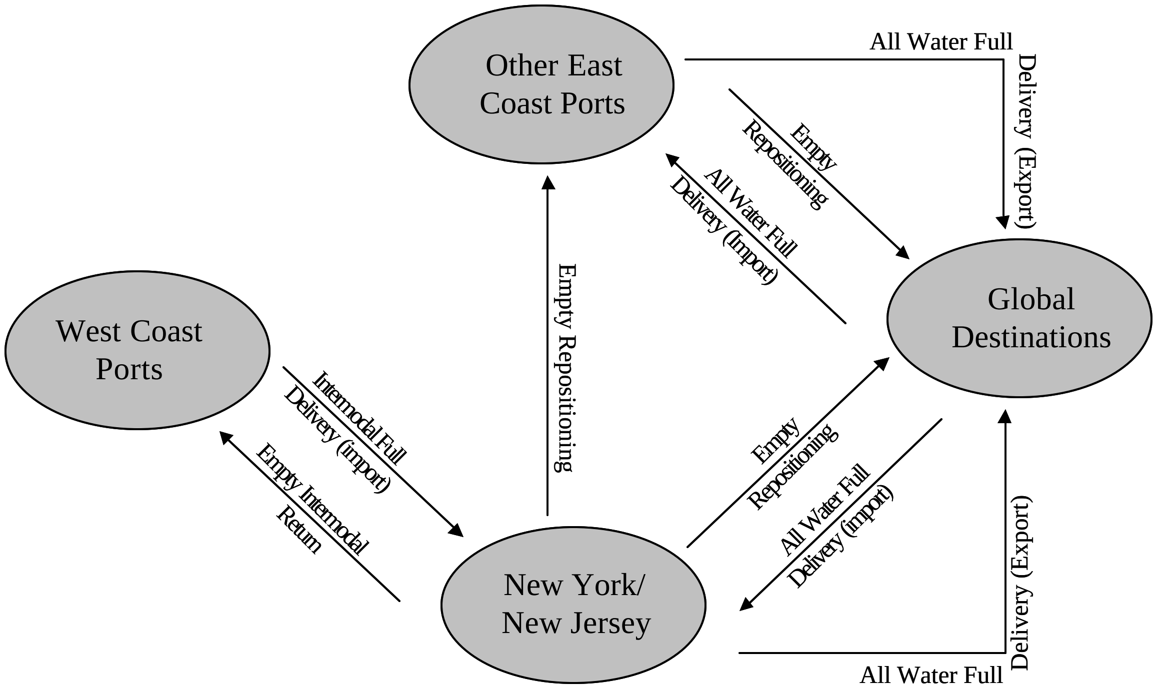


Figure 4: Empty Container Flow – Federal and Regional Level Interactions

In figure 4, the relative position of NY/NJ regarding the global and regional flows of containers is considered. Full Container Imports can be accomplished from Global Origins either directly all water or through other East Coast ports or West Coast Ports (intermodally). Since normally NY/NJ is a high surplus empty container area (primarily due to trade imbalances) empty containers are sent back to global empty container demand areas either directly through all water transportation, or through West Coast Ports (transported to them intermodally and then all water to final destination), or through other East Coast Ports (transported to them either by water or by truck or intermodally) and then through all water route. Of course empty containers from other East Coast Ports can reach their final destination with an intermediate stop at NY/NJ.

The detailed relationship between ocean carriers and land-based partners in the NY-NJ region is given in Figure 5.

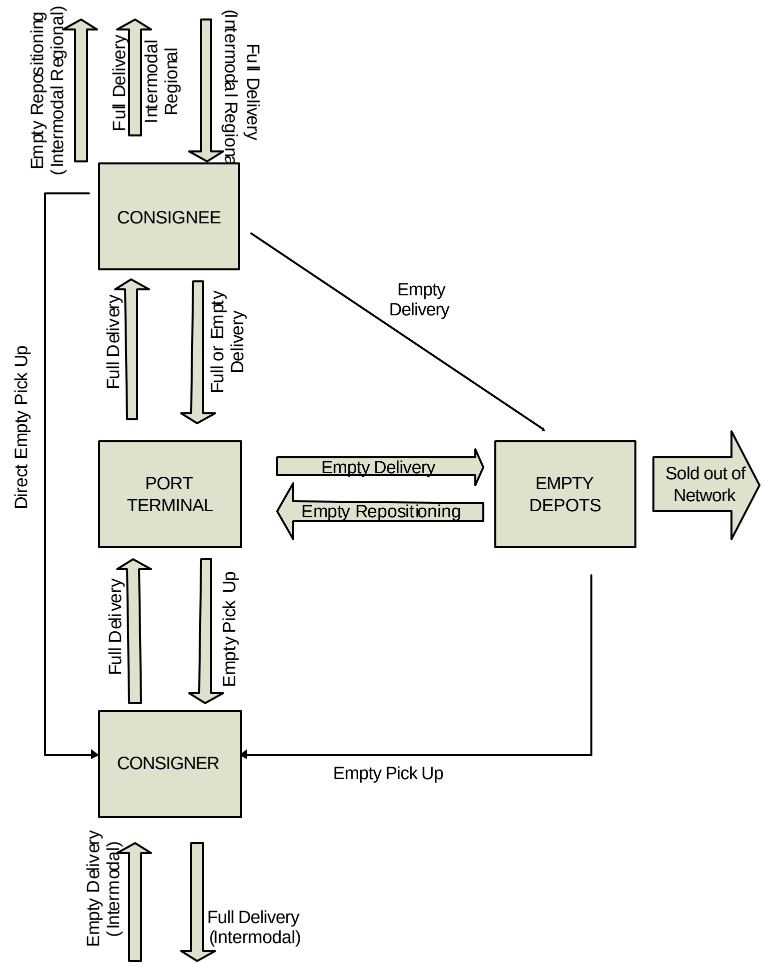


Figure 5: Empty Container Flow (NY/NJ Region)

Direct empty pick-up (street turn) is the most efficient interchange procedure in terms of equipment use and empty trip minimization. Following emptying a container at a consignee's premises the following options are available: either to return it to the marine (port) terminal to be repositioned through all water transportation or to send it full to the next destination or to reposition it intermodally or to return that to a depot or to street-turn it to the next customer to be used for export. Empty containers reach also depots from marine terminals to be stored temporarily. These containers can be property of ocean carriers or lessors. If containers are property of lessors (leasing companies) they can be off-hired by ocean carriers, depending on the lease contract terms. In that case repositioning is responsibility of the leasing company. If containers are aged and have a long storage period at the depot, they can be sold to the secondary market. Ocean Carriers consider containers as cargo carrying equipment, while leasing companies consider them as assets. Therefore the way they are handling them is different depending on the stakeholder involved.

Empty containers accumulated in a region and often stored in depots fall within the following categories: (1) Those that are within the transportation network, temporarily stored, waiting to be filled and exported or to be repositioned back to demand areas, and (2) Those that are long term stored, waiting to be sold in the secondary market, aged (more than ten years) and effectively out of the transportation network.

These two categories require different approaches: (a) Those in the network require an industry-based initiative to increase matching possibilities and decrease empty trips, and (b) Those out of the network require periodically reviewed measures to increase the possibility of removing them to secondary market or to scrap. A continuous monitoring system would be required to record the accumulation and movement of empty containers.

THE EMPTY CONTAINER ACCUMULATION PROBLEM

Empty container accumulation is a very prominent problem in many ports areas worldwide. There are several reasons that lead to the accumulation of empty containers as these are discussed later in this report. One of the many reasons is the trade imbalance. When the container arrives in a country with commodities from another foreign country, ideally it should go back to the same foreign country, by the same carrier. Unfortunately, this seldom happens. The export orders are not this perfectly timed and thus containers go empty into a depot nearby, for inspection and cleaning; waiting for an export load. This turns into an expensive long wait. [(55)] Several places around the globe face problems related to empty containers. Some of these problems have a more permanent character requiring long term, sustainable solutions, while others are rather temporary requiring a short term, focused solution. Issues that have occurred and/or are occurring in several regions are discussed in this chapter.

Australia

The Nationwide News Pty Limited, Weekly Times (Australia) in January 2003, reported that, “At Sydney, there has been nearly a 50 per cent increase in empty containers in the past six months and that has been replicated in other ports.” Shipping chief executive in Australia explained the reason behind this stacking as the drought that beat the volume of agricultural products being exported. He added that the containers full of imports still come in at the same rate while the empties keep piling up on wharves of the port due to the insufficient exports that take up. Shipping Australia chairman emphasized “the decline in export cargo caused by the drought had coincided with a surge in imports, placing great pressure on storage and repatriation of empty containers”. It was found that sending empty containers back overseas was far expensive. It costs $300 to $650 to return a container to overseas markets, making it "easy to imagine the cost impact of having to send back 200,000 containers over the next year."

Ship owners warned that cargo rates on incoming boxes would have to rise to cover the cost of shipping the unwanted containers back. Sydney Ports have also dropped the $10 charge on shipping empty containers and is planning a forum of industry bodies to find a solution.

South America

As reported by the Lloyd's List International in April 2003, container lines in South America have vessels leaving almost full to all destinations from its east coast, but have their utilization rates ranging from 40% to 60% for inbound ships. A high proportion of these volumes are empties being repositioned for the outbound leg. The growth in empties being handled is having an impact on the country's major terminals, with leading terminals, especially in Brazil, offering lower prices to handle empty containers to keep business on the outbound boxes. As the distortion between exports and imports is growing day after day, the level of empties being handled by the major operators is also growing. While empty containers used to account for about 15% of the volume, that figure has now leapt to 25%.

The William Reed Publishing in May 2002 reported of the Argentinean corned beef saga. As the peso devaluated and lesser imports were seen in Argentina, shipping companies imposed a surcharge in the amount of US $200 per 20-ft and US $300 per 40-ft on empty containers needed to export goods from Buenos Aires. A shipping company spokesman said: “We simply do not have enough two-way traffic to meet the export demand. We will ship empty containers but it will incur extra cost, hence the need for a surcharge with immediate effect”.

This policy further reduced the exports from the country and buyers switched from Argentina to Brazil. An overspill of the problem was the result and Brazil faced a problem of greater magnitude in meeting and keeping up with the demands. Prices rose sharply as canners struggled to meet the market and no change on prices was seen in cattle cost, which aggravated the problem.

United States

The following figure 6 shows the US coasts and the location of its ports. It shows the various routes through which sea containers potentially enter the country. Empty container accumulation is a problem at most of these ports.

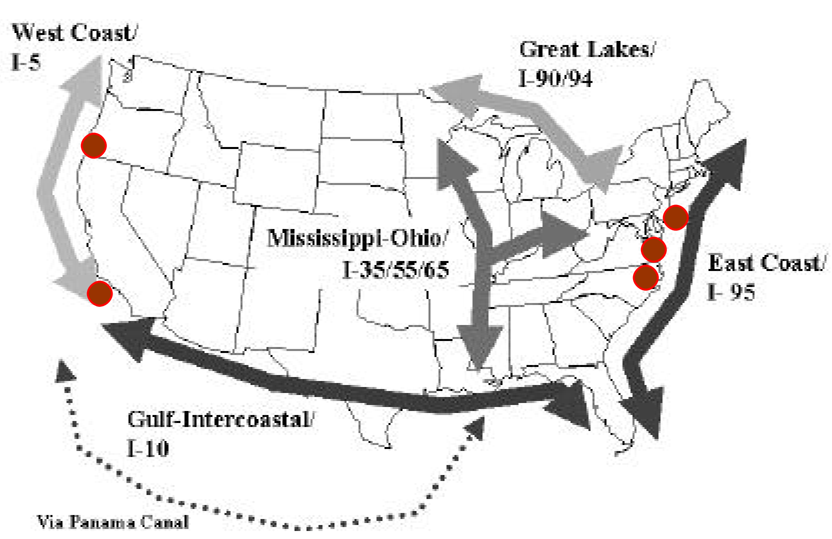


Figure 6: US Coast and location of Major Ports

Source: Expanding opportunities in coastwise shipping, National industrial transportation league, 93rd annual meeting, TRANSCOMP 2000, November 2000

Portland - Oregon

The Business Journal of Portland reports high container stacking at the Portland's marine terminal. The reason or the root cause was identified as the Asian economic troubles. The growing trade imbalance between US and Asia is draining profits each day. The strong US dollar with the weak Asian currencies lead to a cooled export of Northwest products and has surged its imports. As a result, empty boxes are flooding West Coast ports with very few exports to fill them.

Wilmington – North Carolina

The Star news in April 2003 reports, "As you drive down by the state port, you'll notice rows of colorful, empty shipping containers. It's a lesson in economics that brings the balance – or imbalance- of trade home." The director of public affairs for the N.C. state authorities says that around 1,658 empty containers are currently sitting idle at the port. For every two shipping containers coming in, there's one going out.

Several policies and potential solutions were tested in NC. One such solution was the recycling of containers. Although empty containers can be of great utility, used for storage sheds or offices at job sites, they did not prove to be 'hot' in the market. One of the local companies in NC, 'Tidewater Storage Trailer Rental Inc.', tried renting out the containers, so that they can be used for temporary storage when renovating homes, or as additional warehouse space. They found some success over recycling and renting out empty containers brought some good to the port area in NC.

Port of Hampton Roads - Virginia

In order to deal with the rising number of empties at the port of Hampton roads, Virginia, the authorities imposed a quota on the number of containers that can be stored at the port property, reports The Associated Press in February 2003. This policy when implemented, improved the port operations. The General Manager of Virginia International Terminals (VIT), which operates Virginia's ports, said: "Port agencies around the country are continually battling to attract cargo and the availability of storage space for empty containers is a strong marketing attraction". The quota policy that Virginian ports imposed is believed not to be applicable to the port of Newark-Elizabeth, where the situation and number of empties stored is the worst. It is said to be so because the empties sitting at the port of Newark are on private properties. Also, imposing the quota at Hampton Roads was in one-way good for the authorities and port management systems. However, it brought down the port's popularity among the other competing ports, according to a Port official.

California

The Commonwealth Business Media Journal of Commerce, in March 2004, said that "the weakening U.S. dollar, coupled with resurgent economies in most US export markets, spelled welcome news for the outbound leg of the US container trade last year. But while containerized export growth of 8.7 percent largely kept pace with import growth, the actual volumes tell a different story." Containerized imports eclipsed exports by slightly more than 6 million TEUs, leaving a staggering number of boxes stacked up in US container yards, waiting to be filled or repositioned back to Asia. The resulting imbalance on all lanes continued to create headaches for the major liner companies as they scrambled to reposition their boxes, often shipping them empty back to China and other Asian ports, rather than waiting to fill them.

Booming import volumes underlay the roughly 40 percent increase in trans-Pacific freight rates last year. The import boom is so strong that it has led to a shortage of vessels available for charter, especially for any contract periods of less than five years. The flood of imports has also created headaches for ports and terminal operators as they scrambled to increase capacity enough to handle the resulting traffic.

Congestion on the roads to and from California ports is so bad that California Assemblyman introduced a bill that would impose a surcharge on daytime pickups. This inevitably means extended hours for ports, terminals and carriers. Atlantic and Gulf ports are experiencing the same problems as more carriers introduced all-water services from Asia to those ports to avoid the delays caused by congestion on the West Coast.

New Jersey

The Port of NY/NJ is the largest port on the east coast of the United States. Each year more than 21 million tons of ocean borne general cargo moves through this port, including 3.75 million TEU's (twenty-foot equivalent units) of containerized cargo. Statistics show that this port handles more than 14 percent of the entire nation's container imports and 12 percent of the exports (2001 statistics). The volume of loaded and empty containers has increased each year with 14.7% in 1999, 7.8% in 2000, 8.7% in 2001 and 13% in 2002. [56]

With such high numbers of container handling, it is imaginable the amount of storage space that this Port might need. In the recent years, the Port is facing a huge difficulty in handling and managing the empty containers that have stacked-up in and around the Port area. The shipping container surplus in New Jersey (around Port Newark and the adjacent Port Authority Marine Terminal at Elizabeth) is a consequence primarily of the U.S. trade deficit. Because of the deficit, the port takes in and unloads more containers than it can fill up and ship out. Indicative of nation's trade deficit, the Newark-Elizabeth complex unloaded more than 1.6 million full containers in 2002 and shipped out only 688,000, making 150,000 empties stay back, in that one year only.

Estimates are that there is around 400 acres of land currently devoted to the long-term storage of the empty containers in the 10-mile radius of the port of Newark/Elizabeth in New Jersey. [57] The following figure 7 shows aerial photo of several locations [58] around the Port where empty containers are currently stored.

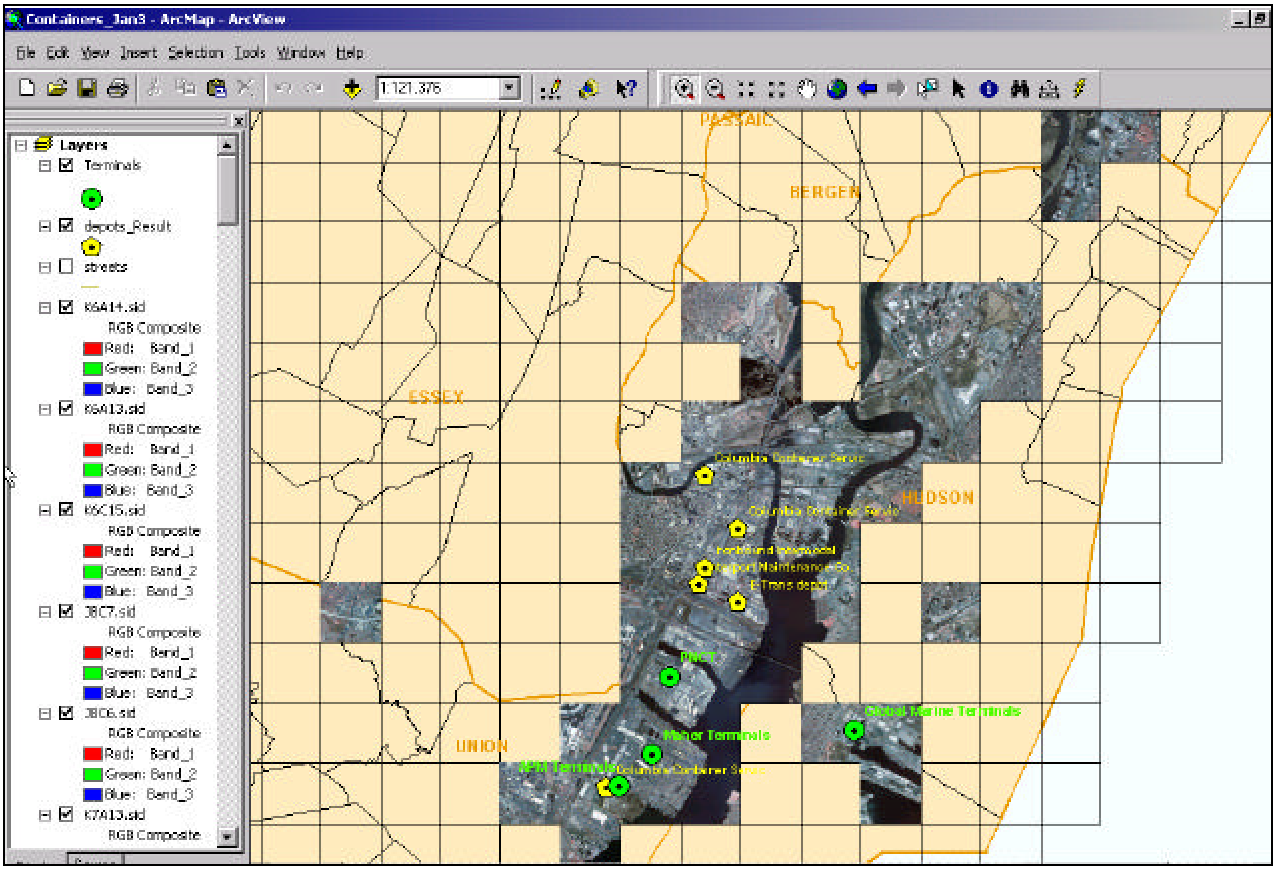


Figure 7: Aerial pictures of locations in NJ where empties are stored with major depot and terminal locations

The New Jersey State authorities aim to discourage container storage on prime locations around the port. The goal is to have such policies and strategies in-place that may facilitate the reuse of the land for freight-related activities, and turn these properties into productive and tax-paying facilities.

In February 2004, the Mayor of Newark, passed a legislation [(59)] that "*requires the department of environmental protection, to prepare and adopt a plan to tax dormant cargo containers that remain empty or unused for 90 days or more.*" In-addition to the taxation issue, Mayor James also considered having weight and height limitations imposed on empty container stacks. He says that as containers can be transported and cannot be taxed as property, there should be a limit assigned to the number of containers that can be stored on a certain square footage of land. The following figures 8 and 9 show empty containers presently stacked as high as six or seven near the port area and at many places along the roadways.

Figure 8: Empty Containers around the Port of Elizabeth, NJ

Figure 9: Empty Containers stored in facilities along New Jersey roadways

This new legislation faced a great opposition from the terminal operators and other associations. Maher terminals, International Longshoreman's Association and others opposed the legislation critically. According to the agencies and operators, *"fine on the storage of containers would be bad for the business"*. They say that, *"If the goods don't come in, we don't put many people to work."* A spokesman added, *"Being able to store containers is essential to the efficient operation of the port."*

After two months of the proposed legislation in Newark, in April 2004, The Business Media Journal of Commerce reported that during the last few months and for the first time in years, the big container stacks at the ports in the US has been seen to shrink. This drawing down of container inventories first began at western depots, and then spread to the East Coast. The reason however behind this shrinking was not the legislative policies, but the ‘booming demand’ and ‘tight supply’ that left ocean carriers short of containers to carry U.S. imports, which made them willing to spend the thousands of dollars it takes to reposition a container from the East Coast to China. The article mentions at the end however, that, “*Eventually, the current conditions will change, and we'll see another accumulation of containers*.”

Since the beginning of the year 2004, there has been a very important move in the trade industry affecting the shipping industry massively: the rise in the steel prices. In March 2004, Lloyd’s list reported, “container lines have been stung by a massive increase in equipment costs since the start of the year as rocketing steel prices hit manufacturers.” The rise in the steel prices has tremendously increased the cost of constructing new containers. In the past, the cost of repositioning a box was $1,200 and a new container was available at $1,300. With the hike in steel prices, the cost of new containers increased to $2,100, while keeping the cost of repositioning remained at $1,200 for a 20-foot box. The increase in steel prices has been largely due to the strong demand by China for both iron ore and steel. In the past two years, prices for many types of steel have doubled. Shipping lines believe that this could prove to be a ‘hidden blessing’ for them as the demand for containers have suddenly risen and carriers are now prepared to take delivery of leased boxes themselves and ship them back to Asia.

ROOT CAUSES OF EMPTY CONTAINER ACCUMULATION

There are several reasons that lead to accumulation of empty containers at the Ports. Root causes of the empty container accumulation problem have been identified and are summarized below:

1. Trade imbalance
2. Rate imbalance
3. New container prices vs. cost of inspecting and moving empties
4. Un-timed delivery and shipment of containers
5. High storage fee in areas of high demand for empties

Trade imbalance

Trade imbalance is cited as the number one factor contributing to the empty intermodal container accumulation problem. In New Jersey, there is an imbalance close to a two-to-one ratio imports to exports with related vessel fill factors of 90%-plus for the outbound moves to 50% for inbound moves.

As reported by the Dyna Liners in February 2005, Table 2 below shows the grand total movement of containers to and from the USA. Figure 10 also shows how imports and exports have been for USA over the past five years. Figure 11 shows the container trade imbalances.

Table 2: Total Imports and Exports from the USA

	2004	2003	2002	2001	2000
Total imp	**15,562**	**13,748**	**12,693**	**11,023**	**10,890**
Total exp	**7,835**	**7,230**	**6,693**	**6,520**	**6,771**
Total	23,397	20,978	19,386	17,543	17,661
Growth TEU*	2,419	1,592	1,843	-118	1,552
Growth%	11.50%	8.20%	10.50%	-0.70%	9.60%
Imbalance	**7,727**	**6,518**	**6,000**	**4,503**	**4,119**
Imbalance%	**50%**	**47%**	**47%**	**41%**	**38%**

TEU *1,000 rounded.
Source: DYNA LINERS, 06/2005, 11 February 2005

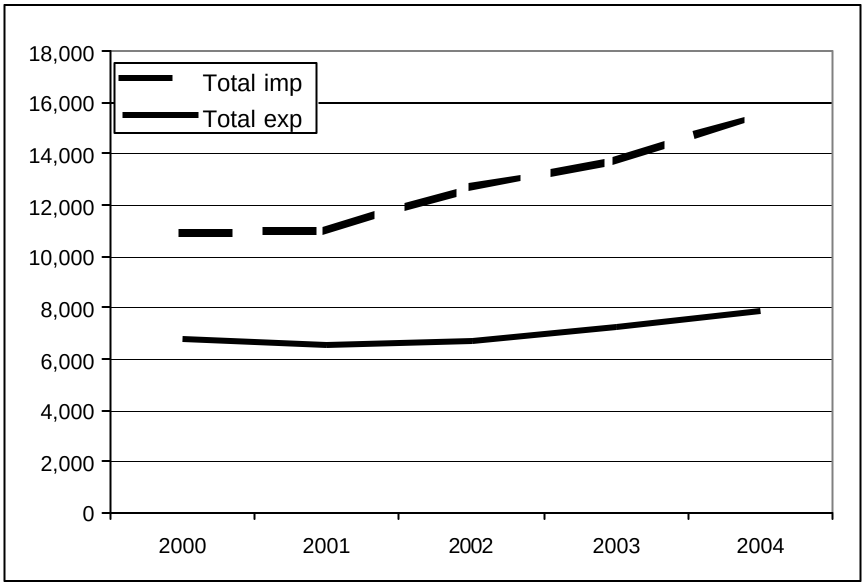


Figure 10: Imports and Exports from USA, 2000- 2004

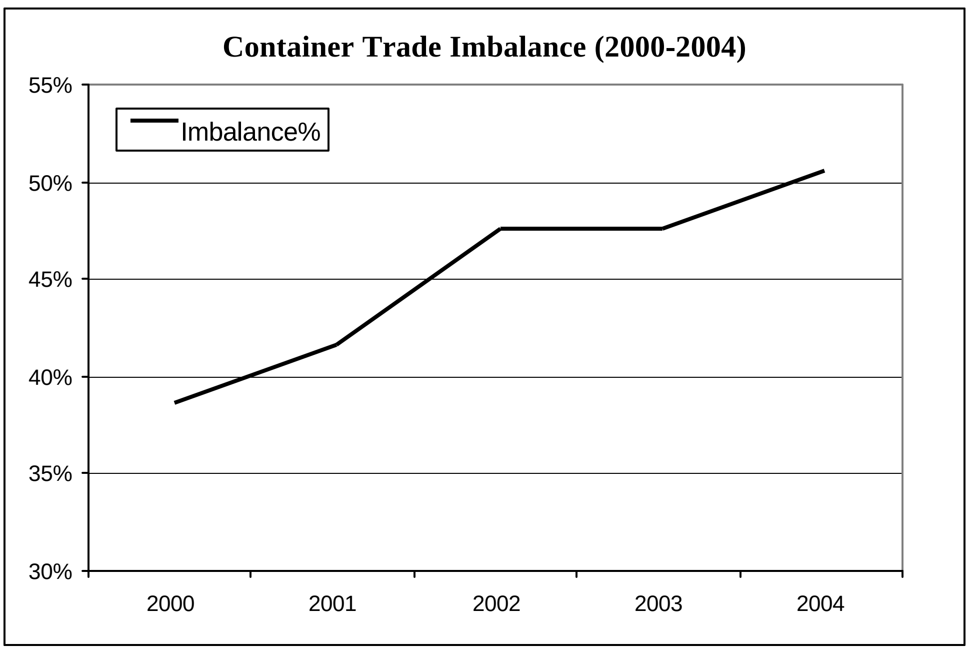


Figure 11: Container Trade Imbalance, 2000- 2004

In year 2002 only 40% of the containers used for imports in the NY-NJ region were reloaded for exports. In the relatively balanced Transatlantic trades, ***TACA*** reports that in year 2004 westbound carryings to US East Coast ports increased by around 5% and although increase in the other direction was 10% the imbalance stands at around 35%. [60]

In year 2004, as the total US containerized (overseas) import grew faster (13,2%) than its export (8.4%), the container imbalance between both cargo flows reached an all time high of 50%. In other words: no less than 7.7 million TEUs had to leave the largest economy in the world empty again. Theoretically, *eighteen 8,200 TEU ships per week* are required to evacuate such a volume, which underlines how major a headache this must be for whichever carrier is involved. [61]

As imports into US grow faster than its exports, the problem to reduce the chronic empty container equipment imbalance position in the trade seems worsening. Thus, trade imbalance remains as a serious cause of the problem, which needs to be dealt with.

Rate imbalance

In addition to the trade imbalance, rate imbalance is contributing to the empty container accumulation problem. While rates in the peak direction are at a high level, in the opposite direction they are substantially lower.

In the transatlantic trade example, the average rate in the dominant westbound move to the US East Coast during the first quarter of 2003 increased by 3% compared with the previous quarter, or 7% compared with the same period in 2002. In the eastbound transatlantic trade, the average rate in the first quarter of 2003 fell by 1% compared with the previous quarter – the same result as compared with a year earlier. Figure 12 shows the freight rates between several trade regions during year 2004 and the second quarter of 2005, demonstrating the rate imbalance.

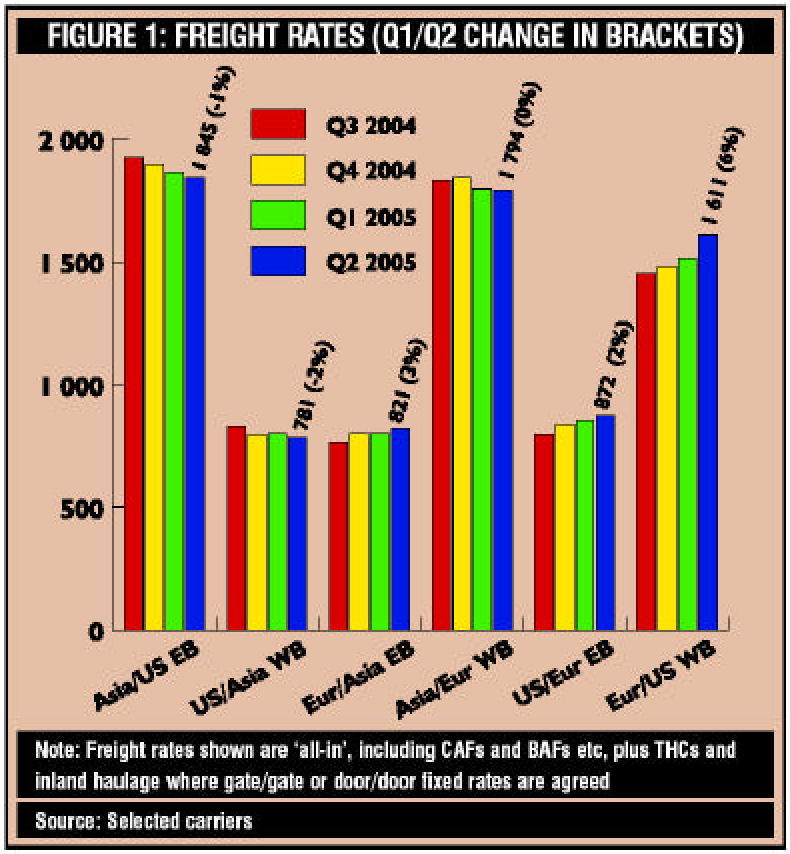


Figure 12: Rate Imbalance

Source: Containerization International

This rate imbalance and the need to reposition empty containers back to Asia, especially China, creates another problem. As an example, Michael Hann, line manager at the Vancouver (BC)-based NVOCC Cascadia Container Line, indicates that westbound transpacific freight rates from all Pacific North West ports are very low for lumber, varying between US$200 and $400/40ft. 'Rates from Vancouver - a major gateway for lumber exports - to Shanghai and Hong Kong are particularly low because of the high demand for empty equipment at these ports by carriers' he explained. Rate imbalances, together with trade imbalance complicate the dynamics of ocean container transportation, thus complicating the empty container transportation problem.

New-container prices vs. Cost of Moving Empties

Moving empty containers both inland and by sea is a very costly exercise. The shipping Digest in May 2004 reported that it costs leasing companies about $1,200 to reposition an empty container from the US East Coast to Asia, whereas the new containers are built at a cost of $1,300. New container prices used to be very low compared to the cost of re-positioning, or storing and inspecting old containers. As a result, the option to purchase new seems to be more appealing than moving empties leading to the accumulation of empty boxes in areas with high inbound and low outbound traffic. The steep increase in the steel prices and the steep rise in demand for maritime transportation using containers has changed this trend dramatically. This sharp increase in factory container prices has resulted in substantial increase in leasing rates. The very dynamic relationship resulted in temporary alleviation of the container accumulation problem in the regions previously shown empty container surplus. Although China dominates (approximately 82% of the world production) the container making industry, ocean carriers and leasing companies are currently willing to pay the cost of repositioning empty containers back from the US to China to cover the unprecedented demand in container equipment. It is inevitable that this situation is highly dynamic and unstable. Should demand fall in future, the situation will be reversed, resulting in more severe empty accumulation problem due to the increased container population worldwide.

During the year 2004, prices for new built boxes rose further. For a 20 ft dry cargo box China factory figures of USD 1,900/2,100 are reported, while two years ago this price ranged between USD 1,200-1,400.

China dominates this market, since no less than 82% of the world container production is in its hands. In January 2004 the lease component of the box inventory stood at 9,964,000 TEU according to reporting from the Institute of International Container Lessors. Both groups, i.e. carriers and leasing companies, hold each other more or less in balance.

Table 3: Major Lessors' Container Fleet on Operating Lease of all Types in Inventories of over 100,000 TEUs

COMPANY	2004 SHARE(*)	2004 TEUs(*)	2003 TEUs	2002 TEUs	2001 TEUs
CAI	6%	580	541	476	430
Capital	5%	465	428	318	240
Cronos	5%	426	410	390	375
Florens(**)	10%	908	805	685	571
Gateway	3%	311	300	300	265
GE SeaCo	10%	975	1,010	940	960
Gold	3%	256	250	200	195
Interpool	9%	891	895	795	702
TAL Int.	11%	1,030	1,105	1,050	920
Textainer	12%	1,169	1,115	1,005	965
Triton	15%	1,367	1,147	1,022	916
Others	11%	1,019	834	719	666
Total	**100%**	**9,395**	**8,840**	**7,900**	**7,205**

Notes: 1. Figures in TEUs*1,000
2. (*):estimated
3. (**) includes containers leased to Cosco
4. CAI is a 50% affiliate of Cosco

Table 4: World Production of Main Container Types

(Both Maritime and Domestic Production)

Type	2004 TEUs (*)	2003 TEUs	2002 TEUs	2001 TEUs	2000 TEUs
Dry Freight	2,607,000	2,233,000	2,233,000	1,593,000	1,837,000
Reefers	140,000	135,000	135,000	115,000	101,000
Tanks	13,000	12,000	12,000	12,000	12,000
Total	**2,760,000**	**2,760,000**	**2,380,000**	**1,720,000**	**1,950,000**

Table 5: World Container Throughput (in TEU):

Year	TEU
2005*	362,000,000
2004	323,000,000
2003	293,000,000
2002	266,000,000
2001	243,800,000

Source: Dyna liners 27th issue, 2004 and UNCTAD, RMT 2004

It is generally expected that the ***container newbuilding surplus stock*** of around 500,000 TEU (instead of 700,000 as reported in DL 20/05) will be absorbed within the next few months when the peak season is on, which however is assumed to get a slow start. Newbuilding prices meanwhile have fallen to around USD 2,250 per 20' standard dry steel unit. (Dyna Liners 23, June 2005). Figure 13 below shows container newbuilds and figure 14 shows the average price of new container builds.

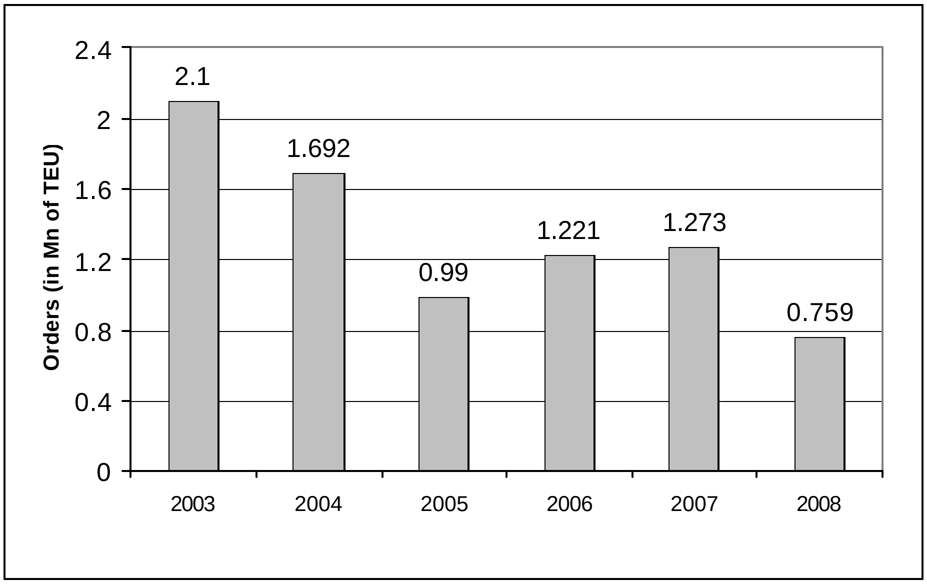


Figure 13: Container Newbuilds

Source: Dynaliners Trade Report; 2005: Issues 9, 14; 2003: Issues 35,37 and 38

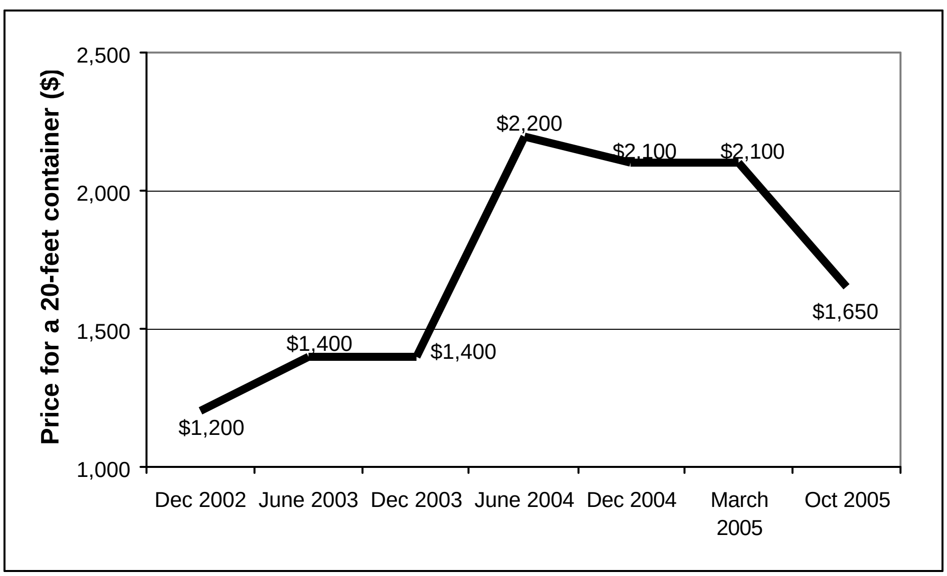


Figure 14: Average Price of New Containers

Additional cost components that could be factored in the analysis described above, include the cost of repositioning empty containers and the cost of inland transportation, the cost of leasing vs. cost of buying new containers, the terms of leasing contracts, the cost of inspection and maintenance of aged containers, and the marginal and volatile profitability of the leasing industry.

Un-timed delivery and shipment of containers

The container shipping business model seems simple enough: make an empty container available to the shipper, deliver it to the consignee and retrieve it when empty again. If the cost of doing so is less than the rate paid by the customer, a net profit remains. Unfortunately it is not as simple as that, for two main reasons. Firstly, the 'cost of doing so' involves the allocation of the ship system's fixed costs to the single container transportation act. And secondly, it ascribes the cost of making available and retrieving the empty container to the single transportation act. These costs are of almost mythical quality, being largely the consequence of the flows and availability of containers throughout the global container pool.

High Storage Fee in Areas of High Demand for Empties

No lessor can afford to ignore a large build-up of idle containers, as their storage and 'dead' handling costs rapidly eat into profitability. Ironically though, the highest storage charges are increasingly incurred in the areas of strongest demand, such as Hong Kong, South Korea and many coastal locations in China.

These same costs are generally lower in North America and parts of Europe, where the secondary market for containers is also better developed. Thus, lessors have a choice: to reposition their idle containers into more expensive, but higher demand areas in Asia, or leave them in cheaper 'graveyard' locations, where the best option may be to sell the unit out of the fleet altogether.

RESPONSE TO THE EMPTY CONTAINER PROBLEM – State-of-Practice

It can be argued that keeping empty containers idle is not only a major economic concern, but creates serious traffic, environmental, social, and aesthetics problems as well. On the other hand, moving empty boxes is also costly and very unproductive, consuming vessel capacity that could be better utilized, for example to serve shippers of lower rated cargo, as discussed above. As the efficiency of the intermodal transportation system lies also on having the right equipment in the right place when needed, several options have been explored in trying to deal with the accumulation of empty intermodal containers in places where there is not demand for them. Since these containers have been introduced as components of the intermodal transportation system, keeping them part of this system would be the most desirable approach. Thus, the primary focus of this task is on options that would help keep containers a part of the intermodal transportation system, while minimizing the inefficiencies caused by these containers moving empty or sitting idle in a yard or depot. As this is not always feasible due to logistical, economic or practical purposes, other options such as alternative use, recycle and reuse of these boxes will be considered.

The next sub-section presents some of the options that are currently being used in the direction of keeping containers into to transportation system. In addition, alternative solutions by converting empty containers into attractive commodities will be presented in the following sub-section. The last sub-section presents options for reuse and recycle of intermodal containers.

Keeping the Empty Containers a Part of the Intermodal Transportation System

Keeping empty containers part of the intermodal transportation system requires that managerial, policy, logistics, and/or technology solutions, which are very often interrelated, being implemented.

Managerial Solutions

1. Grey box pools

Cooperation between container owners/operators (mainly carriers and leasing companies) has been difficult so far. More boxes must be repositioned full, and carriers need improved equipment visibility, to divert boxes to cargo demand locations at short notice. Carriers complain of information 'black holes' once containers leave their yards en route to hauliers' or shippers' premises.

One solution to the problem is combined container fleets between carriers, so-called *'grey box' pools*, being established. Some global carriers habitually exchange equipment on an ad hoc basis. However, others' corporate cultures discourage arriving at customers' premises with a competitor's box.

With the increasing use of e-business tools in the transport industry, cooperation between carriers, which so far has been labour-intensive, expensive and inefficient as it involves carriers faxing details of available loads to each other periodically, will be facilitated, making the ‘grey box’ solution increasingly attractive.

2. Box swapping

Carriers container repositioning, a world-wide industry practice costs several billions of dollars a year. Formal management systems may help decrease this amount substantially. In this direction, a box swapping system, a co-operative equipment scheme, can work for both carrier-owned containers and for leased ones.

The box match concept is easy to manage and produces significant savings for both the surplus and the demand parties, compared to other alternatives. For the demand line for example, leasing an extra box for 8 to 12 months costs $700-800 after including all charges (per diem, on-hire/off-hire and pick-up/drop-off costs, repairs); borrowing a box from a fellow carrier under a formal box match interchange scheme will cost hardly any more than using ones own container (i.e., around $400 - a depreciation cost of around $300 for the same period plus a flat pre-determined repair fee of $100 and a small cost to cover the box match administration). For the surplus line, repositioning a box using ones own containership costs some $500, as mentioned above; having a surplus box picked up and redelivered to an agreed point costs its owner nothing but the administration fee, as the depreciation and repair costs are passed on to the other party.

The box match concept is one innovative way of reducing empty equipment repositioning. The other solutions are: ad-hoc one-to-one equipment interchanges between carriers; leasing and off-hiring equipment as required and joint container pools. A further option is to contract an outside repositioning firm to do the job for you by using your empty box to carry another line’s cargoes.

3. Passing boxes to carriers once their lease expires:

There are great incentives for passing boxes to carriers once their lease expires, as it cuts the lessors' exposure to short-term/master leasing, forces up utilisation and reduces depot expenses. Moreover, all this is achieved without 'overloading' the secondary market, as this will be reviewed next, and risking a collapse in used box prices. The only downside is that the leasing company loses any claim to the container's residual value at a later date, although the unit does generate some additional revenue while it remains on lease.

Almost 300,000TEU were cleared from the lessors' entire operating fleet during 2001. At the same time, some of the market leaders converted many old containers on to full payout finance lease, effectively removing them from their operating fleets. Such containers are destined to pass into carrier ownership, once the lease term expires.

4. Horizontal Diversification

Many big carriers are horizontally diversifying by introducing supporting units to their primary activity. For example, Maersk Domestic and Maersk Data USA provide support to Maersk Sealand, to increase productivity and improve their operations.

For example, a high percentage of Seattle/Tacoma imports have a final destination, which is over 500 miles inland. A major concern to ocean carriers is the cost of repositioning equipment from the Mid-West and other regions, back to the Pacific North West (PNW). As the population base in the PNW is relatively small, a large proportion of containers are transported back empty. Facing this problem, Maersk Domestic works to generate some backhaul revenue for Maersk Sealand. A priority for carriers is to reposition the containers back to Asia as quickly as possible, for them to be loaded with more profitable eastbound transpacific cargoes. Maersk Data USA with its new tool DrayWatch provides visibility for containers leaving the ocean carrier’s yard by truck.

5. Yield Management

To be profitable, a container shipping line has to take action to become a proactive operator of the global pool through a programmatic approach to yield management. Yield management is the art of maximizing profit in a business with substantial fixed assets by controlling and steering the asset's utilisation. The target of successful container management is not utilisation in the literal sense, but the minimisation of displacement.

Yield management for a global container operator means to engage in a comprehensive effort to reduce container displacement, while at the same time making best use of the shipping resources at hand. This may sound obvious at first - all container-shipping lines try to avoid empty movements - yet, it is rarely done in a systematic and sequential manner.

In the case of HLCL, yield management is one of the reasons the carrier is being 'pretty good' in reducing the incidence of empty container repositioning. Introduced three years ago and currently undergoing further refinement, the system compels HLCL staff at the time of making a booking to take account of the next turn of a container. Typically, it is not the first move, which matters; but the second. Whilst the first one can be very productive and very profitable, it can be spoilt by the second.

<u>Policy Solutions</u>

Various policy solutions are being proposed and/or have been implemented in various parts of the world. These solutions include various taxation schemes for containers stored for more than a certain period of time, limiting the height at which empty containers may be stored, changing equipment depreciation period, etc.

In Argentina for example, punitive measures were introduced for containers stored for more than a certain number of days. More specifically, Article 46 of the new law stipulates that each containerised unit faces a fine of $100 per day, up to a maximum of 90 days, if it exceeds the 270-day limit. This means, that a unit which is only worth about $1,500 if purchased in Asia, could lead to a fine of as much as $9,000 being imposed. Three Buenos Aires-based shipping agencies have already been fined, and a sum totalling $40,000 is said to be hanging over one of the three. These agents include Nabsa, which represents Kien Hung, and Williams, which represents Compania Sud Americana de Vapores.

As a result of these punitive measures, several container lessors - among them GE SeaCo and Gold - have declared that they will no longer store empty containers in Argentina, but will instead have them removed to Brazilian depots, with the nearest port of Rio Grande being the favoured destination.

Logistics Solutions

Very often, the most expensive part of an intermodal container's trip is the inland part. Furthermore, moving intermodal containers inland creates an additional problem to returning them, usually empty, back to the port. The railroads are being put under pressure to move empty domestic boxes back to the West Coast to collect the waiting domestic traffic. Unfortunately, because the railroads are not paid to move empty domestic boxes they are extremely reluctant to undertake the movement of empty boxes west because doing so will not generate revenue for them.

Another option is to take all of the contents from two 40ft international boxes and place them into one 53ft domestic container. This will ensure that a cheaper price is available for the cargo, with one box having to move instead of two but, importantly, this procedure ensures that two international boxes become available on the West Coast immediately. The boxes can be returned to Asia instantly, instead of facing a three to four week wait whilst they move inland before being subsequently returned, with or without export cargo. The relationship between domestic intermodal equipment and international boxes is a critical logistics consideration.

IT Solutions

One of the problems in successfully implementing some of the above solutions is lack of equipment visibility. In the last few years, a number of US-based IT companies have developed web-based solutions to the problem. These include SynchroNet Marine Inc, International Asset Systems (IAS), and Maersk Data USA Inc, part of the AP Moller-owned Maersk Data Group.

The functionality of these software products varies, but all are essentially tools for repositioning or providing visibility of equipment. They also specialise in different aspects of the transport chain, reflecting the wide range of service providers involved. Some products focus on ocean carriage, others on US intermodal road or rail transportation, while others provide ocean carriers and leasing companies with visibility of equipment.

SynchroNet and IAS both provide webbased container interchange services. These are online marketplaces enabling ocean carriers, container leasing companies, US-based stacktrain operators, intermodal marketing companies (IMCs), and other participants in the transport chain, to search for or provide surplus/deficit containers anywhere in the world. For example, a shipper in China may ship a full 40ft intermodal load eastbound, destined for Chicago (IL). Once the container has been stripped at the US consignee's premises, the box operator can advertise the availability of the empty box via the interchange. Another carrier may be short of a container for a rail shipment from Chicago back to Los Angeles, so he can utilise the box once stripped. As the container would have to be repositioned back to the US West Coast in any case, the operator earns additional revenue for this transit.

SynchroNet's customers include both global and niche ocean carriers, as well as major leasing companies. These include Maersk Sealand, CMA CGM, APL, Hanjin, K Line, GESeaCo, and Transamerica Leasing itself. IAS' Interbox service focuses on the North American market, but also counts a number of major global carriers among its customers, mainly those who operate stacktrain services (notably Hanjin and MOL).

Maersk Data USA has recently introduced a web-based visibility tool for containers once they leave an ocean carrier's yard by truck. So far, Maersk Sealand is the only ocean carrier using DrayWatch, but Maersk Data USA intends to market it to other carriers later.

Container Technology Solutions

Another potential solution to the empty container accumulation problem is the promotion of alternative container designs, such as the collapsible, or folding container. Collapsible containers, such as those shown in Figure 15, are designed with hinged walls to fold down when empty. They can save space and reduce the cost of moving empties. According to a collapsible container manufacturer, some of the key features of collapsible containers include: (a) increased return ratios (empty containers outbound vs. full containers inbound); (b) they are designed with folding walls that allow them to collapse to a shorter height. This allows many more containers to be shipped back with the same cubic space as set-up containers and when shipped, they reduce the logistical need for land storage; and (c) straight walls of set up containers allow more cubic interior box space and maximum product per inbound container. Some issues to consider in a more detailed evaluation of this option include the savings in empty storage vs. non-collapsible container option, savings in empty container return freight cots vs. non-collapsible option, repair and durability issues of moving parts of folding walls, and time and labor costs to collapse vs. space/return freight savings. The effect of folding containers on shipping and storage is illustrated by the following example. Assume that a normal batch of 100 x 20 ft containers, 100 TEU, was replaced by 25% of non-folding containers plus 75% of folding containers. Then the total shipping or storage volume would be equal to 25 plus 75/3, which equals 50 TEU.

It has been estimated that if 75% of empty containers shipped were foldable in 2010 this would amount to a saving of some 25 million equivalent TEU per annum in shipping transportation, or 50% of the total volume of empty containers shipped. In financial terms this would equate to over $1000 per empty container when using folding containers, a considerable benefit to shippers, particularly in the industrially developing countries where empty container movements are 30% to 40% of all containers shipped.

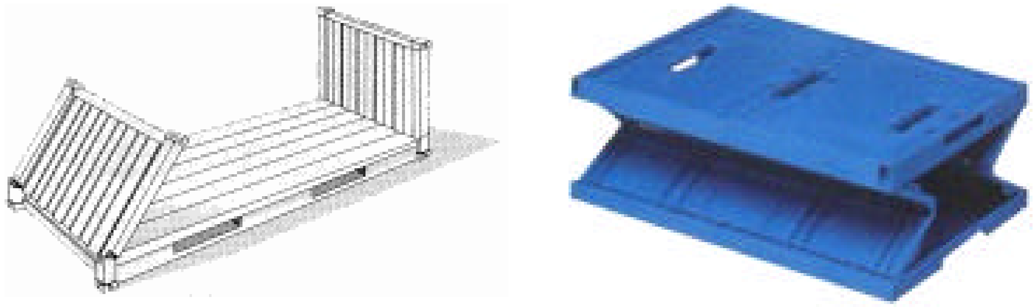


Figure 15: Collapsible Containers

There are some safety hazards associated with collapsible containers, however, which need to be considered in evaluating this option. Collapsible containers consist of platform bases together with end frames, which can be folded down onto the bases. When the containers are not in use or are being returned empty, the end frames are folded down and the containers are stacked in blocks usually of 5 units, which are then locked together for easy transport. The end frames of many containers are counter-balanced by a spring so they can be manually folded down. In the erected position the frames must be locked by means of shot-bolts or twist-locks to maintain them in position. Accidents have occurred in the past involving containers with non-counterbalanced ends. In one case, the ends of the container were unlocked and allowed to fall under gravity. In another case, the ends had not been locked in the upright position and when the last side gate was dismantled the unsupported end frame toppled. It is recommended that enforcement officers visit container storage places to ensure that users are aware of the risk associated with such containers and of the correct erection and dismantling procedures. Despite these risks, collapsible containers may provide a solution to the problem of storing or repositioning empty containers.

Making Empty Containers Attractive Commodities for Marketing

Secondary Uses of Empty Containers

Many container depots are exploring new revenue streams and focus on more efficient use of resources. A common diversification is into trading and local leasing of containers. Depots are ideally situated to purchase containers being cast off by their customers because of age or because they do not meet the owner's repair cost/book value criteria. Workshop facilities at depots often have downtime, so discretionary work repairing or modifying purchased containers is low overhead work for a depot.

Many depots have developed a good business in selling containers for domestic use or as "one way to nowhere boxes" and in many places there is profitable business in modifying containers to make sport pavilions, offices, housing units, and a whole range of other uses. According to Zim, one of the largest container shipping companies in the world, container housing has several advantages including inexpensive building, fast production, easy transportation, solid, self-sustained housing. The pictures in Figure 16 show how containers can be recycled that have been taken out of sea service. The possibilities, according to Zim are unlimited and restricted only by the imagination.

Classroom

Gas Station

House

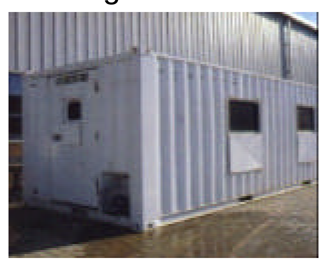
Public Lavatories

Restaurant

Sales Center at Building Site

Workers Village

Room in a 20' Container



Refurbished Container

Figure 16: Alternative Use of Intermodal Containers

Source: http://www.zim.co.il/contsale.htm

In addition to the above described regular uses, second-hand containers may be used in emergency situations as relocate-able relief housing with applications for a variety of needs, including post flood, fire, earthquake, typhoon, or similar natural disasters. Sean Godsell, architect, designs such units, called Future Shack, using second hand shipping containers, universal modules that are mass-produced and inexpensive, robust and durable. The units are totally self-contained, with water tank and solar power cell. Future Shack can be fully erected in 24 hours.

Figure 17 shows examples of the "Rapid Deployment Dual Housing" (RDDH) units, designed and manufactured by GV Custom Modular Construction, Inc., which house two separate families. These units may be shipped in the same manner as overseas containers and can be operational in one day, as they require no assembly, only minor connections once set in place.

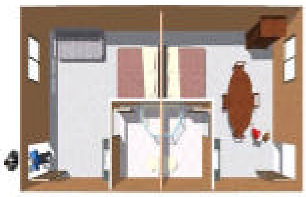
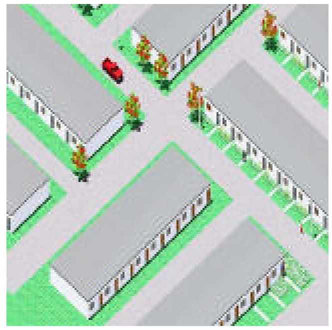
  

Figure 17: Floor Plan and Site View of Emergency Housing

Source: http://www.gvcm.com/emergencyhousing.html

World over similar innovations have been proposed and are in use. For example, as reported by The Evening Standard (London) in a January 2003 issue, there has been a new scheme named 'HOPE' introduced in London, which proposes to convert low-cost steel sea containers into homes. The idea has come from the Urban Space Management, the company behind the eye-catching and highly publicized Container City at Trinity Buoy Wharf in Tower Hamlets, east London. This scheme will give an insight for first-time buyers as new, low-cost housing schemes involving ingenious building techniques are mushrooming around the capital. The development, built from a stack of standard, multi colored steel lorry containers**,** is used as artists' studios. The containers have proved to be ideal for providing much-needed low-cost space for the creative community.

The Telegraph Group Limited, (London) reported in March 2004, a 'Container City' alongside a wide and wild stretch of the Thames opposite the Millennium Dome, where two clusters of old corrugated sea containers are providing cheap studio space for artists and small, creative businesses. The original development of 18 rust-red containers, stacked four high, became so successful that another, Container City II, was added (Photo shown below in figure 18). This time 33 containers have been painted bright red, yellow, orange, and maroon. All of these are stacked asymmetrically. With their balconies and porthole windows, they were more Legoland than a shantytown. The container idea came from Rotterdam, where the containers were being converted for use as recording studios.

Figure 18: Container City in London

Source: www.containercity.com

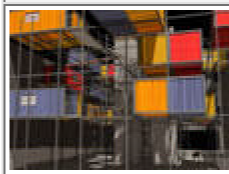
According to Zim, one of the largest container shipping companies in the world, used container has several advantages including inexpensive building, fast production, easy transportation, solid, self-sustained housing.

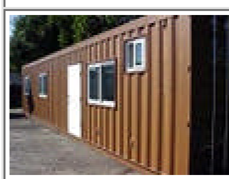
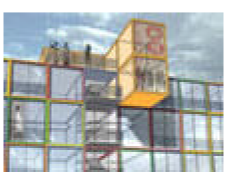
Recent projects utilizing shipping containers for habitation

There is a growing interest in the use of shipping containers as the basis for habitable structures. Containers are relatively inexpensive, structurally sound and in abundant supply. Also, although, in raw form, they may be are dark windowless boxes, they can be highly customized. Some of the other recent and interesting examples are shown below in figure 19.

A	Project Name	Designer Location	Status as of December 2004
	Habitainer	Barcelona Spain	Container-based live/work units. Development stage. Seeking resources.

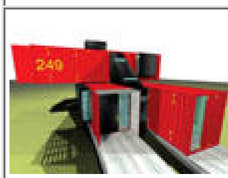
B	Project Name	Designer Location	Status as of December 2004
	Simonstown High School Shipping Container Hostel	South Africa	Built in 1998

C	Project Name	Designer Location	Status as of December 2004
	Ten Year Hotel	Montreal, Quebec, Canada	Studio design project dealing with city, surface, and cell. This is a temporary approach to hotel design.

D	Project Name	Designer Location	Status as of December 2004
	Container School for humanity in Cross Keys, Jamaica. August and September 2000	Atlanta GA USA	GlobalPeaceContainer.com builds sustainable, low-cost alternatives to traditional construction methods.
	Chuckhouses	Santa Rosa, California	Container-based structures designed for commercial and residential applications.
	Keetwonen	Amsterdam, The Netherlands	Temporary village using 1050 ISO 40' containers converted into student homes near Amsterdam city center. City council contract signed. Awaiting permits

E	Project Name	Designer Location	Status as of December 2004
	12 container house, Brooklin, Maine	New Jersey	Used as a vacation home by the client

	The Collector's House at Shelburne Museum in Shelburne, VT	New Jersey	Open for inspection (during months when museum is open).
	Quik Build	New Jersey	2000 sf kit house. 3 bedroom, 2.5 bathroom.

F	Project Name	Designer Location	Status as of December 2004
	Guzman Penthouse	New York, NY, USA	Residential project completed1996
	MDU Mobile Dwelling Unit	New York, NY USA	Built prototype currently travelling through museums in North America. See second link for exhibition schedule.
	Container Kit Home	New York, NY USA	2003 project currently in development

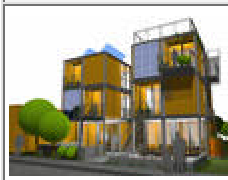
G	Project Name	Designer Location	Status as of December 2004
	Four-over-Two	Seattle, WA, USA	CargoTecture: Coming Soon to Urban Infill Seattle; 72 Cans around 14th & Madison & Pike.

Figure 19: Container Use for Habitation Purpose

Source: http://www.lot-ek.com/main.htm, http://www.fabprefab.com/fabfiles/containerbayhome.htm

Recycle of Empty Containers

Recycling is an environmentally responsible method. Steel has a very high recycling rate and more than half of all steel manufactured in the U.S. today is made of recycled material. Recycling of second-hand containers could be examined as an alternative to dealing with the empty container problem, especially in areas where container storage yards are located near by steel recycling centres and where the cost of moving empties is high.

Several scrapping facilities are located in the PONYNJ region. In these facilities, typically, containers are processed through either a mobile or stationary shear. A container is moved to a scrap yard and weighted. It could be worth about $100 per net ton. Major costs associated with this procedure include transporting the container to the scrap yard, preparing it (removing wood floor and insulated doors – typical composition: clean steel 0.681%, insulated doors 0.137%, wood floor 0.182%) and cutting or shearing the metal down to a manageable, shippable size. The metal is then shipped to steel mills throughout the world. The metal is a commodity that has a value set by market conditions and dependent on geographical location, thus the selling price varies widely.

ADDRESSING THE PROBLEM IN THE NY/NJ REGION

The description of empty container movements and the factual information presented above highlight the fact that empty container logistics is a global issue, greatly influenced by international transportation practices, governed by global trade patterns and mostly dictated by major ocean carriers' interests. To this end, complete and direct control of empty container accumulation at a regional and local level falls far beyond the ability of local and regional authorities and other interested stakeholders. Institutional, fiscal or regulatory measures can be proved inefficient in lessening the accumulation problem and even detrimental to the competitive position of transportation resources of this region in the international marketplace if the global environment is not considered in formulating them. Measures taken at a regional level should be taken cautiously, bearing in mind the broader trade environment, the operational conditions and constraints of the industry, and its influence in the competitive position of the region. Both the external environment and the structure of the transportation industry in the said region should be taken into account when formulating policies seeking to alleviate the empty container accumulation problem. Any policies to be adopted should be taken bearing in mind the very dynamic nature of the maritime transportation industry.

Recent global developments affecting the region

In early 2004, there was an unpredicted and unforeseen hike in steel prices all over the world. Rising steel prices, resulting mainly from the increased demand in China caused a cutback in container production, which also is centered in China. Shippers without equipment soon started feeling the pinch. The acute shortage of containers in Asia forced shipping lines to take desperate measures and make every effort to keep cargo moving. Container manufacturers in China told most carriers that they could fill only half of the carrier's orders. Carriers started reporting difficulty in obtaining enough new containers to replace the boxes they retire, and the containers they were purchasing started costing them about 40 percent more than they did the previous year. The price of a new 20ft dry box went up from around $1,400 to $2,000 within a very short period of time, while lease rates also soared by about 50% over these couple of months.[(63)] Though there are countless empty boxes scattered around the globe, most of them were far from where they were needed.

Shipping lines, in a struggle to overcome the equipment shortage, began repositioning empty containers from areas with surplus, such as the U.S. and Europe, to areas with shortage, primarily in Asia. But repositioning options with carriers' were limited. On westbound backhaul voyages to Asia, empties were competing for space on the ships with U.S. export loads. Chartering of vessels to carry empties to Asia was an option, but a costly one. Charter rates for ships started approaching record levels, and the market became extremely tight.

The container shortage is further aggravated by persistent problems on the North American intermodal rail network. The Union Pacific and Canadian Pacific systems have developed bottlenecks that have slowed trains and added to the time needed to deliver empty containers from interior points to seaports for repositioning to Asia.

Until this year, excess manufacturing capacity during the last decade had enabled shipping lines and container lessors to buy new containers at bargain rates. Carriers had grown accustomed to replenishing their fleets with new boxes and retiring containers after depreciating them for seven to 10 years.

The effect of the increase in steel prices along with other possible developments has been obvious in the area around the Port of Newark/Elizabeth. For the first time in years, the big stacks of containers near the Port started shrinking. Booming demand and tight supply left ocean carriers short of containers to carry U.S. imports. As a result, most carriers became willing to spend the $1,000 or so it took them to reposition a container from the East Coast to China.

To handle U.S. imports, carriers started taking on additional containers from leasing companies. The lessors began reactivating containers that have been sitting, sometimes for years, at container depots. International Asset Systems, an Oakland, Calif., provider of information services for container management, said its survey of more than 600 depots in North America, Asia and Europe indicates that “the depots' supply of empty boxes has declined by 41 percent in the last three months.”

The drawing down of container inventories in the U.S. began at western depots from which containers could more easily be repositioned to Asia. Between July 1999 and July 2005, the number of loaded containers leaving Los Angeles rose by only about 46%, while the number of empty containers leaving Los Angeles more than doubled. In every month over the last six years, more containers have left Los Angeles empty than full. The percentage of empty containers has risen from about 50% in 1999 to 66% in 2005 and 68% in 2006, according to the official figures from the Port of LA. Simply put LA ships out twice as many empty containers to Asia as full containers. This trend was also spread to the East Coast. James Greco Jr., sales manager at Columbia Container Services in Newark, said his company's storage yards have seen "a large egress of containers," especially since January. Steven J. Bernstein, president of Interbox, also based in Newark, said containers stored at his depot have dropped to 15,000 TEUs from 35,000 a year-and-a-half ago.[64]

World Cargo News, in its January 2005 issue reports on the effect that these changes have had for depot operations. More specifically, the article reads: “The vast stockpile of primarily leasing company-owned equipment that built up in US depots in 2001 and the early part of 2002 - estimated at its peak to have been over 450,000 TEU - is now a distant memory, and with container demand still running at record levels, gate activity is at a low ebb. Off-hires have been suspended, gate-in repairs are negligible and storage revenue has dwindled to minimal levels.” Experts say that as a result of these conditions, empty deport capacity has shrunk, as many depot operators were driven out of business.

On the other side of the oceans, Nationwide International News Service, in December 2005 reported that China restrains container production for easing overplus. It said that according to a joint decision passed by the majority of China's container producers, such as CIMC, Singamas, Maersk, there will be a two-month-stop of container production in China so as to ease its output overplus. In addition, a number of new production programs were also to be postponed in China to control the output, according to the news sources. Statistics by CCIA (China Container Industry Association) show that China International Marine Containers (CIMC), the world's largest container manufacturer, produced 4.5M TEU containers while the forecast demand for the year was only 2.4M TEU. Exacerbating the situation is that a further 1.3M TEU of production capacity is under construction and total capacity is expected to increase to 5.8M TEU by 2007. A representative for security affairs at CIMC said, "We will trim down our production by less than 200,000 TEU this year". The surplus of production capacity has caused big waste of land and energy in China and has exerted unfavorable impact on development of the sector, reports the Asia Pulse Pty Limited.

Container shipping, however, is cyclical with a constant ebb and flow in supply and demand for boxes. Although the shipping industry sometimes acts in ways that seem to defy basic economics, it is still governed by market forces. Researchers and forecasters say that "eventually the current conditions will change, and we'll see another accumulation of containers. No matter where the industry is in the container supply-demand cycle, inefficiencies persist in a generally efficient container-shipping system. Nearly 50 years after containerized shipping was extended to international trades, the industry is still struggling with the problem of how to manage empty containers."

Strategic, Policy and Operational Measures Considered in the Region

The state and local authorities aim to discourage container storage on prime sites near by the port. The goal is to have such policies and strategies in-place that may facilitate brownfields reuse for freight-related activities. It is believed that redevelopment of the brownfields will provide the space for warehouses and distribution centers near the port, which will in-turn leave open spaces on the fringes of the region that are currently used, reduce the truck traffic on the highways, reduce roadway maintenances and will improve the air quality. The redevelopment will turn invaluable contaminated properties into productive and tax-paying facilities. The counter argument from some industry experts is that in this market driven businesses, if the land used for storing empty containers could have been used more profitably for other types of operations, it would have. On the other hand, and given the imbalance in trade, empty storage is a requirement in the smooth operation of the system.

In February 2004, Mayor Sharpe James of Newark presented legislation (assembly no. 2042), which "requires the department of environmental protection, to prepare and adopt a plan to tax dormant cargo containers that remain empty or unused for 90 days or more." Mayor James also discussed the possibility of having weight and height limitations being imposed on empty container stacks. He says that as containers can be transported and cannot be taxed as property, there should be a limit assigned to the number of containers that can be stored on a certain square footage of land. This new legislation went to the senate in November 2004. Again, such measures should not be taken without considering the dynamics of the industry as they may adversely affect these businesses and the economy of the region.

In spring of 2005, marine terminals in the PONYNJ region increased demurrage charges on import containers left at the terminal and reduced the free-time period before demurrage kicks in. As an example, typical fees are at $45 per day for the first four days, $95 per day for the fifth through ninth days, and $245 per day from 10 days on. On average, empty containers amount to about 30% of all the containers in a marine terminal, contributing to terminal congestion and reduced productivity.

Maher Terminals has set up a unique inland facility to store excess empty containers. This satellite terminal is a direct extension of the marine terminal and electronically linked to it. Only containers that will be loaded onto a vessel within a two-week period are allowed onto the marine terminal. Most importantly, there is rarely any physical movement of empty containers between the two facilities. Truckers know in advance to which facility they are to deliver the empty. Empties stored at the satellite terminal are used when needed for loading cargo to be exported or to be used in domestic service by the steamship lines for repositioning to another port. A somewhat similar example is the Barbours Cut Container Terminal at the Port of Houston. The terminal has made arrangements to store empty containers off-site to relieve capacity constraints at the marine terminal itself. Third parties operate at four separate locations for the storage of the empty containers, all within a mile of the marine terminal. Containers are also cleaned and repaired at these sites. One of the main differences with the previous case is that empty containers are transported by marine terminal chassis over the private port road network to/from the storage facilities. The costs for this transfer operation are absorbed by the stevedoring companies who in turn then include it in their package of charges to the steamship lines. The operators of the empty storage facilities charge the steamship lines directly for their services.

Additional policy guidelines, stakeholder strategies and managerial and operating measures may be devised to address the empty container accumulation at a regional level. *Policy guidelines* may include objectives for overall annual reduction rate for long-term stored containers, redistribution objectives for these containers, developing or using an existing auditing mechanism for the reduction of the total number of long term stored containers in the state. *Stakeholder strategies* may address matters specifically associated with a certain stakeholder and a certain type of empty containers (eg. promoting the immediate relocation of containers as soon as they are entering the state and being emptied) or promoting synergies between representatives of the same stakeholder (eg.

networking depots) or promoting cooperation and synergies between stakeholders with conflicting interests. Finally, a set of *managerial and operating measures* of tactical nature can be effectively applied by individual players in order to support success of stakeholder strategies and policy objectives.

A set of such possible actions has been developed and classified in three levels. Level A, which are considered to be short-term actions, Level B, which includes the intermediate-term actions and Level C, which includes the long term actions. The classification of the possible actions is based on how fast an action may be implemented and how fast and to what extend, the result of its implementation may be observed in the region's empty container inventory. Of these measures, some have more limited application and use than others, some are more practical and others may be more effective than others. The multi-participant nature of the problem further complicates the measure selection decision as actions taken by one stakeholder may contradict with the objectives and needs of other stakeholders. Stakeholder collaborations and consensus building by evaluating alternative paths and selecting the action or the combination of actions that are promising in dealing with the problem while minimizing the negative impacts for individual stakeholders should be considered.

Level A or Short Term measures, some of which are operational measures may include: equipment matching opportunities, which may be assisted by the implementation of a Virtual Container Yard project; tax write-off for income gained from selling old containers; taxation for aged containers – this taxation can scale up with idle time scaling; change in demurrage charges – this measure may also scale up with idle time scaling; free-time period.

Level B or Medium Term measures, also called tactical measures may include: capacity constraints per facility; limit height to stack of a certain number of containers; limit depreciation period from 15 to 10 years so that the exempted from taxation annual depreciation be raised accordingly, but with the obligation to sell boxes after ten years of economic life to a secondary market – this measure may apply to companies owning boxes as assets, which are registered in NJ, unless a government regulation is developed; General taxation for containers being idle for x period of time in a region (even if the container has been stored in different locations within the same region).

Level C or Long Term measures, also called strategic measures may include: develop new zoning rules to raise disincentives or even eliminate the possibility of locating or operating a depot in a particular location or sub-region; relaxation of brownfields land use impediments; raise land value, which will make it unprofitable to use the land for empty container storage; improved accessibility, by developing dedicated corridors or priority truck lanes, which will make empty container storage sites attractive locations for more profitable land uses.

Again, caution should be exercised, in selecting and proposing to implement these measures to ensure in depth understanding of the behaviour of the industry and its dynamics, as well as the potential broader impacts of each measure.

A Decision Support Tool

To facilitate dialogue among various stakeholders and facilitate the decision making process, a Decision Support Tool is being proposed. The decision support tool is presented here based on the idea of a continuous monitoring system, which would provide information on the empty container inventory in the region. A certain level of monitoring is currently in place in major port regions. Although the tool described herein may be used with the aggregate level of information which is currently available, a more detailed monitoring application will be required to provide full functionality to the tool. A description of such a monitoring system is presented in [(65)] and is described later in this report. The structure of the proposed decision support tool is shown in figure 20.

The tool, implemented within a GIS framework, provides flexibility in the location and size of a region to be analyzed and facilitates data storage, analysis and visualization. The number of empty containers stored in a region or sub-region is monitored. The size of the region to be considered may vary from an individual facility to a county, zip code, or an area extending several miles around a major activity center and may include several zones, sub-zones and intra-zone sections. Based on the observed conditions in the region, stakeholders may select to evaluate policies and strategies, which are expected to help achieve a desired outcome. Different actions may either target the overall container accumulation, or focus on long-term stored containers, or on older containers with the objective to facilitate their selling to the secondary market.

The decision support tool is included in the CD-ROM attached at the end of this report. Appendix A is a user's guide, with a step-by-step description on how to install and use the tool. As a quick overview, by selecting the area to be analyzed, the user retrieves information on the location of empty container storage facilities, as well as the number of empties stored in each facility, segregated by age, ownership, length of time within the location, and any other data that may be stored in the database through the monitoring system. The observed conditions are compared against desirable levels (for total containers or for a particular category) and the action or set of actions that may be applicable in each case and which are expected to help achieve the desired outcome is evaluated.

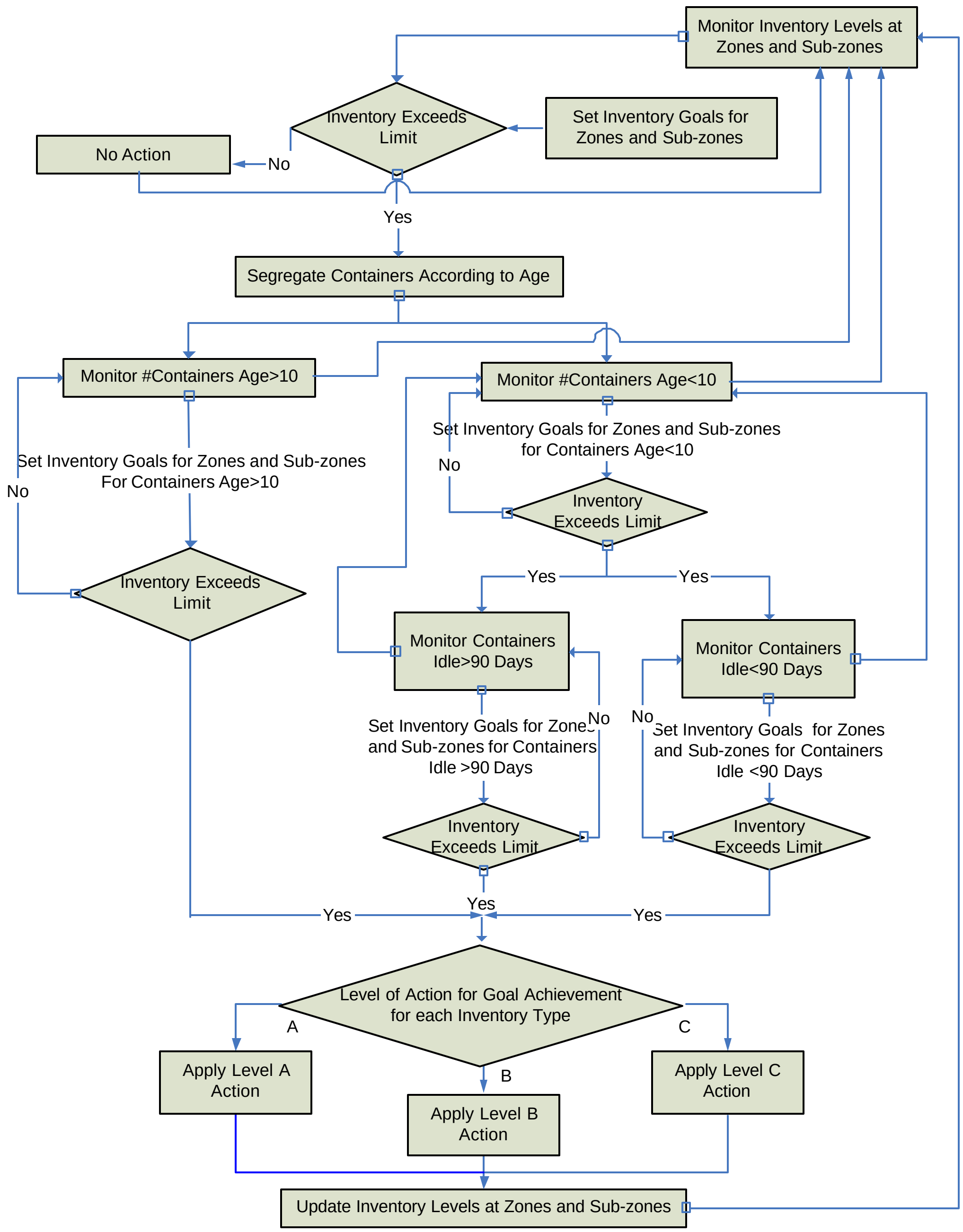


Figure 20: Structure for Decision Support Tool

An expert system needs to be built to allow for estimates of the anticipated impact and for evaluation of the various policies. The inference procedures of the expert system manipulate and use knowledge in the knowledge base to determine the outcome of proposed actions. The knowledge base is built based on factual and heuristic knowledge, meaning knowledge that is commonly agreed upon, as well as more experiential knowledge, including good practice benchmarking, good judgment and plausible reasoning from experts in the region and simulation and analytical model outcomes if available. Given the complexity of the problem in terms of the number of factors affecting the effectiveness of proposed actions, behavioural models that will represent the expected behaviour of key stakeholders under various conditions need to be developed. A more detailed discussion on these models is presented later in this report. The tool is implemented within a GIS framework to facilitate data storage, manipulation and visualization. Figure 21 shows the area near by the port of Newark/Elizabeth with major depots and terminal locations. Figure 22 shows the same map along with and example data on on- and off-terminal empty storage locations, which are available on-line from various terminal operators. Figure 23 shows information on land use and land value associated with each of the empty depot locations.

Figure 21: A Zoomed-in Image of the Major Depots and Terminal Locations

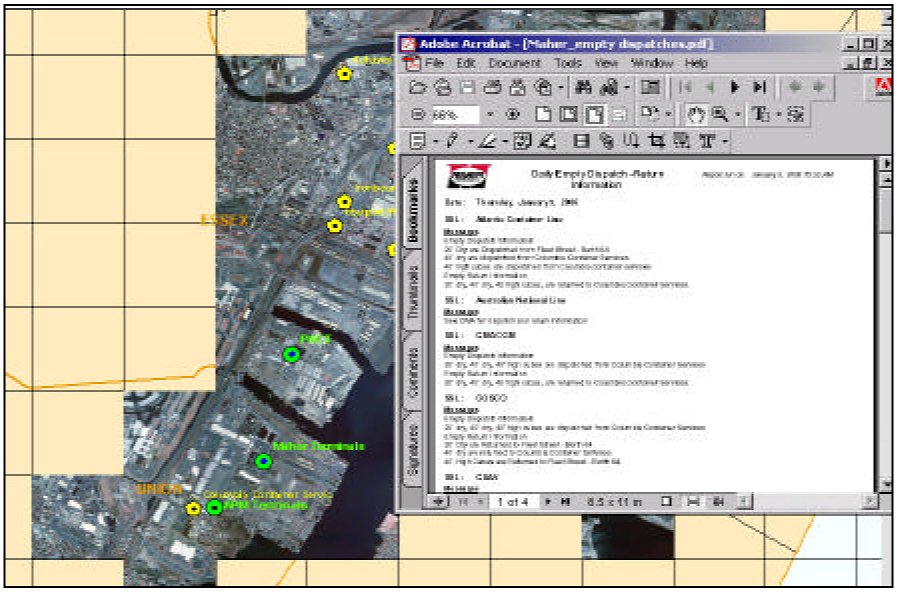


Figure 22: The Table of Empty Container Locations where Maher Terminals stores it containers, linked in GIS

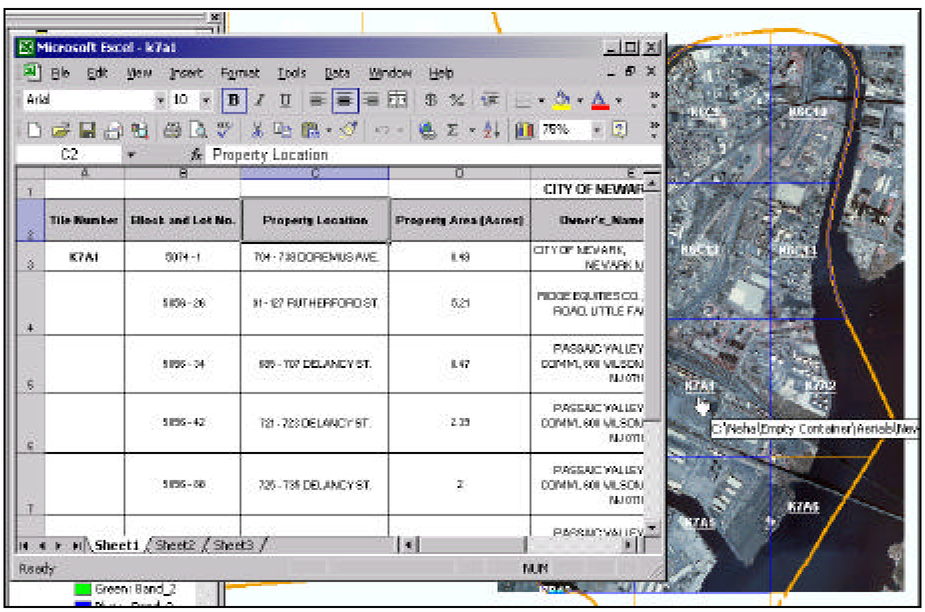


Figure 23: Container Storage Location, Land use and Value Information obtained from the Newark City Hall

Additional details on the GIS interface are given in appendix A.

The system is based on empirical goal setting and what-if scenario inference procedure. Its open architecture provides for later incorporation of algorithms attempting to relate the local conditions to global factors and parameters such as those presented in the paper. The stochastic and highly dynamic nature of these factors make modeling attempts difficult and therefore incorporation of external factors based on international benchmarks should also be examined.

Currently, the tool uses a synthetic database, as accurate empty container inventory in the region is not available. The proposed monitoring system may help overcome this issue. Furthermore, current information on the effectiveness of the proposed actions is very limited. Additional observations over a longer period of time of the effects of various policies and measures that have been implemented in our region and in other areas around the world need to be made and their effect modelled in the proposed tool. In addition, interviews and surveys of key stakeholders for the purpose of developing behavioural models and functions are required. These functions will help determine the anticipated reaction of the stakeholders if certain measures were implemented. The elasticity of these functions with respect to changes in various parameters could also be established.

The tool presented in this section is not intended as a solution to the empty container accumulation problem. It is meant to be used as a means to facilitate the decision making process in determining the most promising measures in terms of achieving desirable levels of empty container accumulation, while considering other direct and secondary impacts that implementation of these measures may have.

RECOMMENDATIONS AND PROPOSED FUTURE ACTIONS

In addition to the continuous review and analysis of data obtained through trade journals and magazines, several discussions with people from various sectors in the industry (including the Port Authority of New York/New Jersey-PANYNJ; New Jersey Department of Transportation-NJDOT; New York Shipping Association-NYSA; Metropolitan Marine Maintenance Contractors Association-MMMCA; Institute of International Container Lessors-IICL, Third Party Logistics Providers, North Jersey Transportation Planning Authority-NJTPA; New York Metropolitan Transportation Council-NYMTC; City of Newark, Bayonne, Jersey City, Kearny, Elizabeth, Harrison and North Bergen Township; Marine Terminal Operators; Depot Operators; Scrapping Industry and Secondary Market representatives) have helped us broaden and deepened our understanding of the issues. The following recommendations and proposed future actions are the result of this work and the research that has been performed within the scope of the project. Although the feedback that we have received from the industry is invaluable, the findings of this study and the recommendations do not necessarily reflect the official views of our industry contacts.

It becomes apparent from our study that full understanding of the empty container accumulation requires additional efforts. Following is a list of such key efforts and related projects: development of a monitoring system; study of the behavior of key players in the empty container industry; a systems approach, which will investigate the optimal location of empty container depots in the region and which may be part of a broader effort; and a systems approach to the study of the secondary market. Each of these efforts, if completed, could be implemented within the decision support tool to further enhance its capabilities. Nevertheless, each of the projects, as a stand-alone project, would bring a better understanding and would increase the knowledge base of the industry, facilitating the decision making process. The following sections present the proposed projects pointing out anticipated benefits from their implementation.

Monitoring System

Questions that came up frequently during the various presentations of this study to industry stakeholders were: ”how many empty containers are stored, where, and for how long”. Although some information may be available, it is rather aggregate and often outdated, as it represents a rough estimate of an overall empty accumulation in the region during some past period of time. We have seen in this study that the amount of empty containers stored in the region fluctuates due to seasonal variations, but also due to external factors that may make moving containers overseas a preferred alternative to storing them in the importing regions. Furthermore, it has been observed, that traditional roles that regions play as either surplus or demand regions for empty containers, may be reversed. China for example, which traditionally has been a demand area, has now become a surplus area with many new containers stored in the region. Los Angeles on the other hand, is experiencing a very low to no surplus of empty containers as the share of empty containers shipped out of the region has increased significantly over the last few years.

To be able to answer the questions mentioned above, a monitoring system, mapping the conditions prevailing in empty container accumulation over time, could be implemented. Such a monitoring system could be part of a broader system for equipment tracking and tracing, used to improve productivity, efficiency and security of facilities and services. Information about ownership and location of containers as they move from origin to destination is said to be crucial in reducing the vulnerability of the freight transportation network and related infrastructure.

The proposed monitoring system will collect, collate and analyze information on empty containers along with the historical and recent container trade statistics for the port. The monitoring system will provide stakeholders (carriers, shippers, terminal operators, land and depot owners, port, local and regional authorities and agencies) and researchers with information on:

- Empty container trade
- Accumulation
- Storage capacity and utilization
- Amount of storage space and empties needed in the region
- Estimates on age, period stored, ownership, and other specifications
- Past and present trends in empty container trade and fluctuations
- Local/regional and global external factors (e.g.: hike in steel prices in early 2004, local policies on storages and taxation, etc.)

The monitoring system could be made up of a broad spectrum of activities involving numerous parties and stakeholders, including data and information producers (shipping association, depot owners, terminal operators, carriers, leasing companies, shippers), analysts (state DOT, MPO, port authority, stakeholders and researchers), and users (a range of government and industry decision makers, market analysts and researchers).

This monitoring system would be internet-based and subscribers with their unique usernames and passwords will be able to login and view the most current log on empty containers for the NY/NJ region. This system could be part of another regional effort, minimizing the cost for setting up and operating it.

Although the proposed system would have different level of utilization and would bring different benefits to the various stakeholders, it is anticipated that overall, it has the potential to improve the efficiency of the system in the future. The table 6 below presents a summary of anticipated benefits to various stakeholders.

Table 6: Summary of Benefits to Different Stakeholders

Benefits from the monitoring system	Carriers	Leasing Companies	Depot Operators	Terminal Operators	Port Authority	Local & State Govt.	Public/ Society
1) Facility Management			✓	✓			
2) Container Inventory Management and decision making	✓	✓		✓	✓	✓	
3) Understand industry cycle - Provide updated complete information on empty containers with trends on their trade, accumulation and affecting external factors	✓	✓	✓	✓	✓	✓	
4) Revenue generation from facilitating scrapping or selling containers in the secondary market	✓	✓					
5) Security – Automated data flow and empty container optimization from e-seals	✓	✓	✓	✓	✓	✓	✓
6) Economic Benefits – optimal number of empty containers where needed	✓	✓	✓	✓	✓	✓	
7) Optimizing and balancing empty containers – integration with VCY - resulting in better aesthetics, fewer empty VMTs, lesser pollution	✓	✓	✓	✓	✓	✓	✓

Facility Management

The monitoring system would provide an up-to-date information on trends, estimate on number of empties and space required for their storage, which can help depot owners and terminal operators in managing, maintaining and efficiently running their facilities. The monitoring system will provide them with easy to access information on empty containers. It will assess the number of containers that will need to be stored and the space needed for them, given the import-export statistics from the previous year, present quarter, and anticipated trends.

Container storage is land intensive. 245 acres (stacked 3 high) to 105 acres (stacked 7 high) of land size is required for holding 100,000 empty containers (about 200,000 TEU), depending on the height at which containers are stacked. In addition some 10% to 50% additional land is required for handling equipment, access roads for trucks, chassis, office space, repair and other equipment handling (a 14-acre depot uses about 35% of the land for access, office and equipment).

Estimates made in 2003 indicated that around 150,000 empty containers (about 300,000 TEU) were present in NJ, waiting to be repatriated. Though many containers were repositioned (as a result of hike in new container prices) in 2004; with shipping industry following a cyclical trend in supply of boxes another increase of the accumulation in the region will occur. Efficient management of empty containers is vital to the industry, the region and the stakeholders.

Although at any particular location some type of a monitoring system may be available, the proposed system would have the capability to link facilities together via an information system, which will provide users information on all the facilities that they are using for storing their, or their customers' containers. It will also provide relevant historical data for the region, linked to direct as well as secondary factors that have affected the level of accumulation.

Container Inventory Management

The monitoring system will help depot owners and terminal operators identify containers in their inventory, segregated by category. Containers that are 10yrs or older could potentially be sold for scrap or recycled. Containers between the ages of 7 and 10 years can be sold in the secondary market or suggested to be moved to other locations in which it will be easier to sell in the secondary market, possibly at a better price. Making this information available to second hand retailers, may increase the possibility of selling containers in the secondary market and may also increase the efficiency of this activity.

Understand ‘Industry Cycle’ for efficient management of empty containers

The proposed monitoring system will record industry cycles and trends such as new-builds, new container prices, repositioning costs from our region to different regions or other parts of the world, leasing costs, etc. Studying the impact that changes in various factors have in the empty container accumulation will help understand the behavior of the industry.

Revenue Generation

The monitoring system can help identify containers in the inventories of the depots and group them by age, suggesting different measures for different ages of containers. This activity will generate more revenue and liquid money for container owners.

Security-Automated data flow and empty container optimization through E-seals

As information on location of containers as they move from origin to destination is said to be crucial in reducing the vulnerability of the freight transportation network and related infrastructure, knowing the location of specific equipment could minimize the risk to security. In addition, use of electronic seals would reduce the container vulnerability to be tampered with. It is believed that if electronic seals are put on the empty containers, and with the proposed monitoring system in-place, it would be possible to track these containers, know where they are and if they have been damaged or tampered at any stage of their movement.

Economic benefit

The monitoring system, integrated with an equipment management system could help reduce operating costs as well as other costs associated with empty movements.

Optimizing and balancing the empty container

The proposed monitoring system, integrated with other regional efforts, could help determine optimal locations for storing empty containers, thus improving the efficiency and increasing the economic benefit.

Behavioral Models for key Industry Players

Another question that needs to be answered relates to the potential behavior of the key industry players in choosing the best option from within a set of alternatives, as they react to changes in current policies and strategies. Industry behavior is affected by various factors. Changes in the value of these factors along with the underlying market conditions may influence the behavior of players in various directions. A study needs to be performed, to determine the factors that influence the behavior of the industry. Based on these factors, behavioral models should be developed and calibrated. Their sensitivity to variations in the values of the factors should be established. Industry players usually have several options available to them. Proposed policies and strategies should not lead to industry actions that may have a negative overall impact to the region.

Strategically Located Depots

Trade imbalance and seasonal variations in demand make the need for empty container storage inevitable. Due to business agreements and typical operations, empty marine containers are usually stored near by marine terminals. During a typical operation loaded containers arriving at the port are picked up and delivered by truck to the consignee's premises. Once unloaded, the containers return empty back to the port and are stored in container depots from where they may move empty to an overseas destination or to an exporter's facility, to be loaded, return to the port and shipped overseas. A Virtual Container Yard (VCY) effort is underway in the New York / New Jersey region which aims to minimize the number of empty returns to the port, by increasing the number of street turns.

Along with this effort, a set of optimal locations for temporary storage of empties may be determined, so that empty containers are available at satellite locations and along the Port Inland Distribution Network, when an export load becomes available. These deport locations may be linked through an information sharing system or become integral part of a VCY. This would help ease congestion at marine terminals and depots near by these terminals. It may also facilitate selling of these containers in the secondary market, an effort that is described in the following section.

Systems Approach to the Secondary Market

It has been estimated that about 8% of the over 16 million containers that exist today are taken out of the transportation system and into the secondary market each year. Containers that are stored at or nearby marine terminals are most susceptible to the economic swings of market demand.   Furthermore, if containers are located nearby a high demand area, they typically sell at higher prices in larger quantities. The secondary market for marine containers is not fixed in either size or location. Nevertheless, the size of this market is significant and requires further attention. A systems approach to this market may assist in determining the regions in which older containers should be moved to, to sell to the secondary market easier, in higher volumes and at better prices. Monitoring of this market, by location, quality, and price, can help determine the best directional decision strategies to pursue for moving containers. With this information in hand, carriers may select to move older containers to depots and locations near by the demand areas for the purpose of selling them into the secondary market. Having a network of optimally located container depots, as described above, would further assist this effort. The National Portable Storage Association serves the constituents of the marine container industry; ocean carriers, leasing companies, depot operators, buyers/sellers of new and second hand marine equipment, and third party service providers and vendors. Their mission is to provide industry professionals with effective support to create, protect, and enhance portable storage business practices.

CONCLUSIONS

Trade imbalance is the number one factor causing accumulation of empty intermodal containers at various regions around the world. To accommodate trade and maintain the efficiencies that currently exist in the freight transportation and logistics industry, temporary storage of empty containers is inevitable. Movement and storage of empty intermodal containers, part of the operating procedures but often described as inefficiencies of the freight transportation system, cost the industry billions of dollars each year and have raised environmental, social and economic concerns.

This report examined the root causes of the empty container accumulation, the state-of-practice in dealing with related issues around the world and synthesized factual data to develop a detailed mapping of how containers move at a global, regional and local level, including moving and accumulation of empty intermodal containers with a focus into the New York New Jersey region. Findings of this study highlight the fact that empty container logistics is a global issue, greatly influenced by international transportation practices, governed by global trade patterns and mostly dictated by major ocean carriers' interests. To address empty container accumulation at a regional level requires collaboration among all stakeholders, to ensure that any policies or measures proposed to be implemented will not prove detrimental to the competitive position of transportation resources of this region in the international marketplace. A decision support tool aiming to facilitate collaborations and assist in the decision making process is presented.

The study identifies and presents various key efforts which, if fully developed and implemented have the potential to bring a better understanding and increase the knowledge base of the industry, facilitating the decision making process. These efforts include the development of a monitoring system; study of the behavior of key players in the empty container industry; a systems approach, which will investigate the optimal location of empty container depots in the region and which may be part of a broader effort; and a systems approach to the study of the secondary market. These key efforts have the potential to increase the efficiency of the current system and reduce the overall costs associated with moving and storing empty containers.

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APPENDIX A: USER MANUAL FOR DECISION SUPPORT TOOL

The application presented herein was created in and requires ArcEditor 9.0 for full functionality. For this application basic understanding of Geostatistical Analysis is required. To use the application, simply open the map named: ***EmptCont_V1.mxd***, add the layer(s) you wish to analyze. The map already contains three (3) layers: a) the New Jersey State, b) the New Jersey Counties, and c) the Known Contaminated Sites (KCS) in New Jersey[1]. The values in the KCS layer, containing information on container number, age, duration, and container number goal per site, have been simulated and do not correspond to real values. They are only to be used for demonstration purposes of the tool.

The procedure described herein assumes that a shape file exists (referred as the main layer) containing geospatial information on empty container depots.

Step 1: Creating the Analysis Zone/Sub-Zone Layer(S)

The first step in the procedure is to create, using the main layer, the new zone(s)/sub-zone(s) layer(s) to be analyzed. Three options are available: a) selecting a zone/sub-zone center and creating an area extending several miles around the center, b) selecting individual sites based on an attribute value i.e. zip code, county etc, or c) selecting sites manually.

The first option requires the following steps: a) select the zone/sub-zone center (manually or based on an attribute value i.e. name), b) create a buffer around the center extending to the desired radius, and c) create the new layer by clipping the original layer over the newly created buffer. This procedure can be accomplished by using the add-on tool created by CAIT and the ArcInfo clip tool.

For the other two options ArcInfo standard procedures are used for the analysis zone/sub-zone layer(s) to be created.

[1] http://www.state.nj.us/dep/gis/digidownload/zips/statewide/kcsl2001.zip

Step 2. Simulation

After the facility zone/sub-zone layer(s) have been created the simulation can be initiated via the add-on button. The user needs to select one zone/sub-zone layer at a time, and define the fields that contain the number of containers, age of containers and duration of stay at the specific depot. After this input is selected the user can view the aggregated container data and input the desired aggregate inventory goal limits. The user can also choose to simulate based on individual site limits. Choosing the second option deactivates the first and vice versa. Once the inventory goals have been set, the user initiates a procedure to evaluate alternative options over a specific period of time that will help towards achieving the set objectives regarding inventory levels. A list of possible actions is available, classified in three levels (Level A, B, and C). The user may select any number of actions from the list. Actions that are deemed to be unacceptable for certain locations, periods of time or to individual stakeholders may thus be excluded from the analysis. After the simulation is performed the inventory levels are updated for the selected zone/sub-zone and the user can view simulated aggregate results and decide if the simulation should be performed again, implementing different combinations and/or different levels of action. After existing the simulation, disaggregate results per site can be viewed as well.

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Creating Zone(s)/Sub-zone(s)

As described in the previous section the first step in the procedure is to create the zone/sub-zone(s) layer(s) that will contain the depots to be studied/simulated.

Option A: Zone/Sub-zone(s) Layer(s) via a Depot Center

The concept of creating zone(s)/sub-zone(s) via a depot center is to study all the depots in an area around that depot. As shown in figure 24 the user has to select a container depot as the center of the area, either by visual observation or by an attribute. Using this depot the user creates the area by buffering around the depot.

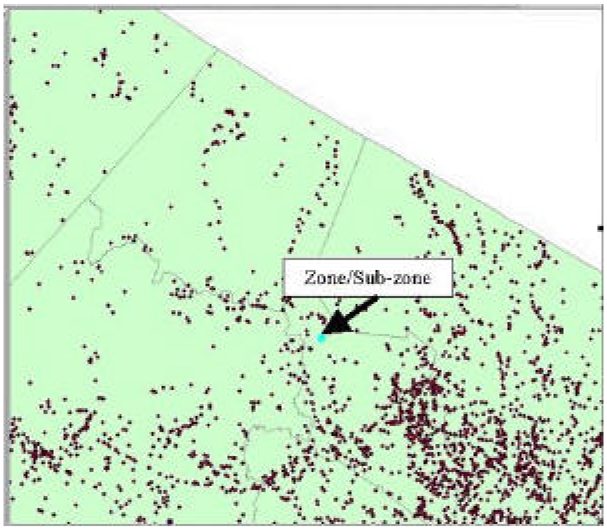


Figure 24: Selecting Site by Zone/Sub-zone Center

Buffers can be created by using the buffering add-on button (fig. 25).

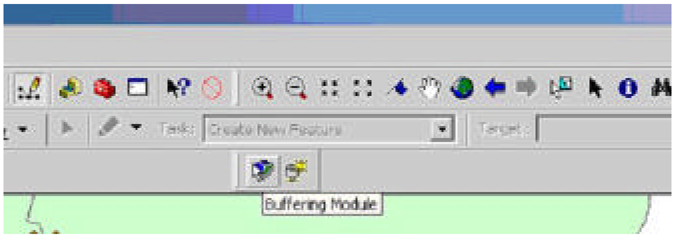


Figure 25: Buffering Add-on Button

The buffering add-on button (module) opens a new window (fig. 26) in which the user needs to select the layer to buffer from, the fields to be carried over to the buffer (minimum of one field), the buffer distance, determine whether the user wants to buffer all the points or only the selected ones and finally select the name and location that the new layer will be saved at. Fig. 27 shows the results of this procedure.

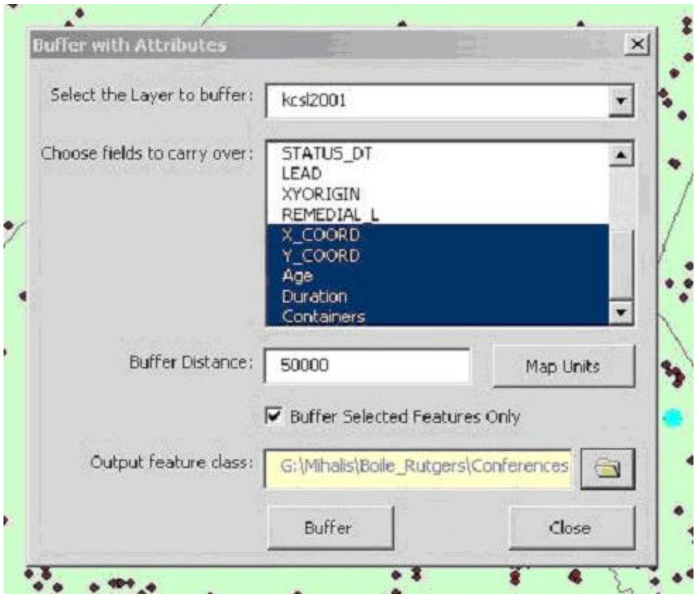


Figure 26: Creating Zone/Sub-zone Buffer Using the Add-On Tool

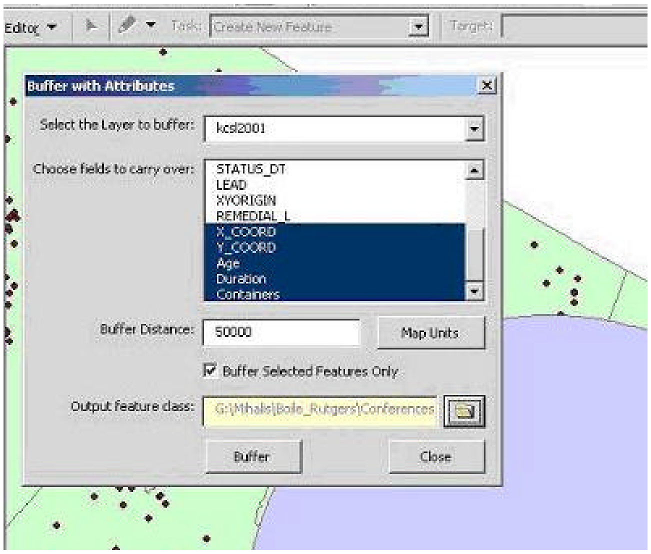


Figure 27: New Zone/Sub-zone Buffer

After the buffer zone/sub-zone(s) has been created the user needs to use the clip procedure (available through the Arc-Toolbox) to create the new layer that will contain only those depots that are within the buffer area. In fig. 28 the clip procedure has been initiated via the Arc-Toolbox. The buffer created previously is chosen as the clip feature and the main layer as the input feature. Fig. 29 shows the final result of the created zone/sub-zone.

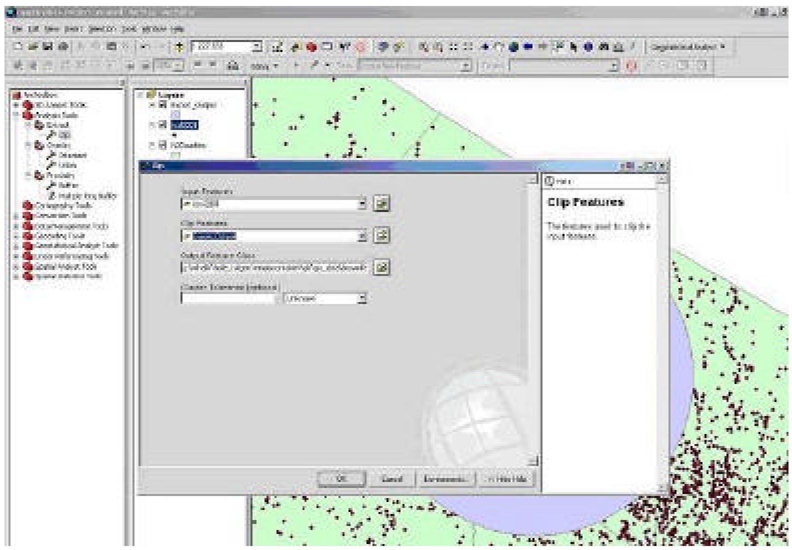


Figure 28: Creating the new Zone/Sub-zone via the Clip Procedure

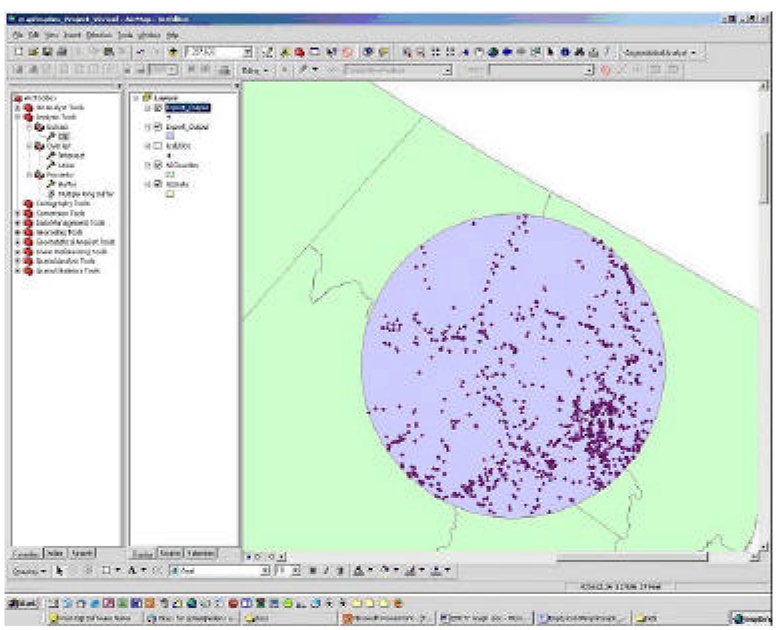


Figure 29: Buffer and New Zone/Sub-zone

Option B: Zone/Sub-zone Center

In the second option the user can study depots of a specific attribute value (i.e. number of containers with age over 10 years exceeding a target number) irrelevant of their location. This can be achieved by selecting individual sites based on an attribute value i.e. zip code, county etc. In fig. 30 the second option for creating the zone/sub-zone(s) is shown. The user is performing a query based on the status of the containers. The queried selected sites are shown in fig. 31.

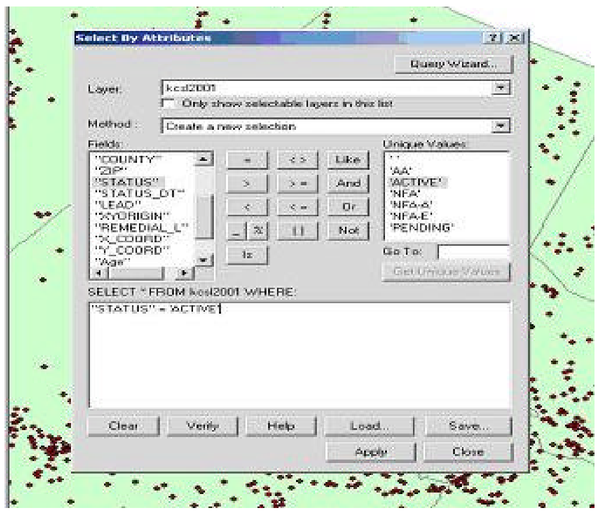


Figure 30: Selecting Sites By Attributes

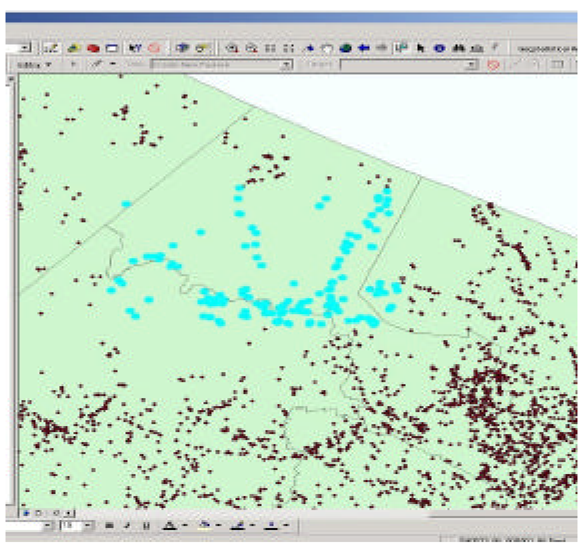


Figure 31: Selecting Sites Manually

After the selection has been performed the user can create the zone/sub-zone by exporting the selected sites into a new layer by using the standard geo-processing features of Arc-Info.

Option C: Zone/Sub-zone Center

The user may want to select the sites manually by using the select tool of Arc Info (fig. 32). This option is not recommended. After the selection has been performed the user can create the zone/sub-zone by exporting the selected sites into a new layer by using the standard geo-processing features of Arc-Info.

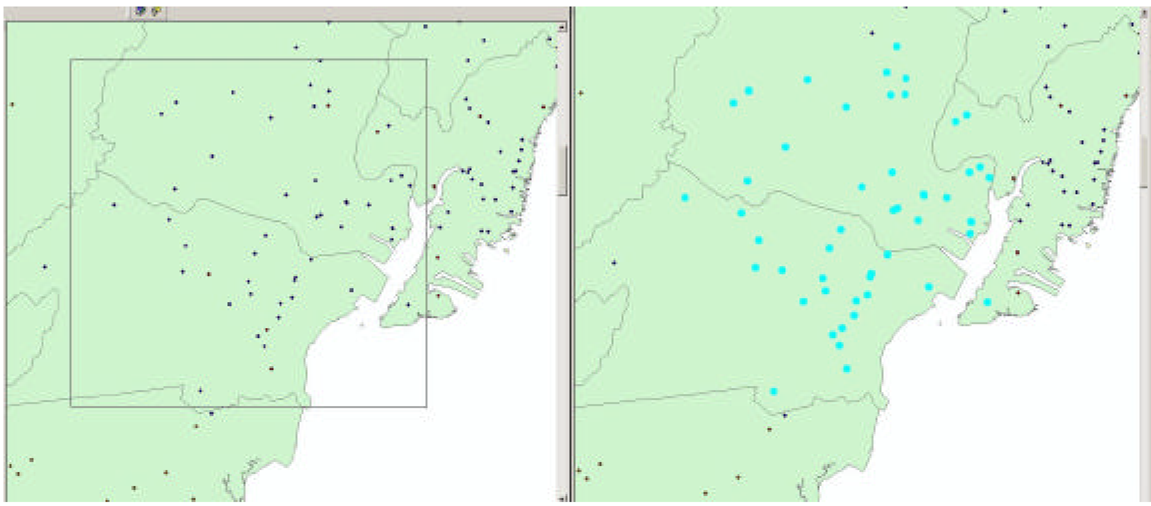


Figure 32: Selecting Sites Via Selection Tool of Arc Info

Performing the Simulation

After the zone(s)/sub-zone(s) layer(s) are created the simulation can begin via the second (Simulation) add-on button (fig. 33)

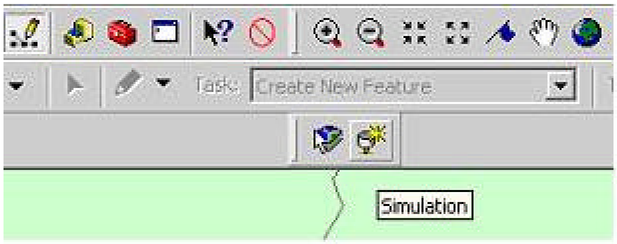


Figure 33: Empty Containers Simulation Add-On Button

This button will open a new window (fig. 34).

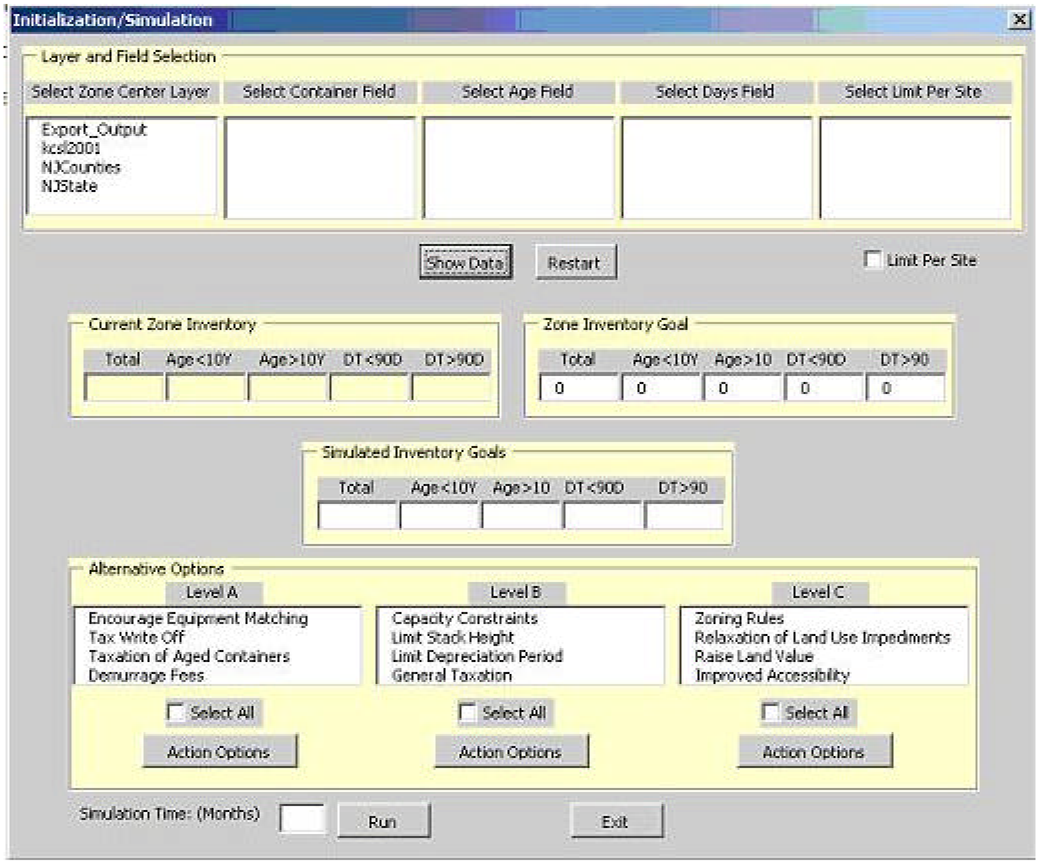


Figure 34: Simulation Window

The user needs to select a zone/sub-zone layer (one per simulation), and define the fields that contain the number of containers, age of containers and duration of stay at the specific depot (fig. 35).

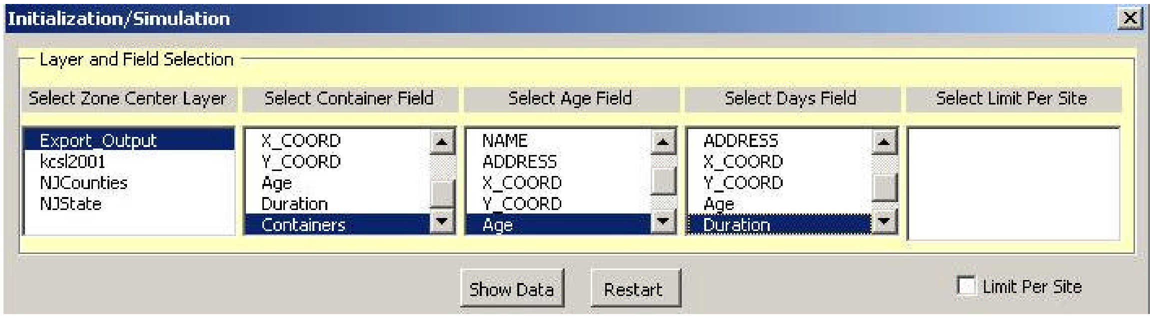


Figure 35: Zone Layer and Container Information Fields (Total Number, Age, and Duration of Stay) Selection

After this input is selected the user can view the aggregated container data and input the desired aggregate inventory goal limits (fig 36).

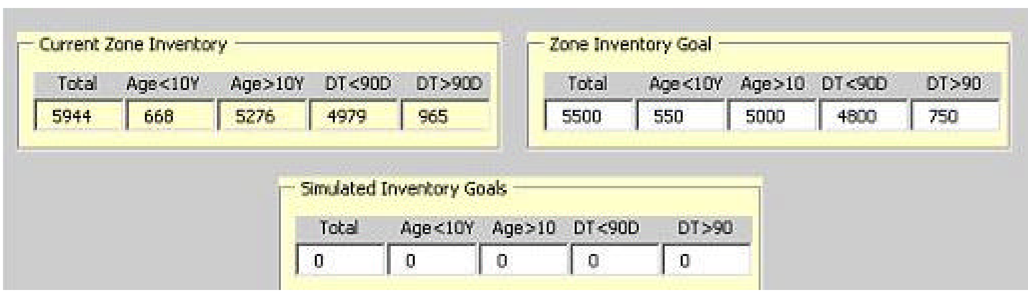
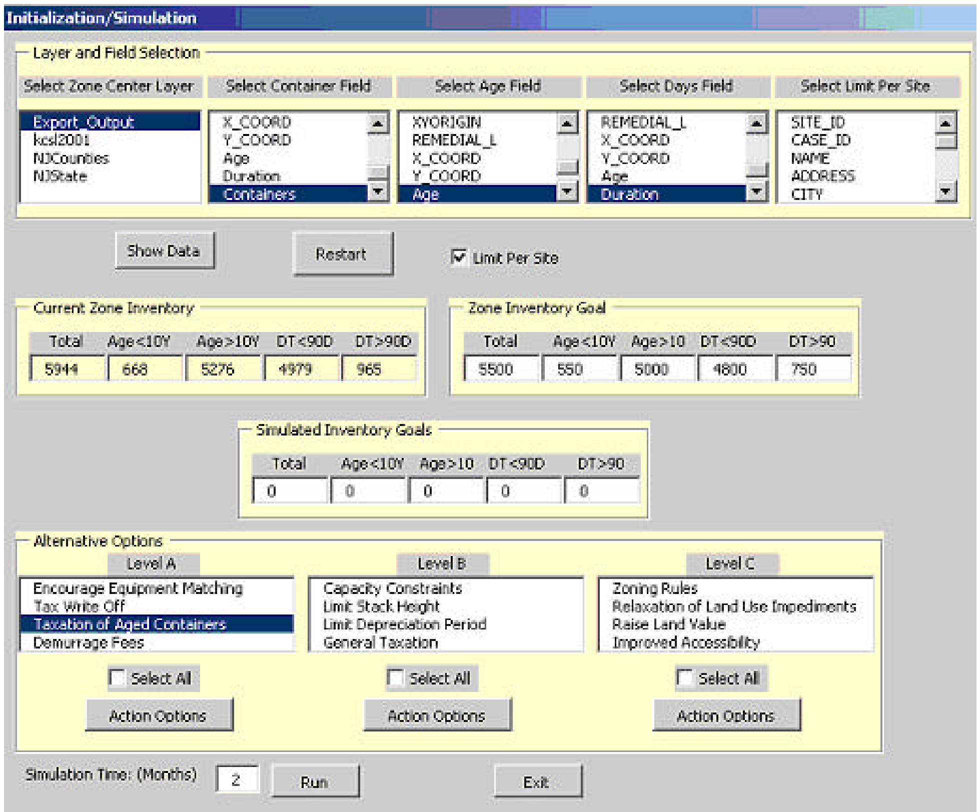
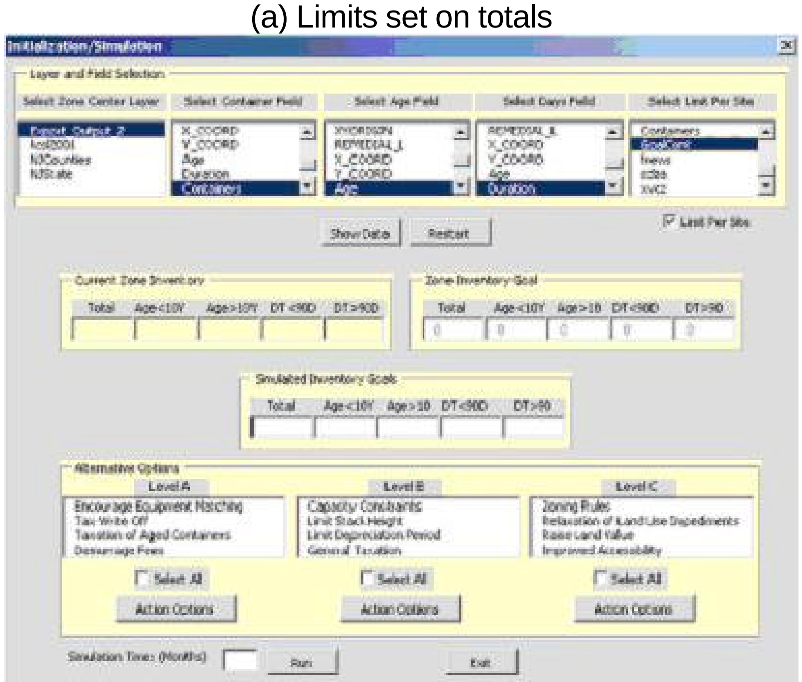


Figure 36: Disaggregate Pre-Simulation Container Data for Selected Zone and Zone Inventory Goal (Input)

The user can also choose to simulate based on individual site limits. Choosing the second option (Limits set per depot) deactivates the first (Limits set on totals) and vice versa (fig. 37). As seen in the second part of fig. 37 the Zone Inventory Goal option has been deactivated. In this case the goal for each site is set through the *Select Limit Size* field that must be defined as a field and receive values by the user before the simulation can begin (fig. 38).

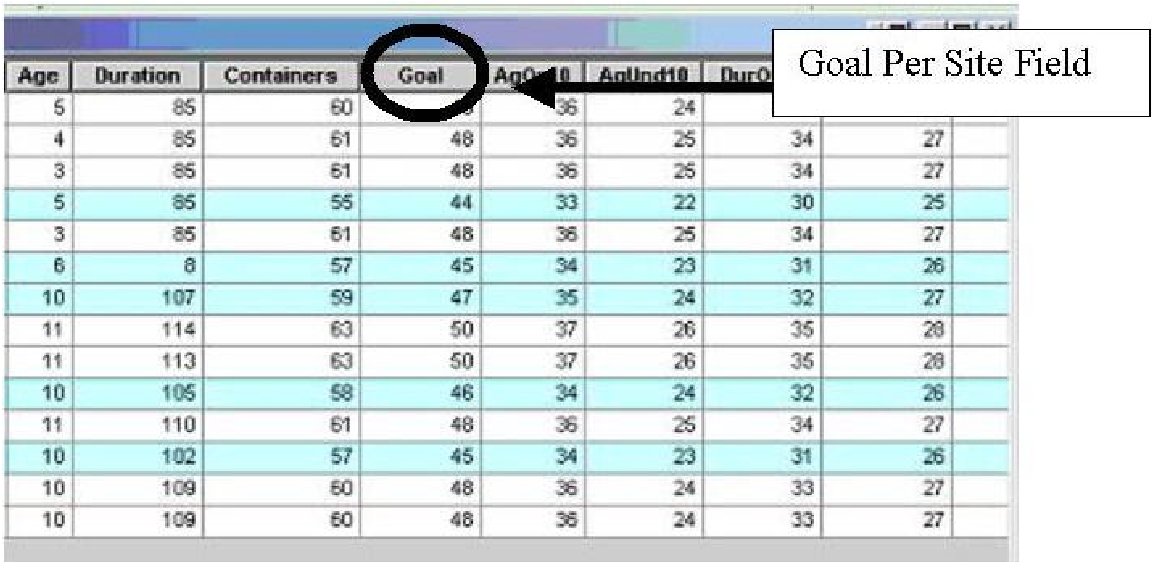


(a) Limits set on totals



(b) Limits set per site

Figure 37: Initializing Simulation



Age	Duration	Containers	Goal	AgO<10	AgInd10	DurO	
5	85	60	[illegible]	36	24	[illegible]	[illegible]
4	85	61	48	36	25	34	27
3	85	61	48	36	25	34	27
5	86	55	44	33	22	30	25
3	85	61	48	36	25	34	27
6	8	57	45	34	23	31	26
10	107	59	47	35	24	32	27
11	114	63	50	37	26	35	28
11	113	63	50	37	26	35	28
10	105	58	46	34	24	32	26
11	110	61	48	36	25	34	27
10	102	57	45	34	23	31	26
10	109	60	48	36	24	33	27
10	109	60	48	36	24	33	27

Figure 38: Attribute Table Showing Container Limits Per Site (Goal field)

Once the inventory goals or the goal per site field have been set/selected, the user initiates a procedure to evaluate alternative options over a specific period of time that will help towards achieving the set objectives regarding inventory levels. A list of possible actions is available, classified in three levels (fig. 39). At the current stage, some synthetic estimates based on current literature are available for selected options. To develop fully functional options, additional studies, as these were presented in the final report are required. This system, developed as an expert tool, requires expert input (historic datasets, expert surveys and interviews, etc.) to become fully functioning.

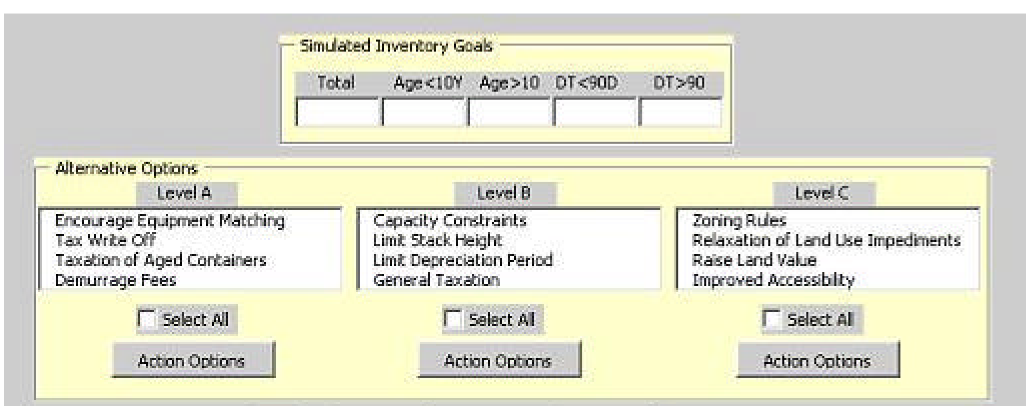


Figure 39: List and Levels of Actions

The user may select to consider all the actions available, or select a number of actions from the list, thus excluding actions that are deemed to be unacceptable for certain locations, periods of time or to individual stakeholders. After the simulation is performed (fig 40) the inventory levels are updated for the selected zone/sub-zone and the user can view simulated aggregate results (fig 41) and decide if the simulation should be performed again, implementing different combinations and/or different levels of action.

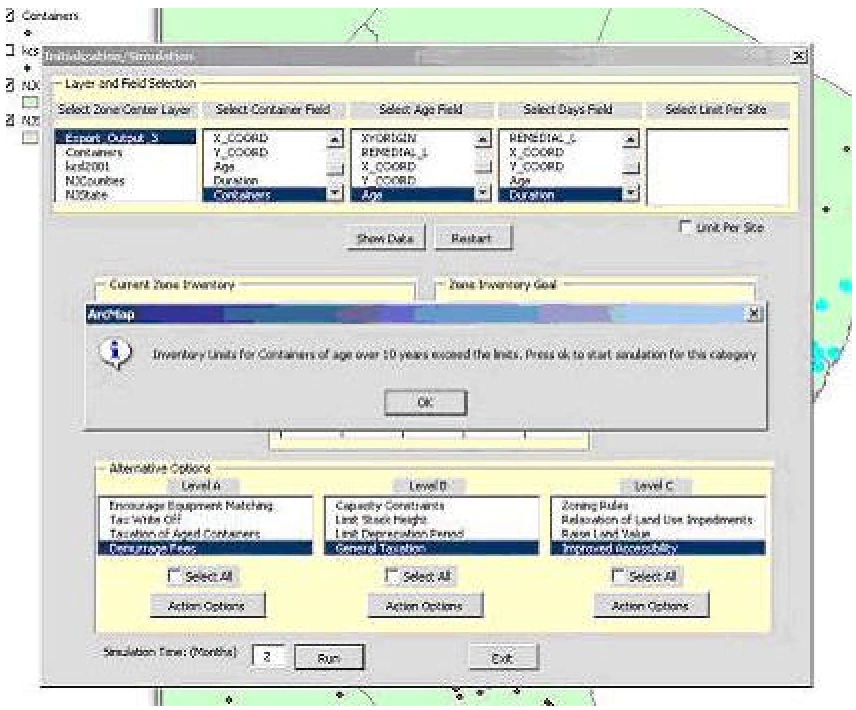


Figure 40: Running the Simulation

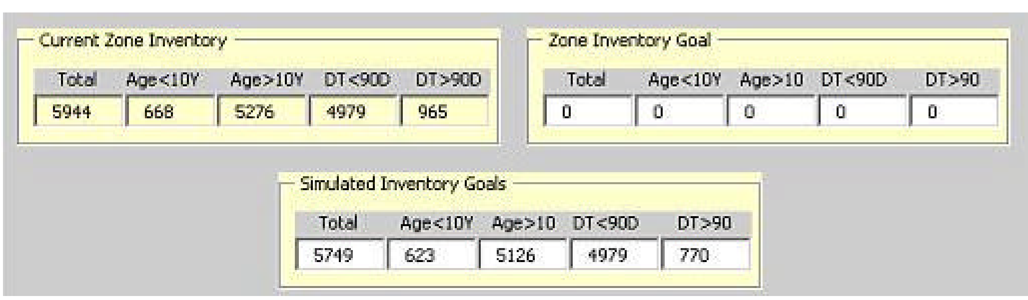
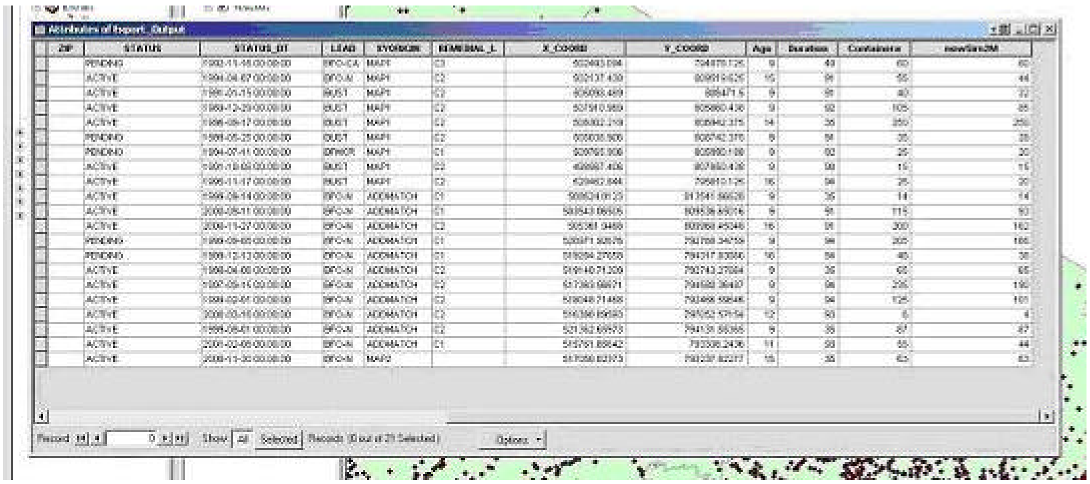


Figure 41: Aggregate Results After Simulation (Limits Set Per Site)

After existing the simulation, disaggregate results per site can be viewed as well from the layers attribute table (fig. 42).



Attributes of Export_Output

ZIP	STATUS	STATUS_DT	LEAD	SYORIGIN	REMEDIAL_L	X_COORD	Y_COORD	Age	Duration	Containers	newSim2M
	PENDING	1992-11-16 00:00:00	BFO-CA	MAP1	C3	502493.094	794079.125	9	40	60	60
	ACTIVE	1994-04-07 00:00:00	BFO-AI	MAP1	C2	502137.430	809919.625	15	91	55	44
	ACTIVE	1991-01-15 00:00:00	BUST	MAP1	C2	505098.469	808471.5	9	91	40	32
	ACTIVE	1989-12-29 00:00:00	BUST	MAP1	C2	507910.969	805660.438	9	92	105	85
	ACTIVE	1996-09-17 00:00:00	BUST	MAP1	C2	508002.219	808942.375	14	35	250	250
	PENDING	1998-05-25 00:00:00	BUST	MAP1	C2	505038.906	808742.375	8	91	35	35
	PENDING	1994-07-11 00:00:00	BFHKR	MAP1	C1	509765.906	805990.188	9	92	25	20
	ACTIVE	1991-10-03 00:00:00	BUST	MAP1	C2	498887.406	807860.438	9	90	15	15
	ACTIVE	1996-11-17 00:00:00	BUST	MAP1	C2	429462.844	795810.125	16	94	25	20
	ACTIVE	1999-09-14 00:00:00	BFO-AI	ADDMATCH	C1	509524.0125	817541.56628	9	35	14	14
	ACTIVE	2000-06-11 00:00:00	BFO-AI	ADDMATCH	C1	500543.06505	809536.65016	9	91	115	93
	ACTIVE	2000-11-27 00:00:00	BFO-AI	ADDMATCH	C2	505361.0468	803968.45046	16	91	200	162
	PENDING	1999-09-05 00:00:00	BFO-AI	ADDMATCH	C1	520371.50575	792708.34755	9	94	205	166
	PENDING	1999-12-13 00:00:00	BFO-AI	ADDMATCH	C1	519284.27050	794317.83066	16	94	45	36
	ACTIVE	1998-04-08 00:00:00	BFO-AI	ADDMATCH	C2	519140.71209	792743.27094	9	35	65	65
	ACTIVE	1997-09-16 00:00:00	BFO-AI	ADDMATCH	C2	517383.08671	794593.36487	9	96	235	190
	ACTIVE	1999-02-01 00:00:00	BFO-AI	ADDMATCH	C2	518048.71468	792496.56646	9	94	125	101
	ACTIVE	2000-03-16 00:00:00	BFO-AI	ADDMATCH	C2	516390.69593	797052.57194	12	93	5	4
	ACTIVE	1999-06-01 00:00:00	BFO-AI	ADDMATCH	C2	521362.69973	794131.56365	9	35	87	87
	ACTIVE	2001-02-06 00:00:00	BFO-AI	ADDMATCH	C1	515761.89642	793306.2436	11	93	55	44
	ACTIVE	2000-11-30 00:00:00	BFO-AI	MAP2		517050.82373	793237.82217	15	35	63	63

Record 0 Show: All Selected Records (0 out of 21 Selected) Options

Figure 42: Disaggregate Results