Investigating the Feasibility of Establishing a Virtual Container Yard to Optimize Empty Container Movement in the NY-NJ Region

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16. Abstract

A Virtual Container Yard (VCY) is a mean of developing a shared resource information system to match empty equipment needs through the adoption of next generation internet and new technology information platforms. The project examines the feasibility of developing and operating a Virtual Container Yard to serve the freight and maritime community in the NY-NJ region. Definition of user requirements and potential business and institutional impediments in successfully establishing the system are identified. To support user requirements production and solutions, and to address potential impediments, literature dealing with local, US and International experience in applying web-based shared information systems is critically reviewed. Subsequently, the conceptual architecture, specifications and functionalities of the system are developed based on latest e-business collaborative solutions, systems and protocols. Special attention is given to systems security architecture to make the application robust and attractive to potential partners. Proprietary products either dealing directly with street-turn matching or with wide range matching applications are critically evaluated in view of the developed user requirements. An analytical formulation and simulation model developed to evaluate the potential benefits of a VCY under different market conditions is presented. Financial and economic evaluation, potential funding alternatives and investment recovery strategies to ensure successful development and long term viability of systems' operation, are presented. Systems governance structure and potential partnership is proposed to serve the purpose of long-term sustainability of the system. Finally, a staged application timeline and implementation plan is produced, to cater for an intermediate pilot demonstration phase, necessary to draw experiences leading to proper full-scale application. The project provides for an integrated support product to enhance setting up a Virtual Container Yard system application in the NY-NJ region.

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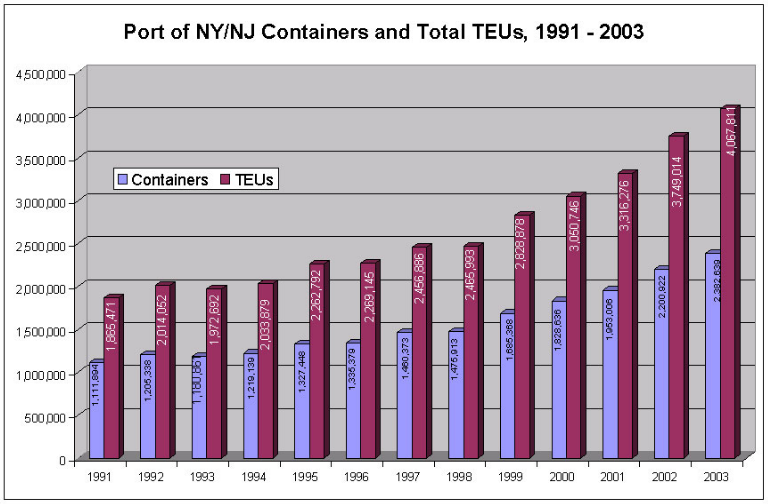
1 INTRODUCTION

During the last decade there has been a significant and steady growth of international trade between the United States and the rest of the world, in particular with the N.E. Asia countries, led predominantly by the imports from China. The trade imbalances between imports and exports have created a substantial problem of empty container management. In particular, in the port regions that are densely populated economic centers, such as the NY-NJ region, the tremendous increase in container volumes coming into and going out of the port have caused a corresponding increase in the number of truck trips to and from the port, and more specifically, an increase in the number of unproductive, empty truck trips to and from the port. This, not only causes significant inefficiencies that need to be addressed, but also adds to the congestion in and around the port, and the highways that feed into the port area.

Figure 1 shows a steady annual increase of the container volume through the Port of NY/NJ during the recent years.

Given the population density of the New York- New Jersey metro region and the projected container volumes that are expected in the next few years, it is clear that there is an urgent need to introduce and implement a solution to the problem of empty truck trips.

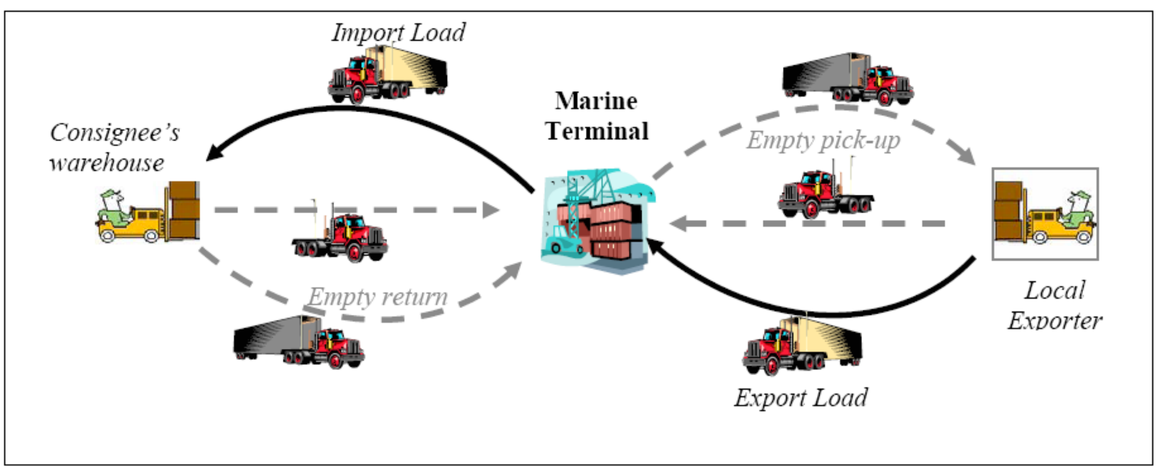


Source: www.panynj.com

Figure 1: Annual throughput in containers and TEUs (1991-2003), PONYNJ

The two main effects of the overall empty container management problem deal with the empty storage accumulation at the ports and other facilities and excessive unproductive empty trips to and from marine terminals and empty container depots. While these two problems are related, and are caused by the same driving factors, it is important to bear in mind the distinction between them. A solution that addresses the issue of empty storage accumulation by means of any new initiatives introduced at the ports could have minimal effect in reducing the empty trips to and from the port. Thus, there is a clear need to specifically tackle the issue of excessive unproductive trips made to and from the port. In the Port of New York and New Jersey, this problem needs to be addressed with a sense of urgency, as the NY-NJ region is also one of the most densely populated residential areas in the neighborhood of a port, where port related truck traffic causes not only additional vehicle miles traveled (VMT) and the related truck emissions, but also concomitant marine terminal and depot gate delays and roadway congestion.

According to the existing logistics patterns, the trucks leave the port with the imported full container to the importers' facilities and warehouses, and make a trip back to the port to return the empty container. When a need for an export load arises at any warehouse facility in the region, either close to the previous importer's facility or elsewhere, another empty truck trip needs to take place from the port to the export facility, after which the export container load is hauled back to the port before it leaves for its overseas destination. This pattern, shown in Figure 2, produces two unproductive trips associated with every export-import cycle. This situation arises because there are no established collaborations among key players and as a result no information about empty containers available for loading in certain locations, or empty container demand in other locations.



(Source: Hanh, Le Dam, P. I, "The Logistics of Empty Cargo Containers in the Southern California Region, :Metrans)

Figure 2: Illustration of Empty Truck Trips

One of the most efficient ways to minimize unproductive empty trips and the related problems is to facilitate the direct interchange of empty containers, the so called “street-turns”. The street-turn will involve a trucker delivering an import load at a particular facility, and then utilizing directly the empty container from a nearby facility using either the same trucker or another truck operator, thus eliminating the need for two empty truck trips. To enable these street-turns, next generation Internet and new information technology platform solutions may be used, such as of the so-called Virtual Container Yard (VCY). The VCY is a Web based platform to post information and to enhance direct empty container interchanges between an importer (consignee) and a next exporter (shipper) and avoid empty trips to/from the marine terminal.

The key purposes of a VCY, in general, are the following (*1*):

- provide information about containers and their status and location.
- facilitate communication between parties (motor carriers, ocean carriers, leasing companies, chassis pool operators), with a view to matching their needs
- •permit equipment interchange and other processes to take place without moving the empty container back to the marine terminal.
- assist the parties to make optimal decisions regarding container logistics (return, reuse, interchange, etc.), rationalize moves, and plan ahead.

Figure 3 is an illustration of regional port related movements in two cases: with and without a VCY.

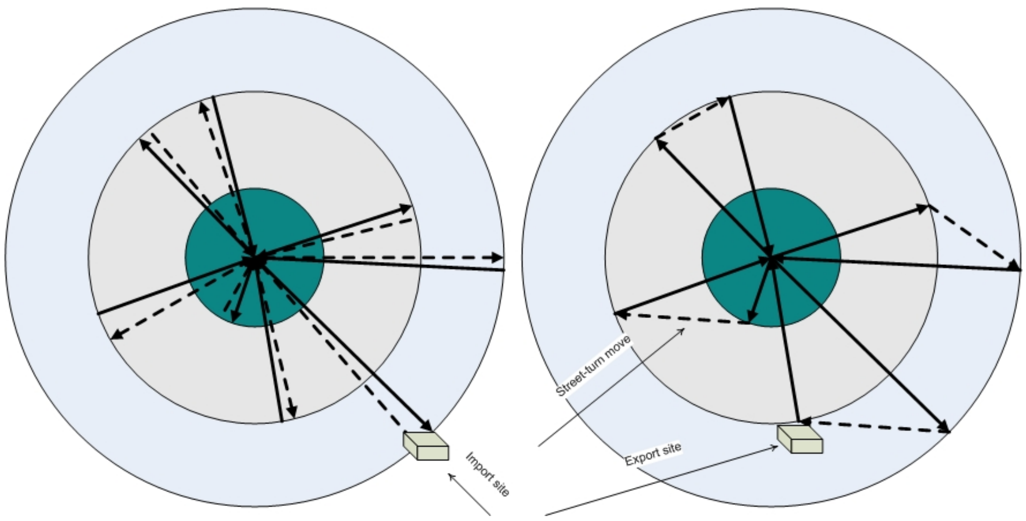


Figure 3. Illustration of regional movements without (left) and with (right) a VCY

In figure 3 the port is represented as the center of a circle, in an operational sense, not a spatial one. The trips emanating from the port are shown with arrows pointing out in thick lines for an import delivery, or by a dashed line for an empty export pick-up. The trips to the port are with arrows pointing in, either a dashed line for an empty post-delivery return trip or a thick line for a full load export consignment back to the port.

This project examines the feasibility of developing and operating a Virtual Container Yard to serve the freight and maritime community in the NY-NJ region. Experience gained so far has shown that there are informational, institutional and business related barriers impeding in many cases the successful application of a Web based communication platform for empty container interchange. These barriers should be properly defined, analyzed and addressed prior to developing a Virtual Container Yard System. Hence, defining user requirements and business or institutional barriers, formulating the system's conceptual architecture with the user needs as the basis, and further developing specifications and functionalities of the system are extremely important. Evaluating proprietary designs available in the market and systems developed elsewhere, based on user requirements and functionalities developed for the system will provide an important factor for assessing the feasibility of the system to be set up.

To address user requirements and potential impediments, literature dealing with local, US and International experience in applying web-based shared information systems has been critically reviewed. A discussion on user needs for all potential users is presented in section 3, followed by an overview of various existing port community systems in section 4. Proprietary products either dealing directly with street-turn matching or with wide range matching applications are evaluated in view of the developed user requirements. Subsequently, the conceptual architecture, specifications and functionalities of a system addressing the user needs are developed and presented in section 5, based on latest e-business collaborative solutions, systems and protocols reviewed in section 4. Special attention is given to systems security architecture to make the application robust and attractive to potential partners. An analytical formulation and simulation model developed to evaluate the potential benefits of a VCY under different market conditions is presented in section 6. The results for different scenarios of input parameters, system environment and practical constraints in order to make the system feasible are presented and analyzed. A proposed system governance based on potential stakeholder participation, which is important for a successful system implementation is presented in section 7. Financial and economic evaluation, potential funding alternatives and investment recovery strategies to ensure successful development and long term viability of systems' operation, are presented in section 8. The financial and economic feasibility, the funding mechanisms and the investment return mechanisms available will determine not only the development but also the long-term operation viability of the system. Finally, section 9 presents a staged application timeline and implementation plan, to cater for an intermediate pilot demonstration phase, necessary to draw experiences leading to proper full-scale application. Section 10 summarizes the findings and concludes the report.

2 LITERATURE REVIEW

The early literature published to study the empty container management issues was directed at framing the problem as a fit-case for optimization. Crainic, Gendreau, and Dejax (*2*) proposed a two-stage stochastic model that considers the inland transportation of empty containers between ports, depots, and individual customers with a view to minimize the expected penalty cost for the surplus and the deficit of empty containers at ports and at customer sites. They had estimated that for a major European container shipping company the land movements cost approximately U.S $50 million and of these 40% were empty truck movements. In a similar work, Cheung and Chen (*3*), demonstrated that a stochastic network model was appropriate for modeling the dynamic empty container allocation problem. However, as the problem of the inefficient truck trips has assumed alarming proportions only recently, most of the literature published previously falls short of suggesting any solution methodologies in order to minimize the inefficient empty truck movements. IAS, a private company, analyzed data gathered from one of its earliest street turn programs launched in September 2003 in the Midwest and Ohio Valley, and reported that these street turns can potentially result in savings of more than $400 per container for ocean carriers and IMCs per round trip (*4*).

Until recently, there has not been substantial literature aimed at implementing or critically analyzing new and innovative solutions to deal with this problem. In the early years of the new millennium, the potential for the use of information technology and the Internet for improving generic collaboration among the port actors has been recognized, and a few Internet - based port community systems have come up. In 2001, the Port of Rotterdam embarked on the Virtuele Haven project in order to study the technological feasibility of using Next Generation Internet (NGI) in improving the transparency and the connectivity among the partners in the port of Rotterdam (*5*). In 2001, the Port Authority of New York and New Jersey initiated FIRST (*6*), an Internet-based, real-time network that integrates numerous sources of freight location and status into a single, easily navigated Web portal to allow port users to access cargo and Port information to facilitate planning and logistics, but acceptance was not satisfactory, especially from the trucking industry, since truckers claimed to be unable to get the accurate, real-time information they needed.

In other cases, rather successful implementation of similar concepts has been reported, such as Pacific Gateway Portal at the Port of Vancouver, Canada, that includes features like the Truck Appointment system and a real-time Web-cam facility (*7*). Other online collaboration systems from private companies such as eModal, ,SynchroNet and IAS are also worth mentioning. eModal has developed a Port Community Website that has been used more than a dozen ports in the U.S. The Port of Los Angeles-Long Beach (LA-LB) has entered into a contract with eModal and International Asset Systems (IAS) Ltd. to establish a VCY, (*8*). In LA-LB, most of the potential participants such as the ocean carriers and a majority of the trucking companies reportedly already use eModal for other information, and so the street-turn feature will be added to the existing suite of services. The Port of Oakland and SynchroNet Marine Inc, have partnered to implement SynchroMet, which is a congestion management tool, designed to facilitate the street turns by the concept of a VCY (*9*). Further, SynchroNet has partnered with Profit Tools Inc., a trucking software firm which was already providing many truckers tracking solutions at the port of Oakland. The integration is expected to enable trucking companies using Profit Tools to automatically post available and needed empty containers into the SynchroMet matching service without redundant effort or data entry. The SynchroMet service will then proactively notify the trucking company's dispatcher of any matches. By making posting to SynchroMet a routine, seamless part of the dispatch process, the alliance will enable trucking companies to reduce operating costs, while at the same time reducing port congestion. Recently the Port of New York and New Jersey has initiated a similar effort and has awarded a two year development and pilot operation contract to eModal.

While there is arguably good potential use for the concept of the VCY system, there have also been researchers who have suggested that the potential of such applications in the existing market scenarios is not encouraging. Le Dam Hanh (*10*) concluded that the applications of technology being advanced with the idea of virtually sharing information about the location of empty containers and waiting export loads appears promising in the long-run, and may provide significant value when the condition of the market is right. However, the study concluded that, in the short-run it would be prudent to acknowledge that the growth potential of these systems is constrained by existing market conditions, which will in-turn limit the potential these initiatives have for rationalizing empty container movements in any particular region. While market conditions most certainly determine the potential for growth for such an initiative, it is still very much possible to model ideal market conditions for the successful implementation of the virtual container yard concept. Jula, Chassiakos and Ioannou (*11*) modeled the dynamic container reuse using an analytical approach by means of considering both street-turn and depot-direct methodologies, and concluded that street-turns are more effective when traffic congestion and cost functions are to be minimized, whereas depot-directs are more effective when waiting time is to be minimized. However, this model does not deal directly with the analytical estimation of the vehicle miles traveled, which is the basis for any objective analysis and quantification of potential benefits. While the paper considers the street-turn alternative at a high level, the simulation does not expressly address the specifics of the interchange, which are extremely important in light of the unwillingness on the part of the port players to share information with others. Hence, the restrictions to be placed on these interchanges need to be addressed in specific detail, to be able to realistically simulate the practical institutional and business barriers that will exist in any actual implementation.

In an attempt to address these issues, this report examines user requirements and the functionality of various proprietary products, and proposes a VCY system architecture. It also presents an analytical formulation and the results of a simulation-based model that uses a detailed algorithm for the container interchange, which provides more realistic representation of the practical environment in the freight and maritime community. The simulation leads to encouraging results for the use of a VCY, but notes that under certain conditions of the system the benefits may be less important than anticipated. Potential funding alternatives are also examined and a proposed system governance is presented. A staged application timeline and implementation plan is suggested. The report concludes with recommendations to make the conditions more favorable, so that the benefit to be accrued from the implementation of a VCY system is maximized to the extent possible.

3 USER NEEDS

3.1 Introduction

The Virtual Container Yard (VCY) concept aims to reduce the unnecessary truck trips and ease truck traffic at the terminals caused by hauling empty containers to and from the Port of New York and New Jersey. The VCY will act as an Internet-based bulletin board where the container owners can post availability and location of the containers in order to match them with the demand for export containers in the region.

Proper information sharing about the demand and supply of empty containers has been a major hindrance in enabling higher number of “street-turns” or direct interchange of the empty container at the importer’s location, in the past. It is therefore commonly believed that, in principle, such a system of Internet-based information sharing arrangement has sufficient potential to achieve substantial reductions in the empty truck trips and the congestion at the terminal gates. A successful implementation of such a system will be based on a solution that combines the theoretical potential of the VCY with the practical dimensions of the problem.

The port community includes several stakeholders, all of whom have their own business and administrative goals and roles to fulfill. Given the number of stakeholders and their varying degrees of involvement in the port activities, it is clear that the key first step in establishing a VCY is to understand their diverging needs. In order to enable a solution that converges from the various expectations of the different players, it is important to understand the motivations and the driving forces behind the stances adopted by the different users. Therefore, we attempt to study the needs of the Users with regard to the empty container problem. Figure 4 shows an extended concept of a VCY system and information exchange among various stakeholders. In its simple form, a VCY may facilitate information exchange among fewer stakeholders, such as, for example, ocean and motor carriers.

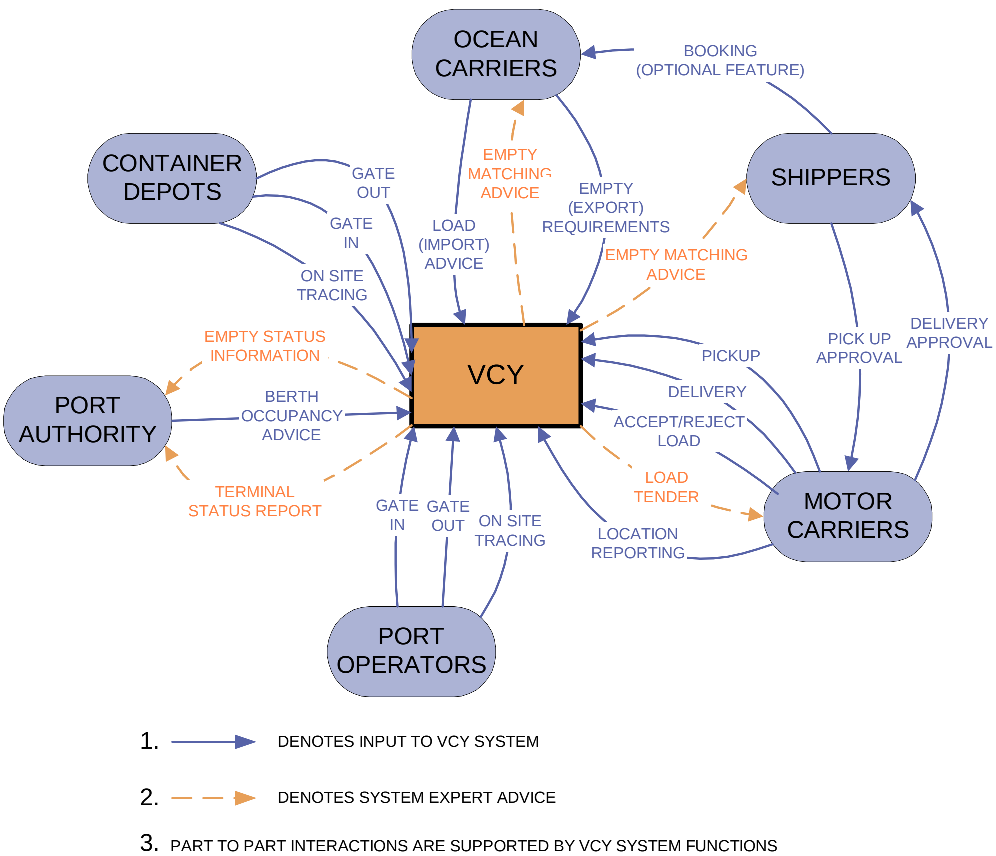


Figure 4: Virtual Container Yard System Players and Information Flow

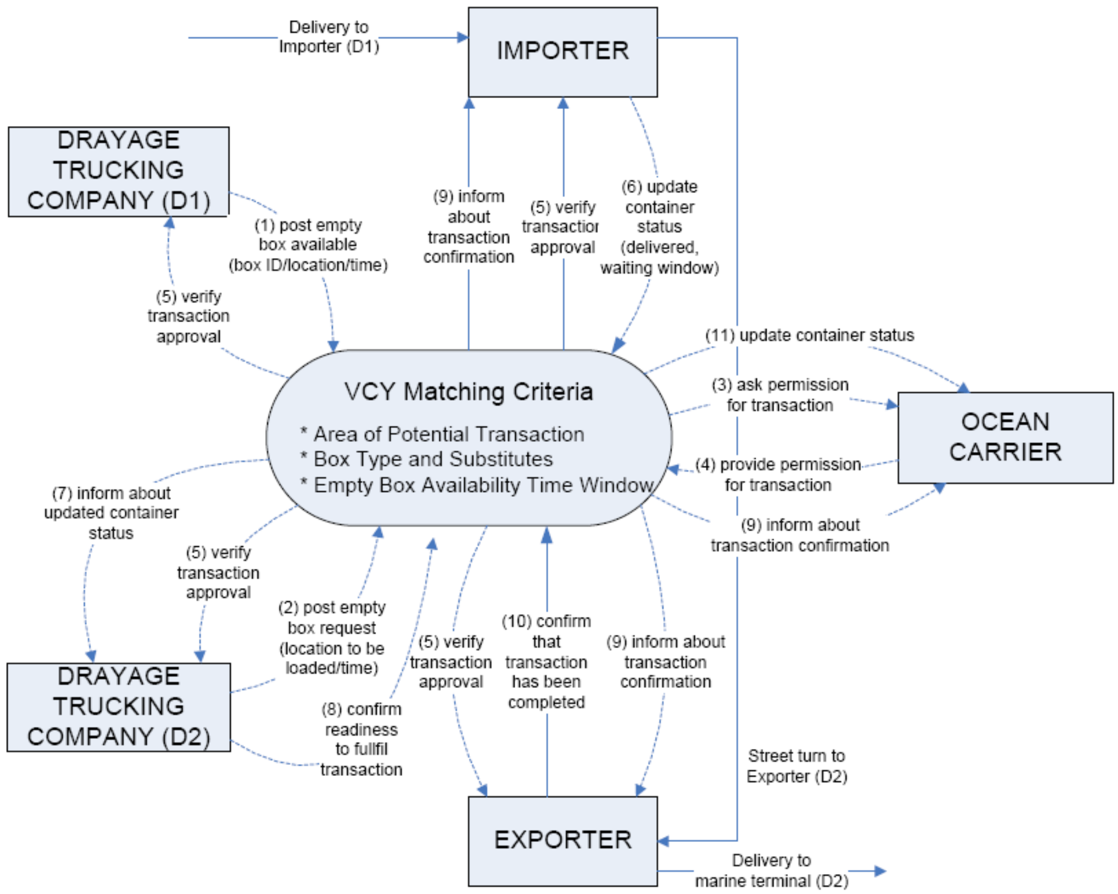
Figure 5 presents the empty container interchange transaction process flow for the case where the drayage trucking companies are the direct users of the VCY. Again, the role of ocean carrier is indispensable, since a drayage company participating in the system has to be admitted by the ocean carrier, owner or lessor of the container to make the transaction using the empty box and for the transaction itself the permission of the ocean carrier has to be ensured. Following the permission of the transaction relevant information is released to the parties involved. Important parameters in making the system successful include ensuring clear and efficient interchange rules and solving associated per diem and liability issues.

Although the system is in its infancy, the picture is promising, since benefits to users include:

- significant reduction in empty, unproductive vehicle miles travelled (VMTs) by trucks originally returning empty containers to marine terminals for temporary storage. This fact contributes significantly in mitigating freight transportation related congestion around ports and associated adverse environmental impacts.
- better use of trucking operators' equipment and therefore, more cost efficient activity by decreasing empty trip turnaround time and increasing number of paid trips per day. Gate transaction time significantly contributes in extending unproductive waiting time for trucks.

- increased container visibility for ocean carriers, when containers leave the port for land-side transportation. Ocean carriers have excellent visibility of their containers when at sea or at the port, but visibility decreases when containers leave the port.
- enhanced possibility for shippers and consignees to negotiate, either directly or indirectly through their intermediary representatives, better prices for drayage operations dealing with containers they use for their activities.
- more efficient use of marine terminal storage capacity. Long dwell times of containers inside marine terminals are considered as a main cause of poor performance of port operations and associated port congestion problems.
- reduced traffic at marine terminal gates and more efficient processing of full inbound and outbound containers.

Today, estimates indicate that about 2% of empty containers are street turned on an ad-hoc basis, without the support of a VCY. Introduction of a VCY is expected to increase this percentage to about 5-10% (*1*).



Note: solid lines indicate physical flow, broken lines indicate information flow
Source: Theofanis et.al 2007 (12)

Figure 5: Empty Container Interchange Transaction Process Flow

3.2 Users

The different categories of users that have been considered for the purpose of this project are:

1) Ocean carriers

2) Truckers /Motor carriers

3) Container Leasing Companies

4) Shippers

5) Terminal Operators and

6) Port Authorities

Ocean carriers are primarily involved with operating the vessels over the seas and carrying the shipments of cargoes from one port to another. Ocean carriers, apart from owning and operating vessels, also own a significant percentage of the world's container inventory. The ocean carriers can be large liner shipping companies or much smaller carriers. The large and small ocean carriers have very different business models, and consequently differ in their opinions on several institutional and business issues.

Motor carriers or Truckers are involved with moving the cargo from the ports to the inland customer location or vice versa. These motor carriers can be large or small companies that hire the drivers to move the cargo on land, or independent drivers who are not contracted to drive for any company. Again, there can be several differences in the way that a large company interacts with the other stakeholders compared to a small trucking company.

Container Leasing companies use their containers as assets and lease them to the ocean carriers, motor carriers and other leasing companies. These companies typically use their judgment and understanding of the freight industry to set the lease prices for the use of these containers.

Shippers are the companies that contract with their customers to transport their goods to a certain destination. They then get into arrangements with freight forwarders or the ocean carriers and motor carriers directly in order to transport the cargo. The shippers do not usually own or transport the containers and involve the other stakeholders to move the cargo from one place to another.

Terminal operators are usually private companies that operate a particular terminal of a port and offer stevedoring, vessel and container handling services. They have the infrastructure required to load and unload a vessel and they collaborate with the ocean carriers and the port authorities.

Port Authorities are the institutional, administrative, governmental organizations that have the overall responsibility for the management of the port. Apart from being the land owners of the water front at the ports and harbors, they actively regulate and manage the activities by collaborating with the terminal operators.

3.3 User needs

With such a vast variety and number of stakeholders in the port community, it is expected that there will be various user needs from a system like a VCY. The next sections summarize some of the user needs, grouped together, but with the knowledge that the different users belonging to the same user group will also have different and often diametrically opposite points of view, depending on several factors. Still, the following set of user needs is meant to be indicative of these needs as understood from several sources.

3.3.1 Ocean Carriers

- Carriers are not unanimous in their support for a VCY, as the gains of saving on two empty container hauls are not big enough to risk not having the container at the right place at the right time (*10*). The savings for large ocean carriers by sharing their empty containers are said to be not attractive enough.

- For some ocean carriers, sharing the empty containers reduces control over container inventory, which is a risk in not being able to meet a customer's demand and losing his account (*10*). Ocean carriers are wary of exposing themselves to a risk where sharing their containers to other carriers could mean that they no longer exercise the same amount of control over their assets. In a particular case, they may need a particular size or type of containers for a customer, and if such containers are not in their control all the time, they may either have delays in sending the container to the customer, or not having the container in the right condition, all of which are risks in keeping the customer satisfied.

- Large ocean carriers are wary of losing their competitive edge to smaller companies who primarily rely on leasing containers rather than owning them. Thus, sharing is more advantageous to small and medium sized carriers (*10*). In the very competitive liner shipping market, there is no room to make a mistake, because the shipper or the customer will move to another ocean carrier if there is a reason to be unsatisfied with the service provided by the existing ocean carrier. It may even be said that large ocean carriers like to differentiate themselves from the small and medium ocean carriers by their ability to fulfill the customer demand, however large or sudden. In such a scenario, large ocean carriers are not keen to share their containers without a very strong incentive.

- For the large carriers, repositioning the containers back to Asia or Europe as quickly as possible for the next shipping to the US is important. Thus, they are keen to bring back empty containers into their container yards at the ports (*10*). Since the demand for container shipping is strongly seasonal, the large carriers see enough incentive in shipping empty containers back to Asia or Europe, in order to make the most of the high demand period. This, in fact, shows that the ocean carriers clearly prioritize the regular demand of existing customers over a one-off demand for another customer, unless there is a promise of future demand from the same customer, especially during the peak season.

- Attempting to match a specific import load with a potential export load may require sensitive, proprietary information regarding the customer base and shipment commitments of each ocean carrier. The ocean carriers are wary of divulging such information for reasons of both commercial advantage and cargo security (*1*). In the competitive shipping market, retaining a regular large or medium customer is vital for every ocean carrier. Apart from the risk of exposing the customer details, there may be a risk in exposing proprietary operational procedures or strategies, which is counter-productive to the ocean carrier's business goals. Furthermore, the fear of cargo security and container security is another factor that the ocean carriers may have in showing active interest in the virtual container yard concept.

- Ocean carriers must be able to permit "street" interchange, request and receive authorization to off- hire containers, and verify responsibility for their equipment at any point (*1*). The ocean carriers interested in the virtual container yard concept need the system to allow the street turns, securely authorize such transactions and be able to monitor the containers after the transfer has taken place. While the current state-of-the-art of Internet technology can meet such requirements, the ocean carriers need assurances about the robustness of the system to meet the requirements in all conditions.

- Ocean carriers would like the VCY to differentiate by type and ownership of container (*1*). Mismatch in the container type and ownership during the interchange process or at any later stage will be of critical consequence to the ocean carrier. For instance, if the VCY shows a particular container as belonging to a particular ocean carrier, accurate information on whether that particular container is a reefer container or of a certain size may be important in deciding to interchange this particular container.

- Ocean carriers need a VCY to maintain unbroken liability, inspection, and responsibility records (*1*). Liability issues are definitely very important in the competitive liner shipping market, since the VCY concept when implemented, will require that the system be able to retrace the track of a particular container from the past, should there be any legal issues with regard to the container condition or ownership.

- Ocean carriers need strong incentives to allow tracking and tracing of empty container location, possession, and status (*1,10*). While the ocean carriers need the liability transfer of the containers being shared, they are also not keen to share information regarding the container location and possession at all times. When a particular ocean carrier has sufficient export loads to deal with, he may not like to post details of his container location and status, while when he has a lot of empty containers he might be willing to share the location details.

- Facilitating interchanges between two truckers who are serving the same ocean carrier (*1*). The ocean carriers may be initially more willing to share the containers and information virtually to permit the interchanges between different truckers who are serving them. From an ocean carrier's point of view, this situation is comparatively less risky, and to a certain extent, this kind of interchange is presently common among some carriers. Some large ocean carriers have their own websites where they share some information online with their truckers. Such ocean carriers need incentives to migrate from their existing system to a common VCY.

- Post restrictions on the reusability of containers (*1*). Based on certain operational or strategic reasons, ocean carriers may not like to allow the reuse of their containers under certain conditions. These restrictions may be in terms of the cargo that may be moved, or the geographic region in which it may be used or quite simply on the truckers, shippers or customers that may use the shared container. The ocean carriers need the VCY to allow posting of any restrictions, conditions or special information about deadlines etc.

- The ocean carrier needs the emptied import container to be suitable for the export load, and the container must be acceptable at the terminal used by the export vessel (*1*). This is a basic need that should be taken care of by the availability of accurate information on the requirement of the containers and the details of the surplus containers. The compatibility or suitability of a particular empty container for an export load depends not only on the cargo being shipped but also on the vessel type of the export ocean carrier.

- Proximity and timing of the export opportunity are important criteria, but the factors such as the goodwill of customers need to be borne in mind (*1,10*). Ocean carriers would not be willing to risk losing customer goodwill by the non-availability of an empty container when and where required. Ocean carriers, in some cases, may refuse to allow an otherwise optimal container interchange when they see a need to satisfy the demand of an existing customer, perhaps even at a much farther location or slightly later in time. The ocean carrier would always like to reserve the right to permit or deny the interchange without specifically divulging the reasons behind it.

- Ocean carriers would like to interchange leased container boxes among themselves typically for large blocks of container capacity and not for individual movements (*1*). It is possible that ocean carriers may like to share not individual container movements, but large blocks of containers between a few partner ocean carriers for a period of time. While this is not the purpose of the VCY, the need of the ocean carriers to get into such an arrangement may be recognized.

- Ocean carriers would like to minimize their fleet size, wherever possible (*1*). Ocean carriers without doubt would like to minimize their fleet size to the extent that it does not harm their business interests. With the mergers and acquisitions that have become common in the liner shipping industry, the ocean carriers sometimes have a surplus of container assets. However, the way to deal with their container surplus is based on prudent business judgment rather than short-term gains.

- In Regions of surplus of containers, most carriers attempt to off-hire leased containers. Thus, in such cases ocean carriers prefer that a leased import container be returned for off-hiring rather than loaded with exports (*1*). Most carriers, typically the small or medium ones, do not mind paying drop-off charges in regions of container surplus compared to possibly an opportunity of an export load.

- Ocean carriers want their empty containers back to satisfy the needs of foreign shippers for eastbound shipments, and westbound export rates are now so low that there exist little incentive to wait for an export load (*1*). With the growing difference between the imports and exports in the U.S. the market for shipping back U.S exports to Asia and Europe is simply becoming unattractive, even to the point of moving empty vessels across the seas, rather than wait for an export, as there is so little demand anyway.

- The excess of supply over demand has depressed rates to the point where some ocean carriers have stopped soliciting the lowest-rated export commodities and are simply moving more empty containers back. The ocean carriers would be willing to extend free time in return for a reduced total drayage bill and better overall container fleet utilization (*1*).

- Ocean carriers impose per diem charges primarily to encourage prompt return of empty containers and discourage non-maritime reuse, but per diem is also a source of revenue when it can be properly charged and collected. Tracking, charging, and collecting per diem is difficult, time-consuming, costly, and frustrating, and ocean carriers are currently not very successful at it. The VCY needs to simplify and not further complicate the per diem issue (*1*).

- The ocean carrier is concerned that there is no gap in responsibility or liability, and that the first trucker does not escape his responsibilities to the equipment owner. There is currently no readily available mechanism for transferring liability between the first trucker and any subsequent user of the container and chassis. Such a mechanism might resemble an electronic interchange within the Virtual Container Yard where the first trucker electronically returns the container to the ocean carrier who then electronically interchanges it to the second trucker. The difficulty with this process is the loss and damage liability of the first trucker and the inability of the ocean carrier to verify the condition of the equipment (and by extension whether or not to bill the first trucker for any damage) (*1*).

- Ocean carriers do not like to get involved with trucking issues especially with regard to the liability in the event of an accident, even if there is a clear transfer of liability. The legal issues can be time-consuming involving large sums of money (*1*). The shipping industry works in a way where time is money, and in such an environment to spend time and money over unprofitable, legal squabbles is something that every ocean carrier wants to avoid.

- Ocean carriers currently have well-established websites of their own for their customers and may not see any real incentive in sending data out of their system. In addition, they may not be willing to incur additional costs for the planning and the system related costs for sharing the data with the larger port community (*15*). Experience from the FIRST project implementation demonstrates the need for ocean carriers to have concrete incentives in order to ensure their active participation in the VCY. The involvement of the ocean carriers and the truckers is the most important factor in the success or failure of the VCY implementation.

- Ocean carriers had different viewpoints on matters such as the free time: some would readily allow extra free time to obtain an export load while others would enforce free time limits to insure prompt return of empties needed elsewhere (*1*). This probably shows the difference in viewpoints of the medium from the large ocean carriers. It may be assumed that the medium carriers in general would allow extra free time to obtain an export load, while the large carriers have more interest in insuring prompt return of the empty containers for use elsewhere.

3.3.2 Truckers/Motor carriers:

- The truckers need information that is accurate, real-time and easily available at the right time. Trucking firms are interested in more information to help in dispatching, but are unlikely to turn over actual dispatching control to another party or automate it. Dispatching — assigning drivers and trucks to specific trips — is a critical function in a trucking company, and a major element in equipment and driver utilization (*6*).

- Truckers may not like to pay for information about the opportunities of export shipments (*1*). This statement needs to be seen in the light of the quality of information available. While the truckers are looking for accurate and timely information, which helps them to increase their export haulage and minimize empty trips, they may not like to pay for this information until they see the real benefits accruing to them by using that information.

- Motor carriers need to receive permission to interchange containers, authorization to off-hire empties directly to depots, and verification that they are relieved of liability when their possession ends (*1*). This ties in to the similar need for the ocean carriers to allow such transactions real-time. In the case of the truckers, decisions need to be made in the field in a really short span of time, and hence the ability of the system to allow permissions in real-time can be the difference between a good and an unsuccessful implementation.

- Truckers with boxes to be off-hired would seek off-hire authorization and, if appropriate, a payment or allowance for off-hiring the unit. (*1*) Again, the need for truckers to off-hire the containers and complete the transaction quickly and without any hassle, is important. Motor carriers also try to minimize their costs in unproductive hauling or waiting time, and the real benefit of the VCY will depend on the real-time posting of information and the real-time accessibility of that information.

- The VCY should post information regarding the free-time for the containers and also allow re-starting the free time allowance for the container for confirmed bookings, where permitted by the ocean carrier (*1*). Truckers looking for empties would review postings to find suitable boxes with sufficient free time in appropriate locations. This information will help in letting the truckers decide which empty import container to transfer from among the many surplus containers in the region.

- The truckers' interchange agreement with the ocean carrier must allow for such reuse and the ocean carrier must be able to track and document the interchange between parties (*1*). This is an obvious need from the trucker's point of view in order to insure that the liability has also been transferred along with the container. Since there are agreements that regulate the container movement in the industry, care must be taken to insure that these agreements are modified to allow the changes, especially with regard to liability on the specific trucker that logically bears the responsibility at all points of time.

- When truckers receive a container in interchange they are ordinarily allowed five business days of "free time" before "per diem" charges are assessed. Per diem is the daily charge for holding a container past this free time allowance and is currently $44 for a 40' dry container. The per diem "clock" begins when the container leaves the marine terminal and runs until the container is returned, unless the ocean carrier and customer make some special arrangement (*1*). The rules with regard to per diem charges and the free time allowances will need to be modified to allow the street turns. As the ocean carrier and trucker both stand to gain due to the possibility of an export load, this matter can be agreed in discussions at a suitable stage of implementation.

- Ocean carriers typically charge trucking companies for per diem since it is the trucking company that has received the container but trucking companies typically blame customers for any delay and avoid paying per diem bills unless they can be sure of customer reimbursement (*1*). In case of the VCY implementation, there is bound to be further complication to the matter of the per diem charges since the first trucker may blame the second trucker for the delay, and hence the regulations should clearly take into account who pays for what under what circumstances.

- To complete a regular "street" interchange between two trucking companies a process ideally with representatives from both trucking companies present is required. In case where the two companies trust each other completely or when no damage or other conditions are being found, this procedure might be conducted by one person alone with the results communicated to both firms (*1*). So the physical location of the interchange needs to be agreeable to both the parties.

- It is commonly imagined that this process would take place at the import customer facility where the container was emptied, and that the container could then be moved to an exporter for loading. This procedure might be difficult to implement. Import customers are very unlikely to permit the second truck driver and truck onto their property to receive the container due to security concerns, especially when the import customer will not receive any significant benefit for the interchange process (*1*).

- Truckers are reluctant to reveal the identity, location, or business particulars of their customers to potential competitors (*1*). In the case of a street turn, the truckers might not like to expose details of their customers, and their locations to the other truckers. The first trucker would like to retrieve the empty container and park it in his own lot or at a neutral location (perhaps even on the street). The interchange inspection and paperwork would then take place away from the customer's facility.

- Trucking firms carry insurance policies that indemnify their customer in case of an accident. The second trucker's insurance would not indemnify the first trucker's customer, leaving the customer with an unacceptable liability exposure (*1*). This is one of the loose ends that need to be tied up in order to make the VCY implementation without any loopholes. The liability transfer between truckers should clearly state the terms under which trucking company, in the event of an accident, indemnifies the customer, after the street-turn is completed.

- Truckers do not have standardized processes for day-to-day interchange and reuse of containers (*1*). Especially, sometimes the truckers may not agree on the condition of the container. One trucker may argue that the container was in good condition with minor wear and tear, whereas the trucker who is now taking the liability might want to call it a container in repair. Lack of standardized processes makes it difficult to have an acceptable and objective inspection of the condition of truckers, especially in the absence of a third-party inspector. The agreement between truckers on the condition of the container being interchanged is fundamental to the working of the VCY.

- If the truckers transfer the container at the site of the importer, it may be that one trucker is in a hurry to meet the demand of the next customer, while the other trucker has no incentive to act fast. There also may or may not be a person readily available who can undertake the inspection of the container. To avoid potential disputes in a very competitive market, there needs to be some mechanism to insure that there are no undue delays caused willingly or unwillingly by any party in the functioning of the VCY.

- Truckers are reluctant to adopt any practice that would expose them to additional per diem charges since the $44 per day charge is higher than any profit potential for reusing containers. So, as with the ocean carriers, the per diem issue is delicately balanced (*1*). In order to make the reuse of empty containers an attractive proposition to the truckers, it is necessary to understand the concerns regarding the per diem charges.

- In recent months, truckers have been faced with the problem of finding and retaining enough drivers over issues of pay, especially during the peak season. Most drivers are paid by the trip and hence, they are not paid for the waiting times, which prove costly for them (8). Additionally, fuel surcharges are another point of contention. Therefore, the need from a trucker's point of view is that there must be an agreement on who pays for what, vis-à-vis, the ocean carrier and the trucker. As the demand in the industry is seasonal, a lot of drivers have been lured away from the job as it imposed heavy burdens on them, especially with the delays at the port, for which the drivers were not even paid.

- The Uniform Intermodal Interchange & Facilities Access Agreement (UIIA) is an agreement administered by the Intermodal Association of North America, and participants include 8 railroads, 45 ocean carriers, and over 4,500 motor carriers. While this does not specifically prohibit "street" interchange, its basic language anticipates that the party who is using the equipment (the trucker) will return it to the party who provided it (the ocean carriers). Cautious truckers or carriers might interpret this as a prohibition on street turns. Thus, some truckers will need assurance on the rewording of these regulatory agreements (*1*).

- Additionally, the Ocean Shipping Reform Act (OSRA) has provisions that allow a conference of ocean carriers to collectively set prices that can act as ceiling rates for the truckers, which in turn will affect the supply of drivers. The truckers will be wary of the power of ocean liner conferences and the issue of rates will still be contentious in any form of collaboration. While the truckers and the drivers resolve the contentious issues that they face, it is equally important for the implementation of the VCY concept to understand the needs of the truckers with regard to the ocean carriers who are able to collectively set prices for the trucking companies (*13*).

- Motor carriers have grievances against what they call unfair and unwarranted practices employed by and terminal operators and ocean carriers. In California (*14*), one complaint was that they were charged late fees for the return of empty containers, even when terminals are closed or when returned containers are refused due to congestion in the terminal. The motor carriers also maintained that they are charged parking fees inside the terminal when their assigned space is unavailable, and are fined if they refuse to move containers to off dock and other locations. In this light, in April 2005, the bill SB 45 in California proposed to:

    a. Provide that "unilateral termination, suspension, or restriction of equipment interchange rights of an intermodal motor carrier shall not result from intermodal marine terminal actions."

b. Prohibit a marine equipment provider or terminal operator to "impose per diem or detention charges on an intermodal motor carrier relative to transactions involving cargo shipped by intermodal transport" under certain circumstances

3.3.3 Container leasing companies:

- Container leasing companies levy Pick-up and Drop-off charges to the carriers. Pick-up charges are applied when an on-hire container is leased at a place where inventory is tight. Similarly, drop-off charges are generally assessed when a container is off-hired at a place where inventory is in surplus. Thus, at the time of executing a lease contract, the charge for leasing a container ($/day) is determined principally by the intended pick-up and drop-off locations, as constrained by quota conditions (*10*). From the time they take possession, carriers are responsible for all damage or destruction that may occur to those containers. Based on the above practice, it is likely that there are locations that are usually more export oriented than other areas. Identification of such locations in the areas surrounding NY/NJ might be an interesting exercise.

- Since the shipping imports and exports in the U.S are seasonal, there are clearly differentiable peak and off-peak seasons. Carriers tend not to use off-hire during the peak season (May-Sep) but more during the off-peak season (Nov-Feb) (*10*). This results in the fact that during the off-peak seasons, there is a surplus of empty containers and the leasing companies are charging higher drop-off charges, while the carriers avoid off-hiring them in that period as much as possible. With the addition of a VCY, the leasing companies may be able to reduce drop-off charges compared to the current scenario because there is a better utilization of empty containers.

- Leasing companies must be able to authorize empty off-hire either at a depot or “in place” somewhere else (*1*). Just like the equivalent return of empties to the ocean carriers, the leasing companies need the VCY to allow off-hiring virtually. As a fairly large percentage of the containers in use today are leased, this need for the leasing company to be able to off-hire and hire virtually without the need for a physical transaction at the depot is important.

- The VCY should be able to maintain unbroken liability, inspection, and responsibility records (*1*). Liability issues are definitely important in the competitive liner shipping market, since the VCY concept when implemented, will require that the system be able to retrace a particular container from the past, should there be any legal issues with regard to the container condition or ownership. Pick-up and drop-off charges and liability issues are important in the case of a leased container.

- Leasing companies should be able to electronically authorize depot-direct off-hiring since returning a container to the depot (instead of to the marine terminal) effectively shifts it from the ocean carrier's account to the leasing company's responsibility. The authorization process and any terms and conditions would be spelled out in the lease agreement between leasing company and ocean carrier (*1*).

- Leasing companies that have leased out a particular container to a particular ocean carrier A may not be able to lease the same container out to ocean carrier B, even though the leasing company may be serving both ocean carriers. (*1*) This depends on the kind of arrangements that are in place between the leasing companies and the ocean carriers. While the VCY concept does not offer any clear and direct advantages to the leasing companies from the existing situation, the concerns of the leasing companies must be understood.

3.3.4 Shippers

- The needs of the shippers are indirect in the sense that they are tied together to the needs of the ocean carriers and the truckers. There cannot be a generalization of the needs of the shippers, because of the different kind of relationships, contracts and agreements in place between the shippers and the ocean carriers and the motor carriers. For instance, the terms of individual shipper contracts can affect free time and per diem charges, so assessing and collecting per diem becomes complex (*1*)

- The shippers are in several complicated contracts with multiple ocean carriers and truckers and hence the dynamics of the interactions between the ocean carriers and the truckers will need to have the concurrence of the shippers. Therefore, it is extremely important to involve the shippers in the early discussions of the VCY concept to understand their concerns and needs.

3.3.5 Port Authorities:

- Increased mobility and reduction of congestion at the port. The port authorities are definitely concerned with the problems of congestion and the concomitant problems such as inefficient operations, delays at the gates, increased pollution etc. The VCY can help in reducing the congestion at the port by making better use of the space currently used by the empty containers.

- Improved air quality in and around the Port and Metropolitan area. The VCY aims to increase the number of street turns and decrease the empty container trips to and from the port, thereby reducing the direct air pollution and also indirectly by aiding the better movement of traffic and eliminating the unnecessary delays caused at important nodes of the Metropolitan area, resulting in an overall improvement in the air quality in and around the New York/New Jersey area.

- Improved overall security of the port. By reducing the movement in and out of the port premises, security process efficiency increases, because the port authorities can inspect fewer containers at the gates. Also, by making more efficient use of the space used by some empty containers, the port can have better tools to control security inside its premises.

- Improved efficiency of the operations of the Port of New York/New Jersey. Improved efficiency of the operations at the Port can directly result in being able to deal with higher number of ships and containers. The overall productivity gains from making better use of the space being occupied by empty containers cannot be estimated, but it is significant, especially with the growth projected for the immediate future.

3.3.6 Terminal Operators:

- With the direct responsibility to reduce port congestion, terminal operators are trying to reduce free time and increase demurrage charges. However, this faces great opposition from the truckers. The need for the terminal operators is to streamline the operation at the ports without alienating any particular segment of the port community (*15*).

- The need to reduce congestion at the gates is significant, as better organization of the entry and exit at the port gates could improve the overall speed of the import-export process.

- Equipment Interchange Report (EIR) completion and inspection is currently usually performed by the terminal operators on behalf of the ocean carriers (*1*). This operation may be performed without the intervention of the terminal operators in the scenario of a VCY, but the terminal operators will still conduct their own inspection, which will be aided by the decrease in congestion at the gates and in the terminal.

- The terminal operators have a need to enhance overall port throughput and efficiency of operations. The VCY will aid in this direction by making better use of the space of the terminal. It will help the terminals in receiving an increased number of containers, and meet the demand for the immediate future.

- Terminal operators have all the different stakeholders as customers and need to improve customer satisfaction of all the players at the terminal.

3.4 Summary of User Needs

Previous sections present in detail the issues and needs of the various potential users of a VCY system, as these have been reported elsewhere and based on the authors' knowledge. Table 1 summarizes user needs, classified in various categories.

Table 1: Summary of User needs

FINANCIAL	Inexpensive to user
	Strict penalty
	Equally attractive returns for all users
	Simplify Per diem collection
	Liability, indemnification, insurance
	No additional per diem fees
REGULATORY	Simple tracking and collection of per diem
	Liability: Interchange agreement with ocean carrier
	Modification Free-time per diem counts
	Strict asset control and tracking
	Agreement on Objective inspection criteria
	Standard Transfer procedures
	Inspection methods
	Interchange facilities agreement
	Collective prices
	Late fees
	Competitive Aspects
INFORMATION	Information security
	Freedom and flexibility on information shared
	Scalability and compatibility
	Accurate, reliable information
	Useful information
	Real-time accessibility of information
	Quality of information
	Detailed type, ownership
FUNCTIONALITY	Continuous container tracking
	Continuous responsibility transfer and monitoring
	Allow restrictions- time, location, user, cargo type
	Freedom to permit or deny an interchange
	Electronic transaction should mirror real interchange
	Easy to train
	Robust
	Event-tracking and records – time, location, users
	Allow permissions for different situations
	User-friendly

4. OVERVIEW OF PORT COMMUNITY SYSTEMS

This section presents an overview of proprietary products, which either deal directly with street-turn matching or with wide range matching applications, currently implemented either as pilot or full scale applications at various ports. These systems are evaluated in view of the user requirements, as these were discussed in the previous section. Review of these systems is based solely on information available on their web sites and other Internet sources.

4.1 Port of Vancouver

The Port of Vancouver (PoV), Canada, is a key port along the West Coast of North America. The Vancouver Port Authority (VPA), is the agency responsible for business and operational decisions at the PoV, in addition to the land owned by industry, provinces, and municipalities. The Pacific Gateway Portal is the port community website in use at the Port of Vancouver.

4.1.1 Pacific Gateway Portal (PGP)

The Port of Vancouver's Pacific Gateway Portal (PGP) is a Web-based port community site that serves stakeholders and customers in the Vancouver area and elsewhere who have business in the port. The initial strategic planning of the concept of the PGP began as early as 1999, by some members of the PoV community. In 2000, the first community Web application for Dangerous Goods came online. Following further development, the main Website that exists today was online in January of 2002.

System Features

Although the public can access limited areas of the PGP Website, only registered users with an authorized login and password can gain access to available and specific information via subsequent Web pages.

Vessel information such as Estimated Time of Arrival (ETA) and Estimated Time of Departure (ETD) made its debut on the PGP first. This feature provides information on the status of vessels in the port, as well as expected arrivals of ships calling the Port of Vancouver. Users can find out when a particular ship is arriving, departing, and its current location. Users can also sign up to receive emails when an arrival or departure occurs

Landside features such as Web-cameras for real-time video feed from the Port are included on PGP. Users can access this feature from the PGP home page without having to log onto the system. This feature allows users to see live video feeds from cameras around the Port of Vancouver. Users can determine if there are long lines at certain terminals or if an incident has occurred on one of the roads leading to a certain portion of the port.

The Safety and Pollution Prevention feature on the Pacific Gateway Portal allows users to view requested vessel inspections as well as submit new service requests to the Port of Vancouver.

The truck appointment system at the Port of Vancouver has been in place since March 2001 and is known as the Container Terminal Scheduling System (CTS). It is fully operational at three terminals within the port – Centerm, Vanterm, and Deltaport. In a joint partnership with the Vancouver Port Authority (VPA), Terminal Systems Inc. (TSI) developed CTS as a truck reservation system designed to provide a given number of time slots during gate hours when a carrier who holds a valid permit with the Vancouver Port Authority can reserve and be assured of being handled. A reservation electronically through the terminal's web page is made against a time slot. Each time slot has a dedicated number of reservable transactions. These transactions are determined by the terminals and reflect the capacity that can be catered for. Dependent on the number of reservations a specified number of dedicated lanes are available for processing the trucks with reserved appointments. Reservations are given in hourly time slots. All trucks with reservations must be in line at least 15 minutes prior to the expiration of their reserved time slot. Should they arrive later, they must use the non-reservation lines or reschedule in the case of import containers – as it is a requirement that all import containers utilize the reservation system. If, on the other hand, a truck is early to its appointment it is served as soon as all other reservations are served or at the time of its reservation – whichever comes first. While the system provides great benefits if used properly, there are penalties if the system is abused. Carriers that over-book reservations or fail to show for their assigned time period or attempt to use the reservation line without a bonafide reservation, risk restriction or loss of access to the reservation system. Companies that persistently abuse the system risk having their licenses revoked.

Other features that are included on the PGP are security-related due to an increased concern over freight and port security. Further applications and features are available to those who have special privileges such as the dangerous goods features.

Payment Scheme

The PGP is a non-profit organization and aims to off-set operational costs with the fees collected from paying customers. At the same time, the PGP does not want to slow down its progress while ongoing revenue sources are established. Currently, the PGP receives bridge financing by private and government stakeholders while the needed revenue sources are found. Additional support for the Web portal is provided by members through substantial "in-kind" assistance.

The PGP does not charge port community members for data/information that it receives for free, unless approved by the owner of the data/information. There is no cost for using the appointment system. Additionally, the PGP only charges a price that reflects the cost of obtaining the same data somewhere else. Revenue sources that are in place now or are being pursued by PGP include advertising fees, annual membership fees for defined services, and transaction fees for defined services. The PGP allows all 500+ registered users to access basic features contained on the public site, as well as limited selection of additional features.

Information Exchange

Current members of the port community allow the PGP access to the existing relevant system assets they own. This includes domain expertise, source code, data, and intellectual property. Specific examples include the existing PGP hardware and network infrastructure, EDI partnerships with shipping lines, and the terminal systems themselves. Members that have provided in-kind contributions through source data or other resources are given free data in return and/or a discount on PGP services they use.

Accessibility

Any licensed truck driver expected to call at the Port of Vancouver may access the system with any computer having a Pentium processor of 200mhz or greater, a windows 95, 98, 2000, NT 4.0, or XP operating system, 64 MB of RAM, and at least a 56k modem

Reasons for Success

According to officials with the Port of Vancouver, the participation of the stakeholder group and the freight and business community at-large in the creation and development of the system has led to the success of the Pacific Gateway Portal.

Additionally, the truck appointment system, which has been in place at the port for several years, has helped reduce pollution and increase operation efficiency.

4.2 Port of Los Angeles/ Long Beach

The Ports of Los Angeles and Long Beach, Southern California are major gateways of the United States to international commerce and the largest container ports in the US.

As part of its Truck Trip Reduction program, LA/LB began efforts to develop a virtual container yard application by this year. They conducted a study to examine the feasibility and effect of applying an Internet-based dispatching system to facilitate and manage street turns directly (i.e., a virtual container yard), or indirectly via an empty container depot. Such a depot could serve all terminals/steamship lines, and would enable the temporary storage and transfer of containers. It is envisioned that a depot(s) would be located at centers of warehousing, distribution, manufacturing, importing, and exporting activities within the Los Angeles Basin.

Most Port of Long Beach and Los Angeles container terminals and numerous harbor trucking companies are currently using systems developed by eModal.

eModal provides a Web site wherein trucking companies can access information about containers at a single-source site. The system provides multiple fields of information for full and empty containers transiting through the Ports. The system provides a useful tool for the trucking companies to track information about containers to be picked-up or delivered and provides for more efficient operations at the terminal gates. eModal is constantly being enhanced and expanded. An appointment system for container pickup, was developed, which would enable trucking companies/drivers to alter their schedules to avoid terminal congestion and queues. Also, the Advanced Traveler Information Systems at this port provides information about the terminal gates, by camera to the truckers, and this type of information sharing will reduce truck trips and enable the shifting of some peak truck traffic to off-peak hours. By having real time freeway and terminal conditions information, truck drivers can better plan their drayage trips. A Virtual Container Yard concept has also been considered for introduction on a demonstration basis by a partnership with eModal and International Asset Systems.

4.2.1. eModal, Inc.

In 1999, eModal, Inc. began its operations out of Irvine, California. By February 2000, eModal.com, the company’s Port Community Website came online to the public. eModal.com is a private company with a large membership. The company has signed up 14 ports in the United States, with 36 marine terminals providing data to the system. There are over 6,400 registered companies signed up with eModal.com representing all areas of the freight and port community. Registered members include a variety of port community stakeholders (including brokers, consignees, freight forwarders).

Overview

eModal.com (eModal) came online in 2000. Designed to improve efficiency and decrease congestion at container terminals, eModal is a single point of contact for multiple container terminals. eModal works with the marine terminals to consolidate their information into the eModal system and make it available to the trucking community, as well as for developing future business applications to serve all aspects of the transportation chain. As an information and data service provider to the transportation industry, eModal acts as a data warehouse to the port and freight communities to provide "one-stop shopping" and grouping of data, through the use of its Website, www.emodal.com.

System Features

Features such as weather conditions at terminals/ports as well as the online membership directory are two examples accessible for free to registered users. The public can access limited areas of the eModal Website. However, only registered users can access features such as "Folder Manager" and "eDO™".

Activity Folder, that helps view container and booking status at any of the participating terminals. Users are able to create, edit, customize, and view Activity Folders that hold information on containers as well booking number. eModal is gaining access to an Activity Folder, which helps the registered company track containers or bookings, sort container information in a customized fashion, keep container information in one place, and receive instant updates.

Fee payment that allows users to pay demurrage, US customs and terminal fees online.

Scheduler that helps to schedule an appointment for a container at a particular terminal for a certain time-window, currently 1.5 hours. eModal allows for access to a Scheduler, which gives the member admission to valuable marine and trucking scheduling information. The marine terminals and trucking companies work on a specific schedule and sometimes do not communicate with outside parties. However, as a registered user of eModal, access to this information is guaranteed.

eDO the eModal electronic Delivery Order provides an unprecedented level of issuing, receiving, tracking and managing delivery orders. Customs Brokers can issue delivery orders more efficiently and securely. With the eModal electronic Delivery Order, trucking companies, marine terminals, and steamship lines all have a coordinated electronic method to handle the delivery orders.

Ticker tape: Another feature, the Ticker Tape, is an asset that may be utilized to gain information on the marine and trucking industry. With eModal’s Ticker Tape, news related to the port and freight community is easily accessible once a member logs onto the site. If the member has paid for access, the Ticker Tape scrolls across the top of the eModal Website for instant news and information on the freight industry.

Information Exchange

Data provided to eModal from the ocean carriers and marine terminals are transmitted mostly via FTP to keep transmission costs to a minimum.

Payment Scheme

As a private, for-profit company, eModal charges a fee for most of its features available to its members depending on the level of service desired. There are a few features on eModal that are accessible for free through a secured login that is obtained at registration. Features such as container information, marine terminal weather conditions, and members' contact information are available to all registered users at no charge. There are no advertisement fees collected because eModal provides free advertising to all registered users by including members in the online directory.

Reasons for Success

According to eModal, the success of their port community system has been a result of careful business planning and consideration for the customer. Efficiency-enhancing tools and customer satisfaction in conjunction with an user-accepted fee structure, has helped eModal reach out to ports and other freight community members on the West Coast and other portions of the United States and North America.

4.2.2 International Asset Systems (IAS)

Founded in 1998, International Asset Systems provides the global container transportation industry with innovative equipment information services, including InterBox, the leading online container exchange. It is backed by a private global investor.

IAS Concept

IAS has deployed the asset management application and the communications infrastructure that makes this virtual closed network possible. IAS Event Manager provides ocean carriers and their trading partners with visibility of equipment as it moves along. A “Virtual closed network” will help carriers bridge the technology gaps in today’s transportation chain, allowing them to streamline their data management processes and reduce IT costs.

Data from carriers and their partners in the transport chain could be transferred to a central data hub in a variety of standard formats. Streamlined data transfer between multiple partners in the transport chain, as shown in Figure 6, would reduce the time and administrative costs of using that data. Data could be captured at a greater number of points in the transport chain, reducing blind spots and improving asset utilization.

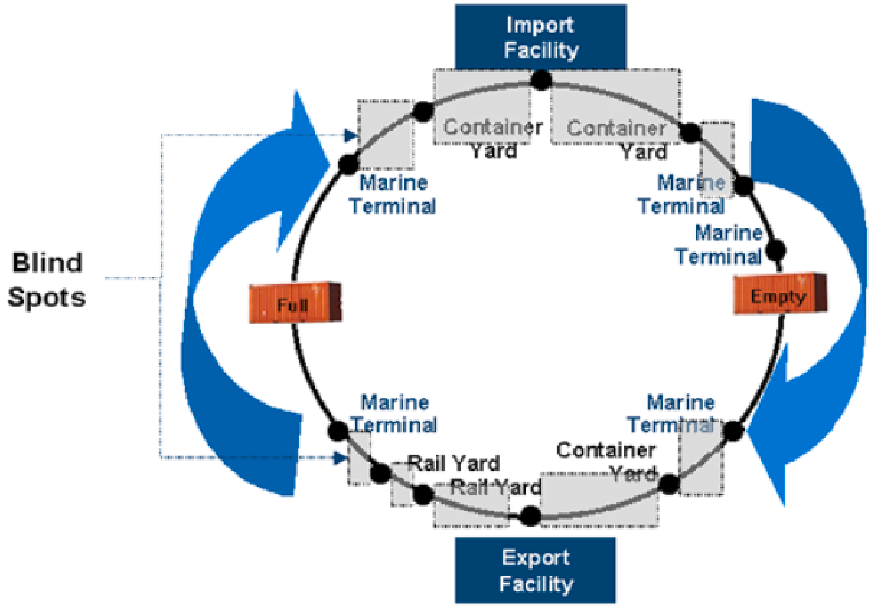


Figure 6 IAS Concept

Since asset information currently moves between several diverse participants whose systems may not communicate easily with one another, i.e. they may be incompatible because of EDI, email, fax, different proprietary vendor and customer systems, it is complex to analyze data and communicate among the members.

Carriers, their customers and vendors would benefit from a central data hub providing full equipment visibility along the transport chain. The hub will gather valuable information about the equipment status at numerous points, which will allow carriers to make more timely and cost-effective equipment management decisions. For example, at the end of the import cycle, i.e. at the consignee's facility, back-haul, interchange, empty repositioning or triangulation decisions can be potentially better performed with the help of such a hub.

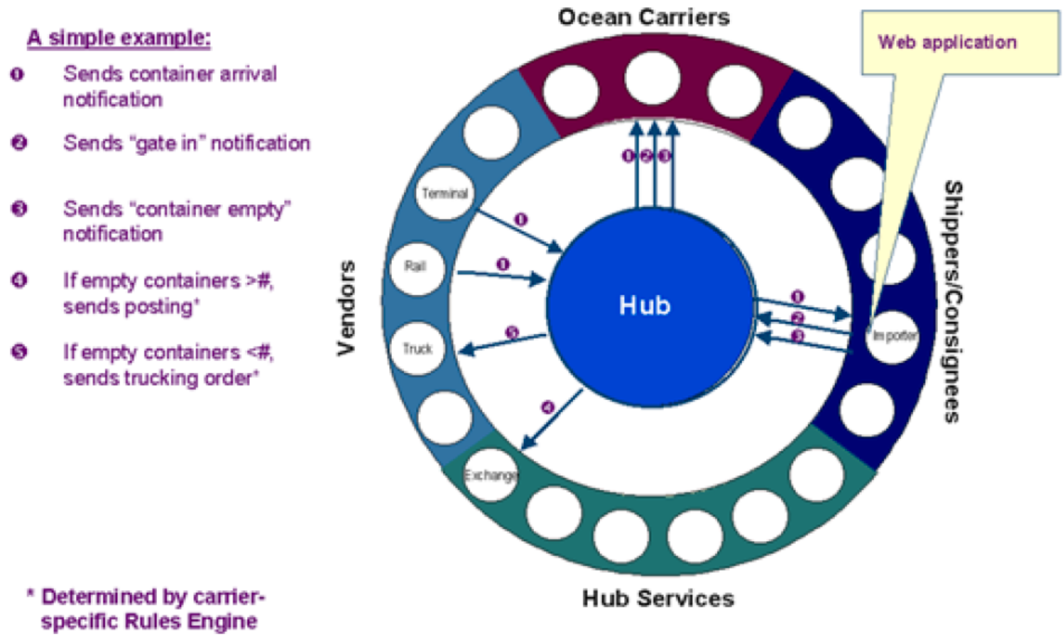


Figure 7. IAS architecture

The ideal data hub would employ open architecture, similar to that shown in Figure 7, to enable the seamless flow of information. In order to make the hub available to all parties, data transfer would be conducted simply and inexpensively over the Internet. An integrated rules engine would allow carriers to define their preferences for how, when and where the hub would channel the data. In addition to being secure and scalable, such a hub would use industry standard XML to readily enable systems integration.

For instance, in the above illustration, these notifications could be sent to the hub,

1. At marine terminal arrival of container

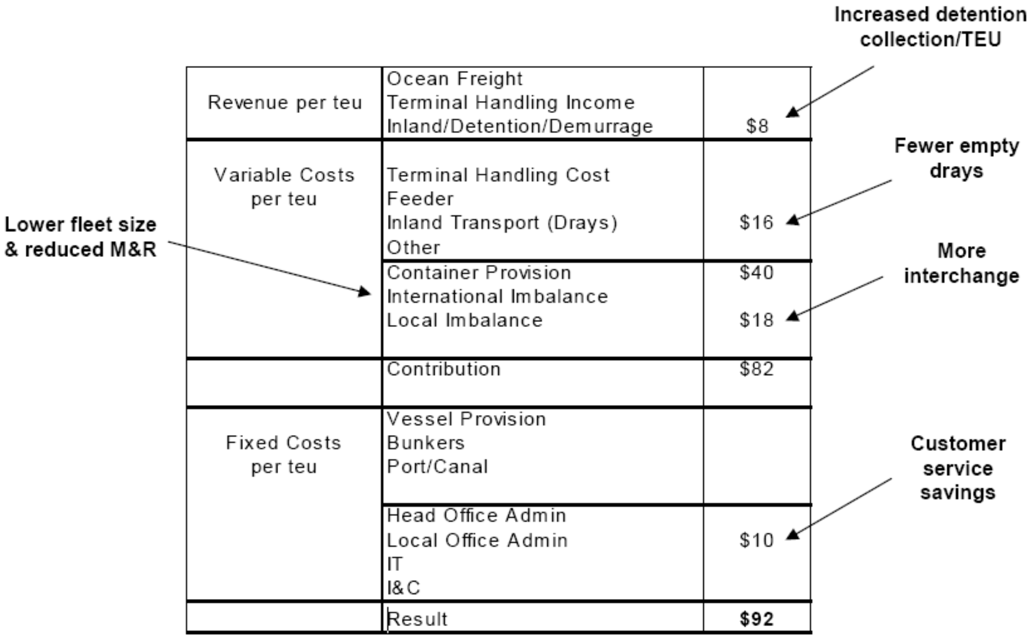
2. At inland depot arrival notification to consignee and carrier
3. When container is empty at consignee location
4. Depending on carrier's preferences and regional inventories of containers, notification of container availability status is sent to hub.
5. Else, notification to carrier to return the container to inland depot.

The benefits of such a hub would be,

1. Reduce equipment management costs by increasing utilization, reducing repositioning and related administrative costs while allowing for setting carrier's preferences in the rules engine.
2. Enhance customer service by improve equipment visibility, thereby proactively responding to exceptions and re-routing requests and improve interfaces between the different legs of the transport chain.
3. Bridges technology gaps by using simple data sources and open architecture, making it scalable and also use the hub to power in-house applications of different carriers.

As per this concept, IAS estimates the operating performance benefits for an ocean carrier to improve by the following way (see Table 2):

Table 2. Benefits estimated by IAS Event Manager



Revenue per teu	Ocean Freight Terminal Handling Income Inland/Detention/Demurrage	$8
Variable Costs per teu	Terminal Handling Cost Feeder Inland Transport (Drays) Other	$16
	Container Provision International Imbalance Local Imbalance	$40 $18
	Contribution	$82
Fixed Costs per teu	Vessel Provision Bunkers Port/Canal	
	Head Office Admin Local Office Admin IT I&C	$10
	Result	**$92**

Operating Performance Benefits of IAS Event Manager

Overview

IAS currently operates its Exchange which enables match-making for container owners. The IAS Exchange offers members live exchange opportunities as opposed to hypothetical "matches." Members post their needs and are committed to carry through with acceptable exchanges based on common trading rules. Approximately 80% of container fleet owners/operators are IAS Exchange members. Due to the rapid adoption of the IAS Exchange within the industry, all sides of the container market are represented, ensuring a wide range of exchange opportunities.

System Features

Since the IAS Exchange is a secure, neutral, Web-based marketplace, it is an appealing alternative to traditional approaches to improving container utilization such as client-server matchmaking software, alliances and in-house interchange contacts, which do not provide a large enough pool of options.

The Exchange notifies members via email and their Exchange homepage when matches are posted. Expiration dates on postings are completely user controlled. Users can set an expiration date on opportunities when they are posted; the expiration date can also be updated by the posting member at any time.

Members receive a return confirmation and return detail report notifying them of transaction progress and pending obligations. On current and completed activity screens, each transaction is reported in detail to provide users with step-by-step tracking. In this area members see return confirmations and return detail reports that show the return facility.

The Exchange will soon be integrated with the IAS Hub. When equipment is interchanged, it will be automatically registered on the IAS Hub. Both partners will be able to monitor the equipment's location in order to track its return to the original owner. Carriers will also be able to use the Hub's business rules engine to pre-define advantageous exchange scenarios. Excess equipment can then be automatically posted to the exchange.

IAS assists any member that has a dispute with another by providing all pertinent information to both transaction participants. If disputes cannot be resolved between members, an arbitration process is recommended. In order to help with disputes, specific information and rules pertaining to it are maintained in the IAS Exchange Rule Book.

Exchange fees are determined on a sliding scale based on volume starting at $18.75 per container transacted.

Future Prospects

Automated data collection of container events worldwide could boost the speed at which industry efficiency can be addressed. Active Radio Frequency Identification (RFID) has the capability to deliver what other technologies such as passive RFID and Global Positioning Systems (GPS) cannot, and advances in RFID standards and supporting technology now allow it to be deployed more cost effectively than before. Motorola and IAS are developing the concept of a Container Visibility System that would deploy an RFID reader network around the world, partner with ocean carriers and equipment lessors to tag the global container fleet within 3-4 years, and link the resulting automated data flow to carrier systems and third-party applications that serve the ocean carriers and their customers.

Applying the Container Visibility System to all of the world's ISO containers will provide a broad base of powerful information at the actionable points, founded on three key principles:

1. A primary focus on commercial benefits that also satisfy security needs
2. Ubiquitous, low cost "license plate" tags that leverage a broadly deployed, sophisticated network
3. An open technology architecture that supports full scalability.

4.3 Port of Oakland

The Port of Oakland loads and discharges more than 99 percent of the containerized goods moving through Northern California, the nation's fourth largest metropolitan area. Oakland's cargo volume makes it the fourth busiest container port in the United States

The Port of Oakland has a few port-community systems that aim to achieve different purposes, such as the appointment systems and the virtual container yard concept.

4.3.1 Voyager Track Premier Appointment System

One of these systems has been developed by Marine Terminals Corp, which operates three facilities within the port of Oakland. The technology is tailored for the type of cargo the terminals handle--certain cargo takes longer to clear U.S.

Customs Service inspection than others, for instance--so truckers won't schedule a pickup of a container that has yet to be cleared. Voyager-Track TM Premier Appointment System (PAS) is a Web-based appointment system for all transaction types, and is available free of charge to the users.

4.3.2 SynchroMet

SynchroNet Marine Inc. provides equipment interchange, asset management and cost optimization services to improve profitability and reduce costs for its customers in the global transportation industry. SynchroNet provides customer value through creative customer solutions and technology innovation. SynchroNet's B2B equipment interchange, asset management and cost optimization services improve profitability and reduce costs for its customers in the global transportation industry. SynchroNet provides a set of services such as SynchroBox, SynchroMet, and SynchroSlot.

SynchroBox provides customers with the ability to review and select interchanges in a real-time online environment. SynchroBox maximizes the potential for cooperative container management that exists between short-sea operators and major trade lane carriers in the Asian and European market. In addition the service assists international carriers to inexpensively reposition equipment from inland or coastal USA points.

Overview

SynchroMet™ is a congestion management tool, developed to improve asset utilization and operating efficiency for transportation service providers in the Metropolitan Bay Area. The system is supported by the Port of Oakland and endorsed by members of the California trucking community. SynchroMet™ reduces operating costs and gate congestion at local marine terminal facilities as well as public road congestion and pollution.

SynchroMet provides Motor Carriers with the ability to:

- Communicate street inventory or equipment needs
- Facilitate a street turn transaction with Ocean Carrier approval
- Generate an EIR and transfer liability for the equipment
- Access empty equipment direct from local ramps and depots

SynchroMet provides Ocean Carriers with the ability to:

- Authorize individual street turn requests on-line
- Dispatch equipment from local ramps and depots
- Incorporate required business rules and special terms
- Automate the confirmation process via EDI

In Phase I, SynchroMet provided equipment visibility and opportunities for collaboration that reduced road and gate congestion at local marine and rail terminal facilities. The phase one of SynchroMet service is designed to reduce road and gate congestion, cut waiting times at terminal gates, minimize empty truck miles and cut diesel emissions. SynchroMet reduces empty truck miles and waiting time at local marine terminals; which both have a positive impact on the local environment.

Phase II integrates ocean carriers with motor carriers through a virtual container yard (VCY) to perform mutually beneficial street turns, to reduce costs and ease port congestion. SynchroMet links community members to their own highly secure and proprietary segment of an Application Service Provider (ASP) platform. Additionally, Phase II facilitates the liability transfer between motor carriers, and the provision of additional free days to the receiving motor carrier.

System Features

Empty equipment can be released through the virtual container yard (VCY) and matched in real-time with off-dock equipment needs to cover export bookings.

SynchroMet allows users to track street-turned containers by individual unit number and provide confirmation of a street-turn event to terminal operators and steamship lines.

SynchroMet provides truckers with a one-stop-shop for information on port and terminal operations, customer service and contact information with links to steamship line and leasing company web sites.

SynchroMet will provide trucking companies and shipping lines with a real-time communication tool and technology platform that can help to reduce road congestion in the port.

The system effectively addresses the liability requirements between stakeholders and provides visibility to the street turn process. SynchroMet establishes strict, standardized and binding community guidelines for Community Members who use the platform. An Equipment Interchange Receipt (EIR) form with standard terms and conditions is provided, but ocean carriers have the ability to incorporate additional terms into the EIR form. With SynchroMet, there is clear accountability and liability between motor carriers for damage/insurance and per-diems.

Accessibility

Customers can access the SynchroMet service through the Internet on their web browser.

User Friendliness

The SynchroMet web interface has been designed with significant assistance from local trucking companies to ensure it is user friendly and easy to navigate.

The minimum system requirement to access SynchroMet via the web is a standard PC with an Internet connection. This web site requires a minimum resolution of

800 x 600 pixels (256 colors) using medium sized fonts. Internet Explorer browser versions 5 or higher should be used for accessing SynchroMet™. All standard modem connections may be used.

Information Exchange

Entering data is very easy. Minimal information is required from the user in order to present potential street-turn opportunities to the SynchroMet community. Users also have the ability to edit and copy current and historical records to eliminate the need to continually re-key information for recurring opportunities.

SynchroMet links users to their own secure and proprietary segment of an ASP platform, where they can review and select opportunities for mutually beneficial street-turns. Inbound containers can be posted as empty street-turn opportunities and matched in real-time with off-dock equipment needs to cover export bookings.

Payment Scheme

SynchroMet is a subscription-based service. Customers pay a monthly fee to access the service

Variety

SynchroNet has the system capabilities to recognize opportunities for all equipment types. The complete range of ISO and domestic equipment (48ft & 53ft) types can be street turned via SynchroMet.™

4.4 Port of Rotterdam - Europe Container Terminals (ECT)

ECT is the largest and most customer-oriented container terminal operator in Europe, handling almost three-quarters of all the containers that pass through the port of Rotterdam.

There are some E-services that ECT offers to its customers via the Internet, emails and also SMS. The ECT website is divided into a public and a non-public part, which requires registration.

ECT offers a set of E-Services:

- 24 Hour Reports - With this authorized service a carrier can view his 24 hour reports by selecting a specific customer code and a day of the week.
- Load/Discharge container lists - With this authorized service one can view his load and Discharge lists.
- Container Number Release Order ECT-Delta/ECT-Home - With this authorized service one can submit Container Number Release Orders to ECT.

Apart from the above, accessible to the public are the following services:

1. Object Status : This service helps to find the current status of an object (deep sea, short sea, barge, feeder or rail) at the terminals of ECT in Rotterdam.

2. Container Status: This service helps to find the current status of a container at the terminals of ECT in Rotterdam.

For registered customers, the non-public services are offered:

– Alerts Object Status: This service makes it possible for the users to configure alerts on events (e.g. alert on arrival) on any object (deepsea, shortsea, barge, feeder or rail) with a specific object name or voyage number. ECT can send an alert via SMS or e-mail.

4.4.1 Virtuele Haven

Virtuele Haven is a joint initiative of the ABN-AMRO bank, CMG information technology, trans-shipment company ECT and Port CommunITy Rotterdam, stimulator of above-company information technology in the port of Rotterdam. They are supported by the Erasmus University Rotterdam and Telematica Instituut. The project to investigate the Next Generation Internet (NGI) advantages for the Port of Rotterdam was started in June 2000. The project focuses on four areas of research:

- Next Generation Internet (NGI)
- Messaging
- Mobile access
- End-to-end security

For the purposes of e-collaboration between the members of the port community, a few collaboration models have been examined and studied. An extract of a brief description of the functionality of three e-collaboration models for the Virtuele Haven is given here. The models vary in technological sophistication and implementation challenges. The purpose of the models is to convey the range of opportunities for collaboration in the port community.

Bilateral Information Model (BIM). In this model information is exchanged directly between the different actors on a bilateral basis. This model is closest to the current situation, especially for the big companies in the Rotterdam port. Furthermore specific messages and confidential information is likely to be exchanged on a bilateral basis.

Centralised Information Model (CIM). In this model the data is stored at a central information service provider. Information can be retrieved from this central information service provider by trading partners that have the right to do so. This model has been worked out, since central storage of data is becoming more used in other sectors. It is especially interesting for SME's to connect to and some first (pilot) applications (like W@VE and Web-RODOS) in the Rotterdam port community, which are based on this model, appear successful in practice

Decentralized Information Model (DIM). In this model data is stored and controlled by each individual party. A broker service can help in retrieving the information from the right source. This third model has been chosen, since there is still a lot of resistance and fear among actors in the port community to share their data via a central service provider. Model DIM overcomes this fear by keeping data at the originator and connecting and synchronizing distributed databases (via bilateral information exchange) by sharing metadata at or via the broker service. Furthermore, via this model the deadlocks that may occur in the current message-push based situation can be overcome. The three models differ in how information is exchanged and who is responsible for storing data and providing information to the different parties.

Information Exchange

The focus is on XML based communication over the Internet between different parties in the port of Rotterdam.

The larger parties (e.g. container terminals and shipping lines) have been communicating via EDI for several years. These parties will gradually migrate to a situation where EDI-messages are exchanged via Virtual Private Networks over the (next generation) Internet as underlying infrastructure or EDI-messages are mapped into XML-messages via a middleware layer (model BIM). They migrate to XML communication from that perspective and have their focus on back office integration and transformation of data. XML will enable them to communicate with the thousands of SME companies active in the port. Furthermore they can act as a DIM, authorizing other business partners' access to their databases.

The smaller parties, however, have been communicating via paper, phone and fax and have a small office system or no automated system at all. They migrate to XML communication (almost) from scratch and have their focus on low-threshold solutions that enable them to communicate faster and less error prone with their partners in the port or Rotterdam. Usage of the CIM model is especially interesting for this group.

4.4.2 W@VE: A Port Community System in Rotterdam

Overview

W@ve is a web-based application that provides a communication medium between a shipping agent and an inland-carrier on one hand and between an inland-carrier and a terminal/depot on the other.

W@VE is based on the possibilities of combining EDI with the Internet and the World Wide Web. This is made possible by using the web browser without investing in EDI software. W@VE also offers the possibility to receive transport orders from the principal via Internet. The data from the transport order is used to produce a pre-notification message for the container terminal. This prevents a lot of unnecessary manual input by the road carrier. In 1999 a pilot has been launched with a number of container road carriers and their principals to test the possibilities of W@VE.

The basic idea about W@VE is to help the Inland Carrier (Haulier) in communicating electronically with the terminal and his principal (customer). The main purpose of W@VE is to make a pre-notification to the terminal where the inland carrier announces that he will bring or pick-up a container (see figure 8).

It is a service where transport companies can receive transport orders over the Internet and the transport company can send a pre-notification to the terminal (based on the transport order) and the terminal will react with a status notification.

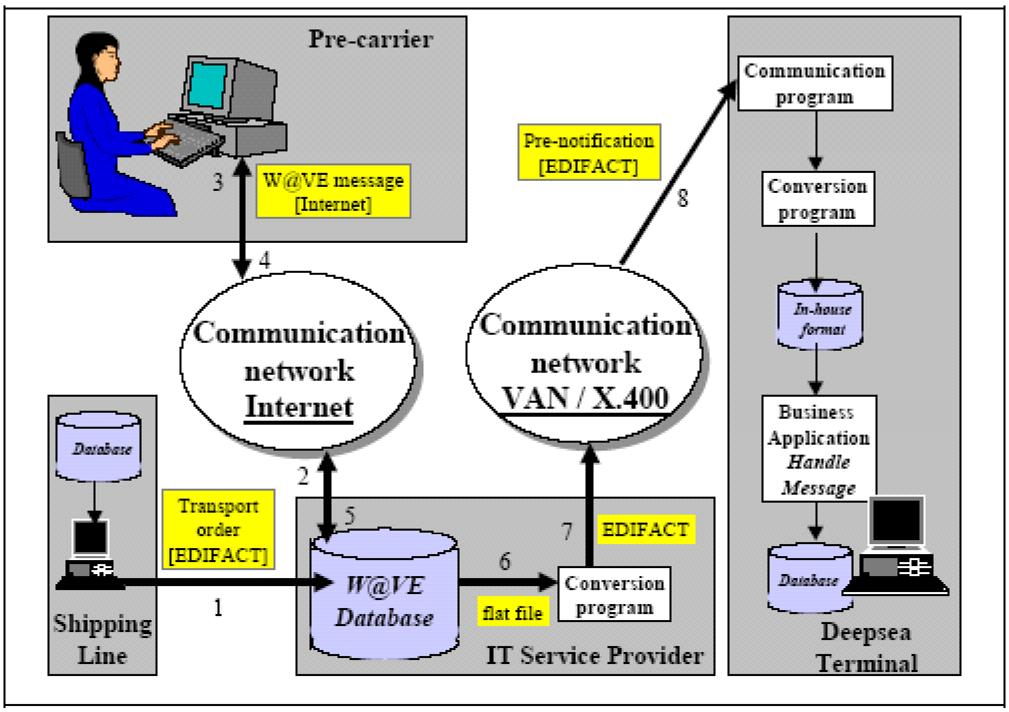


Figure 8 W@ve system architecture

Information Exchange

W@ve consists of Oracle PL/SQL-scripts that generate HTML and WML respectively. Data-access is covered by SQL-statements while the transport of the data to the business-logic of the application is done via cursors.

W@VE is based on a database, which is located at an IT service provider. Principals (a.o. liner-agents) send their transport orders in EDI-Land format to the W@VE database by EDI. This information is stored in the database. Via the web-application the road haulier can extract the information from the W@VE database and add some elements for the pre-notification. Next, this pre-notification is translated by the IT service provider into an EDIFACT message and sent to the terminal. The W@VE application also provides a direct link with the in-house system of the road haulier (the sender of the pre-notification). Files can be downloaded in XML format to W@VE. On the side of the receiver the W@VE pre-notification is received as a regular EDI-message.

4.5 Summary of Port Community Systems Features

Table 3 gives a brief summary of some of the features of the systems that were reviewed. Features available over the internet at the time the information was included in the report are considered. In this dynamic field, it is anticipated that additional services and features are becoming available by vendors and service providers.

Each of the systems presented above has a diverse set of features and is tailored to the needs of its users (both existing and potential ones) and the region it serves. Based on the review of these systems, the following section presents a conceptual system architecture for a generic system that could serve the needs of the New York – New Jersey region.

Table 3. A comparative evaluation* of features of some port community systems

	Feature	IAS	E-modal	SynchroMet	Virtuele Haven/ ECT	Voyager-Track
Regular Daily Operations Features	Scheduling Appointments	No	Yes	No	Yes	Yes
	Demurrage, Customs, Terminal Fees	No	Yes	No	No	Yes
	Container Status	No	Yes	No	Yes	Yes
	Conditions at port and terminal	No	Yes	No	No	Yes
	User fees	Volume based	Most features	Most features	No	No
Interchange Related Features	Interchange Opportunities	Yes	No	Yes	No	No
	Focus Community	Ocean Carriers	Truckers, Terminal Operators	Ocean carriers, (and in phase II Truckers)	Truckers, Terminal Operators	Truckers, Terminal Operators
	Information Technology – Integration	XML	FTP	ASP	XML-EDI	N/A
	Tracking Delivery Orders	No	Yes	Yes	No	No

* based only on information publicly available.
Note: This is not intended to be a comprehensive evaluation of the systems in question, but merely a summary of the information freely available on the Internet.

5 CONCEPTUAL SYSTEM ARCHITECTURE

Based on the review of user requirements and features of existing systems, this section proposes a conceptual system architecture. This architecture focuses on two major aspects, the physical level description and the information level description, as shown in figure 9. Each of these aspects is discussed in turn.

5.1 Physical Level

At the physical level, regulatory aspects, interchange functionality, security and financial aspects are considered.

5.1.1 Regulatory Aspects

There are a host of regulatory aspects that need to be considered for the VCY solution to be operationally viable so that it can meet its objectives.

Operational framework

As the asset-owners, ocean carriers have expressed reservations about losing control of their container inventory, and their fear that they might lose out on the loyalty of an existing customer in trying to optimize the container utilization. In order to address this aspect, it is important to lay down strict conditions for the users of the containers, and failure to abide by the conditions should attract due penalties to the users that will deter them from returning the containers later than the agreed time, or in a damaged condition. This is a way of meeting the concerns of the ocean carriers while at the same time trying to retain the full functionality and potential of the VCY.

A few ocean carriers have indicated that they might not like to share their inventory with trucking partners who are servicing smaller, competing ocean carriers. Other truck and ocean carriers have expressed a concern that details of their customers should not be revealed to their competitors either directly or indirectly. In order to accommodate this need, it is important to visualize in what circumstances the information regarding customer base may get revealed. The information aspects of this concern are addressed in the section on information security, but besides that there is a physical component such as visibility, or access. This also ties into the ideal location for an interchange between truckers, if the truckers are performing the interchange at the import customer's facility or at the export customer's facility. In such cases, to avoid competitive hassles to the greatest extent possible, the location for an interchange could be at any mutually agreeable location to all the parties, or simply at an external or neutral location. The other aspect with physical access is to allow ocean carriers the freedom to post restrictions on the VCY system with respect to who can use their containers. In cases where an ocean carrier is not comfortable or confident of sharing a container or information with a particular user, there must be an operationally secure way of ensuring that.

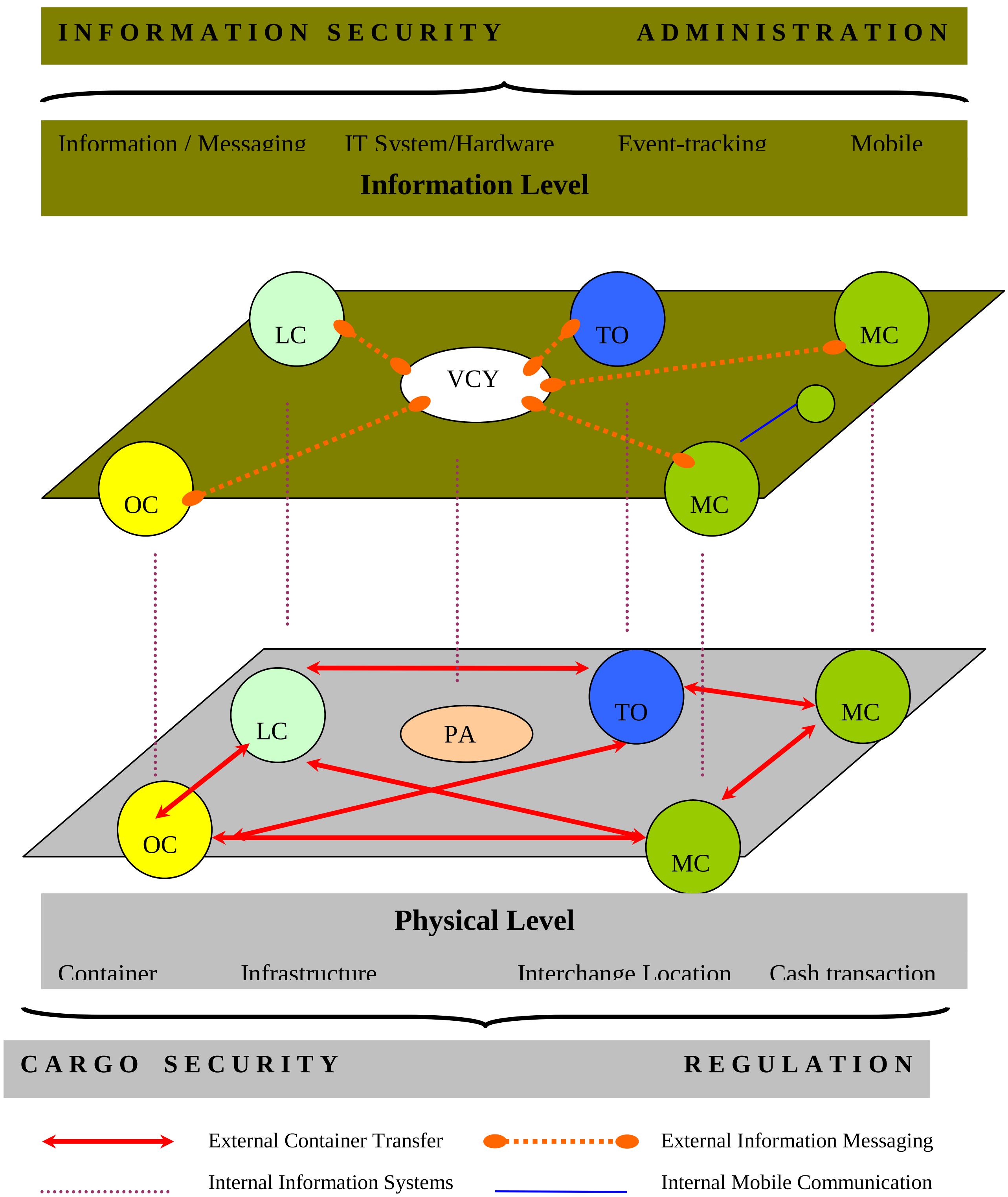


Figure 9 System Architecture - Physical and Information Level Description

Competitive Aspects

In order to make it more attractive, there should be very minor entry and exit barriers to enter the VCY system, so that the users have confidence and the flexibility to choose their levels of patronage of the system.

With regard to the concerns of “poaching” of customers, the VCY concept should have sufficient safeguards to ensure that the advantages of sharing information far outweigh any possible feared disadvantages.

5.1.2 Interchange functionality

An Equipment Interchange Report (EIR) is used by industry participants to document the condition of containers in order to establish responsibility for any ensuing container damages. This inspection is required at the point when a container is transferred from one party to another in the process of being transferred and routed for distribution. Terminal and depot gates are often the points used for inspecting the condition of containers whenever they are picked up or returned. Often terminal and depot operators, on behalf of ocean carriers, undertake the inspection and confirm container condition with the truck driver picking up or dropping off the container.

Now, with the VCY concept, the interchanges are likely to take place in the field without the presence of a third-party observer, such as an official from the terminal operator, as was the case earlier. In such a case, in order to ensure smooth transfer of responsibility and to avoid any potential disruptions or discontinuities in the daily operations of the truckers, the following will be helpful:

a. developing clear, unambiguous and objective inspection criteria to remove subjective evaluation and the concomitant disagreements on semantics or minor technicalities,

b. simplifying and standardizing the transfer procedures which are going to be performed by representatives of the two parties to the interchange. As illustrated in the conceptual representation in Fig.1, there are different kinds of containers transfers or interchanges that take place,

    i. between an Ocean Carrier (OC) or a Leasing Company (LC) and a Motor Carrier (MC)

    ii. between a Motor Carrier (MC) and a Terminal Operator (TO)

    iii. between an Ocean Carrier (OC) and a Leasing Company (LC) and

    iv. between two Motor Carriers (MC)

    Presently, all of the above interactions except (iv) take place in some form, and in fact the idea of the triangulation or “street turns” introduces the transfer between two Motor Carriers (MC) that really makes the concept of the VCY attractive

c. establishing the location and time frame for a container interchange is within the interchange agreement among the users of the VCY.

> While it is commonly imagined that this process would take place at the import customer facility where the container is emptied, and that the container could then be moved to a exporter for loading this procedure might be difficult to implement. One of the main concerns is that import customers are very unlikely to permit the second truck driver and truck onto their property to obtain the container due to security concerns, especially when the import customer will not receive any significant benefit after the interchange. An alternative location would be in a location owned by the one of the truckers, or at a neutral location, possibly even on the street.

It seems that considering all the factors of competition and feasibility for the street turns, any mutually agreeable location to the two truckers may be a good choice. Even then another issue remains, the time aspect. The time of the interchange is important because after the transfer, the free time must be reset for the new trucker. Besides, the time it takes for the interchange is also a factor to be considered, because any long delays due to disputes or ambiguous regulations or disagreements will hamper the usefulness of the VCY concept. During the time of the interchange, one trucker will have completed a delivery while another may be about to pick-up an export load. Obviously, the sense of urgency is bound to be higher for the trucker going to pick-up the export load, and if the other trucker does not cooperate, it can cause

Truckers are reluctant to reveal the identity, location, or business particulars of their customers to potential competitors (1). In the case of a street turn, the truckers might not like to expose details of their customers, and their locations to the other truckers. The first trucker would like to retrieve the empty container and park it in his own lot or at a neutral location (perhaps even on the street). The interchange inspection and paperwork would then take place away from the customer's facility.

5.1.3 Security Aspects

In the case of the physical interchange, the security aspect ties into the interchange functionality with regards to the partners involved and the location of the interchange. The threat to security is perceived to be either from the truck and the container on the import facility, or on the contrary the threat of security of the container after the interchange. although, this is not a very big concern, the security aspects need to be tightly framed in the regulations involving the physical process of container interchange.

5.1.4 Financial Aspects

The most fundamental financial concern is that of ***user fees***. If the system is to be operationally viable, and successful, it relies heavily on the patronage of the whole community of port users, and this in turn is based to a fair extent on each of these users judging whether or not, it is in their business interests to participate in such an initiative. A right balance must be struck between off-setting of the costs associated with the setting up of the VCY, commensurate with the expected benefits, and the need to attract users to the idea of the VCY, especially given that there is such a wide variety of demands, opinions and expectations from it. The amount of user fees, if any, must be reasonable and justifiable.

The other important financial aspect is the one dealing with ***per diem fees.*** On an important point such as this, which has many divided opinions, the judgment from the regulatory perspective on this issue has to take into account the reasoning behind each of the user's viewpoints. It is therefore, extremely critical, that at some point, a dialogue between the representatives of different stakeholders is made possible so as to bring together the diverging views on a table to orchestrate a most-acceptable solution.

Similar to the concerns about per diem fees, there needs to be clear, unambiguous accountability, change of ownership and equally important, tracking of the ***liabilities*** of the container transfer at all points during the export-import cycle. This may involve both paper work, internet based confirmations or a combination of both. The claims that might result due to ***insurance, damage and penalties*** on account of the physical interchange or the transaction associated with it, must be immediately addressed, and this requires a well-defined frame-work of rules and regulations.

Lastly, there needs to be a concerted effort to consider the ***financial viability*** of the VCY system, from the ***perspective of each stakeholder***. The worst thing to happen to a project of this nature would be a disparity in the potential benefits amounting to each stakeholder, as it will jeopardize the concept in total. Hence, the financial concerns of each group of users should be appreciated and a well-formulated, widely-acceptable solution must be developed that is ***equally attractive to all users***, and all the different classifications in each group of users.

5.2 Information Level

At the information level, the IT system, external messaging, information security, and internal mobile / wireless communication concepts are discussed.

5.2.1 IT System Concept

The IT system concept is broken down to consist of two distinct portions, namely the VCY IT System and the Users' IT Systems. The VCY IT system is intended to be a centralized repository or server that is external to all the IT Systems of all the users who provide information to the VCY System. In other words, if a third-party provides an IT system as a supply-demand matching tool for containers, that system is referred to as the VCY IT System. It is imagined that this VCY system will be hosted on a server outside of the IT systems of the users, and that the users IT systems will exchange information with the VCY IT system via the external messaging concept through means of the Internet.

VCY IT System Functionality

The primary functionality of the VCY IT System is that it should mirror the actual on field events so that a virtual copy of the real world interchange is available and real-time decisions about “street turns” can be made.

A few conceptual specifications are:

a. electronic tracking and recording of events (time, location, parties involved etc.) such as container interchange and returns, for issues of responsibility transfer

b. continuous online container tracking for asset visibility for the owner, as there are concerns among the ocean carriers that they may lose control over their assets once it leaves their hands or their partners’ hands.

An additional functionality of the VCY system must be that the users who are providing the information, must have control over what information is shared, as they cannot be expected to compromise their business interests. So the freedom to decide what information will be shared and for how long, must be given to the user. However, as an extreme case, if all the users were not to provide any valuable information, for fear of competition or security, then the VCY system will not function. The collective information being provided, therefore must be at least good enough to keep the system working even if a few users place restrictions on the information sharing from time-to-time. So, the information may either be “pushed” from the user’s IT system into the VCY system, or it may be pulled from the user's IT system with the user being able to place restrictions on the accessible portions of his IT system.

Again, the user has to be given freedom to permit or deny any interchange from taking place. The system should have the ability to track certain key events in the export-import cycle, so as to ensure complete visibility. Some of these important events could be

- Arrival of container at the marine terminal
- Notification to consignee and carrier, at arrival at inland depot, if any
- Delivery at consignee location
- Physical Interchange completed
- Pick-up at export consignor location
- Or decision to return empty to inland depot or port

User IT System Functionality

The major users of the VCY, such as the Ocean carriers, the truckers and the container leasing companies have varying degrees of internal IT system usage. While some large ocean carriers have fairly well established systems, and are already using the Internet and web-based portals to collaborate with their trucking partners and shippers (customers), there are some others who have very limited electronic collaboration with their partners. Among the truckers, the large trucking companies have invested in IT systems and some of them have bilateral collaboration with their partners, while some others do not have a well established

IT system. However, almost all of the users do access the Internet for sharing or obtaining information with their partners, and therefore, the Internet offers a good platform for enabling greater levels of collaboration such as required in the implementation of the VCY.

The ocean carriers and the container leasing companies are the primary sources of Information as they happen to be the owners of the containers, while the trucking companies are largely the information-receivers. Nevertheless, the truckers also provide information to the VCY that is crucial to the working of the system. A brief sample of the kind of information that may be provided by each user of the VCY is given in Table 4.

Table 4: Sample of Information that will be provided

Information Provider	Information
Ocean Carrier/ Container Leasing Company	Container Serial No.
	Container Type (e.g. Reefer)
	Container Specification (e.g. size)
	Restrictions on reuse – based on time, location, cargo type or user
	Return time and location
	Free time and per diem charges
	Container ownership
Motor Carrier or Trucker	Location
	Interchange time/location

The characteristics of the information that needs to be provided are critical to the success of the VCY concept, especially as some earlier collaborative systems have not been successful in their purpose due to lack of quality information that in turn led to poor patronage of the system. Some of the characteristics of the information provided are the following:

a. Accuracy
b. Usefulness
c. Real-time information

In the internal IT system of the users, there needs to be a compatibility in the data formats used by them internally with the data formats that are going to be used in the VCY IT System. As the users have varied systems with different data formats, the best way of ensuring compatibility is to define the VCY IT system in such a way that it can handle most types of data formats possible. This ties up to the messaging concept, which is addressed in the next section. Other requirements of the IT systems, such as secure access to the Internet of the users are very modest, but due attention must be paid to them also.

5.2.2 External Messaging Concept

The fundamental concept with the external messaging concept is the ***compatibility*** between the various enterprise IT systems of the users. The need for interconnectivity between the IT systems of the users cannot be overemphasized, as it forms the links that makes the VCY concept possible. In fact, if there were no uniformity or standards for external messaging between users, there will not be any form of electronic communication possible today in the first place. Along the same line of external compatibility is the concept of forward compatibility, which means compatibility between present day standards and future applications, so that past standards are not rendered obsolete.

Another important feature with respect to external messaging concept is ***scalability***, where the messaging system should be able to handle an increase in the volume of messaging. This may be an in-built capacity of the system after determining the expected volumes of messages or the system should be able to easily add to existing capacity as the need for it becomes predominant.

Speed of the messaging system is central to the success of the VCY concept, and the messaging should be as fast as possible, in order to ensure real-time communication. However, there may be a trade-off between the speed of the messaging and the ***cost*** incurred due to improve the speed of the messaging. Broadly, it may be said that any speed that enables real-time communication within an acceptable range of time should be sufficient, and additional speed gained over and above this does not really offer value for the additional costs incurred.

Another aspect that is also important is the ***robustness*** of the messaging system, which is the ability of the messaging system to perform correctly across a wide-range of acceptable operating conditions, and to fail with adequate warning and without causing any damage to the system outside the range of those acceptable operating conditions. This applies to the network of the messaging system at large, and also to the messaging standard.

Additionally, ***security*** of the messaging system is a inviolable requirement and it is addressed in the next section on information security architecture.

5.2.3 Information Security Concept

In the above representation of the VCY system conceptualization, there are three areas in the information layer where the security architecture needs to concentrate.

The first is the security at the user end, where the Internal IT system of the user needs to be secure against forbidden external access. Each user reserves the right to share as much information as he deems appropriate, within the overall regulatory framework so that the functionality of the VCY is not hampered. This means that each user needs to determine the information that he wants to share, and should push it to the VCY, so that the internal IT system of each user is secure. This requires that the system guarantees that access to the system features, shall be available only to authorized users, by way of individual account.

Further, the second area of security is the link or the External Information Messaging between the user and the VCY, that cannot be compromised, and the information is not modified or accessed by agents external to the VCY system. This means that the messages must be completely encrypted to ensure a high level of confidentiality and security; it is recommended that a long key with 128-bit key be used as a minimum.

And lastly, the most crucial area of information security is the integrity of the information within the VCY. The core of the VCY IT system must be secure so that information is not accessible by other users, except as permitted. Not all users should be allowed access to all the information in the system. As much as relevant and reliable information is beneficial to the users, in the light of competitive concerns, it must also be noted that any information that is available in excess of a user's requirement from the VCY could possibly be abused, or be utilized in a manner that is counter-productive to the objectives of the VCY.

5.2.4 Internal Mobile/ wireless Communication Concept

The primary communication using mobile/wireless technologies is intended to be between the Virtual Container Yard and the driver on the field, either directly or indirectly via the motor carrier's office. This concept needs to be relatively inexpensive, in terms of additional investment for the truckers/ motor carriers, in addition to offering reliable and instant communication, which are the pillars on which the success of the “street turns” concept.

There are several wireless technologies that are well established, and a significant percentage of motor carriers have employed various technologies to facilitate communication to the driver on the field, or on the road. While advanced technologies like satellite-based communication such as GPRS or on-board computers are still relatively expensive, text messaging, paging and mobile telephony are the more inexpensive and popular ways of communicating with the drivers.

Recent studies have shown that 65% of respondents interviewed were utilizing wireless technology to communicate with drivers on the field, and 50% were utilizing it for route optimization and scheduling. Further, they revealed that over 49% of respondents interviewed were investing in wireless and mobile technology to improve internal efficiencies by better route management and lower fuel costs, while 39% were doing it for improved customer service. Most common among these wireless technologies currently in use is text messaging by cellular/mobile phones, with over 66% favorably using it. The next most favoured technology was paging with over 33% using it, followed by mobile phone with satellite-enabled solutions, such as GPRS being used by close to 25%. Regular mobile phone with voice was employed by 11% and in-cab computer was used by 14%, and surprisingly 15% respondents are not communicating with drivers on the field at all. This trend shows that text messaging may be the best way of communicating with the drivers, as it is relatively inexpensive among the current technologies.

The use and functionality of a VCY system as well as the needs of various users have been presented so far. To evaluate the potential benefits of a VCY system, the next section presents a model VCY which is used to test and evaluate various scenarios.

6 VCY SYSTEM MODEL

In this section we evaluate the potential benefits of a VCY under different market conditions. The analytical formulation and the simulation model that have been developed capture the essential features of such an implementation. The results for different scenarios of input parameters, system environments and practical constraints are presented and analyzed.

6.1 Modeling Approach and System Description

An analytical formulation to evaluate the impact of a VCY is presented. The fundamental quantifiable benefit from the VCY system is the reduction of the total vehicle miles traveled (VMT), as well as other benefits, including direct and indirect cost savings, or reduced emissions and secondary benefits, which are based on the reduction in the total vehicle miles traveled. The emphasis on the estimation of the vehicle miles traveled, for both empty and loaded truck trips, as the primary metric for analyzing the efficacy of the virtual container yard distinguishes this effort from other similar efforts undertaken to simulate freight logistics. The model involves all the major players in freight logistics at the port, namely, the ocean carriers, the truckers, the importers and exporters and the Port Authority.

First, the basic formulation of the physical network of the model by means of the locations of the import and export sites, as they are distributed in the regions around the port is presented. A coordinate system in which the port is aptly chosen to be at the center or the origin is employed. Then, the different groups of entities such as ocean carriers, truckers, importers, exporters and most importantly, the containers or boxes are defined. Subsequently, a set of interactions between the entities based on which the VCY system will be woven around is established. Each importer or exporter is associated with a set of ocean carriers who do business with them. In turn, the set of truckers that are associated with each ocean carrier is defined, with no specific restrictions that make a given trucker exclusive to one or a few particular ocean carriers. Finally, the set of containers including the characteristics of each, such as the owner, and the current location and status is also defined. In this simulation model, it is assumed that all the containers are owned by the ocean carriers. This assumption helps simplify the simulation without necessarily impacting the results one way or the other.

The problem is treated as a single commodity problem, involving one type of containers to be interchanged, although the same approach can be extended to capture the multicommodity problem of various container types. Chassis are assumed to follow container, an assumption which is considered to be realistic in view of the latest developments in establishing cooperative chassis pools. Demand was considered deterministic, although the problem formulation and the simulation allow for consideration of stochastic demand. The multicommodity and stochastic nature of the problem and a detailed description of the simulation model are presented in Theofanis et. al, 2007 (*16*)

6.2 Notation

Variables

V_i the node i, i = 0 to I;

in particular,

V_0 the node representing the port

A_{ij} the arc connecting node V_i and V_j

d_{ij} distance between the nodes V_i and V_j along a route permitted for use by trucks

C_n container or box number n, n=1 to N

U_x ocean carrier x, x=1 to X

t time period of simulation, t=1 to T

z_{tj} =1, if there is an export demand at node j at time period t,

=0 otherwise.

p_{tj} the final overseas destination of the export demand generated at time t at node V_j

w_{ni} = 1, if container C_n is delivered at the import node V_i,

= 0, otherwise.

s_{nij} = 1, if container C_n is interchanged at import site V_i and goes to export site V_j., and = 0, otherwise.

Sets

α_t {($C_{n,}$ i) / At time period t, C_n is available for interchange at node i), i.e., the set of all ordered pairs ($C_{n,}$ i) of all containers available and their current node locations.

β_x the set of all final overseas destinations permitted by ocean carrier U_x for interchanges on containers owned by U_x

Functions

$\Sigma(V_i)$ = the ocean carrier who exclusively serves node V_i

$\Omega(C_n)$ = the ocean carrier who owns container C_n

$\Pi(U_{x,} U_y) = 1$, if ocean carrier U_x and ocean carrier U_y collaborate in sharing containers

= 0, otherwise.

6.3 Analytical Model formulation

Let **G (*V_i*, *A_{ij}*)** describe the network of import and export sites around the port completely, where, The total Vehicle Miles Traveled (VMT) in a day, is given by

$$M = \sum_{n=1}^{N}((\sum_{i-1}^{I} d_{oi} * w_{ni} + \sum_{i=1}^{I}\sum_{j=1}^{J} d_{io} * w_{ni} * (1 - s_{nij})) + \sum_{i=1}^{I}\sum_{j=1}^{J} d_{ij} * s_{nij} + \sum_{i=1}^{I}\sum_{j=1}^{J} d_{jo} * s_{nij})$$

where the first term corresponds to the total miles traveled from the port to the importers facility; the second term corresponds to the empty return-trip miles to the port made by trucks without an interchange match; the third term corresponds to the empty vehicle miles traveled during the street-turn between the importers facility and the exporter's facility; and the last term corresponds to the miles traveled in bringing the export load back to the port.

Therefore, the sum of the second and third terms gives us the total empty vehicle miles traveled.

Where,

$$d_{ij} = \min_{(C_n, k) \in \alpha_t} (d_{kj})$$

subject to the following constraints,

1.Conservation of container flow at export site V_j,

$$\text{Export Demand at site } j = \sum_{n=1}^{N}\sum_{j=1}^{J} w_{nj} - \sum_{n=1}^{N}\sum_{j=1}^{J}\sum_{k=1}^{K} s_{njk} + \sum_{n=1}^{N}\sum_{k=1}^{K}\sum_{j=1}^{J} s_{nkj}$$

2. Conservation of container flow at import site V_i

$$\text{Import Demand at site i} = \sum_{n=1}^{N} w_{ni}$$

3. s_{nij} =1 if and only if

$\Sigma(V_j) = \Omega(C_n)$

or

$\Sigma(V_j) = U_y$ ***and*** $\Pi(\Omega(C_n), U_y) = 1$)

and

$p_{tj} \in \beta_{\Omega\,(Cn)}$

The above is the basic formulation for the general case of partial collaboration. In addition, under the three scenarios we have considered, i.e, complete collaboration; partial collaboration, and no collaboration, we will impose the following additional constraints:

Scenario 1: Complete collaboration

Under this scenario, all the ocean carriers are collaborating completely, and therefore, we have

$\Pi(U_x, U_y) = 1$ for all U_x, U_y

Scenario 2: Partial collaboration:

Only those ocean carriers who are collaborating with each other will share containers together, as laid out in the general formulation, namely,

$\Pi(U_x, U_y) = 1$, if ocean carrier U_x and ocean carrier U_y collaborate in sharing containers

= 0, otherwise.

<u>Scenario 3: No-collaboration condition:</u>

This is the same as the current as-is scenario, in which there is no collaboration at all between any two ocean carriers. This can be expressed as,

$\Pi(U_{x,} U_y) = 0$ for all $U_{x,} U_y$

Under this condition, no interchange takes place in the system.

6.4 Simulation Modeling

Seeking a closed-form analytical solution the formulation presented above cannot capture adequately the dynamic nature of the problem. Therefore a simulation model was developed to cope with the nature of the VCY operation and the estimation of the interchanges expected to be realized.

The simulation model estimates the vehicle miles traveled, split by empty and non-empty trips, and provides a quantitative perspective on the percentage of successful container interchanges as a fraction of the total number of containers going through the system. Further, this detailed view of the likely internal functioning of the virtual container yard system, allows us to better understand the differences in the environment. For instance, comparing and contrasting between the environment where all the port players are collaborating with each other, with the more likely scenario where some groups of port players are willing to share containers and information amongst themselves, might give an indication of the relative quantity of VMT reductions that could be generated in the former scenario.

Also, this level of detail on the specific internal dynamics in the Virtual Container Yard system helps us place constraints on the container type, or container's final overseas destination, and foresee the impacts that they may have.

The simulation performed is of dynamic nature that continually updates the location and status parameters of all the containers in the Virtual Container Yard system for every period. The simulation was run based on a C program expressly developed for this purpose, on a Windows XP operating platform in an Intel Pentium 2.7 GHz processor.

The different combinations (Input Cases A,B,C) of input parameters considered are as follows:

Total volume of containers = 5,000; 10,000 and 15,000.

Further within each case, we examine the effect of having 30,50 or 100 nodes.

The total volume of containers per day includes all empty and loaded containers, either counted while leaving the port or entering the port, not both.

The different virtual container yard system scenarios are as follows:

1) No collaboration between any ocean carriers outside their own group of truckers, (current condition without a VCY).

2) Groups of ocean carriers collaborate with their respective pools of truckers on collaborating and sharing containers; this specific example considers 5 groups of 3,3,2,1 and 1 collaborating ocean carriers each.
3) All the ocean carriers and truckers participate with collaboration and sharing of containers with all the parties involved.

Furthermore, the impacts of the constraint pertinent to the restriction placed on the final overseas destination prior to sharing a container are taken into account. This condition assumes significance because in reality, if a large percent of imports to the U.S originate from a particular geographic region, such as China, the ocean carriers may see greater economic incentives to collaborate by sharing information and containers with a set of ocean carriers, as that will also make their empty repositioning efforts more efficient. Therefore, for instance, an ocean carrier with a large percentage of volumes on the Trans-Pacific route may impose a condition that the container to be shared with others may only have China as its final overseas destination.

The model for the simulation was set up with a network distribution of warehouses such that 30 percent of the export and import sites were within a radius of 25 miles from the port, 60 percent between 25 and 70 miles and the remaining 10 percent beyond 70 miles. Also, each site was specifically designated as an import warehouse or an export warehouse, and in all three different input cases considered the ratio of import to export sites is kept the same, around 0.42.

For purposes of this simulation, a period was defined to be 4 minutes, keeping in mind both the accuracy in estimating the vehicle miles traveled and the number of periods that need to be simulated for computational efficiency. The information assimilated by the VCY simulation model during every period is put together once every 5 periods, or 20 minutes to look for potential matching opportunities between empty import containers and export loads, subject to the restrictions placed on the container characteristics, the exporter and the ocean carrier.

Each simulation was run until the completion of one 12-hour day of simulation, or until the container volume for the particular case, as either 5000, 10000 or 15000 was satisfied, whichever is later. The average of 20 different simulation runs, each representing a day's operation, was calculated, and the results are tabulated below:

6.5 Simulation Results

Simulation results are presented below:

Table 5: Comparison of VMT results

Volume	Nodes	Base case		Partial collaboration		Full collaboration	
		Total VMT	Empty VMT	Total VMT	Empty VMT	Total VMT	Empty VMT
5000	30	445,623	202,348	432,956	187,915	435,822	188,250
	50	448,193	211,235	436,153	186,124	468,159	201,043
	100	475,147	215,216	462,011	195,580	437,999	183,366
10000	30	930,147	433,178	948,344	415,416	786,505	358,256
	50	869,992	431,113	858,905	389,588	901,500	401,178
	100	986,269	452,652	941,306	431,633	890,579	384,110
15000	30	1,183,223	548,315	1,017,785	466,430	1,070,505	487,035
	50	1,016,253	499,034	941,306	431,633	1,085,285	484,590
	100	1,214,327	566,235	1,068,130	484,056	1,092,630	474,283

Table 6: Comparison of Interchange percentage results

Volume	Nodes	Base case	Partial collab.	Full collab.
5000	30	0	2.07	2.65
	50	0	3.43	3.81
	100	0	7.47	7.89
10000	30	0	3.46	4.1
	50	0	5.47	6.36
	100	0	14.12	14.52
15000	30	0	4.08	5.13
	50	0	7.55	7.87
	100	0	15.07	15.39

It can be easily observed from Table 5 that, in the case of the as-is scenario, without a VCY implementation, there is no interchange taking place, although in practice existing ad hoc container street turns are reportedly around 2% of the total container traffic. The empty VMT for Case A with 5000 containers and no-collaboration is 73,963 miles more than the case with a partial collaboration between the 10 ocean carriers into groups of 3, 3, 2, 1 and 1 each. These savings are derived in a reduced scale simulation, which considers only a volume of 5000 containers with 10 ocean carriers and 30 facility locations. The potential savings could therefore be significantly higher than these estimates for an actual implementation. If the container volume is increased to 10000 without a corresponding increase in the number of nodes or ocean carriers, as in Case B, the benefit of partial collaboration over no-collaboration is reduced to only 19,453 miles, still, however, significant. The percentage of containers interchanged, in this case, decreases from 3.79 in Case A to 2.05 in Case B. It is therefore an indication that the number of opportunities for interchanges is dependent not only on the container volumes, but also on the number of export and import sites. In

Case C, in which not only the number of boxes, but also the number of export and import sites increases, the percentage of containers interchanged, increases as well. In terms of total VMT, it is derived that the benefits of the partial collaboration condition over no collaboration in Case A is expressed by significant reduction in VMT (57,170 miles as compared to 77,903 miles in Case B). This may be explained on the basis of the fact that even though we have a smaller percentage of interchanges, there are more containers in circulation for the same number of export sites.

This reinforces the importance of ensuring a good fit between the container volumes, number of export and import sites, along with the number of ocean carriers, which play a decisive role in determining the percentage of successful interchanges, while simultaneously maximizing the benefits in the total and empty VMTs. It is also interesting to note how for the same volumes as Case B, a complete collaboration condition instead of partial collaboration is ensured, an increased percentage of interchanges from 2.05% to 2.88% is attained, owing to the fact that many more interchanges are made possible due to removal of restrictions based on the collaboration groups. Case C is better than Case B for the same set of scenarios, either scenario 1 or scenario 2, due to the fact that more export and import locations are available, increasing the potential for interchange opportunities. Furthermore, under the same input parameters, either for Case B or Case C, scenario 1 is obviously better than scenario 2. Scenario 1 is an ideal case, in which all ocean carriers and their truckers collaborate and can be used as a basis to measure the full exploitation potential case.

In Table 6, the results for scenario 2, partial collaboration, from introducing an additional constraint at the time of the interchange are presented. This constraint forces only containers that are destined to a particular overseas destination out of the possible five to be allowed for an interchange. This situation is also practically quite realistic, as already mentioned, and expectedly, a sharp decrease in the interchange percentage across all the three cases takes place, showing that the constraint introduced is a very strict one. It is also interesting to note that an increase of close to 20 percent in the total VMTs is introduced in Case C, and close to 9 percent in Case B, compared to the respective, unrestricted cases in table 5.

The modeling and simulation approach presented herein and the associated results show a promising picture and give a rough estimate of the benefits that can be gained from a well orchestrated, well accepted and well implemented VCY system. The results from the simulation study provide a good indication of the anticipated benefits and can assist in designing a successful system, under a given environment at the port. Taking into account the fact that current business practices of ocean carriers do not permit the complete collaboration scenario, it is evident that a VCY has a better potential to be initiated and implemented on the basis of partial collaboration. The simulation results for the partial collaboration scenario look encouraging. Furthermore, the fact that established collaborations among groups of carriers exist on other business aspects, increases the expectation for potential success of a VCY system.

The following sections discuss the business and financial models that would render the full scale implementation of a VCY viable.

7 SYSTEM GOVERNANCE STRUCTURE

Resource sharing systems and platforms need a viable and comprehensive set up of a development, implementation and operation governance structure. Experience gained so far leads to the conclusion that most failures can at least be partly explained through weak project governance and limited partner participation. Therefore developing a clear and viable proposal for project and system governance, as well as finding potential partners to share their participation in the system is an integral part of the VCY feasibility study.

Experience drawn from the successful track of the Ocean Shipping Portals can be elaborated and used accordingly. Two extreme models of VCY Governance are considered and further discussed regarding their functions and relative merits.

In the first model the Service Provider is the System Vendor and the Port Authority acts as a System Regulator and Business Facilitator. The System Vendor takes the risk of establishing the business with the initial business facilitator and financial support of the Port Authority. As soon as the System becomes financially self sustained and depending on the contractual arrangements, the Port Authority limits its role in monitoring the efficiency of the System. A Monitoring Board consisting of representatives of stakeholders involved directly or indirectly, and/or beneficiaries, will assist in monitoring operational effectiveness and anticipated benefits of the System. The Monitoring Board indicatively will consist of representatives of Ocean Carriers, Motor Carriers, Container Leasing Companies, Shippers, Depot Operators, Local Communities, MPOs and Agencies such as TRANSCOM and Turnpike Authority. Goups like the I-95 Coalition can also participate and provide their input regarding the spill over effect of the initiative, if any, to a wider area. The Monitoring Board will have only advisory function regarding System functionality and effectiveness and at the same time will act as an outreach vehicle both to prospective business partners and System indirect beneficiaries. The Port Authority will be the sole body responsible in monitoring Vendor's compliance with contractual arrangements. The unique institutional structure of the PANYNJ as developer and operator of a wide spectrum of transportation infrastructure in the area provides an additional strong advantage in fulfilling the function of System facilitator and regulator.

In the second model, the VCY is somewhat considered as a part of the port's Management Information System, or as an extension of the System. In that case and since System's financial self viability and autonomy are considered as decisive factors in fulfilling System's objectives, a Special Purpose Vehicle (SPV) is established with the participation of the Port Authority and the Vendor. Again a Monitoring Board, consisting of the same participants as in the first model, will provide advisory and outreach functions. Terms pertinent to the establishment of the SPV will provide for financial support at the initial stage of the System operation.

Since in the long run the VCY is considered to be a purely business activity and neutrality as well as trustfulness for the System is considered of utmost importance for the potential partner/users to register and use it, we consider that the first Governance model is more robust and flexible for the System to be established and become successful.

8 FINANCIAL ANALYSIS

The basic formulation of the financing alternatives for the VCY may be based in terns of the following costs and earnings:

Costs:

1. Capital Investment
2. Annual Operating cost
3. Annual Maintenance Cost

Investment contributions:

The assumption is that the vendor will operate the system, and therefore will bear the entire maintenance and operating costs. For the Capital investment, on the other hand, we could have a few alternatives, such as:

a. the Port Authority paying a percentage of the Capital and the Vendor paying the rest
b. the Vendor paying the Capital cost excluding the Installation/ Access Fee
c. the Vendor paying the total Capital cost, including the Installation/Access Fee

Revenues:

On the earnings side, we could broadly consider a case where the earnings do not pay for the entire costs invested into the system, or alternatively, a case in which the investments may be fully recovered by the earnings.

The users of the VCY system, primarily the truckers, will pay for their use of the system in one of the following arrangements:

1. By means of an annual fee per user.
2. By means of a fee per transaction. A proper definition of a transaction will have to be agreed upon, so as to clarify if the user pays for a fee when s/he accepts a container, or while sharing container info with other users, or both.
3. A hybrid arrangement where the user pays an annual fee and also a transaction fee, depending on his preferred combination of the two.

In order to understand the feasibility and total benefits of the VCY concept, aside from purely financial considerations such as the acceptable returns on investment, we also have to consider the potential economic benefits due to the reduction in the VMT, emissions and congestion that accrue to the community at large.

However, by means of an Economic Modeling Tool (described briefly in the next section), we model only the direct financial considerations relating to the different investments, investment scenarios, investment recovery periods and fee structures. The estimation of the potential benefits due to reduction in VMTs, emissions, congestion etc. are out of scope of this Tool and are addressed elsewhere in the project report.

Economic Modeling Tool

This modeling tool enables us to perform two kinds of analysis:

1. Fee Estimation Analysis and
2. Volume Estimation Analysis

In the first case of Fee Estimation we estimate the fees that would need to be paid by the user under each of the different fee structures, given :

1. the time-period within which the investment is set to be recovered,
2. the average annual volume of interchanges or transactions. In this case two options are considered:
    a. the number of interchanges is equal to the number of transactions, in which case either the transferring party or the accepting party pays the fee.
    b. the number of transactions is twice the number of interchanges, as both parties involved in an interchange pay the fees.
3. the average annual number of fee-paying users in the system.

In the second kind of analysis, i.e Volume Estimation, we estimate the minimum number of users and interchanges that would be needed in order to sustain the system at a desired level of profitability under a given fee structure and profile of user fee scheme preferences. In this case, the information provided into the system includes:

1. the time-period within which the investment is set to be recovered.
2. percentage split of all users of the system between the different user-fee schemes.
3. the details of the user-fees for each of these schemes, and
4. the desired policy for revenue generation. This policy estimates what percentage of income is expected to be realized trough each of the fee schemes, so that appropriate strategies such as incentives, promotions and discounts may be offered.

In the following pages, a brief explanation of the Economic Modeling Tool is provided:

8.1 Fee Estimation Analysis

The input module of the tool has 3 sections, Costs, Percentages and the Time-frame. In the costs section, first we enter the Capital investment required, followed by the estimated annual operating costs and maintenance costs. In the Percentages section we input the percentage contribution of the Vendor to the

Capital Investment, as opposed to the percentage contributed by the Port Authority. In the next field, we enter the percentage of the investment that the vendor is aiming to recover within a given time-period. The next field includes the Profit margin as a percentage. In the Time frame section we select the closest period of time by which the investment is expected to be recovered by the Vendor. Depending on the time period of recovery selected, the fees are estimated. A screenshot of the tool from an example application is shown in figure 10.

In this example we assume a $1.5 million investment with annual operating cost of $100,000 and annual maintenance cost of $20,000. The vendor invests 80%, and expects 100% recovery with a profit margin of 10% to accrue in a 7-year period.

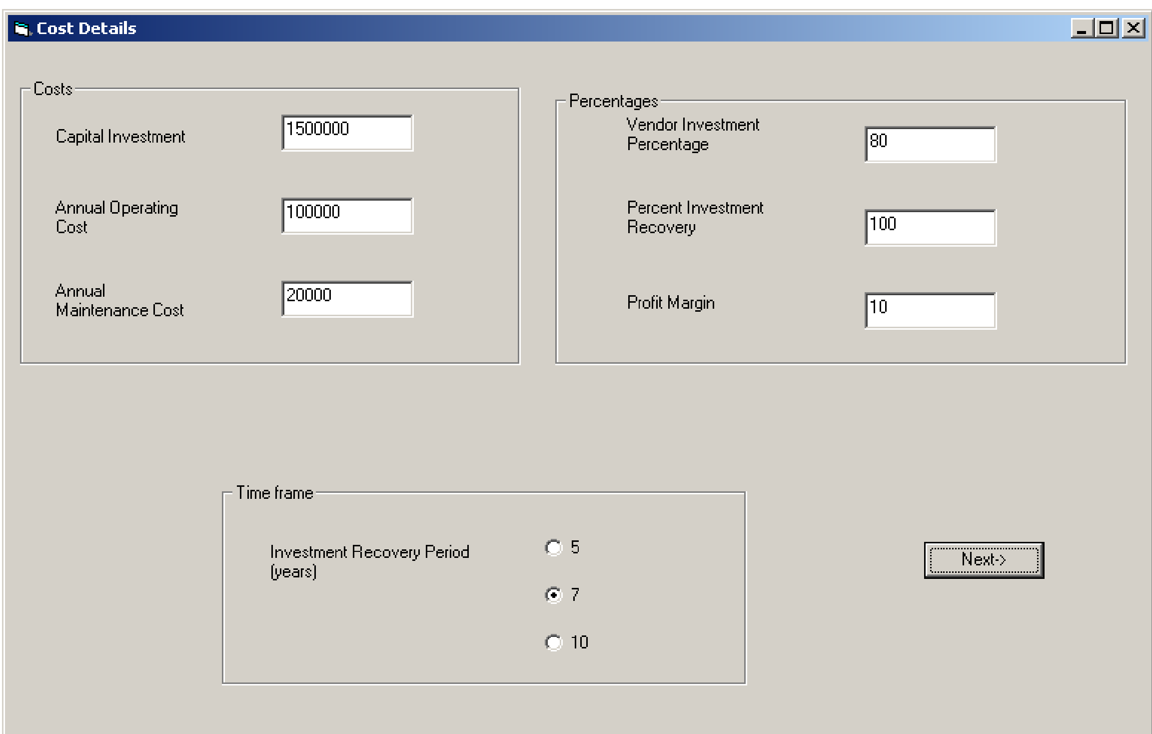


Figure 10 Input screen with example data for Fee Estimation Analysis

The second screen has 3 sections, Volumes, Fee options, and Output. The Volumes section requires two inputs on the volume of interchanges expected, and the volume of fee-paying user patronage of the system.

Figure 11 shows that if, for example, the annual average number of interchanges in the 7-year period is 50,000 per year, with an average of 140 users, an annual fee of $2064 in the first year, incrementally increasing to $2250 in the 7th year is estimated, under normal assumed rates of inflation of 4% and money-value discount rate of 6%.

In the Fee Options section, as was discussed earlier, there are three options for the user to select from:

a. annual fee
b. per transaction fee
c. hybrid fee

Figure 11 shows the output for the annual fee option.

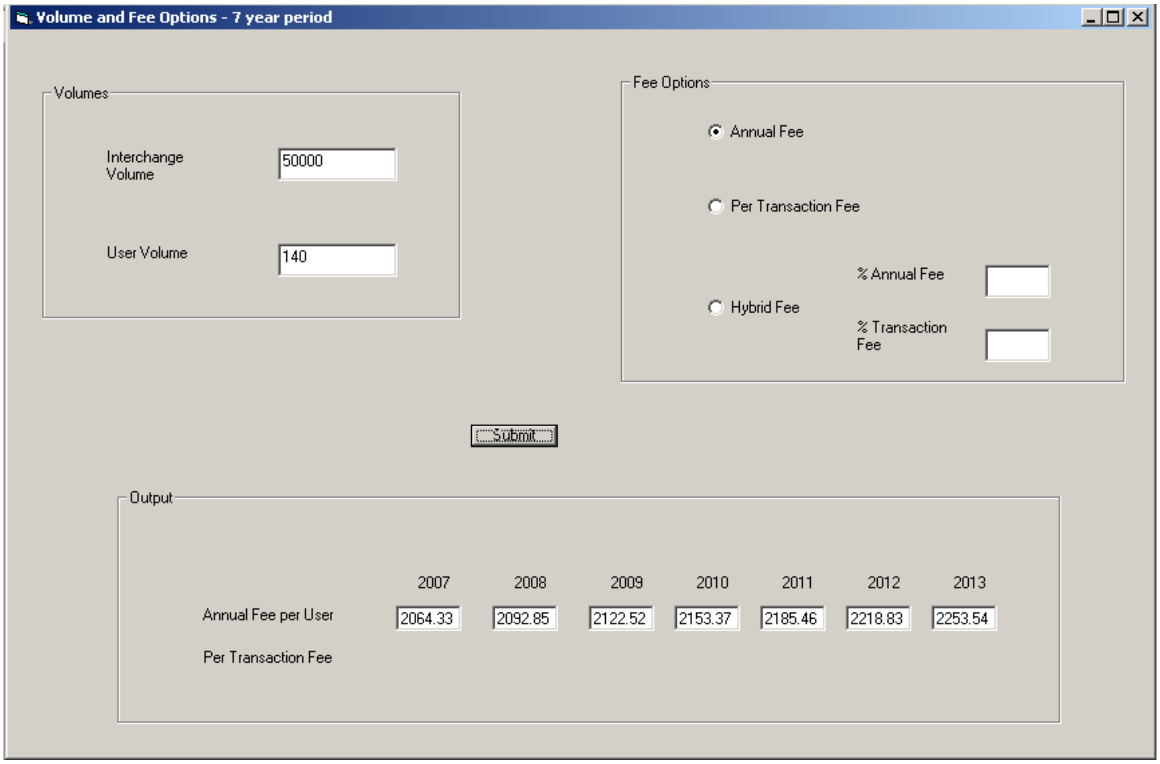


Figure 11 Example Annual Fee per user in Fee Estimation Analysis

Figure 12 shows the results for the per transaction fee option.

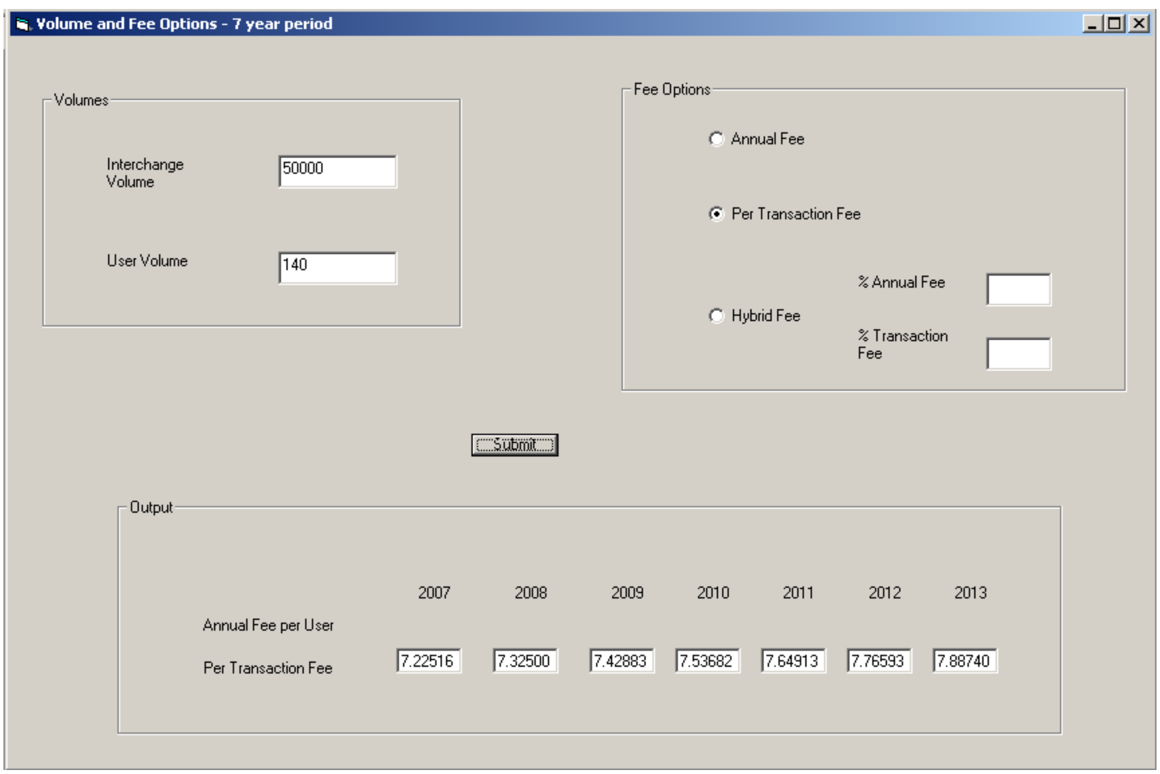


Figure 12 Example Per Transaction Fee in Fee Estimation Analysis

We consider one transaction as equivalent to one interchange. The fee per transaction of $7.2 that will be paid by either one of the parties or will be split between the two parties of the interchange, will increases to $7.8 at the end of 7 years.

Figure 13 shows results for the hybrid case, with a selected annual payment of 40% and a per-transaction component of 60%.

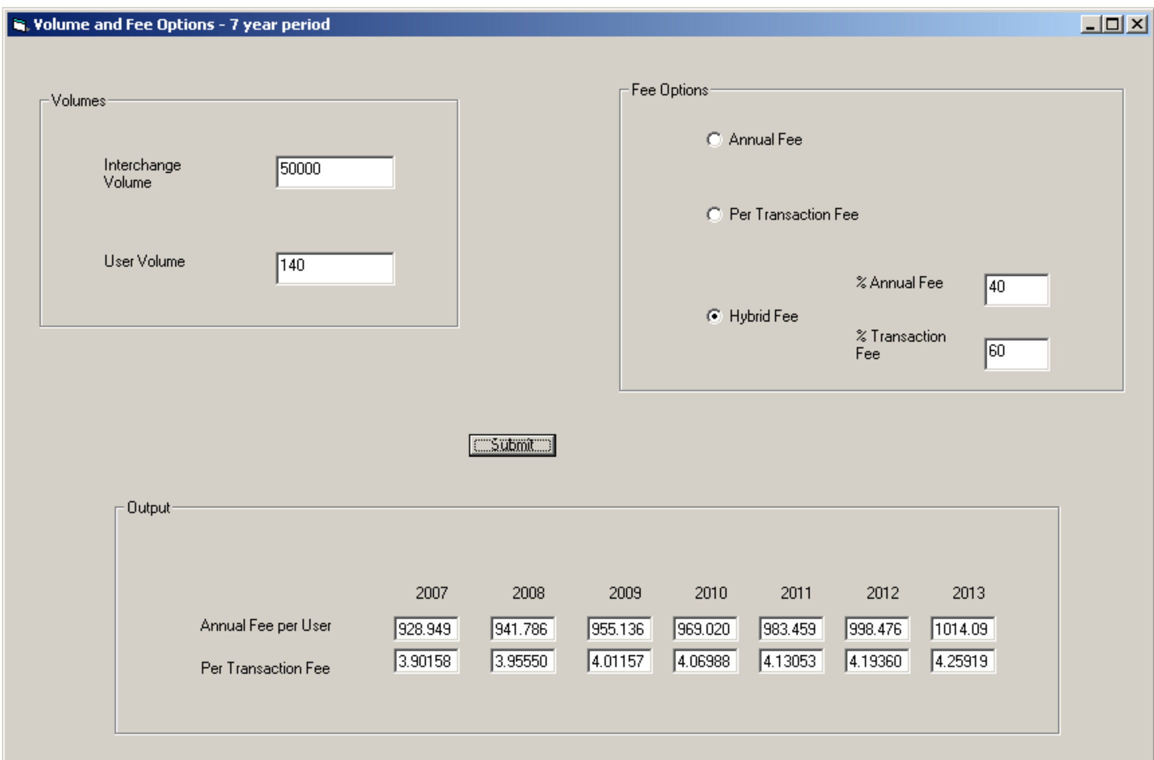


Figure 13 Example Hybrid Fees in Fee Estimation Analysis

In this case we have a combination of an annual fee of $928 and a transaction fee of $3.9 during the first year, which increase to $1014 and $4.26 respectively, in year 7.

8.2 Volume Estimation Analysis

In the case of the Volume Estimation Analysis, we estimate the volume of users and transactions needed to sustain a given fee structure. Figure 14 shows the input screen of the Volume Estimation Analysis module.

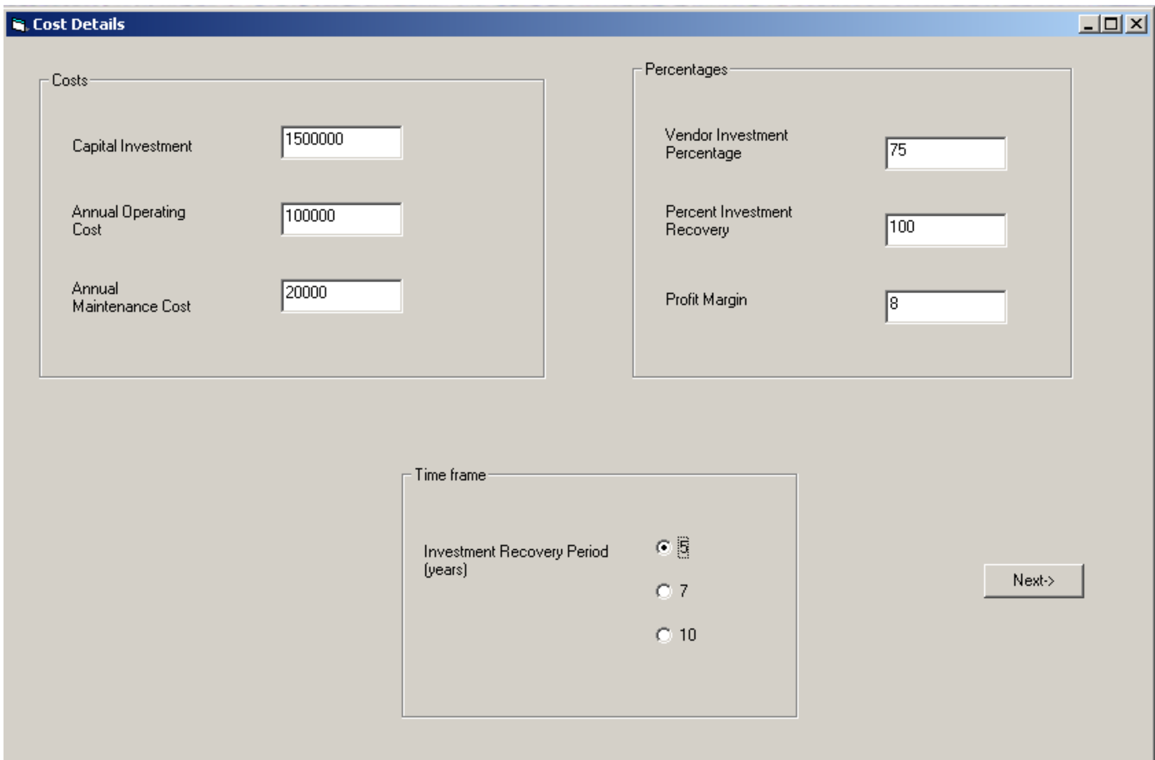


Figure 14 Input screen with example data for Volume Estimation Analysis

In this case, an investment of $1.5 million with $100,000 annual operating and $20, 000 annual maintenance expenses are given. The vendor invests 75% and recovers the entire 100% of it at a profit of 8% in 5 years.

In the next form, shown in figure 15, we have 3 sections: Estimates, Fee structure, Revenue Policy. In the Estimates section, we enter an anticipated profile of the users. The first field contains the percentage of users who are expected to pay annual fees, the second field contains the percentage of users who are likely to pay transaction fees, and the third field shows the percentage of hybrid fee users. At the bottom left of the screen, a fourth field indicates the average annual number of transactions per user.

The Fee structure section gives the details of the fees that are paid by different users in each of the fee schemes. The first field shows the annual fee to be paid by each user, and the second shows the per-transaction fee. For the Hybrid Annual fee we enter the percentage of the total annual fee option. Based on this percentage, the hybrid annual and the hybrid transaction fee are automatically calculated.

In the third section on Revenue Policy, we have the percentage of planned income from Annual Fee, and from Transaction fee. These percentages determine the revenue source and help in analyzing different policies for maximizing revenue.

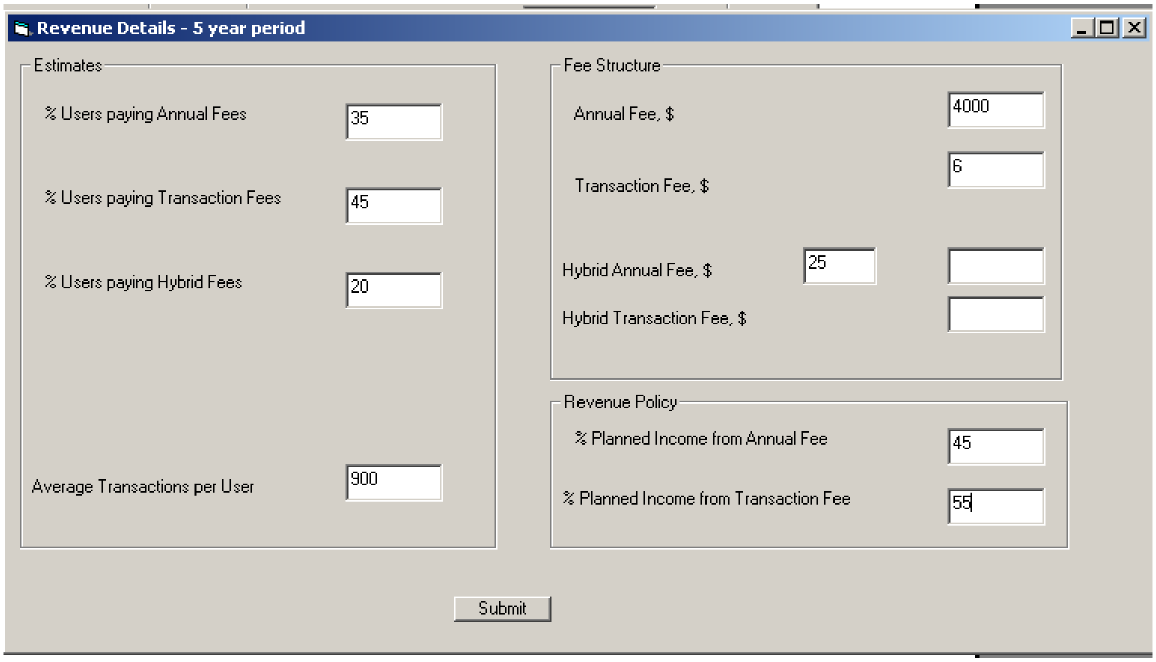


Figure 15 Estimates, Fee structure and Revenue policy in Volume Estimation Analysis

In the example shown in figure 15, the split between the three fee schemes is 35% annual, 45% transaction and 20% with hybrid, together with an expected average annual of 900 transactions per user.

In the fee structure, we have the Annual fee as $4000 and the transaction fee as $6, and the hybrid fee will have 25% of $4000 as an annual fee and the rest as transaction fee. In the policy section, we have a planned revenue of 45% from annual fees and 55% from transaction fees. These percentages include the respective contributions from the hybrid fees. The results of this analysis are shown in figure 16.

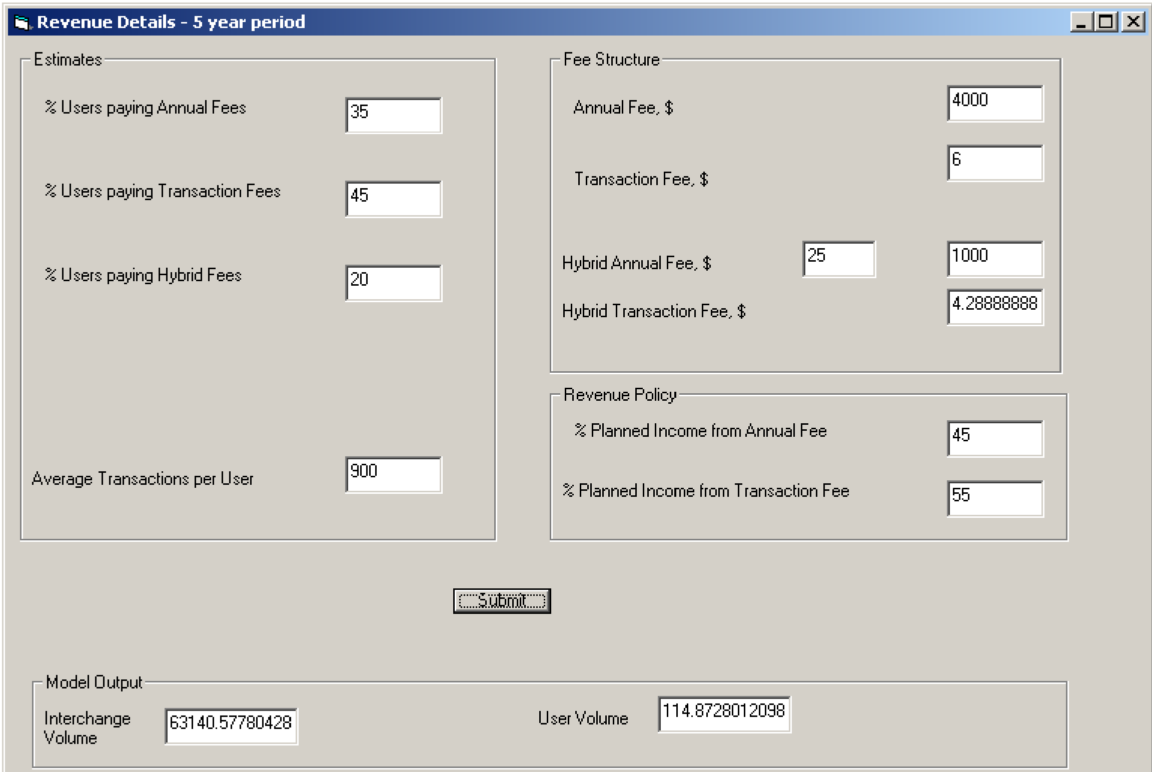


Figure 16 Outputs from Volume Estimation Analysis

The tool calculates the Hybrid annual fee as $1000, which is 25% of the regular annual fee of $4000, and converts the rest of the hybrid fees into transaction fee of $4.28.

In the same form, we see that an output part has appeared on the bottom of the screen, which shows the estimated minimum required volume of interchanges and minimum number of users for achieving the financial goals set up in this example. Results indicate that an average annual volume of 63,140 interchanges and about 115 users annually for the five year duration of the analysis are needed.

9 SET-UP AND IMPLEMENTATION PLAN

The set-up and implementation plan is a suggested multi-phase structure that may be appropriate in rolling out the VCY system in the Port of New York and New Jersey. The proposed phases that will cover this roll-out plan are:

a. Project Planning

b. Customization and Integration

c. System Roll-out

d. Training

e. Run pilot operation and monitor performance

f. Analyze results of pilot

g. Develop a full-business plan for the future

h. Full-scale implementation

<u>a. Project Planning:</u>

This stage will involve putting together a means of identifying opportunities for matching the export and import loads based on the historical data from the Port of New York and New Jersey. At this stage, there must be a clear agreement of the expectations of the system, and the data that would be necessary to analyze and identify the best opportunities.

Suggested time: 1 month

b. Customization:

The VCY system developed must be tailor-made and custom-fitted to the specific needs and requirements of the Port of New York and New Jersey, in collaboration and discussion with the port authorities. The VCY system must specify and provide the best and most efficient hardware configuration and software functionality that will meet the requirements of the VCY concept completely, with a view to service all the different users. The system developed must also be integrated into the existing systems of the port authority and the users.

Suggested time: 3 months

c. System Roll-out:

By means of a phased approach, the system should be rolled out into the entire port community, laying the ground work with guidelines of usage, and making it clear to each user community about their roles and responsibilities to ensure the success of the overall VCY system. This includes establishing clear expectations from each member of the port community, and mechanisms to raise issues and concerns with the system implementation. This roll-out plan will also include risk management plans to cover for any unexpected turn of events, either due to system performance or due to natural forces, so that the port business is not hampered.

Suggested time: 4 months

d. Training:

Training efforts directed at the appropriate groups of personnel in each group must be made. This is a very important element to the success of the VCY concept, as the availability of accurate and relevant real-time information is central to the realization of the potential of the system.

Suggested time: 2 months

e. Run pilot and monitor performance:

With all the essentials taken care of, the VCY system should be put into a pilot operation mode for a suitable length of time, with a prescribed minimum period of one year, so that the system is checked for robustness in light of the seasonality inherent in the import-export cycle. Adequate monitoring mechanisms and metrics must be established to gather data related to usage, exceptions and system performance.

Suggested time: 12- 18 months

f. Analyze results of the pilot:

The data gathered during the pilot operation mode, together with the feedback collected from large cross-sections of users must be used to analyze the pilot performance. This data may also be used to improve any features or iron out any differences between the stakeholders through discussions and meetings. An initial estimate of the costs incurred in proportion to the volumes of transactions may also be studied with a view toward the full-scale implementation. Any exceptions handled during the pilot stage must be shared with the users and solutions agreeable to all users must be shared with the entire community of stakeholders.

Suggested time: 1 month

g. Develop a business plan for the future:

Upon successful implementation of the pilot and the incorporation of any additional features based on the pilot analysis, a business plan for the short-term and long-term of implementation must be developed and discussed with the port authority. This plan will take into consideration growth in trade volumes, anticipated costs, plans to meet the expenses, likely fee structures, means of increasing patronage of the system, quantification of direct and indirect benefits to the port community and other relevant issues. In conclusion, a document summarizing the business plan must be submitted to the port authority.

Suggested time: 3 months

h. Full-scale implementation:

The port authority will review the performance of the pilot and the proposed business plan and decide on the course of action to be followed. A full-scale implementation will then be suggested, if appropriate.

Suggested time: As deemed appropriate.

10 CONCLUSIONS

Past experiences have indicated that successful implementation of a system such as the proposed VCY system is dependent on the involvement and support of all the different players in the port community. For this reason, it is extremely critical to understand the needs and expectations of all the players and to respond positively to them, in order to come to a widely accepted set of system characteristics, processes and institutional arrangements. Indeed, the success of the VCY implementation will hinge on the balance of costs and incentives to all the commercial players in the port community. Nevertheless, experience gained so far has also shown that there are informational, institutional and business related barriers impeding, in many cases, the successful application of a Web based communication platform for empty container interchange. Hence, the practical implementation of such Internet based systems needs a thorough study of the feasibility of the application of real-time Internet technology, to effectively address and overcome the many barriers inherent in this initiative. These barriers should be properly defined, analyzed and addressed prior to developing a VCY System. Attention must be given to identifying user requirements and formulating the system's conceptual architecture to develop specifications and functionalities of the system, with the user needs as the basis of the effort. Evaluating proprietary designs available in the market and learning from lessons from the implementation of similar port community systems developed at other ports, provides an important factor for assessing the feasibility of the system. Institutional problems pertinent to equipment interchange rules as well as project implementation governance deserve also significant attention.

This project examined the feasibility of establishing a VCY to serve the freight and maritime community in the NY-NJ region, addressing the above mentioned issues. To this end, current literature has been reviewed and a summary of local, US and International experiences in applying web-based shared information systems has been produced. The report identified and summarized the user needs for direct VCY users as well as other stakeholders, indirect users of the system. Based on user requirements and business or institutional barriers, the system's conceptual architecture has been formulated and presented, detailing the specifications and functionalities of the system. Several existing applications have been reviewed, based on information on these systems available over the Internet, or other publicly available sources. Financial and economic evaluation, potential funding alternatives and investment recovery strategies to ensure successful development and long term viability of systems' operation, are also presented, followed by a proposed system governance based on potential system participation, which is important for a successful system implementation. Finally, a staged application timeline and implementation plan is suggested, to cater for an intermediate pilot demonstration phase, necessary to draw experiences leading to proper full scale application.

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