Final Report

Development of an Interactive Freight Mobility and Security Database Structure for Research and Freight Modeling Applications

BD548/RPWO#16

Submitted to

Meredith Dahlrose

The Florida Department of Transportation
Research Center
605 Suwannee Street, MS 30
Tallahassee FL 32399

Submitted By

Patrick Kerr
Computer Engineer and Research Associate

College of Engineering and Computer Science
Center for Advanced Transportation Systems Simulation
University of Central Florida
PO Box 162450
Orlando, FL 32816-2450
Phone: (407) 823-0206
Fax: (407) 823-4676
E-mail: pkerr@mail.ucf.edu

October 2006

DISCLAIMER

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Furthermore, the contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Development of an Interactive Freight Mobility and Security Database Structure for Research and Freight Modeling Applications	October 2006
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Patrick Kerr	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Center for Advanced Transportation Systems Simulation University of Central Florida PO Box 162450 Orlando FL 32816-2450	
	11. Contract or Grant No. BD548/RPWO#16

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Florida Department of Transportation 605 Suwannee Street, MS 30 Tallahassee, FL 32399	Draft Final
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Center for Advanced Transportation Systems Simulation (CATSS) has previous experience developing a framework for managing freight data electronically via a Web portal. The data management system CATSS developed allows the Florida Highway Patrol to maintain freight theft and recovery data and share that data with other law enforcement agencies over the Internet. The current project evaluated how a similar development could be applied to the management of freight mobility and security data. Through the development of a Web site, the potential usefulness for evaluating historical freight data was identified.

Furthermore, the Web site has the versatility of an interactive data management and retrieval system. Freight and heavy truck data previously collected from an Florida Department of Transportation (FDOT) funded project to evaluate Florida's seaport intermodal traffic were used to test the application of the developed framework. Through an Internet Web site currently located on the CATSS Web server, users can view, search, and download freight and heavy truck data.

17. Key Word	18. Distribution Statement
Freight security, Intermodal transportation, Relational databases	No Restrictions

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Form DOT F 1700.7 (8-72)   Reproduction of completed page authorized

ACKNOWLEDGMENTS

The author would like to acknowledge the contributions that Dr. Jack Klodzinski made to the completion of this project. Without the use of the vessel and truck data that he provided, this project could not have been completed.

The efforts of Ms. Aparna Muppidi also need to be recognized. Her tireless efforts scouring the Internet for related information were invaluable.

EXECUTIVE SUMMARY

The Center for Advanced Transportation Systems Simulation (CATSS) has previous experience developing a framework for managing freight data electronically via a Web portal. The data management system CATSS developed allows the Florida Highway Patrol to maintain freight theft and recovery data and share that data with other law enforcement agencies over the Internet. The current project evaluated how a similar development could be applied to the management of freight mobility and security data. Through the development of a Web site, some potential usefulness for evaluating historical freight data was identified.

Furthermore, the Web site has the versatility of an interactive data management and retrieval system. Freight and heavy truck data previously collected from an Florida Department of Transportation (FDOT)–funded project to evaluate Florida's seaport intermodal traffic were used to test the application of the developed framework. Through an Internet Web site currently located on the CATSS Web server, users can view, search, and download freight and heavy truck data.

Users can cross-reference freight data records with heavy truck movements based on a specified date, seaport, or both. The difference between this system and a typical online data management system is that this structure and content are based on the needs of a direct customer, such as a traffic planner or modeler. The structure has built-in versatility that can be expanded as the need presents itself for current and future research and modeling applications. Some of these requirements were realized through previous FDOT-funded studies, such as the three-phase intermodal mobility study at six of Florida's busiest seaports (Ports of Jacksonville, Canaveral, Palm Beach, Everglades,

Miami, and Tampa). Establishing relationships between ships' inbound/outbound freight characteristics, truck traffic, connecting highway networks, and the unique characteristics for each of these ports was found to be a significant factor in establishing current and future trends and mobility forecasts. Some of these relationships were successfully tested and applied to produce short-term forecasted truck traffic.

One data group missing from this system is information related to port security and freight theft. Tracking cargo theft at seaports could provide invaluable information if we had the ability to cross-reference such information with available freight data from seaports. It is possible that if cargo theft data can be managed better, a more precise impact of these crimes on the intermodal freight industry may be realized. With the intermodal freight data cross-referenced with cargo theft data, not only could mobility data users benefit, but law enforcement may also find benefits through the online access and management of the information when conducting an investigation. Furthermore, the system has been developed with a simple structure that could be tailored so that individual seaports in Florida could enter freight mobility data, inbound and outbound cargo data, port operations information, and related transportation and security data in order to evaluate possible improvements to the transportation infrastructure and increase the mobility of freight in and out of the port.

The structure for a freight data management system was developed based on a preliminary design of data links from previous research. A prototype system was launched on the CATSS Web server at http://seadms.cecs.ucf.edu. Sample freight and truck data collected from actual field studies were used to test the system. Future applications of this database structure include local seaport data management up to the

storage and management at the state level. This data management system has the

potential to capture and store historical, current, and future freight data and provide any

FDOT agency with the ability to input as well as manage this data on a 24-hour basis

through an online system.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The importance of freight mobility and its integration into the transportation

infrastructure at the local, state, or national level is becoming more important as the

public consumes more commodities that require longer transport distances.

Accompanying this issue of freight mobility is the necessity of safety and security of the

supply chain. With the increased awareness of international terrorism, it has become

evident that heightened security requirements are necessary.

An online data management system that integrates the ability to enter freight data,

port security data, and information; report cargo theft; store these records with previously

entered (historical) data; and cross-reference it could provide a versatile tool for

engineers, planners, and seaport operations personnel. Developing a useful structure that

combines storage and analysis of freight data records through cross-classification of user-

specified information could assist in evaluation of seaport operations, including the

mobility of freight in and out of Florida's seaports. This system could be applied to

future freight research or freight modeling.

The ability to cross-reference or search categorically will minimize research

efforts and prioritize necessary funding for further examination of possible applications.

Use of this resource would increase the potential for coordination across multiple

agencies. Furthermore, joint project funding may improve the management of resources

by providing users with not only information of the referenced resources but possible

applications or recommendations as well.

Resources that may be included would cover many aspects of freight

transportation and mobility, including the intermodal facilities that process the cargo, the

highway components used to transport them, and applications for the management of

these resources. Intermodal facilities include seaports, which are important intermodal

freight terminals, and they can generate high traffic volumes which may include

substantial recreational traffic. These special generators of traffic can have a significant

impact on the local highway networks connecting to these intermodal facilities.

Therefore, the ability to quantify the impact in terms of total traffic and truck volumes is

important when any transportation infrastructure improvement is proposed and

investigated.

The results of this project also address the highway network that supports an

intermodal facility and the management of the network. The Statewide Intermodal

System (SIS) is part of this ongoing applicable relationship for resource utilization and

reference. In order to manage the system and network and use resources as efficiently as

possible, public agencies and private development corporations develop software

applications to analyze facilities under investigation for possible improvements. The

database may provide important feedback to the users of the database concerning which

software applications may be most useful or which may be applicable if enhancements

are provided.

OBJECTIVES

The main objective of this project is to develop a comprehensive database for

referencing documentation regarding intermodal freight transportation, including safety

and security of related facilities. The database will be flexible enough to provide a

foundation as further development and enhancements in freight mobility occur. Recent

advancements in computer technology have led to more sophisticated hardware and

software to manage freight transportation systems and facilities. Through the combined efforts of public agencies and private industry, resource utilization for programs such as the safety and security of freight transportation may improve with an available detailed reference source. This database could "bridge" available information between related agencies and organizations to coordinate efforts in developing such programs as the safety and security of seaports.

METHODOLOGY

Compilation of Freight Security Documents

Using various Web search engines such as Google.com, Yahoo.com, and Altavista.com, searches were made on general topic areas. Documents were then evaluated to see if they pertain to the scope of this project. If they were deemed valuable, they were categorized and then subcategorized using more specific topics. The documents were then entered into the database using the Web site.

Compilation of Freight Data

Freight data collected as part of the project "Development of a Statewide Model for Heavy Truck Freight Movement on External Road Networks Connecting with Florida Ports, Phase II" were compiled from data files stored in Microsoft Excel and Microsoft Access. The freight data that came from that project were from counters/classifiers strategically located around several ports in Florida. The ports also provided inbound and outbound seaside data. The ports under investigation were Port Everglades in Ft. Lauderdale, Florida, and the Port of Tampa in Tampa, Florida.

Relational Database Development

Port and Freight Security Documents

For each port or freight security document in the database, the following information is stored: title, URL, keywords, and categories. To store this data in a way that database queries could be quickly and easily grouped and maintenance would be minimal, a schema was developed to spread the data over several tables. The schema of the tables that store this information is displayed in Figure 1.
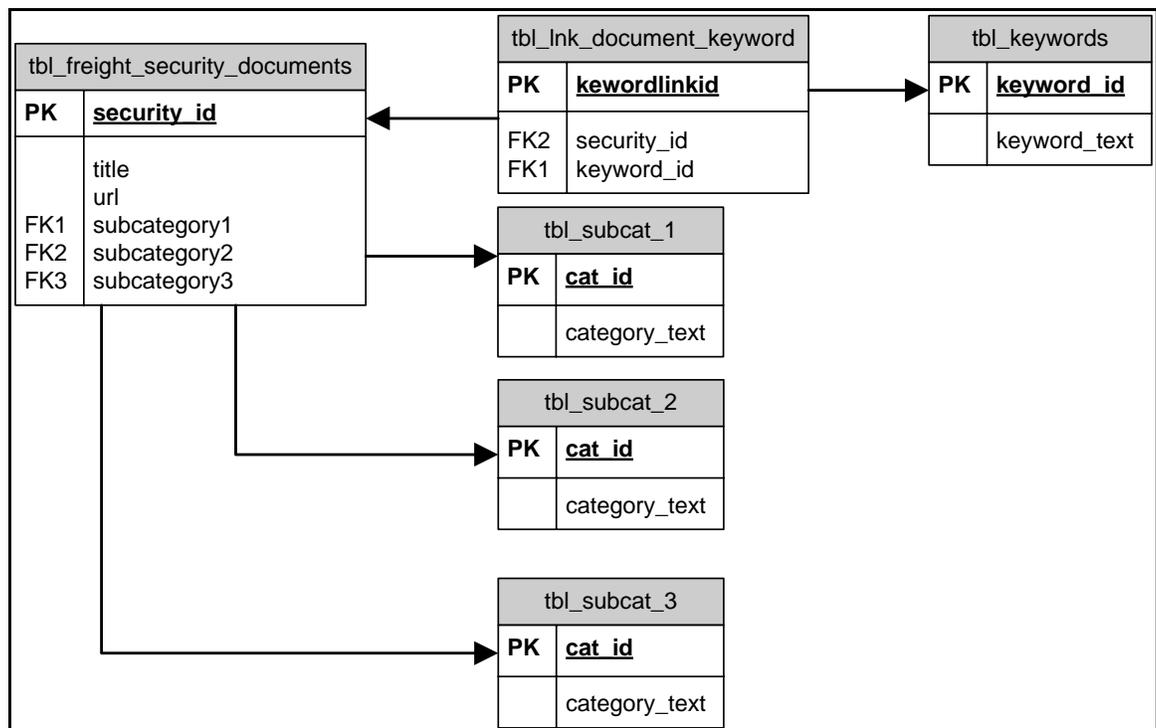

Figure 1. Database schema for port security documents

A freight security document can have several keywords and a keyword can apply to many documents. This structure, known as a "Many to Many" relationship, uses an intermediate link table to link documents to keywords. In some instances, a single document can have only one major topic area, category, and sub-category, and this

structure is called a "One to Many" relationship. In that case, the document table is
linked directly to each of these tables.

Vessel and Freight Data

After receiving the vessel and freight data from the author of the aforementioned
project, the data that were to be included in the database were identified and the relational
database was designed around them.

Port Everglades Vessel Data

Table 1 describes the data that are stored in the database that was received from
Port Everglades. The time frame of the data that were made available for this project is
May 30, 2000 – August 10, 2000.

Table 1. Metadata for Port Everglades vessel database table

Column Name	Data Type	Description
Vessel	String	The name of the ship
ID	Integer	Code used for tracking purposes
Arrival	DateTime	The recorded arrival of the vessel
Docked	Integer	Where ship docked
Departure	DateTime	The recorded departure of the vessel
Ct	Integer	Internal control number to the port
WhfDescrip	String	Commodity type on vessel
Dollars	Money	Value of commodity in US Dollars
Units	Integer	Measured in bbl, each, mbft, or ton
IO	String	Direction of shipment: inbound or outbound
Units Numeric	String	Same as WhfDescription
Arrival_small	Integer	Weight of commodity

Port Everglades Vessel Historical Data

Table 2 describes the older data that are stored in the database that was also
received from Port Everglades. The time frame of this data is June 1, 1995 – August 3,
1995.

Table 2. Port Everglades historical vessel data metadata

Column Name	Data Type	Description
Vessel	String	The name of the ship
ID	Integer	Code used for tracking purposes
Arrival	DateTime	The recorded arrival of the vessel
Departure	DateTime	The recorded departure of the vessel
WhfDescription	String	Commodity type on vessel
Unit Type	String	Same as WhfDescription
Dollars	Money	Value of commodity in US Dollars
Units	Integer	Measured in bbl, each, mbft, or ton
Tons	Integer	Weight of commodity
InOut	String	Direction of shipment: inbound or outbound

Port Everglades Truck Inbound Data

Table 3 describes the data for the inbound truck counts taken around Port Everglades. The stored counts are cumulative for the day at each site. These counts were taken on the side of the street that traffic would use to go to the port. The time frame of these data is June 7, 2000 – July 31, 2000.

Table 3. Port Everglades inbound truck metadata

Column Name	Data Type	Description
Date	DateTime	The date of the inbound truck counts
Eller_Drive	Integer	Truck counts at Eller Dr.
Eisenhower_Blvd	Integer	Truck counts at Eisenhower Blvd
Spangler_Blvd	Integer	Truck counts at Spangler Blvd

Port Everglades Truck Outbound Data

Table 4 describes the data for the outbound truck counts taken around Port Everglades. The stored counts are cumulative for the day at each site. These counts were taken on the side of the street that traffic would use to leave the port. The time frame of these data is June 7, 2000 – July 31, 2000.

Table 4. Port Everglades outbound truck metadata

Column Name	Data Type	Description
Date	DateTime	The date of the outbound truck counts
Eller-Out	Integer	Truck counts at Eller Dr.
Eisenhower-Out	Integer	Truck counts at Eisenhower Blvd
Spang-Out	Integer	Truck counts at Spangler Blvd

Figure 2 and Figure 3 show the database tables that store the vessel data from Port

Everglades. Notice there are no links relating the data tables to each other. No

relationship was defined in the database, since the truck count data are cumulative for the

day whereas the vessel data are listed by cargo, several for each day. For the two tables

to be joined, the vessel data would have to be summarized by date as well. Queries were
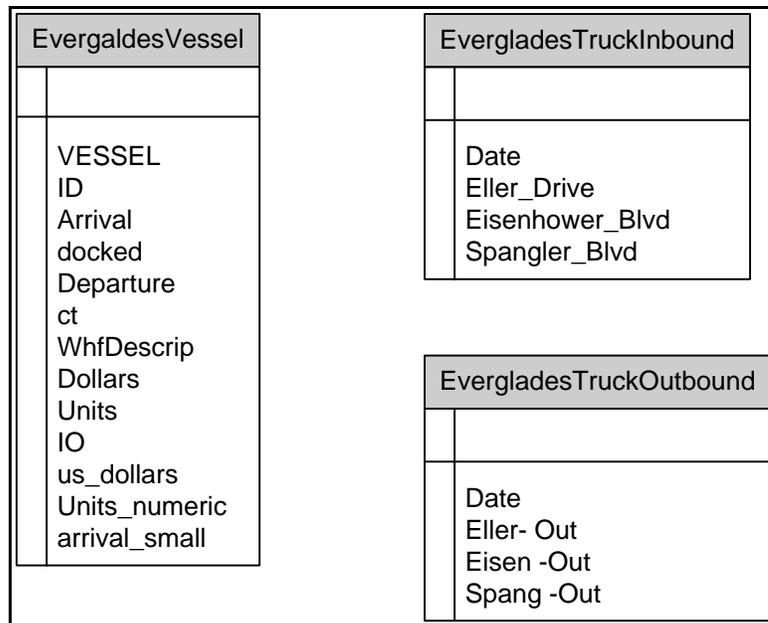
designed around this difference later for analytical purposes.

EvergaldesVessel	EvergladesTruckInbound
VESSEL ID Arrival docked Departure ct WhfDescrip Dollars Units IO us_dollars Units_numeric arrival_small	Date Eller_Drive Eisenhower_Blvd Spangler_Blvd
	EvergladesTruckOutbound
	Date Eller- Out Eisen -Out Spang -Out

Figure 2. Port Everglades vessel and truck database tables
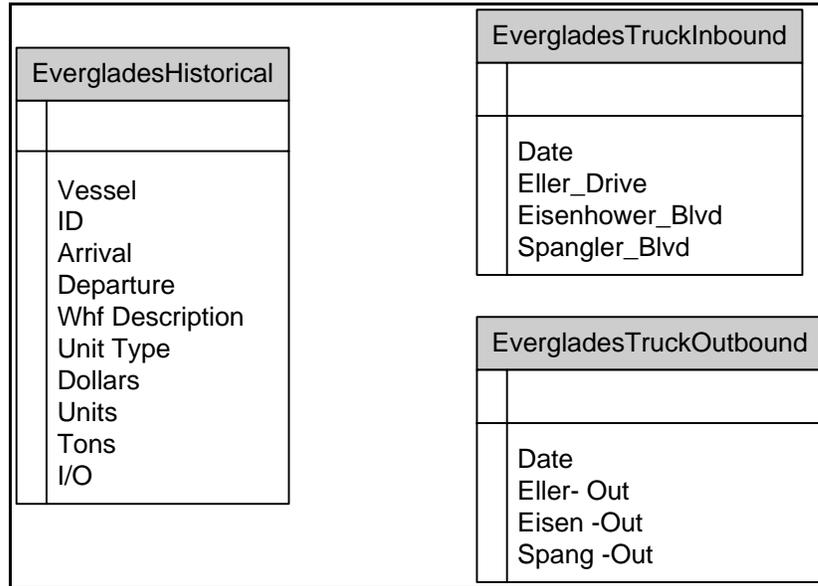
Figure 3. Port Everglades historical vessel and truck database tables

Port of Tampa Vessel Data

Table 5 describes the Port of Tampa vessel data. The time frame of this data is

July 1, 2000 – August 31, 2000. Each row in this table constitutes a different commodity

measured in both tons and specific units.

Table 5. Metadata for Port of Tampa vessel database table

Column Name	*Data Type*	*Description*
ActivityDate	DateTime	The recorded date of loading or unloading of the vessel
Berth	String	The location the ship was docked
CommodityDescription	String	A vessel's cargo description
Units	String	Units of measure, barrels, tons, etc.
UnitType	String	How each commodity is measured in terms of import or export quantity
Quantity	Float	Volume of a commodity
Tons	Float	Measured weight
NoOfContainers	Float	Quantity of containers (when transported)
ImportExport	Bit	Direction of shipment

Table 6 describes the data for the inbound truck counts around the Port of Tampa.

The time frame of these data is July 5, 2000 – September 14, 2000.

Table 6. Port of Tampa inbound truck metadata

Column Name	Data Type	Description
Date	DateTime	The date of the inbound truck counts
22ndSt	Double	Truck counts at 22nd St.
20thSt	Double	Truck counts at 20th St.
CausewayBlvd	Double	Truck counts at Causeway Blvd.
PortSuttonRd	Double	Truck counts at Port Sutton Rd.
PendolaPtRd	Double	Truck counts at Pendola Point Rd.

Port of Tampa Truck Outbound Data

Table 7 describes the data for the outbound truck counts around the Port of Tampa

for the time frame August 1, 2000 – September 14, 2000.

Table 7. Port of Tampa outbound truck metadata

Column Name	Data Type	Description
Date	DateTime	The date of the inbound truck counts
22ndSt	Double	Truck counts at 22nd St.
20thSt	Double	Truck counts at 20th St.
CausewayBlvd	Double	Truck counts at Causeway Blvd.
PortSuttonRd	Double	Truck counts at Port Sutton Rd.
PendolaPtRd	Double	Truck counts at Pendola Point Rd.

Port of Tampa Database Tables

Figure 4 shows the database tables that store the vessel and truck count data from

the Port of Tampa. Like the Port Everglades data tables, there are no links relating the

data tables to each other. Again, queries were designed around this difference later for
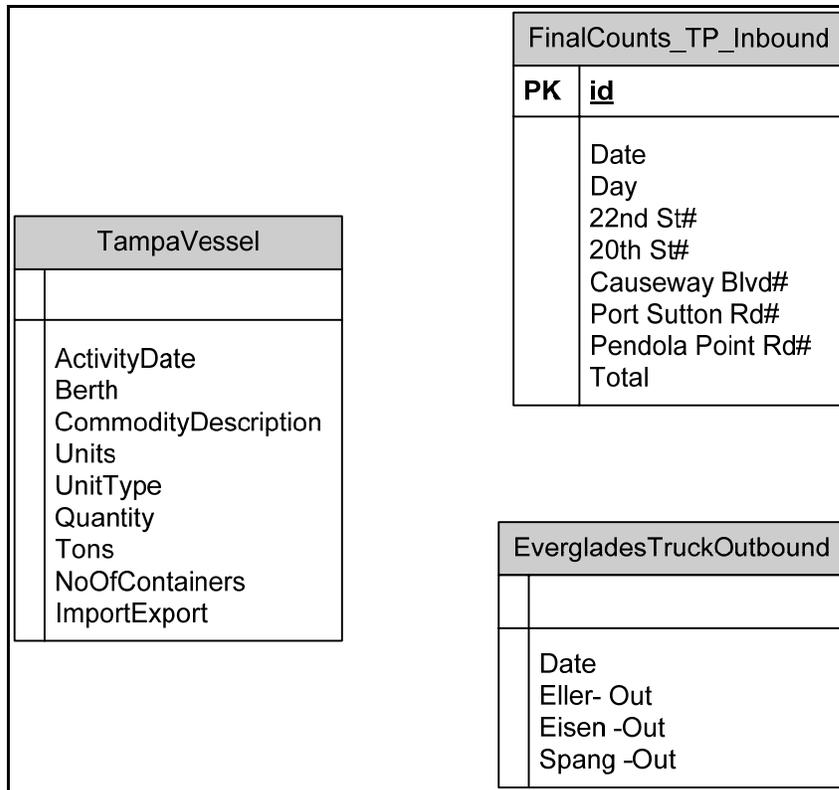
analysis purposes.

Figure 4. Port of Tampa vessel and truck database tables

Web Development

Web Technologies

The site that was created for this project was authored using Microsoft Visual Studio.NET 2003. The Web server is a Windows Server 2003 machine running Internet Information Server 6.0 and the .NET framework 1.1. The language used for the code-behind pages is C# (pronounced C sharp).

Home Page

The home page welcomes the user by giving a brief background and introduction to the site. The navigation bar at the top of the page is consistent across all pages, with the current content area displayed in bolded text. Figure 5 depicts the home page.
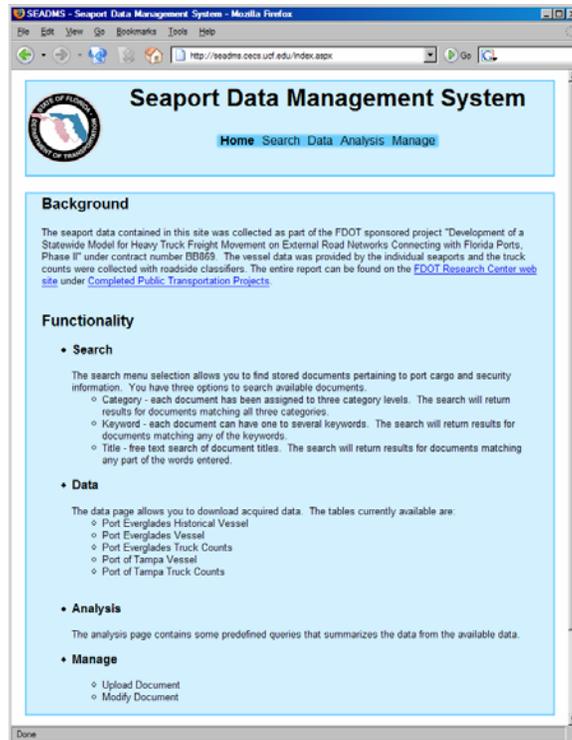
Figure 5. Home page

Port and Freight Security Documents

The content area under Search allows the user to search the database for port or freight security documents. Once the Search button is clicked, the default search by category page is displayed. Also, a secondary navigation bar is displayed to allow the user to search by keyword or title. Figure 6, Figure 7, and Figure 8 show the search by category, keyword, and title pages, respectively.

Searches by category and keyword are limited to values stored in the database by the use of dropdown lists. Search by title allows free text searches using OR logic for multi-word searches. For example, if the user enters the words "truck" and "security," any title that contains either or both of these words will be displayed.

Furthermore, the words that are entered in the search will retrieve partial matches. If the word "port" is entered, titles containing the words "port" or "ports" will return as matches.

Figure 6. Search documents by category

For the purpose of respecting copyrights, documents and Web pages that are referenced in this portal are not actually stored in the database or on the Web server. Instead, links to the documents are stored in the database and displayed to the person using the portal. Because the links to the documents point to different Web sites, the administrator of this site has no control over the content that is displayed on the external site(s). Therefore, whenever a hyperlink to a document is clicked, an advisory is displayed notifying users that they are about to leave the current site and allowing users the option of continuing.

Figure 7. Search documents by keyword

Figure 8. Search documents by title

Although some minor analysis is shown on this Web site, the user has the option to download the data for any use or application. By clicking the Data button on the toolbar, the user can access the available data. Two dropdown lists allow the user to select which table to download and in what format. The two formats that are available are comma separated values (CSV) and eXtensible Markup Language (XML). Both are plain-text files that can be read on most operating systems.

The files are created on the fly when requested and written to the server's hard drive first and then downloaded to the user. To accommodate two or more users requesting the same data at the same time, a numeric code is appended to the filename based on the date and time of the request. The files that are created on the server are automatically removed after the user has downloaded the file. Without this automatic cleanup, over time the server could lose significant amount of storage to this Web application.

Figure 9 and Figure 10 depict the download of data into the two different formats. When the user selects which table to download using the first drop-down list, the page updates with the metadata regarding that table. The source of the data is identified as well as the time frame of the data.
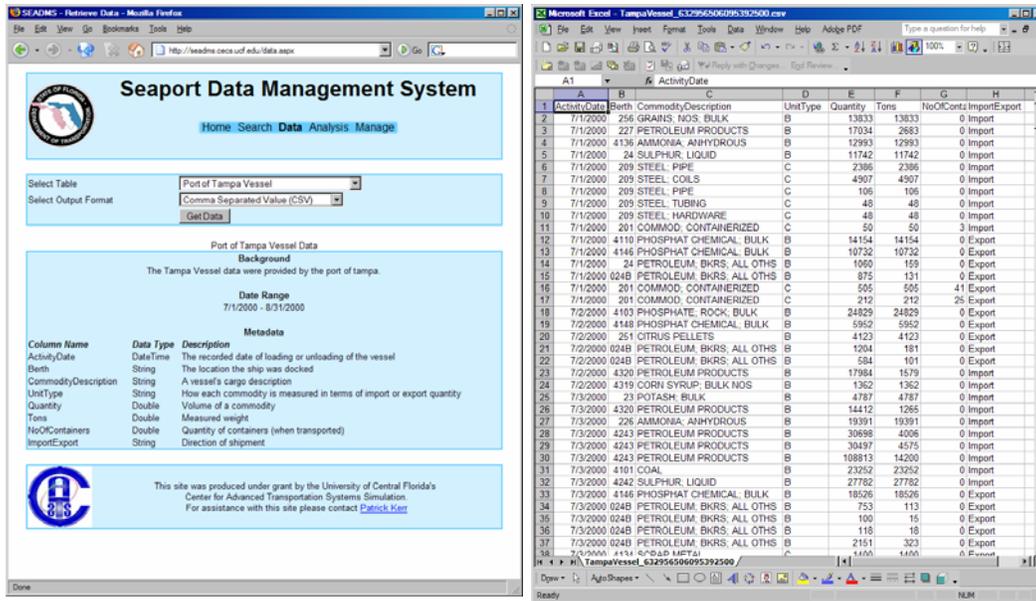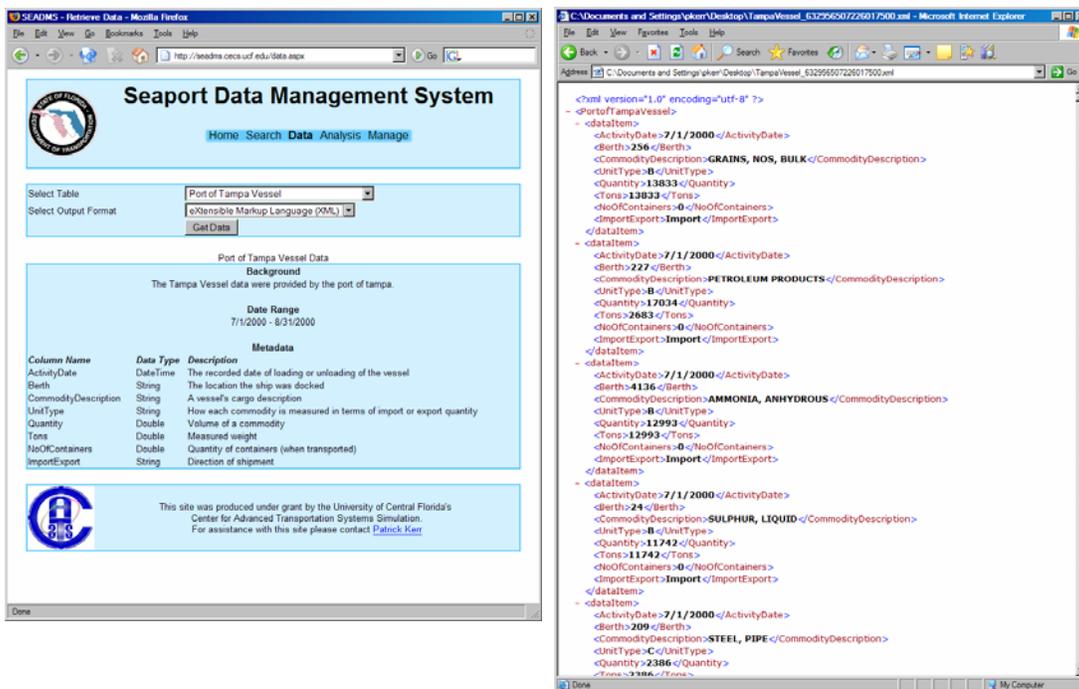
Figure 9. Download data to CSV file

Figure 10. Download data to XML file

Analysis

The analysis page presents the user with some precompiled queries that summarize the vessel data as well as relate the vessel data to the truck data. Thirteen queries are listed with a brief description and a link to run the query. When the link is selected, the results are displayed on the page.

Figure 11. Analysis page

Data Management

Two Web pages were created to insert new and update existing port and freight security documents. These pages were used to insert the existing document data that are stored in the database, which has over 600 articles. Because these pages allow the user to insert any information that will instantly be available to all other users, they have been protected by username and password. Figure 12 shows the page used to insert new documents. The page allows the user to add new keywords and categories as well as upload document files to the server.
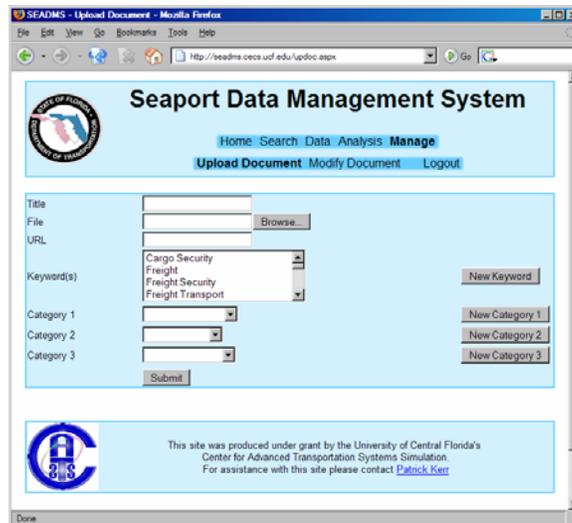
Figure 12. Insert new document

The second management page allows the user to update any information for the security documents. If the information was entered erroneously or if the information changes, it can be updated. This page is shown in Figure 13.
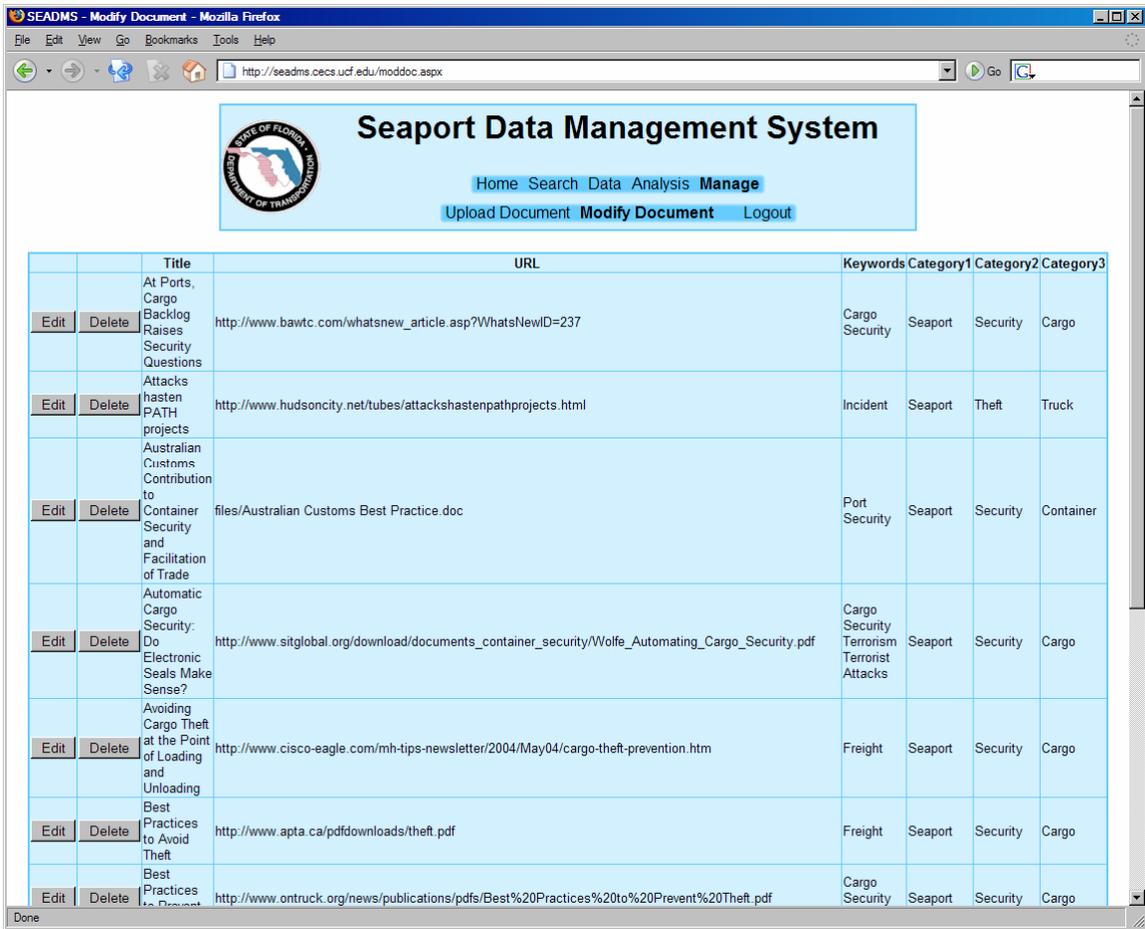
Figure 13. Modify existing document

FINDINGS

Efforts were made in the development of this Web site to upload vessel and

freight data into the database via the Web portal. The purpose of this effort was to allow

users that have not been trained in database development to be able to create tables and

relationships between data. It was determined that allowing the end user the ability to

generate tables and relationships within the database could itself present a risk, not only

in data integrity but also database security. Another contributing factor preventing this

relationship application is the differences in vessel data formats in which the ports store

their records. Even the two data sets provided by Port Everglades (one from 1995 and

the other from 2000) showed some differences. Some historical vessel data may only be available as hard copies and would need to be manually entered into the database.

As with any Web site that uses a database, the services of a webmaster and a database administrator would be needed in order to keep a Web site such as this one maintained and current. The database administrator would be especially important when new data sources, such as additional ports, are added. The database structure would need to be updated regularly as changes are identified in the data sets ports would supply. The overall findings from the online evaluation of the database structure requirements are that the structure would need to be dynamic in order to ensure future versatility as port data changes and is updated, a more defined structure would be required with direct input from FDOT and the port authorities (the targeted users of the data management system), and relationships between data fields would need to be specified by the database administrator because interactive use of the database online would pose a security risk.

CONCLUSIONS

If the businesses that use our ports include roadway and port security in their selection criteria when deciding which port to use, then our ports will need every tool available to build best practices to improve their security. FHP, through the implementation of the online Electronic Freight Theft Management System, has taken steps to improve roadway security. The development in this project attempts to provide a tool for improving the management of their freight traffic and enhancing port security.

The port security document storage and retrieval system can be beneficial to those affected by port security so long as someone is keeping the library current. Having the

information readily available so that desired information can be found easily benefits those searching for this information.

The truck count data not only could assist transportation engineers with modeling but could also assist with roadway security at the port periphery region. Realizing how truck movements are affected by a vessel's cargo could help to identify hot zones that could be targets for theft or terrorism. For this information to be truly worthwhile, shipping manifests would have to be available prior to loading or unloading, particularly if the commodity being shipped is a hazardous material.