An Integrative Conceptual Framework for Stakeholder Collaboration in Maximizing Port Industry Performance – the Case of the NY/NJ Region

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ABSTRACT

The paper presents a conceptual framework for developing regional partnerships and stakeholder collaborations to maximize port industry performance, improving port competitiveness and advancing the regional economy. A unique simulation tool is proposed as a core aspect of this framework. This tool will have the ability to quantify benefits of other projects, evaluate the impact of suggested policies and alternative business or operational strategies, and identify potential bottlenecks in the existing infrastructure under anticipated future conditions. In turn, all these will facilitate *informed* decision-making and increase the probability of consensus building. Example applications of the proposed tool in the NY/NJ region are presented. Further, two other important aspects of the framework, the outreach and educational components are discussed in this paper. The important role that academic institutions can play in developing and implementing the components of the proposed framework and a review of initiatives currently under way at Rutgers University, are also presented in this work.

INTRODUCTION

In today's global marketplace, maritime transportation plays a major role in providing cheap transportation over large distances. The maritime component of the global transportation system has been a remarkably successful and efficient facilitator of regional economic growth, providing a competitive, low-cost and efficient service for international trade.

The United States is the world's most active trading nation, accounting for one billion metric tons or nearly 20 percent of the annual worldwide ocean-borne trade and one billion tons of domestic cargo per year. The ocean-borne cargo moved by the maritime transportation system contributes over $742 billion to the U.S. gross domestic product and creates employment for more than 13 million people *[1]*. The elements of this transportation system are all tightly interwoven, with developments in one part of the system having the potential to affect other parts located hundreds or even thousands of miles away. In 2004, Eastbound container traffic (i.e., Far East to US) in Transpacific Trades grew by 15% over that for the year 2003 *[2]*. Such high year-to-year growth in waterborne traffic exerts immense pressure on the port infrastructure and necessitates substantial improvements in operational practices and use of front-end technology in order for the port system to accommodate the extra traffic without excessive delays.

The freight and maritime transport industry is a complex system of private and government entities that are interdependent but lack established communication processes to fully understand and leverage these interdependencies. Therefore, even when stakeholders in the industry aim to optimize their individual operations, they are often locked into sub-optimal operating conditions and performance due to the lack of appreciation for these interdependencies and the consequent potential for collaborative efforts. For example, approximately 13 percent of container traffic from the port of New York/New Jersey is transported by rail. The Port Authority is expecting this volume to grow to as much as 30% in the near future, as congestion in roadways and consequent truck delays make rail transportation more attractive. However, rail transportation is *not really independent* of the road transport system. This is because containers transported from the port to inland terminals by rail or barge are often moved back to their destination near the port by truck, further exacerbating road traffic congestion in the region. In addition, queuing of container trucks outside the Port and the terminals often spill over to nearby freeways and access ramps causing serious safety and congestion problems for both the truckers and the traveling public.

This paper presents a conceptual framework for implementing and testing new, innovative methodology, drawing on new micro-simulation tools and real-time information made available through the full-scale application of new processing/control equipment and technologies. These new micro-simulation tools, which have not been tested so far in a maritime or port environment, have the ability to quantify benefits of proposed projects, evaluate the effect of proposed policies/ alternative strategies, and identify potential bottlenecks in the existing infrastructure under anticipated future conditions. Their successful implementation will support local and regional efforts to increase productivity and efficiency of maritime freight movement, reduce traffic congestion and associated inefficiencies and, thus, increase the competitiveness of the Port and of the regional economy as a whole.

CRITICAL ISSUES AND RESPONSE FROM THE INDUSTRY – THE CASE OF THE NY/NJ REGION

Maritime transportation is a critical driving force sector in major port areas around the country. Concerns have been expressed about the existing capacity at major ports and terminals (including the associated highways, rail lines, and waterways that serve them) to handle steadily increasing volumes of intermodal traffic, especially containerized freight. Although efforts have been and continue to be made to improve the efficiency and reliability of the intermodal freight network, congestion remains an ongoing problem. Congestion degrades the reliability and performance of carriers, shippers, and terminal operators— which is a serious problem for the health and vitality of the businesses. The lack of information sharing among the various entities is also a matter of major concern. It leads to operational inefficiencies and heightens concerns about safety and security. Therefore, there is a strong and urgent need for a well-coordinated effort to achieve optimal efficiencies at a regional level and to increase the global competitiveness of the regional economies.

With very little room for land and facility expansion, terminals in major ports are struggling with the ever-increasing flow of trucks. With the expansion in world trade and regional consumer demand, the Port Authority of New York/New Jersey (PANYNJ), for example, anticipates substantial growth in container traffic. Cargo volumes are expected to double during the next decade and quadruple within forty years *[3]*. There is a widespread consensus among experts that if no action is taken now, this will lead to multiple problems with costly repercussions, including increased port congestion, delays at terminals, air pollution, decreased asset and personnel utilization, a significant decrease in operational efficiency, and an overall increase in operating and security related costs.

Moreover, the Port of New York/New Jersey has to respond to the tendency of “port regionalization”, which represents the next stage in port development where efficiency is derived with higher levels of integration with inland freight distribution systems *[4]*.

The multi-sided, vital and dynamic nature of the maritime transportation system, therefore, requires an interdisciplinary, integrated and synergistic approach to fully understand and analyze it, and develop methods and strategies to improve its overall productivity, efficiency, and service quality.

The region's maritime community has made serious efforts to respond to the abovementioned issues. New York-New Jersey is wrapping up one of its costliest construction programs ever, with Maher Terminals expanding to 445 acres and APM Terminals to 350 acres. Port Newark Container Terminal is also adding 15 acres. The Port Authority is investing heavily in intermodal railway facilities, with the goal of doubling the railway's share of inland cargo movements to 25 percent *[5]*. Dredging the channels, expanding the physical capacity of the terminals, upgrading equipment, increasing the size of the labor force and introducing information technology on the docks will certainly help address the "water-side challenges" that ports face. Notwithstanding these efforts, the transportation industry has much work to do on the-*landside of the system*, which is and will continue to be a bottleneck considerably restricting the potential benefits accruing from the expansion now underway.

The PANYNJ initiated the Port Inland Distribution Network (PIDN), a hub-and-spoke system, to move containerized cargo by rail or barge from marine terminals in the New York metropolitan area to regional freight terminals in New York, New Jersey and other Northeastern states *[6]*. The cargo is then moved from the regional terminals by truckers to local and regional customers. The inland terminals are located at or near centers of marine customer service and distribution activities (cluster points) in 13 states. Eighty-two percent of the container market within this 13-state area is found within a 50-mile radius of these points. The PIDN system aims to lower inland distribution costs, increase throughput capacity and spur economic development at feeder ports and hinterlands.

To further advance the PIDN system a computer-based data management platform that would create a "virtual container yard" (VCY) is proposed by the PANYNJ *[7]*. A VCY would post information on the status of cargo and containers, facilitate communication among key participating stakeholders, permit container interchanges without moving the container to the port and assist the parties to optimize container logistics decisions. This system would reduce the number of empty trips to the port thus improving efficiency and reducing adverse environmental impacts.

In 2001, the Federal Highway Administration's (FHWA) Office of Freight Management and Operations, the I-95 Corridor Coalition, and the PANYNJ proposed an evaluation/experimental system with a freight project utilizing Intelligent Transportation Systems (ITS) to provide real-time information to the Port of New York – New Jersey (PONYNJ) freight community members. This demonstration project, the Freight Information Real-Time System for Transport (FIRST), aimed to solve the previously identified problems of limited landside access and increasing levels of truck traffic at and around the port *[8]*. This system, however, was not as successful as anticipated. Later in this paper we discuss how our proposed system can evaluate the efficacy/usefulness of an enhancement of the system.

Moving forward with the use of ITS, a service for providing real-time and static information of road and transit conditions collected through TRANSCOM was also created. TRANSCOM's regional architecture enables dissemination of real-time information, optimizing the benefits of ITS on a regional basis *[9]*. Through a computer workstation, member agencies may access this information. A public/private partnership developed the technology to integrate member agency transportation information, process it, and distribute it through the Trips123 services. The network may be further strengthened through coordination with the I-95 Corridor Coalition's Information Exchange Network (IEN), which provides data similar to the one from TRANSCOM, but on a corridor-wide basis.

Terminal operators recognize the need to find ways to ease traffic congestion, quickly moving containers out of the terminal area, minimizing lead times for export container storage, allowing more turnarounds for truck deliveries and increasing the overall efficiency of cargo movement in the PONYNJ. For instance, Maher Terminals have invested in research, development and implementation of an up-to-date automated gate processing and control system. This system is one of the most advanced gate processing systems in the world, using Optical Character Recognition (OCR), Computer Character Recognition (CCR), Commercial VACIS (Vehicle and Cargo Inspection System) and other technologies *[10,11]*, to optimize security and productivity simultaneously *[12]*. When it becomes fully functional, the gate system is expected to possess the capacity to accommodate approximately 14,000 trucks per day. This gate throughput sets new standards in the container terminal gate processing subsystem, as compared to the terminal annual capacity and throughput. Furthermore, it demonstrates a new philosophy of enhanced gate delivering process, aiming at maximizing container movement and minimizing container storage transit time, while at the same time enhancing security through the use of technology.

In addition to high levels of gate automation due to technologies implemented by the marine terminals, the PANYNJ's SEA LINK system *[13]*, a uniform truck driver identification system, further helps speed trucks through the marine terminal gates. With a single identification card for calls at any of the PONYNJ marine terminals, driver information is transmitted to terminal operators, reducing the gate clearing time for dropping off and picking up cargo.

Through such a fully automated terminal gate system *[14, 15]*, the license plate and container number are automatically recorded by the OCR for a truck arrives at the gate. . At the same time, digital cameras take pictures of the condition of the container, a reader records the number and status of the container's seal and the container is inspected for security purposes. In the meantime, drivers use a SEA LINK Card to give the trucking company's and their own names, and to confirm the matching vehicle license plate. The reduction in waiting times that can be potentially achieved through such automation is very important for truckers. This is because contractors are paid by trucking companies to haul containers, but not by the hour. This means that any time spent waiting in line at a terminal costs the truckers considerable sums of money (especially considering that the wait may last up to six hours). Therefore, ideally truckers should have multiple moves at a terminal to make a reasonable profit.This list of regional efforts is certainly laudable, clearly indicates the urgent need for solutions and the importance that the maritime industry attaches to the timely development of these solutions. However, solutions developed in isolation by an individual entity might offer optimal benefits to that entity but most likely provide sub-optimal solutions for the whole system. Furthermore, for regional efforts to succeed, active participation of critical stakeholders in the region is required. Well-coordinated efforts and consideration of potential benefits from a holistic perspective are required to achieve optimal efficiencies and benefits for the entire system.

PROPOSED FRAMEWORK

Globally, there have been efforts to integrate communication and the exchange of information between Port Community players. There are examples of integrated e-collaboration projects *[16, 17, 18]* that have shown great potential in adopting Port Community cooperative approach. However such examples are rare given the - severe fragmentation among port players owing mainly to business practices prevailing in this sector *[19]*. To overcome difficulties in adopting cooperative approaches, it is critical that tangible benefits are readily available to all the partners involved. Therefore, up-to-date microsimulation techniques *[20]*, successfully adopted and tested in other sectors of the transportation industry, deserve attention as potential tools to ensure tangible results and benefits to the Port Community stakeholders *[21-31]*.

This paper presents a framework for maritime industry stakeholders' collaboration, using a technology platform that could integrate regional efforts to maximize overall maritime industry performance. The ultimate goal of this proposed framework is to assist in developing a strong foundation for sustainable maritime industry collaboration and for effective use of local and regional resources in achieving environmental, economic and social benefits.

To achieve this goal, development of a technology platform based on unique simulation tools and real time information made available through the full-scale application of new processing/control equipment and technologies is required. This platform will be used to facilitate collaboration and decision-making, by simulating strategies and policies proposed by various stakeholders and quantifying their potential outcome. The - flow of information among key stakeholders and between the stakeholders and the proposed system are shown in the figure below. Illustrative benefits to the stakeholders that would arise from implementing the proposed analytical framework are also summarized in the figure. The ultimate benefit of implementing the proposed framework would be the development of synergistic efficiencies, which would result in total accrued benefits to the system exceeding the sum of the benefits flowing to the individual stakeholders.

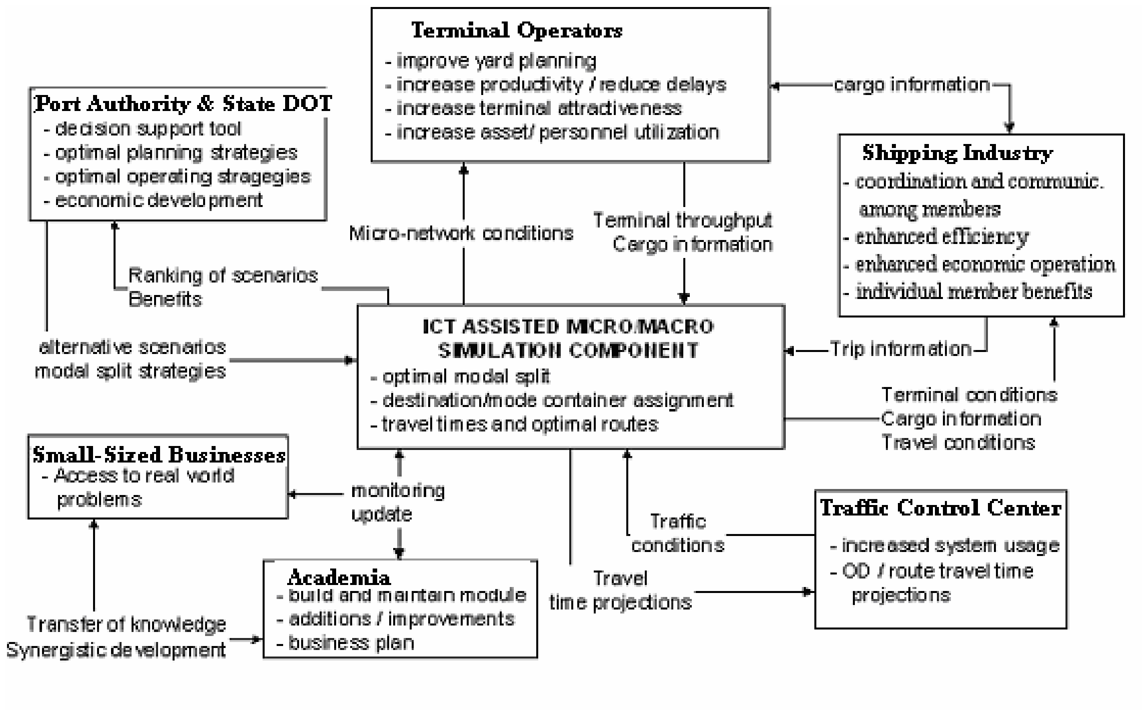

Figure 1: Proposed Framework

Implementing the proposed framework would leverage a maritime expert nucleus to match all members' resources and abilities to address the strategic, tactical and operational aspects of the regional maritime industry in an integrated and unique way.

Technology Platform

The technology platform, - to be used at the core of the proposed framework, integrates analytical and simulation tools with Information and Communication Technologies (ICT). It has the ability to model, in a very detailed level, the transportation network around the port. Additionally, it extends the modeling effort to include inland intermodal terminals, which in the NY/NJ region are part of the PIDN system.

Ideally, this platform would use a hybrid meso-micro traffic simulation tool that has the potential to faithfully represent the particularities of freight traffic *[32]*. The aggregate meso-scopic simulation model would be able to estimate the flows through the sensitive area of the Port from the larger regional network; however, as soon as the freight and passenger traffic enters the area of interest around the Port, a microscopic simulator would be invoked to model traffic propagation and queuing phenomena. This would allow more precise analyses of the impact of policy and operational interventions by the Port as well as by the highway authorities. In addition, the model would be able to capture the individual routing decisions by freight operators in response to the various interventions by the authorities.

The - proposed model could help all stakeholders to *jointly* evaluate the impact of one stakeholder's decision on the rest of the system (and the other stakeholders). For example, while it is expected that if the Port deploys a reservation system at the gate of the terminal (that regulates entrance of truck traffic) will affect traffic conditions around the area of the Port, so far no way exists of quantifying the positive or negative impacts on the passenger traffic, or the accessibility to the Port; the proposed model would enable the stakeholders to perform such data-driven quantitative analysis, making joint decisions. Most importantly this tool will allow all constituents to be aware of the impact of their decisions on the operations of others and the system at large. Several such "what-if" scenarios can be developed and tested, and the anticipated user and public benefits of the proposed strategies and scenarios can then be effectively quantified and disseminated to the stakeholders.

Potential Applications

An enormous number of potential applications of the proposed framework exist, which along with an *outreach campaign* and a focused *educational/training program* would increase the potential for sustainable use of the proposed system. Potential scenarios and strategies - - implemented and tested are representative of all levels of planning, - strategic, tactical and operational, -demonstrate- benefits to all partners involved. Examples of scenarios and strategies that may be modeled include the following:

- *Development of a value-added corridor in New Jersey*. The concept of an International Intermodal Transportation Corridor in New Jersey has attracted great attention over the last few years. There is a great potential associated with the implementation of this project, which aims at increasing the attraction and service of a growing value-added distribution sector located in close proximity to the container terminals of Port Newark and Port Elizabeth. Several questions related to the potential impact of the proposed corridor, including truck trip reduction, emissions, accidents and cost savings, may be addressed through application of the proposed system.
- *Optimal modal split and distribution of freight*. One of the goals of the PIDN system is to increase the utilization of rail and barge, to move cargo quickly out of the port terminals and to inland distribution centers. As mentioned earlier in this paper, about 13 percent of the container traffic is transported off the port by rail and the port authority is expecting that this number will grow to as much as 30 percent in the future *[33]*. Although barge represents a smaller share of the overall traffic, there are ongoing efforts to improve its attractiveness and increase its share. Roadway congestion and associated truck delays make these options increasingly attractive. Concerns have been expressed, however, that boxes that move out of the port and to inland terminals by rail or barge are often moved back to their destination near to the port by truck. Our system will enable evaluating the costs and benefits associated with these movements and can help ascertain better assignment of containers to destinations and modes. Thus, recommendations could be made to the mode operators and the steamship lines and shippers who would make the ultimate decisions on how the containers would be directed.
- *Gate appointment system*. There is ongoing discussion leading to the implementation of a gate appointment system at the ports' terminals. Network modifications in terms of implementation of priority lanes to further assist this effort may be modeled and

evaluated through the proposed framework. The efficiency of such a system may be further improved if linked with the I-95 corridor and other regional information systems. The meso- / micro-simulation tool would be very effective in modeling this option and quantifying the expected outcomes.

- *Vehicle routing decisions.* This new system will also help provide traffic and travel time information to and from the terminal to trucking companies. This information can be used for optimal routing decisions. Routing decisions may then be communicated to the terminal, either as part of the gate appointment system, or to potentially be used to assist yard operations. In a highly congested terminal- in terms of yard storage capacity, where boxes may be stacked three high, there is a substantial number of unproductive moves that takes place to retrieve a container buried at the bottom of a stack. Prior information on the arrival of a truck may assist in eliminating some unproductive moves by selecting containers during this “shuffling” process that are to be picked up within a certain time window, and either leaving them on the top of a stack, or moving them in a temporary storage space. This kind of information can further assist terminal operators in formulating handling and terminal equipment allocation and dispatching.

Evaluating the impact of off peak container delivering strategies to port access network traffic conditions. Off-peak delivery and off-peak terminal gate appointment schemes represent a strategy that deserves further attention in relation to efforts to alleviate port access network congestion and to increase marine terminal and port system productivity. Extended hour gate operation and appointment schemes elsewhere have gathered interest, although first evaluation results show that when measures are imposed from the outside and not as an industry response to a perceived problem results are rather moderate *[34]*. Convincing major steamship lines and marine terminal customers, such as major regional shippers and consignees, to actively support such off peak delivery schemes is directly related to the ability to show tangible economic benefits for them. The micro-simulation quantitative approach will serve as a convincing tool in showing tangible benefits to them. Also, evaluation of the impact of these strategies to the port road access network will be useful in taking appropriate decisions and evaluating their consequences.

Furthermore, combination of strategies may be modeled and their potential could be assessed. For example, due to a variety of internal and external factors, the FIRST system did not gain a significant level of usage over the course of the evaluation period. A simulation follow-up study could be performed, examining the same system with the addition of a gate appointment system at a terminal. The results could be promising showing that small additions to already existing concepts could play a huge role in the success or failure of a project. Implementation of - this tool will provide the platform upon which additional projects may be built, with marginal effort. The platform can also be linked to new regional initiatives to further increase it’s potential and promote the concept of integrated regional systems.

IMPLEMENTATION

Development of the *technology platform* described above is key factor to the successful implementation of the proposed framework. However, other critical factors, such as an *outreach campaign* and a focused *educational program*, would increase the potential for success. These three factors must be interconnected, as shown in Figure 2, to achieve optimal efficiencies of the proposed framework.

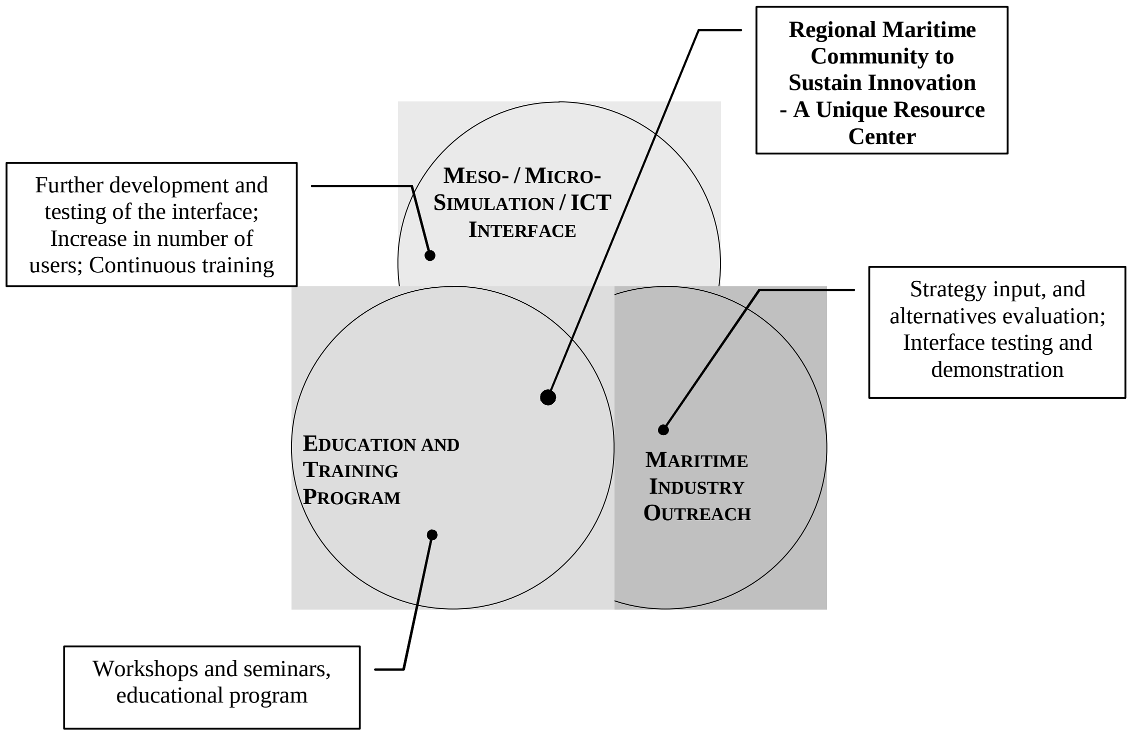

Figure 2: Key Factors for Successful Framework Implementation

Outreach Campaign

An outreach campaign would help bring together the many stakeholders in the port community area. The scope of such an effort would be to communicate to all stakeholders the user and public benefits of various simulated scenarios. Quantifying the anticipated benefits from proposed projects, both for the public in general but also for individual stakeholders, would increase the stakeholders' interest and participation, thus increasing the opportunities for successful implementation of potentially successful projects. The outreach effort would capitalize on the power of coordinated efforts to produce better results and optimal efficiencies.

In a market as competitive and dynamic as the maritime industry, it is often difficult to achieve collaborative efforts, unless there is a strong economic benefit and tangible outcomes for each collaborator. This work will directly help in this direction by quantifying these benefits and outcomes. The outreach effort should develop the means of communicating these results to the stakeholders.

Educational/Training Program

An industry-oriented education and training program would educate the regional work force and produce researchers and practitioners that understand the key issues in maritime transportation and port operations and are able to approach them with a solid scientific background and real world understanding. The freight industry, and as an extension the maritime and port industries, are very complex and dynamic. The new generation of transportation experts who will be involved in various sectors of these industries need to have a solid understanding of these complexities and the dynamics, which, in addition to giving them a competitive advantage in the market place, will also facilitate cooperation and collaboration among them in addressing regional issues.

The Role of the Academia

There are several University efforts trying to address issues in the freight and maritime industry. Among these, Rutgers University, through its various departments and its well established centers and programs supports several focused initiatives aiming to assist this industry. The Freight Transportation Center of Excellence (FTCE) for example, is an initiative funded through the Academic Excellence Fund at Rutgers University and is an outgrowth of the University President's Transportation Coordinating Council (TCC). This initiative establishes a university-wide, interdisciplinary effort, focusing on research and collaboration among the university, government and industry, and could be an excellent vehicle to facilitate the outreach component of the proposed framework. The various departments and other units from the Schools of Engineering, Business, and Planning and Public Policy offer courses that address the needs of the educational component that supports the proposed framework. The Center for Advanced Infrastructure and Transportation (CAIT) through its Maritime Infrastructure Engineering and Management Program (MIEMP) and the Camden School of Business are leading an effort in the development of the proposed technology platform and the demonstration of its applicability to the region's maritime industry.

Academia can play a leading role in the development and successful implementation of the proposed framework, by developing and operating the technology platform, assisting and leading the outreach efforts and implementing the related educational programs within the University curricula.

CONCLUSIONS

Based on a technology platform, this paper presents a framework which aims at facilitating cooperation and collaboration among key industry stakeholders. The purpose of this work is to improve the overall freight movement in a region, reducing traffic congestion and associated inefficiencies and, thereby, increasing the competitiveness of the Port and of the regional economy. Success of the proposed framework depends on the successful implementation of three key initiatives: (a) the technology platform development and implementation, which will enable the partnership as a whole to evaluate collective efforts and the impacts of one's decisions on the others and on the system as whole; (b) the outreach initiative, which will cultivate relationships among stakeholders and will allow them to better understand each others role in the greater freight transport system; and (c) the educational initiative, which will aim to advance a major sector of the global, national and regional economy, and to broaden the knowledge base pertaining to maritime transportation research and education.

The ultimate goal of this work is to build critical collaborations with strong representation from key stakeholders in the port and maritime industry. Such collaborations along with the powerful technology tools will increase the potential to successfully build a stronger regional maritime community, support the policy and decision making process, assist in the selection of the most promising regional projects for implementation and support a dynamic industry oriented education and training program.

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