A Simulation Model to Analyze the Impact of Crisis Conditions on the Performance of Port Operations


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Project Objectives
The main objective of this study is to identify the impact of crisis conditions, such as hurricanes, on the performance of port operations. This objective will be achieved by pursuing two specific aims:

i) Identify and assess the current port operations under crisis conditions. Determine what kind of back-up plans do companies (e.g. grain and soil, automotive, and furniture companies) have to overcome such crisis conditions.

ii) Identify alternative routes/ports for those companies who regularly use the port currently affected by the crisis.

Project Abstract
Background: Ports are major intermodal facilities where multiple modes of transportation (rail, water, trucks) meet. Crisis conditions such as natural and man-made disasters in and around ports will significantly impact the port operations leading to undesired effects such as delays in the flow of
materials through the port. This project will assess the impact of crisis conditions on port operations and develop a simulation model that can be used to plan for such conditions.

The acting administrator of the U.S. Department of Transportation’s Pipeline and Hazardous Material Safety Administration addressed the Organization of Women in International Trade in June 2005. Based on the statistics provided in her speech [1], the U.S. is the world’s largest importer and exporter. The nation’s 361 seaports are the gateway for more than 80% of the foreign trade. All freight moving in, out, and within the U.S. amounts to more than 15 billion tons, valued at over $9 trillion. Of the $9 trillion about $2 trillion is due to international trade. It is estimated that the overall freight volumes will grow by more than 60% by 2020. “In the same time interval, every major U.S. port is projected to at least double the volume of cargo it is expected to handle” [2]. In fact some of these ports will triple or even quadruple the volume they will handle.

In addition to ports, other elements of the U.S. intermodal distribution system, which includes rail hubs, trucking hubs, and other inland hubs, also face capacity challenges. Unfortunately, adding capacity to the intermodal system is time consuming and costly. For example, constructing major landfills for port expansion is a decade-long process. Another example is the Port of Oakland dredging project. This project experienced costs related to environmental compliance, engineering, permitting, etc. that exceeded the actual cost of dredging. These examples demonstrate the need for tools such as the proposed simulation tool that will enable decision makers to better utilize the existing capacity. Although adding capacity may be the only option in the long run, simulation or optimization tools may help reduce congestion and cost in the short run.

A wide variety of industries (e.g. the grain and oilseed industry, the furniture industry, the automotive industry, etc.) rely on efficient port operations to receive the raw materials for their businesses as well as ship their products to the customers. Crisis conditions such as natural and man-made disasters will negatively impact these industries due to delays in the flow of materials through the affected port. Thus, these industry representatives as well as port operators need tools that can be used to assess the impact of such crisis conditions. Ideally these tools should have the capability to determine alternative ports or routes to ship the products.

Research Scope: In order to perform the analysis we will build a discrete-event simulation model. The model will capture the relationship between different players in the supply chain; and reflect the uncertainties related to lead time and customer demand. We will focus on the ports in the gulf coast.

Research Impact: This research will positively impact a number of industries by: (a) estimating the delay in material flow through a port and the associated cost and (b) identifying alternative ports and routes for those industries under crisis conditions.

Project Deliverables:
1) Estimates of the impact of crisis conditions on delays in material flow.
2) A simulation model for port operations that will allow a variety of “what-if” analysis.
3) Final report that summarizes the findings of the study.

Task Description
Task 1: Data collection:
The three major data categories needed to complete this project include data related to inbound logistics, data related to container handling operations, and data related to outbound logistics. In the data collection phase the following questions will be answered:

- How many shipments does the port receive?
- How many containers arrive with each shipment?
- What kind of cranes/fork lifts are used to load/unload the containers?
- What is the typical route a container follows within the port after it arrives and is unloaded?
- How much time does a container spend at the port before it leaves the port?

Majority of the data will be collected from the managers of the New Orleans port. The student will also collect data from published reports by the U.S. Chamber of Commerce.

Task 2: Model development:
Simulation modeling has been successfully used to analyze intermodal operations and capacity issues for a variety of facilities. These models provide analyses mechanism for large intermodal facilities that are difficult to duplicate with other methods due to the interaction of many variables, the large size of the problem and the uncertainties involved [3, 4]. Simulation provides a convenient “test bed” for exploring the impact that variables, such as, equipments, resources (cranes, fork-lifts), infrastructure, layouts, and networks (tracks, storage locations), forecasted demand, arrival and departure schedule, operations rules, have on the performance of port operations.

The development of the conceptual model will be done primarily by the PI and the co-PIs. The student will be mainly responsible for developing the model using simulation software such as Flexsim or ProModel.

Task 3: Model validation and verification:
Once the simulation model is developed it will be validated and verified. Validation will be performed by the graduate student. This process is basically making sure that the simulation code is free of bugs. The verification step will be performed mostly by the PI. This process includes taking the simulation tool to at least one port manager to make sure that the simulation is accurately replicating the actual system.

Task 4: Analysis of the results and preparation of the final report.
After the simulation tool is validated and verified a number of scenarios will be simulated to account for different crisis conditions. The description of the simulation model and the results will be summarized in a final report.

Technology Transfer
The PI plans to disseminate the findings of this research in the form of publications in academic journals and presentations in national and international conferences. The results will also be presented to business development officials and local businesses. For example, we have already discussed the project with the Deputy Director of Port Development in New Orleans and the Emergency Planning & Education Coordinator of the Mississippi Trucking Association. They both indicated that they would be interested in the results of this study and help in any way they can to transfer the technology to the user community.
Benefits of the Project

1. To the Industry: This study will provide a simulation tool that can be used primarily by port managers. However, the simulation model can be modified to analyze inland intermodal facilities also. The simulation tool will allow port managers to perform “what-if” analysis and enable them to make more informed decisions. The tool can also be used by companies whose products are moving through those ports. As indicated by the support letter, if funded, the research outcomes of this project will be of benefit to the industry.

2. To the general body of knowledge: Existing simulation models for port operations are developed assuming normal operating conditions. However, in crisis conditions these models fail to provide meaningful results. The proposed study will contribute to the general body of knowledge by incorporating uncertain events such as natural or man-made disasters into models that simulate port operations.