# Application of GIS Technologies in Port Facilities and Operations Management

Edited by
Neal T. Wright, P.E.

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# APPLICATION OF GIS TECHNOLOGIES IN PORT FACILITIES AND OPERATIONS MANAGEMENT

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# I. INTRODUCTION

The port engineering community is a diverse body of professionals charged with maintaining facilities that vary in complexity from the Ports of Los Angeles and Long Beach on one hand, to small niche facilities specializing in one commodity. The staff available to manage port infrastructure and material handling equipment also varies widely. However, regardless of the size of staff employed or contracted, the port engineer faces a myriad of problems very similar to those encountered by a city or county Director of Public Works.

Managing port infrastructure, and the attendant heavy material handling equipment, is by nature a capital-intensive business. Marine terminal facilities may be state owned and run, leased to large terminal management firms, or owned and operated by private industry. However, regardless of the form of ownership and operation, port engineers are responsible for the proper maintenance and upkeep of existing assets, projecting necessary expansion of new facilities as well as planning to meet port security requirements. The Maritime Transportation Security Act of 2002 (MTSA), signed on November 25, 2002, was fully implemented on July 1, 2004 (USDHS, 2003) and mandates a number of additional security measures.

Marine terminal infrastructure and equipment function in the harshest of environments, causing accelerated deterioration and failure of assets when compared to inland facilities such as highways and bridges. For example, exposure to the combination of tidal action, sustained winds, wave action, high chloride concentrations and invasive marine life is quite unique to marine terminals. Severe operating loads further compound the accelerated aging of a marine infrastructure. Marine terminal facilities are subjected to heavy loadings, impact damage from ships and cargo handling equipment, and a sustained high tempo of operations that lead to massive wear and tear on structures and upland pavements. The result is a significant backlog of maintenance and repair that never seems to be resolved. A critical issue facing port engineers and their leadership is how to balance the need for new construction with the expense of major maintenance of current assets.

## I.A Concept of a Port GIS

How then can port managers and engineers best identify and prioritize projects among competing demands? We believe the key to successful port engineering is the integration of vital infrastructure information in a robust and functioning Geographic Information System (GIS). Regardless of the type of port facilities, similar basic facilities data is maintained, often in hard copy format only. Property surveys, facility base maps, soil-boring data, building plans and facility as-built drawings are fairly common types of records maintained by port engineers. All of such data can be referenced and tied together using a spatial context – thus creating a geographic port data framework.

Applying an integrated GIS to a port offers facility management professionals the opportunity to catalog this disparate information using established standards and data conventions. The catalogued data can then be managed according to parameters set by the users to provide better integration of information and yield better decision support products. Information is no longer fragmented or isolated, and multiple data types and scales start providing critical and usable correlations to support both short-range and long-term decision making processes.

### I.A.1 Basic Concepts

In past few decades, rapid spread of technology has transformed the conventional port engineering and facility management activities into highly information and data-driven decision-making process. Such transformation driven by information/data has enabled the development of extremely complex systems for handling and processing information to assess, analyze, communicate and make decisions on our activities on daily basis. This trend has been particularly accelerated by proliferation of personal computers in late 80's and the growing availability of spatial data.

Many of our decisions are largely depending on the details of our immediate surroundings and require information about specific places on the Earth's surface (and increasingly over and under the surface) in relationship to the specific problem. Such information is called Geographic or Spatial. Thus, a Geographic Information System (GIS) is a container for spatial information that allows us to apply general principles to the specific conditions of each location, and allows us to track what, why, and how is happening at a given location (Longley et al., 2005). Geographical information, intrinsically, becomes essential for effective planning and decision making in the modern society. For many years, though, GIS has been considered to be too difficult, expensive, and proprietary. The advent of graphical user interface (GUI), powerful and affordable hardware and software, and public digital data have broadened the range of GIS applications and brought GIS to mainstream use.

There are many different definitions of GIS that have been evolved over the years, as they were needed. The definition of GIS would often depend on the application of geospatial data. Among them, the most frequently used definition of GIS is based on a simple description of its components; (1) map element (=spatial), (2) data element (=attributal), (3) software and hardware element (=georeferencing), and (4) knowledgeable users (=problem solving). Here, it is imperative to emphasize the importance of the 'knowledgeable users' element. Without the 'knowledgeable users' element, it is highly likely that the GIS implementation would probably end up with a loosely bound mass of top-rated, expensive data, software and hardware that is incapable of functioning in problem solving and facilitating useful information for effective decision making process. The result would likely be a unsuccessful GIS implementation with a depreciated ROI (Return On Investment) potential.

Some other well-known definitions of GIS include the classical one by Dueker (1979), "GIS is a special case of information system where the database consists of observation on spatially distributed features, activities or events, which are