Sustainable Infrastructure: Leveraging the Asset Management Framework Using GIS for Ports

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Infrastructure is the basic framework of structures, facilities, buildings, power lines, etc. Infrastructure is needed for the operation of a city, area, nation, or enterprise. Sustainability is about the quality of life for the future and will have different meanings and methods for different people, disciplines, and organisations but what we may all agree upon is its perceived objectives of economic prosperity, environmental stewardship, and social responsibility. Sustainability permeates the entire physical space that we have around us and therefore touches us in everything that we do. The American Society for Civil Engineers uses a set of factors as the criteria for drawing up a grading scale on which an A grade means that the infrastructure is in excellent physical condition (could be new or rehabilitated to reset its lifecycle) and has the capacity to meet the needs in future. America got a D+ on this report card, prompting us to refocus on how we manage our infrastructure assets.

Enterprise Asset Management (EAM)

There are many ways in which Enterprise Asset Management (EAM) has been defined over the years. Sometimes, it can be defined from an operational perspective since all maintenance work is to be tracked in a system or it can be deemed to be a repository of equipment and its associated functions. Other times it can be viewed to be a kind of financial system as worker and equipment rates help put a dollar value to different tasks rates. Taking a much broad view, the International Organisation for Standardisation (ISO) in its standard ISO 55000: 2014 defines asset management as a "coordinated activity of an organisation to realise value from assets" and an asset is defined, in the same standard, as "a thing or entity that has potential or actual value to an organisation." Simply stated, it is a framework that tells us what to do but not how to do. Organisations can leverage their existing workflow and business processes to implement an asset management program that will facilitate the management of their infrastructure, at the enterprise level.

The Port: A Mini City

In terms of its functions, a port can be very well thought of as a mini city. A port has buildings and structure, rail and road network within and outside the port, infrastructure for ships and vessels; it has vehicles entering and leaving the port, it has utilities, sanitary, storm infrastructure and it is a living economic entity much like a city. It also has security needs not only for the cargo that passes through but also for the ships, equipment, and the people who work there. With that analogy, we can view the functions and challenges faced by port managers and engineers much the same way as the City managers and personnel.

Five key questions

1. Asset Repository

A port manager needs to have access to some very pertinent information starting with basic questions like:
* What do I own?
* Where is it?
* What is their condition?

These answers can be found in an Asset Inventory of the port. The inventory serves as the primary system of record of all assets and the other relevant information that is associated with the asset. Every asset has a defined physical location. While all the other attributes contribute immensely to the identification and details of an asset, the "where" (physical location) provides the spatial frame of reference vis-à-vis all the other factors that are present within and around the area of interest.

2. Levels of Service

The port is an economic entity and has a defined framework in which it operates. From that perspective, a port administrator would like to know:
* Who are the users of the facilities and services that the port offers?
* What is the demand on each of the facilities or the type of service?
* How are those facilities and equipment performing?
* What is the regulatory framework for which compliance must be established and maintained, for example environmental and energy?

These questions establish an operational path to understanding key stake holders for the port as well as the Service Level Agreements (SLA) for the assets and the operations.

3. Sustainability, Criticality and Risk

The demand on the use of a facility or an asset or the need for the availability of a service helps establish its value and therefore its criticality. A port manager needs to know:
* What assets / services are critical?
* What is the likelihood and what are the consequences of failure/non-availability of a resource?

The risk factor and consequences of a disruption of a service provided by the port or the non-availability of an asset on the port can be better and quantitatively assessed through the asset management tools. Business risk shapes the way we function and sustain the organisation. The motive behind these questions or information is to equip port administration with information to ensure that essential functions can be sustained or restored on a priority upon the disruption of normal activities. With all this information, readily available, a port manager can also develop key performance indicators (KPIs) that would become the standards for operations.

4. Life Cycle Costs

Business risk drives the Operations and Maintenance (O&M) costs and hence the determination to repair, rehabilitate, or replace an asset. Tracking an asset in an Asset Management system keeps a trail of work performed on it along with the type of work performed and the associated costs. The amount of work performed on all assets in the enterprise helps determine broadly the costs of running the port, which can be easily bracketed into different facilities/plants or by equipment. Comparing the costs of all work performed on a single asset and the original cost of the asset can help drive the decision to repair, rehabilitate, or replace the asset. Assets, for which repair and rehab options are no longer a possibility, can be moved to a

separate listing that helps draw the Capital Improvements Program (CIP) items.

5. Funding

The costs of ensuring sustained performance of assets and facilities and the need for replacement items from a CIP list provide the core data for the budgetary process. The funding strategy can provide quantitative justification for projects and their timing and hence the need for allocation of budgetary resources towards it. The goal of an EAM is to align to the business goals of the organisation to provide for sustainable levels of services while managing the life cycle costs to be low. (See Figure 1)

What is GIS?

Our physical environment is the "G" that stands for Geography and everything that we see around us is defined by its unique physical location. The way we understand this physical location is as an address, a landmark, that we reference with directions and coordinates. There are additional attributes that we link the location for purposes of recognition, significance, and use. Each and every location thus becomes a data point. That is the "I" that stands for the Information about the elements in the physical environment. The "S" is the System, the technology, science, and tools that we use to comprehend, visualise, and analyse the information about our physical environment. Everything happens somewhere in our geographic space and therefore being aware of what is happening around us has become essential and integral to what we do. GIS provides and enables the following functions:
* Data visualisation and Mapping
* Analysis and Modelling
* Data integration and Management
* Planning and Design
That leads to decision making and action. (See Figure 2)

Integrating the Functions of a Port using GIS and EAM

GIS is a system of record for all spatial and other relevant information. A GIS system serves as the storehouse of all information that can address various business functions on a port like:
* Property Management - Where are all the assets, how much vacant land/space is available?
* Planning, Design and Construction - What can be built where and why would it be more suitable to build a certain structure in a location versus siting it elsewhere on the
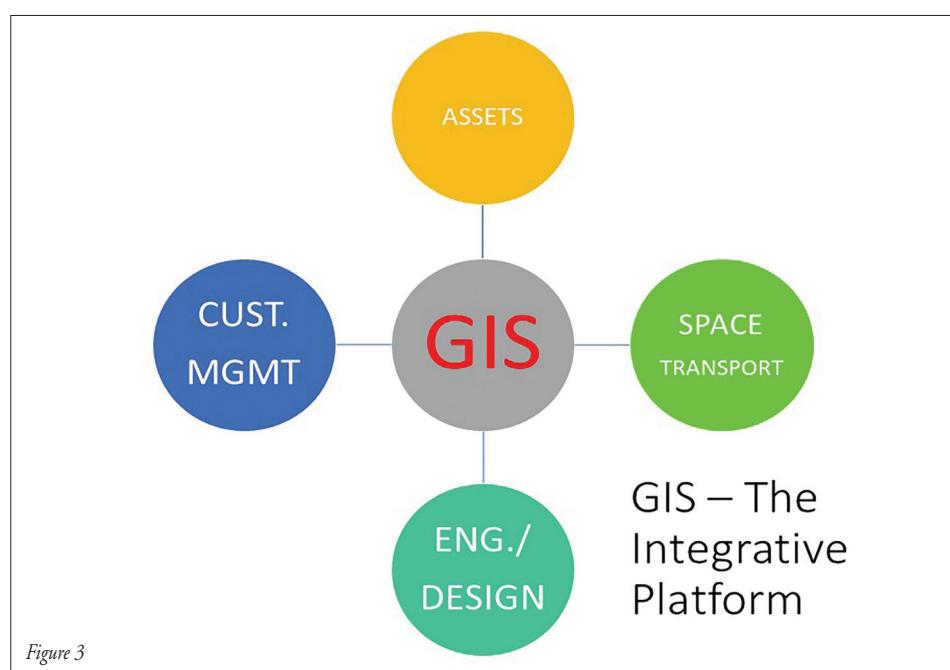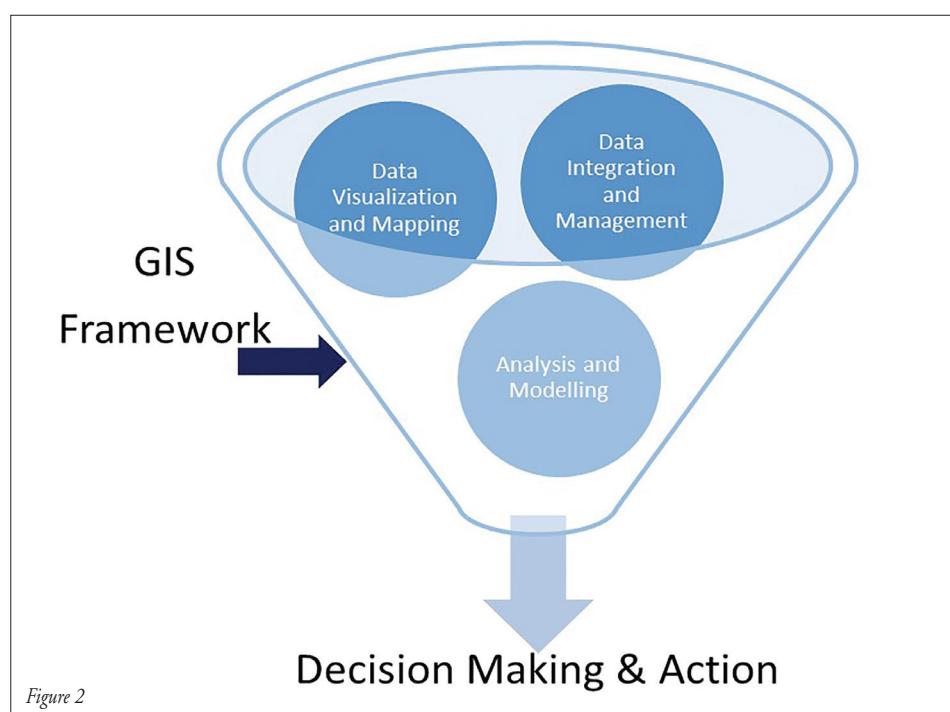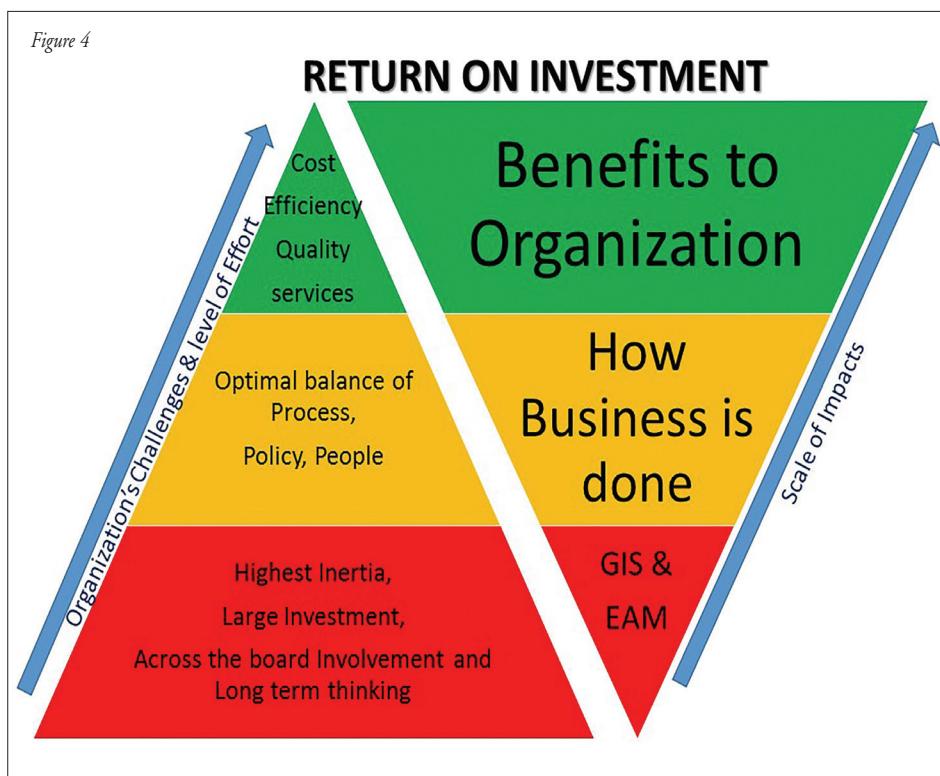

Figure 1

GIS Framework

Decision Making & Action

Figure 2

GIS – The Integrative Platform

Figure 3

Figure 4

RETURN ON INVESTMENT

Organization's Challenges & level of Effort

Cost Efficiency
Quality services

Optimal balance of Process, Policy, People

Highest Inertia,
Large Investment,
Across the board Involvement and Long term thinking

Benefits to Organization

How Business is done

GIS & EAM

Scale of Impacts

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port facility? What are the other structures or facilities that could complement or hinder a proposed piece of infrastructure?

* Space Management - GIS can help carve out areas or zones on a port by use type, proximity, access, or any other business driven criteria. Transactional zones like pick up and drop off too can be created with GIS to facilitate operations and service delivery to its customers.

* Transportation - With the help of GIS access points that connect well with the highway networks can be determined and shared to all service providers and customers.

* Operations & Maintenance - GIS and EAM together help provide information on where the requests for services are located. Where is the work (Inspection, O&M or CIP) located and how much it would cost and what resources will be needed to perform the task? The volume of requests for service received will provide a marker for the workload of that unit or facility. If there are 20 water related issues in a day and with just one crew, the average time to take care of one issue is approximately an hour and it would not be difficult to document a resource gap as well as the backlog of work to be performed. GIS serves as the integrative platform to connect, analyse and manage all these functions at all scales *(see Figure 3)*. Port managers and administrators need to embrace GIS integrated EAM so that

data driven infrastructure management can happen.

A Program not a Project

We live in a world of continuous movement that requires constant monitoring and frequent measurements or else we lose the currency of the data that we have on our infrastructure. New technologies and tools, policies, compliance framework, and reporting needs influence and change the way business is conducted. Therefore, EAM should be a program with a roadmap and dedicated funding aimed at refining its effectiveness at regular intervals.

Hitting the Home Run - The ROI

Getting the most out of an investment is essentially hitting the home run. An investment in GIS lays the foundation by locating all resources as a start. It then can be enriched with more details as attributes and with relationships to another infrastructure to build a network or an ecosystem. Laterals can be located and defined by size, material, inspection and maintenance schedules, criticality, and etc. and can be connected to valves and mains to form the network that can then be used to map the water service infrastructure on a port. Documented work orders, with costs and labour, build the work order history on the laterals or components of the network and provide the information stack that can help drive a repair, rehab, or replace decision. The inspection and

maintenance schedules, when built into the system, enable maintenance staff to plan the work proactively. Performance indicators drawn from different points on the life cycle of a request for service or the life cycle of an asset speak of the efficiencies of the system. With management of risk and safety (down time or non-availability of a resource/service), cost efficiency, and quality of service delivery as its determinants of effectiveness, an EAM provides the proof of its Return on Investment.

The Challenge

The maximum inertia, investment, and heavy lifting resides in the initial steps of setting up of a GIS and EAM system *(see Figure 4)*. A lot of agencies consider setting up and installing the software component as the end all, be all, and hence fail to reap the full benefits of an EAM. The challenge to overcome is a good asset management program that continually revisits its GIS repository, maintains its currency, and keeps refining the balance of technology, processes, and their adoption by the end users. WPD

This technical paper was presented by Pravin Mathur, Director of Geospatial Information Systems, Clark Nexsen, at the 9th Port & Terminal Technology USA Conference & Exhibition 2017 which took place in Norfolk, Virginia back on 11th & 12th April. Officially hosted by The Port of Virginia, the event attracted over 185 key port and terminal representatives from across the globe. For more information on the upcoming 2018 event and to view the call for papers please visit www.mcimedia.com