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INNOVATION IN PORT INFRASTRUCTURE DESIGN

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ABSTRACT

Engineering systems are facing a tremendous challenge today. This also applies to port sector which has to deal with the changing environment highlighted by the economic downturn, the rapidly evolving global market, the changing patterns of trade and consumption, and advancements in technology. The answer lies in gaining insights into new problems and emerging issues, in developing new perspectives, in the ability to accept new ideas, and in the ability to innovate. New trends and changes in vision have emerged, and perhaps, the focus of innovation needs to change. This paper proposes a framework for guiding port infrastructure innovation, which is more effective for present volatile times.

KEYWORDS

Port infrastructures, infrastructure system, innovation, system attributes, uncertainty

INTRODUCTION

The world is in the midst of a significant transition, largely as a result of three major factors: globalization, a changing market place, and changing technology. Engineering systems face the tremendous challenge of meeting the changing demands while ensuring functionality, capacity and service quality (de Neufville (2004), Hansman *et al.* (2005), Roos (2004)). The effect of the changed environment has been two fold. First, it has given rise to new trends in the port sector. Secondly, there have been changes in vision, which have led to new approaches and paradigm shifts in many sectors and disciplines, and instigated new engineering, business and management practices.

Ports have evolved from being cargo loading/unloading centers to logistic nodes in a supply chain (Heaver *et al.*, 2001). The tendency towards integrated transport systems, and changing competition (between supply chains instead of between ports) requires different strategies. As

ports seek to expand, and encroach upon cities, endangered accessibility demands solutions which satisfy social, environmental, and economic interests. Ageing infrastructure, congested ports and inadequate service, the uncertainty posed by leaps in technology, increasing focus on issues such as environment, safety and security, and budget constraints, requires going beyond using state-of-the-art technology to innovative solutions.

The new trends, the rising complexity, and increasing recognition that uncertainty presents not only a risk but an opportunity has led to a search for integrated strategies that will be effective under a wide range of future scenarios. These strategies must encompass a life cycle perspective, and sustainability consideration while satisfying engineering, management, and social requirements.

Being currently surrounded by such an environment, the port industry must keep apace in research areas such as infrastructure and technology development, management practices, port reforms, port investments and policies, and regulations. It must develop new perspectives, adopt a new attitude, accept new thoughts and ideas, and develop the ability to innovate. Innovation has been defined as the process of turning ideas into values and perspectives (Graham, 2008). Innovation, aimed at finding solutions applicable for a wide range of futures, for emergent problems under new constraints, can add value to the port.

RESEARCH OBJECTIVE AND METHODOLOGY

Port research has had to keep apace with an astonishing rate of change since containerization. Port research and innovation themes have diversified in the recent past, and new key research themes are being defined to reflect the changing environment. Even in more traditional areas of research, the focus and approach need to be examined.

The objective of this paper is to:

- propose innovation themes which are more relevant to present times;
- suggest how the approach to port innovation should be changed in keeping with the changes in vision and paradigm shifts in other infrastructure domains.

This will involve the following steps:

1. Examining current trends in the port sector and in port research areas, in order to identify gaps and establish if the research focus needs to be redefined;
2. Identifying emerging issues and paradigms in the field of infrastructure development, that could require change in the present approach to port innovation

Steps 1) and 2) will require extensive literature survey and desk research. The added insights through these steps will used to devise a new framework for guiding port infrastructure innovation. The framework will prioritize innovation themes, and suggest methods and techniques found effective in other infrastructure domains. It will be discussed with experts (from Port Authority of Rotterdam, consulting engineers, and research institutes) and their input will be incorporated in the framework.

CONCLUSIONS

The port industry has been seen as a very traditional, sometimes old fashioned environment, and one that reflects the reactive approach that the industry has had towards the implementation of new concepts (Paixa˜o and Marlow 2003). Innovation is required to

address the unprecedented challenges presented by the growing volatility, and the increasing environmental and social considerations, resulting in stricter regulations.
The scope of this paper is limited to three research areas: port planning and development, infrastructure design, and port operations (Figure 1). On basis of the current trends in the port sector, the themes most relevant to present times are: sustainability, accessibility, efficient space use, energy and energy efficiency, added value in supply chains, accessibility, and operational efficiency. Port innovation (in design, practices, and processes) should be directed at these themes in all three research areas.

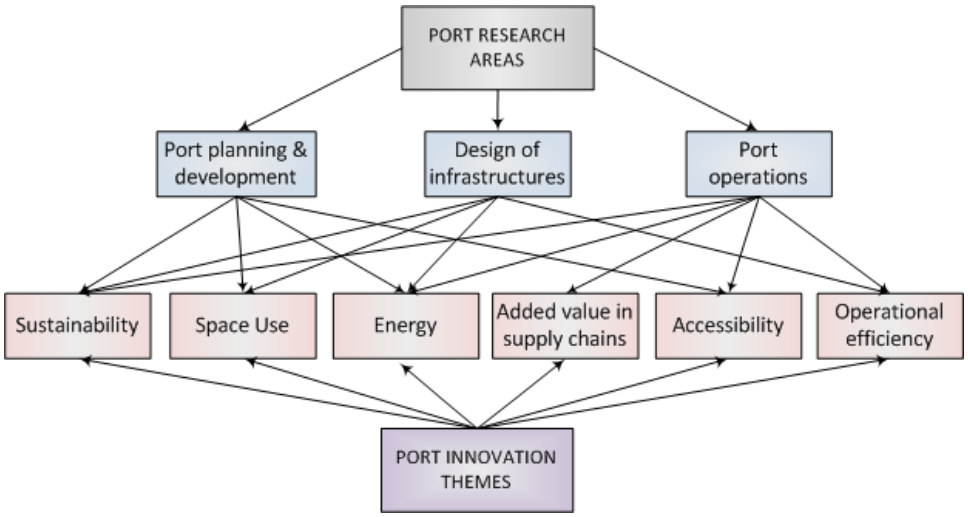

Figure 1: Themes of innovation categorized

The traditional attributes of engineering systems are said to be function, performance, and cost. A life cycle perspective of a system, which emphasizes non-traditional properties, often called "ilities" which include: flexibility, robustness, scalability, safety, durability, sustainability, reliability, recyclability, maintainability and quality, is more appropriate in order to manage the evolution of systems in an uncertain world (Moses, 2004). Thus, innovative solutions must focus on system attributes such as flexibility, adaptability, reliability and maintainability. Flexibility is a fundamental strategy, when incorporated in planning and design of infrastructures, operations, planning, management and organization, or products and services, helps to react to environmental uncertainty. Incorporating flexibility includes examining cost–reliability, and cost–flexibility tradeoffs based on a lifecycle perspective.

Infrastructure innovation generally requires considerable investments e.g., in research, engineering design and development, pilot projects etc, and involve risks. Modern evaluation methods known as Real Options Analysis, which can evaluate such a project under multiple scenarios can bring the risks better in picture than the standard evaluation methods such as discounted cash flow (DCF) methods. This can often support decision-making related to innovative projects.

Volberda (1998) refers to three type of innovation: efficiency, evolutionary, and revolutionary innovation. Efficiency innovation focuses on improving what already exists. Evolutionary innovation addresses existing or new issues using state-of the-art approaches and techniques and is often targeted at new markets. Revolutionary innovation focuses on radically new and

better ideas that may, in fact, transform or even dismantle the existing structure, technology and processes of the organization, as well as the marketplace (*Internet* and *Containerization* are two prime examples). The focus of innovation today lies in elaboration of strategies or visions that already exist, in order to gain incremental efficiency gains. A recent study (INSCOPE 2009) by Erasmus University in assignment of Port of Rotterdam and Port of Amsterdam, to evaluate the innovation performance of port related industry in the two ports, revealed that port innovation is directed two thirds at efficiency and only one third at products and processes (evolutionary innovation). This needs to change. Ports can change trajectories by applying proven tools and techniques from other fields. Though revolutionary evolution is mostly an act of serendipity, acknowledging *Black Swans*, and creating an environment which promotes out of box thinking, open mind, risk taking, and cooperation, can be conducive to innovation.

A strategic logic that is termed as *value innovation* is a recent concept, suggests assuming that competition is not a benchmark, developing new capabilities asking: what would we do if starting anew, even shaping industry conditions, and thinking in terms of total customer solution and satisfaction. Value innovation thinking can be recommended for ports; in fact some past developments at Port of Rotterdam can be categorized as value innovation, and may explain how it has stayed ahead of the game. The decision to bring the container to the port of Rotterdam in 1966 (POR, 2006) and subsequently adapting the infrastructure to handle containers, represents value innovation thinking. Similarly, the bold step taken by ECT (Europe Container Terminals) to build the first automated terminal at the Maasvlakte in 1988, then declared to be the logistic blunder of the century (Visser, 1992), represents value innovation.

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