Towards a Framework for Sustainable Port Site Selection

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Towards a Framework for Sustainable Port Site Selection

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Abstract
Nowadays, the drive towards green field port development is accompanied by a general trend towards sustainable development. The location of a port is critical for its long-term success. However, port-related literature, until the publication of a recent PIANC report, offered limited guidance over a sustainable site selection process. A method for sustainable site selection of deep-sea ports is urgently required as most countries worldwide expand their port capacity. This paper presents a methodology for site selection of deep-sea ports based on sustainable design principles such as building with nature and ecosystem-based management, while taking into account stakeholder needs and values. It further applies the proposed methodology to a case study. Myanmar is a country in Southeast Asia requiring expansion of maritime infrastructure and six ports are being planned. The lessons learnt from the case study are used to further refine the proposed framework. The paper concludes that integrating perspectives of engineering, ecology, economy and governance in the site selection process can create added value for the port and the surroundings, thereby providing the port the license to grow. This research contributes to the advancement of port development by providing a practical, validated, and tested method for sustainable site selection, thus supporting broader sustainability goals.

Keywords: port site selection, sustainable ports, port planning

1. Background

Ocean shipping is the most important mode of transport for international merchandise trade and seaports are essential nodes supporting maritime and hinterland connectivity. Currently, ports around the world are looking for ways to accommodate increased waterborne transport using larger vessels while coping with demands and constraints imposed by the new technology, energy transition and climate change. Site selection of new port projects has become an important issue since the location of a port is critical for its development and long-term success and growth.

Site selection of a port can be defined as the process of allocating a specific site or location for port development. In practice, it is often a political decision, but ideally it should be based on technical, economic, and sustainability considerations. A site selection process that is technically, commercially, and sustainably sound will not only increase support for future projects, but also increase the chances of obtaining funding from development agencies. Until recently, no detailed attention was paid to a site selection methodology in literature.

This paper presents a systematic and integrated framework for the site selection of a deep seaport incorporating sustainability considerations for developing countries. This is based on a framework developed recently as a part of an MSc study and subsequently applied to areal-life case study in Myanmar. The lessons learnt from the case study were used to further refine the framework. Interested readers can refer to the complete thesis [1] for details of the study and a comprehensive list of associated references.

2. Approach to port site selection

This section describes the traditional approach for site selection and discusses the new paradigms that contribute towards a more sustainable approach.

2.1 Traditional approach

Many factors influence the location of the port. In port-related text books and guidelines, site selection is seen as the process of allocating a specific site or location for port development, through first identifying potential sites, evaluating these sites by balancing the selected criteria, and thereafter, making a selection to meet (pre-)defined requirements. Though many sources mention site selection criteria, a uniform framework to guide the process is missing. Therefore, many port consultants have laid down their own procedures, which draw upon practical experience and insights. It was only recently, at the time of rounding off the research presented in this paper, that PIANC guidelines [2] elaborating on the process of site selection of ports have been published. This was very opportune and allowed us to validate our framework.

2.2 New paradigms

Sustainability considerations have become essential in all aspects of life, and innovative sustainable design principles such as building with nature, ecosystem-based management, and co-designing with stakeholders to take their needs and values into account are being embraced in large

infrastructure projects. Some relevant concepts are described here briefly and incorporated (see Figure 1) in the framework in Section 3. The essence of the framework is to show which processes, methods and considerations play a role in site selection.

Site Selection Theory: [3] describes four fundamental types of location theories, one of which is the site selection theory that analyses the reasons for the selection of a specific site. During progression of the selection process, the number of sites reduces while the amount of available information about the sites increases.

Ecosystem-based management (EBM): Ecosystem services are the benefits that people derive from ecosystem are at the heart of EBM. EBM is aimed at conserving and sustaining ecosystem services to benefit current and future human generations [4].

Stakeholder-inclusive approach: Integrating engineering, ecology, economy and governance requires early and transparent stakeholder engagement for an open dialogue, accountability and collaboration [5]. Identifying a broad range of stakeholders and organization of multi-stakeholder workshops in order to understand the local situation and drivers of port development and the potential benefits and dis-benefits to the society is essential in a stakeholder-inclusive approach.

These guiding principles have been incorporated in creating a framework for sustainable site selection in developing countries. An initial framework was developed for basic understanding of the site selection process, and further refined after carrying a comprehensive case study in Myanmar.

Furthermore, in 2017, the first results of the PIANC Working Group 185 'Guidelines for site selection and development of greenfield port developments' [2] became publicly available. The steps in their site selection process were similar to the steps in the framework described in this paper: identification of needs and values for the port, spatial needs and identification of possible sites, selection of appropriate evaluation method (similar to [3]) for site selection.

3. Site Selection Process

Figure 1 Guiding sustainability principles (Source: [1]) presenting the integration of ecosystem-based management and a stakeholder-inclusive approach in the site selection framework

The site selection process consists of the following four phases:

1. Project Initiation;
2. Requirements study;
3. Site identification, evaluation and ranking, and
4. Development of conceptual lay-outs.

Based on literature and findings from the case study, a framework for sustainable site selection is presented here. The core of the framework is phase three (see Figure 2), which concerns the actual port site selection. This phase uses a two-stage (1. filtering of a long list and 2. evaluation of a short list) selection process with the following steps:

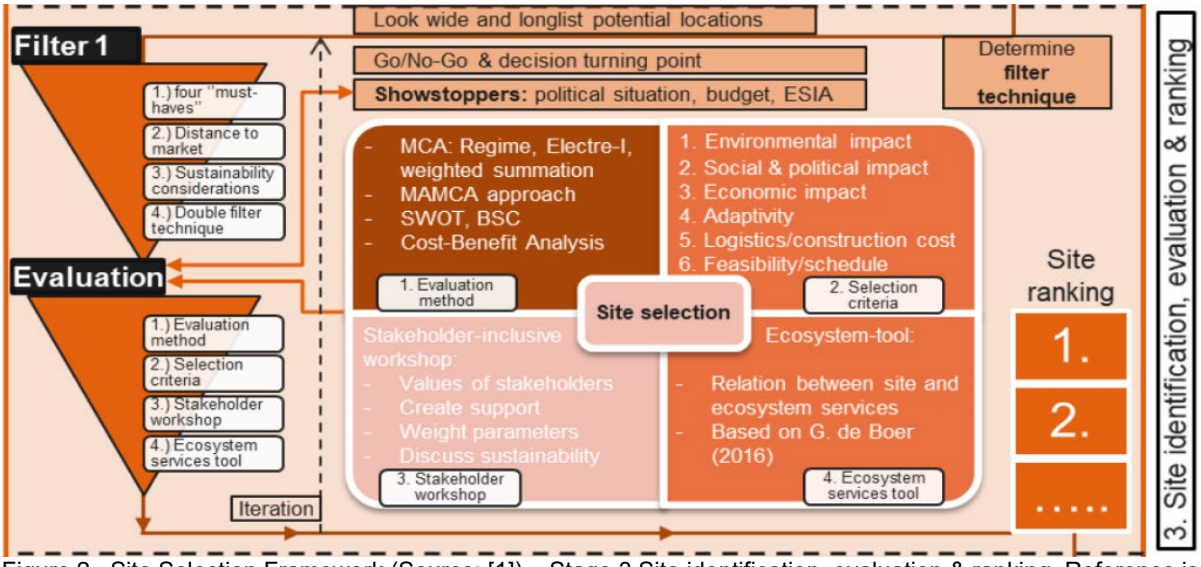

Figure 2 Site Selection Framework (Source: [1]) – Stage 3 Site identification, evaluation & ranking. Reference is made to [1] for the full site selection framework.

- Identification and longlisting of potential sites (both greenfield and brownfield);
- Determination of a filter technique: e.g. physical criteria, distance to market, criteria set up by financing institutions or a combination of criteria;
- Identification of showstoppers: political situation in a specific region, budget, Environmental and social impact assessment (ESIA);
- Evaluation by means of Multi-Actor Multi Criteria Analysis (MAMCA), or similar methods, based on project characteristics;
- Determination of stakeholders needs, values and priorities in a multi-stakeholder workshop
- Identification of ecosystem services at a specific site and the interrelation with a port development;
- Ranking of sites based on stakeholder clustering, economic and political scenarios.
  Detailed information can be found in [1].

4. Case Study

A case study on Myanmar involved three months fieldwork in-country comprised of numerous interviews, desk studies, site studies, a multi-stakeholder workshop (Figure 4). The adopted stakeholder-inclusive approach provided many insights and essential data. The stakeholder values that could be synthesised from the workshop were used for refinement of the initial framework in a bottom-up approach.

4.1 Description

Myanmar, formerly known as Burma, is a country in Southeast Asia with a population close to 60 million. There are nine main ports along Myanmar's coastline. Yangon International Port, located 32 km upstream from the mouth of the Yangon-river, is the largest port handling about 90% of the total throughput and can serve up to 15.000 – 20.000 DWT vessels now, and up to 35.000 DWT in future. Thilawa International Port, an expansion of the Port of Yangon, is located 16 km downstream from Yangon. Figure 3 shows the other ports of Sittwe, Kyaukphyu, Thandwe, Pathein, Mawlamyine, Dawei, Myeik, and Kawthoung. Myanmar's maritime infrastructure needs upgrades since existing ports are mainly up-river, have a limited draught and require continuous maintenance dredging.

Myanmar requires an own deep seaport, apart from the ports developed to serve Indian, China and Thailand. There are several reasons for deep seaport development, presented in below ranking based on Myanmar's priorities:

1. To cater for Myanmar's growing economy;
2. To cater for larger vessels;
3. To boost Myanmar's economy;
4. To lower logistics costs;
5. To compete as a transhipment hub.

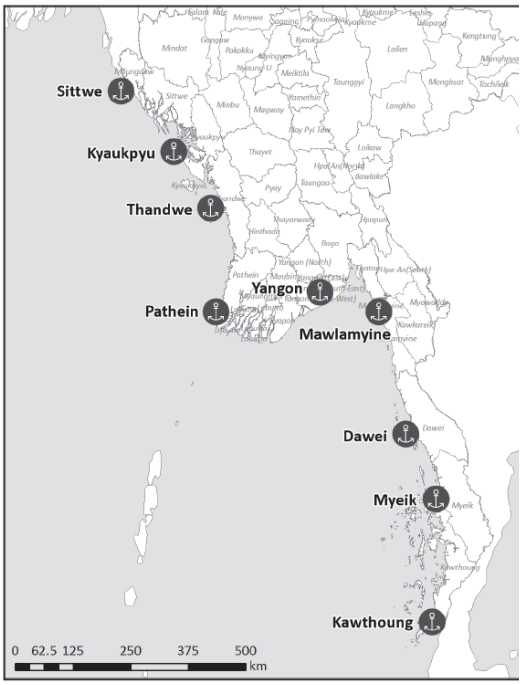

Figure 3 Main ports in Myanmar (Source: [6])

The main motivation for port development in Myanmar is to cater for the growing economy of Myanmar itself, which means serving its own hinterland.

4.2 Steps in the case study

The case study was developed such that the results would be valuable input for the site selection framework. The framework is, essentially, a collection of insights from the case study. The first step in the case study was stakeholder identification and subsequent stakeholder consultation by means of interviews. Twenty (20) stakeholder consultations were conducted, with focus on the following topics:

- Criteria and considerations for current and past site selection and port developments in Myanmar;
- Views of stakeholders on the needs for deep seaports in Myanmar;
- Overview of port development and site selection policy in Myanmar;
- Selection parameters and their importance for selection of deep seaports.

During the case study and enhancement of the initial framework, additional literature and desk study was conducted on different evaluation methods for site evaluation. A Multi-Actor Multi Criteria Analysis (MAMCA) was applied, using a weighted summation method to score the specific site selection requirements.

	Environmental cl.		*Social & political cluster*						
Crit.	DoF	PEG	DMA	MIP	ACP	MPA	MMU	IWT	MPA
1. Environm.	0.31	0.27	0.07	0.14	0.1	0.06	0.07	0.07	0.16
2. Social	0.19	0.09	0.33	0.39	0.29	0.32	0.5	0.33	0.24
3. Economic	0.25	0.17	0.21	0.21	0.1	0.16	0.09	0.21	0.18
4. Adaptivity	0.08	0.13	0.12	0.05	0.15	0.05	0.18	0.12	0.12
5. Log./Con.	0.08	0.22	0.1	0.1	0.18	0.23	0.13	0.1	0.19
6. Feasibility	0.09	0.12	0.17	0.11	0.18	0.18	0.03	0.17	0.11

Figure 6 Environmental cluster and social/political cluster. These weight parameters are input for the MAMCA.

Figure 4 Group picture of interactive multi-stakeholder workshop held on 19 December 2017 [1]

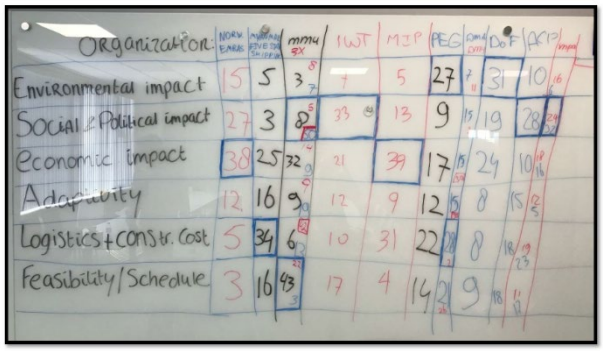

Figure 5 Results of pairwise comparison during the multi-stakeholder workshop for obtaining weight parameters

Finally, a multi-stakeholder workshop (Figure 4) was organised on the 19th of December 2017 titled 'Capacity building on deep seaport development opportunities in Myanmar'. The workshop consisted of two interactive sessions. The first interactive session involved valuation of ecosystem services to investigate the values of Myanmar stakeholders, and to show the impacts (both positive and negative) of port development on the ecosystem. The second interactive session focused on the determination of weight parameters for the site selection criteria (Figure 5) to be used in the MAMCA. The workshop thus supported the stakeholder-inclusive approach of this research.

4.3 Framework application and findings

The application of the framework resulted in a ranking of deep seaport sites in Myanmar. Firstly filter 1 was applied and resulted in a short list based on the key criteria land, depth, connectivity and shelter.

Filter 1 could be evaluated in different ways [1] based on different priorities. Subsequently filter 2 could be applied to evaluate the short list with a Multi-Actor Multi Criteria Analysis using output (weight parameters) of the multi-stakeholder workshop and an ecosystem services tool [1]. Similarities were found within the group of sixteen sets of weighted parameters from the multi-stakeholder workshop.

This enabled the MAMCA to be evaluated based on four scenario's or 'clusters' of stakeholders, i.e., environmental cluster, social & political clusters, economic cluster, and costs cluster (see Figure 6).

Myanmar's coastline can be divided roughly into a North-Western stretch located in the Bay of Bengal, and a Southern stretch located in the Andaman Sea. In general, the Southern stretch is substantially better suited for deep sea port development because of the following four reasons: Arakan mountain range blocking landward access to the Bay of Bengal, corridor (road/rail) developments, mild wave climate of the Andaman Sea, and more stable political situation compared to the North-Western stretch.

Following the site selection process, the first filter resulted in a short list with sites Pathein, Yangon, Mawlamyine and Dawei, all located at the Southern stretch. These four sites were subsequently evaluated in detail with a MAMCA. The results of the analysis suggest that Myanmar should focus on two favored sites for port development. Yangon port should maintain its current activities, and this appears best in combination with a deep sea port near Kalegauk Island, close to the city of Mawlamyine, as Yangon suffers from major physical constraints related to small water depths and large sediment concentrations in the river mouth.

5. Conclusions and recommendations

An important conclusion concerning future deep seaport sites is the fact that the research completed previously [1] cannot point out the 'best site' for a port. Every site has its own pro's and con's, and an optimum site should be chosen based on the actual drivers of port development, selection criteria and corresponding weight parameters determined by the needs and values of stakeholders. The conclusions of the research can, however, provide guidance for the Myanmar decision-makers to formulate their own decisions concerning deep seaport development.

In general, it can be concluded that the framework is suited for site selection using a stakeholder-inclusive approach and ecosystem-based management, which helps Myanmar in selecting a site which caters for the country's own developments. To cite one of the interviewees: *''No one in Myanmar knows which location is best, because all deep seaport projects are introduced, owned, and executed by foreign parties. These foreign parties try to tell Myanmar which location is the best one, however Myanmar needs its own site selection policy.''*

Recommendations for additional research are mainly related to application of the framework on different case studies, and filtering of sites based on e.g. Sustainable Development Goals or the World Bank IFC performance standards.

Site selection is critical to port development and the long-term success and growth of a port, research into optimum and sustainable site selection is of significant value. Validation and application of the framework has proven that the framework is applicable in Myanmar.

The framework is constructed such that it is also applicable in other countries by omitting Myanmar-specific aspects. The essence of the framework is to show which processes, methods and considerations play a role in sustainable site selection.

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