INTEGRATED SUSTAINABLE PORT DESIGN
FRAMEWORK DEVELOPMENT PORT MASTERPLAN
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By

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Ports have evolved into an essential part of a nation’s economy [Schipper et al., 2015]. In order to obtain economic growth and prevent loss of trade and competitive position, the worldwide growth in port development will not stop [PIANC 2014a]. At present the port development process typically results in environmental mitigation and/or harm. This translates into a need for integrated sustainable port master planning [PIANC, 2011].

The aim of this research is to develop a practical tool for sustainable port masterplanning in the form of a framework which can be employed by the port planner in order to systematically guide him/her towards a sustainable port. Developing this framework requires knowledge of the traditional planning process and its missing elements, a clear understanding of what exactly defines a sustainable port and how this port can be obtained through a sustainable process, and various existing knowledge about sustainability of ports through the means of existing sustainable philosophies and well-known global maritime organizations. Case studies can be used for the purpose of enhancing and testing the degree of applicability of the framework.

To start with, the question should be asked: Why does traditional port planning result in environmental harm/mitigation, and hence does not result in a sustainable port? By analysing the traditional port process, it shows that its main objectives aim to integrate the economic, environmental, safety, technical and social aspects and consider enough flexibility to support the long term development. It therefore would be expected that the traditional approach would not result in environmental harm. However somewhere along the process, several elements are missing which limits the achievement of these main objectives. It turns out that in general the port authority selects the port location and an engineering company is responsible for the design process on that specific location [Schipper et al., 2015]. Here it can be found why the main objectives of the traditional approach are not obtained in the end: although the traditional process indeed considers all relevant disciplines, the party responsible for the location selection does not base its choice on the same disciplines and therefore disciplines such as the environment, will only be considered after the location is selected. If the traditional process does not have the most suitable location for sustainability as starting point, it perhaps inevitably will result in environmental harm from the start. Clearly a new sustainable framework is needed that includes the location choice in the design process, so all the disciplines can already be considered early during the location choice.

Developing a sustainable framework requires a clear understanding of a sustainable port and a sustainable port masterplanning process towards this port. The issue encountered with the existing definitions, is that both definitions are intertwined and no clear distinction is made which characteristics belong to the sustainable process and the resulting sustainable port. A sustainable port has obtained and maintains a balance of the economy, environment and society now and in the future, where it also anticipates and considers the needs of future generations, besides their own benefit and the prosperity of the surrounding regions. Furthermore, the definition of a sustainable process can be characterized by the following process ambitions: the location choice as part of the design process, the consideration and search of the multiple perspectives balance of the interlinked economy, environment and society in an early stage, active and early stakeholder involvement, consideration of long term uncertainties and a continuous learning process.
I propose a framework including all the characteristics of a sustainable port planning process which unlike the traditional process, already integrates the significant important location selection in the design process to develop a sustainable port: Integrated Sustainable Port Design (ISPD). The ISPD framework is focused on system level and is aiming to find sustainable opportunities while socio-economic values are created as well. This can be achieved by considering and integrating the physical, environmental, governmental and socio-economic disciplines in order to find the most suitable location for these opportunities. With the consideration of long term uncertainties and the help of stakeholder involvement, it provides a framework for the port planner to achieve and maintain a balance of the economy, environment and society now and in the future, resulting in a sustainable and future-proof port. The ISPD framework adopts relevant aspects from existing sustainable philosophies (such as Building with Nature) and fills in the missing aspects of the traditional framework. From start to finish, this framework follows seven basic steps: (1) Define the project needs and objectives, (2) Find physical suitable locations, (3) Understand the systems and select most suitable locations, (4) Develop alternative designs based on key values, (5) Test the alternatives, (6) Evaluate the qualities of each alternative and (7) Create the final design.

Three real life case studies have been used for the enhancement of the ISPD framework: the Jebel Ali New Container Terminal (Dubai), the Badagry Port Project (Nigeria) and the New Doha Port (Qatar). Their port planning processes and resulting masterplans were analysed, to discover the extent of influence of the planning process on the sustainability of the masterplan. These cases dealt with critical challenges such as limited expansion area due to bad masterplanning of surrounding projects and coastal erosion. Besides the encountered limitations in practice, they also provided several good examples of sustainable planning measures. These learned lessons were used to enhance the framework for better implementation in practice.

The degree of applicability of the ISPD framework was investigated through the application on the Badagry Port Project, which was selected as most suitable to serve this purpose. The illustrative case was designed to follow all seven basic steps of the framework and to discover which (dis)advantages will be encountered along the way. The most significant issue which was encountered is the general thought that sustainable measures require higher costs and bring along more risks than traditional measures. Therefore they require more research, and thus more time and money than traditional measures. These limitations however will always be present in real life and hence should be dealt with in this research as well. For example the important initial location choice, it is up to the port planner to decide if he/she wants to take the risk of possible resistance and limitations of the location on the port design and operation resulting from a rather incomplete initial research, or if the port planner decides to consider this uncertainty by investing more time and money in the research for the most suitable location. It is the responsibility of the port planner to make grounded decisions and the port planner, besides the environmental benefits, should convince the client of the socio-economic benefits of sustainable measures as well. Furthermore, other limitations of the case study were the limited data available of other locations and limitations set by RHDHV. In order to continue the ISPD despite these limitations, the location system of Badagry was analysed and the values, opportunities and challenges of Badagry were specified. The values were prioritized into key values and possible sustainable planning measures were developed. Systematically and focused alternative development based on these key values and planning measures, is a significant advantage of the ISPD framework because less optimization may be necessary in later stages. Three alternatives were developed and after testing and evaluating them, one final alternative masterplan layout is recommended. Since this research does not cover the more detailed design on construction and material level, the final step is not executed.
In the evaluation, the resulting ISPD masterplan is compared with the existing Badagry Port Project masterplan based on predefined criteria which represent the main environmental issues currently resulting from port projects. Despite the limitations of the evaluation, such as the inability to discuss several criteria due to a lack of more detailed level design, subjectivity and exclusion of socio-economic aspects and a quantitative evaluation method, it turns out that the ISPD masterplan shows less negative and more positive impacts concerning these environmental criteria and hence this masterplan can be considered more sustainable than the existing masterplan resulting from a traditional process. A very rough cost analysis is also performed and it shows that based on only the large investments, the costs of the ISPD and existing masterplan are approximately from the same order of magnitude. Finally the application of the ISPD framework itself is evaluated: it shows that the extent of successful implementation of the ISPD framework in practice depends on mainly the port planner, the available capital and time for the project, the client, category of port, global and local context and the proof of feasibility and benefits of sustainable measures. The lessons learned from the evaluations are used to finalize the ISPD framework in the form of an ISPD user guide.

Concluding this research, the Integrated Sustainable Port Design framework can be successfully implemented in practice and despite the presence of limitations, the framework results in a more sustainable port masterplan. Although there are many recommendations for further development, great potential is expected for the application of the ISPD framework in the future.