Simulative approach for the optimization of logistic processes in offshore ports

Stephan Oelker1, Abderrahim Ait Alla1, Silas Büsing1, Michael Lütjen1 and Michael Freitag1,2
1BIBA – Bremer Institut für Produktion und Logistik GmbH at the University of Bremen, Bremen, Germany
2University of Bremen, Faculty of Production Engineering, Bremen, Germany

ABSTRACT

Offshore wind energy has become a key technology for the generation of electricity. In conventional installation concept, the base port is considered as a hub for the handling and storage of different components of offshore wind turbines. Trends of the wind energy industry influence offshore base ports. Therefore, a simulation study is carried out, which considers the influence of the increasing installation trends in different scenarios, resulting from different settings of parameters. Recommended measures that can optimize the capacity utilization of base ports and the influence of the trends on the base port will be derived from the simulation study.

KEY WORDS: Offshore Wind Energy; Logistics; Simulation; Offshore ports.

INTRODUCTION

As a hub between the sender and recipient of goods, the port is generally an integral part of the supply chain and plays an important role in the management and coordination of material and information flows (Hoa and Haasis, 2017). The base port as a hub for the installation of offshore wind turbines (OWTs) in particular acts as a funnel for a large number of water and land-based material flows from the suppliers’ production facilities. Due to the dimensions and weights of the large components of WTGs, this results in extremely high logistical and technical costs, which have to be met by the port operator (Schütt and Lange, 2014). In addition, offshore logistics is subject to trends such as the constantly evolving large components and the rapid growth in the size of construction and supply ships (Färber and Kohn, 2014). Wind energy has established itself as an alternative to traditional power generation. Due to the restriction of suitable land areas, offshore wind turbines are expected to play an increasingly important role in the energy turnaround compared to onshore (Oelker et al., 2017). Another reason is the significantly higher wind energy potential (Lau, 2013). Figure 1 shows the development of installations in the German North Sea and Baltic Sea in terms of cumulative number and annual growth over time.

Figure 1: Development of offshore wind energy in the German EEZ (Rohring 2018).

Figure 1 shows that offshore logistics is not only tending to grow more strongly, but also that there are also some very strong fluctuations between the years. In order to cope with future output volumes, offshore port logistics require innovative logistics concepts for a relatively young industry (Thoben et al., 2014). These include not only port infrastructure, but also onshore hinterland connections (Irawan et al., 2017). The comparatively high electricity generation costs in offshore logistics are largely caused by the costs of operational logistics, which account for at least 17% of operating costs (Poulsen et al., 2017). In the studies conducted to date, 5 to 31% of the operating expenses during the life cycle of an offshore wind farm are allocated to port operations (Poulsen et al., 2017).

However, the logistics of the base port are not only under cost pressure, but under are also dependent on uncertainty factors such as logistical resources (Thoben et al., 2014). The finite capacities of the logistical resources at the base port lead to time bottlenecks along the entire logistics chain due to the hub characteristics and the close networking of the actors (Görges et al., 2014). An important aspect in the efficiency of the base port is the layout, since a port layout that is insufficiently adapted to offshore logistics and its access connections represents a restriction for the other actors in the logistics chain (Irawan et al., 2017). In addition, the base port has to cope with the problems of maritime logistics, which are highly dependent on the weather. If the weather is bad, it is not possible to load large components onto the