English summary

This report deals with a new heavy marine transport concept used to transport modules from fabrication yards to remote and undeveloped locations where new energy or process plants are build. To construct such plants, several resources like: skilled labor, material and equipment are required.
Therefore it is profitable to cut the complete plant into smaller modules, that are constructed at developed, low-cost yards, mainly in Asia and then transported to these remote locations in Australia, United Arab Emirates or Russia. The modules vary in weight from 50 to 5,000 metric tonnes.
Dockwise is the world's leading company in heavy marine transport and has developed a transport concept specialized to deal with the demands of these modular projects.

This 'new' transport concept, uses so called Floating Super Pallets(FSPs) to improve the conventional transport method. These Floating Super Pallets are large barges with the following dimensions: length 60(m), width 40(m) and depth of 6(m).
In the conventional transport method, addressed as 'Dry Transport', there are three main processes: Loading the module on deck of the vessel, sea voyage and discharging the module from the vessel. The loading and discharging is done using self propelled modular transporters(SPMTs). This operation is know as a roll-on, roll-off(RO-RO) operation.
The new transport concept, addressed as 'Piggy Back' uses the same RO-RO loading and discharge method. However, the module is not loaded directly onto the vessel but onto the FSP. This FSP is then loaded and discharged on and off the vessel by a float-on, float-off(FLO-FLO) operation. This additional step results in feasibility and logistical advantages. The general procedure of both transport methods is presented in Figure 1.

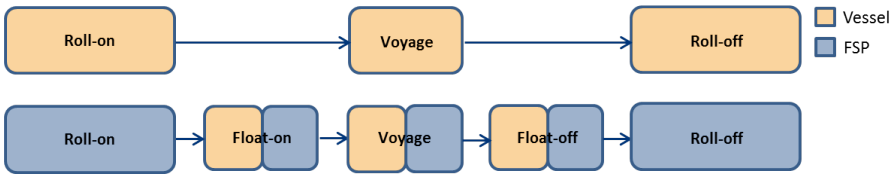

Figure 1: Dry Transport versus Piggy Back

Most important benefit of the Piggy Back method, is that the vessel is not required during the RO-RO operation. In terms of feasibility, the vessel is not required to reach the quay. With a FSP draft of 4(m) compared to 9-10(m) for a heavy transport vessel, more remote locations are accessible, where usually sufficient water depth is not available.

From logistical point of view, the Piggy Back method is preferred because the transport requires less time and is less vulnerable for external disturbances. This is also caused

by the fact that in case of the Piggy Back method, the vessel is not required during the RO-RO of the modules. The RO-RO takes significantly longer than the FLO-FLO of the FSP.
Furthermore the RO-RO operation is a more critical operation due to possible disturbances like: tide variation, weather delays, congestion at quay, module delay, material delay, labor conflicts or insufficient equipment. However the FSP still needs to ready once the vessel arrives, so sufficient FSP and modules need to be available in order to eliminate the impact of these external impacts on the vessel process.

A simulation model is developed to determine the impact of: shipment list, transport method, number of vessels, vessel type, number of FSPs and duration of port processes and sea voyage. A shipment represents a predefined set of modules that should fit on one FSP in terms of weight and footprint limits. The results of the simulation quantify the logistical advantages of the Piggy Back method over the Dry Transport method.
In scenario 1, where an original shipment list was used, the Piggy Back method showed a increase in the number of shipments delivered on time from 23.1% in case of Dry Transport with one vessel to 69.2% for a comparable Piggy Back configuration with one vessel and 6 FSPs.
Modifying the shipment list by changing the free date of some of the shipments, to optimize shipment availability proved more of the piggy Back potential. In this case Dry Transport delivered 46% of the shipments on time using 2 vessels. Piggy Back using 2 vessels and 6 FSPs acquired 100% on time delivery. Furthermore by comparing Dry Transport for scenario 1 and Piggy Back for scenario 2, the number of vessel days was reduced by 44% when using 2 vessels and 6 FSPs and 48% when using 2 vessels and 8 FSPs. This proves the impact of the combined result of modifying the shipment list and using the Piggy Back transport method.
To quantify the potential to deal with external disturbances a discrete probability function for the roll-on duration was applied on scenario 2 for both transport methods. In case of Dry Transport the number of shipments arriving on time was further reduced from 46% to 35% were the Piggy Back method retained the 100% on time shipment delivery.
The simulation clearly proves the potential of the Piggy Back method.

In terms of a cost comparison, for these two scenarios the Piggy Back method is always more expensive. However in the situation of scenario 2, the Piggy Back method reduces the number of vessel days which results in 1% higher cost for using 6 FSP with 2 vessels instead of 2 vessels in Dry Transport configuration. For this comparison an FSP day rate of 10% of the vessel day rate is assumed. This extra cost results in 100% on time delivery instead of 46%, and potential to deal with external disturbances.

The main goal of this master thesis was to determine the feasibility and service potential of the FSP transport concept. Both have been proven by using the Piggy Back transport method instead of the conventional Dry Transport. However the presented results are based upon 2 scenarios. More research should be executed on different scenarios and the impact of probability distributions for the port processes and sea voyage should be further addressed. In addition to that, the cost comparison can be improved and a detailed analysis on the possible investment approach is useful.