Maritime Fleet Renewal of Offshore Support Vessels

By: Hanne-Sofie Skogen Strømberg
Supervisor: Bjørn Egil Asbjørnslett
NTNU, May 2015

NTNU – Trondheim
Norwegian University of Science and Technology

INTRODUCTION

Oil and gas installations must be regularly supplied to ensure efficient and continuous production. The only way to supply all of them is through offshore support vessels (OSVs).

OSVs can perform various subsea operations:

- Survey and seabed mapping
- Subsea installations
- Seabed intervention
- Decommissioning
- Inspection, maintenance and repair

All of these operations are necessary to keep the down-time on installations to a minimum.

OSVs are costly resources for both operators and ship owners. In fact, OSVs are the largest cost elements in the upstream supply chain of oil and gas installations. In order to reduce costs, it is beneficial to have good fleet logistical planning for the future.

A ship owner has a big challenge when predicting the future market demands of ships. The shipping market of OSVs is known to have cyclic fluctuations, which is mainly dependent on the oil price. It can be essential to have an appropriate fleet in hand if sudden market changes occur.

Strategic planning can contribute by helping companies survive in a though market. By adapting fleet capacity and vessel characteristics to new market requirements, the ship owner will be better equipped to meet future market changes. When performing strategic planning, the planner wants to foresee the requirements for each type of vessel. Normally, the main question for planners is basically if they should financially decide to have few large ships or many small ships.

OBJECTIVE

Good decision tools can result in reducing the necessary number of OSVs in the fleet, while maintaining an efficient and reliable supply service. Such effects can result in great cost savings.

The objective is to develop an optimization model for the maritime fleet renewal problem (MFRP) for a fleet of OSVs. The aim is to study if it is possible to solve this problem for a fleet where every ship is complex and has its own individual design.

METHOD

This thesis handles operations research for a fleet operating for an offshore service company. The fleet is optimized to perform strategic fleet renewal. The MFRP consists of deciding how many ships of each type to use in order to meet future demand in a long planning horizon. The MFRP also decides when and how to do so.

The solution of the problem finds the best modification of the current fleet of ships, in order to adapt to changes in the market.

Typical decisions in a MFRP are operational decisions such as operating trades or contracts, buying and selling of ships, chartering ships in and out of the fleet, and scrapping and lay-up of ships. These decisions is done while maximizing profit or minimizing the overall costs.

MATHEMATICAL MODEL

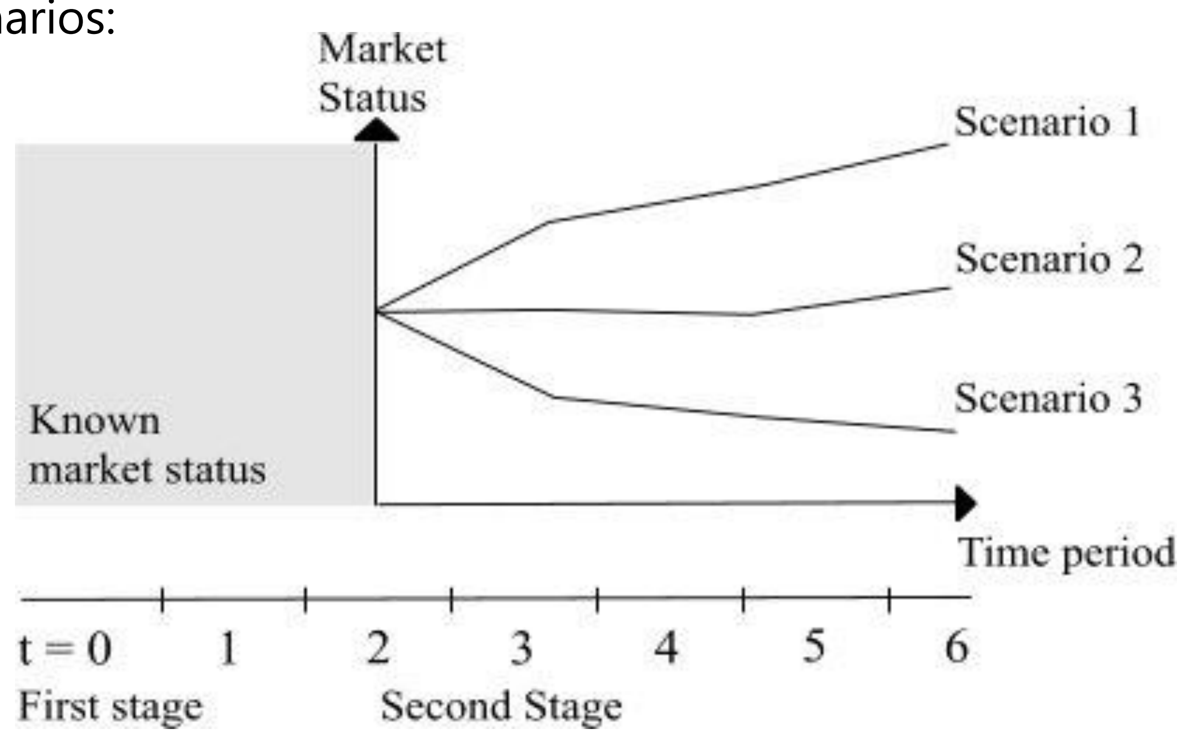
The proposed mathematical model maximizes profit in the objective function. Costs and revenues related to operation of each contract, are included into the objective function, in addition to savings, revenues and costs for charter in, charter out, lay-up, selling, and buying of ships.

Constraints are added to satisfy various limitations. The different categories of constraints are:

- Compatibility between ship type and contract type
- Minimum and maximum frequency of operation on each contract type
- Time restriction for mobilization, operation and demobilization
- Pool relations for each time period
- Limitations on maximum number of available ships in the market
- Restricted limitation on available ships of specialized design
- Non-anticipativity constraints
- Convexity and integer constraints

The mathematical model has a stochastic approach. The stochastic approach handles the uncertainty in the problem, where the uncertainty lies in the future market status.

The problem is solved with a test case in Xpress IVE as a two-stage stochastic problem with three scenarios. A scenario is a possible development of the market status for the offshore industry. The development of the scenarios has impact on demand, costs and revenues for this problem. The following figure illustrates a two-stage stochastic problem with three scenarios:



CONCLUSION

By using stochastic programming, the solution get a realistic approach on the uncertainty aspects of the problem. The stochastic solutions were compared with the deterministic solutions, by calculating the value of stochastic solution. By testing the model for sensitivity, the results show that there are still room for improvements for both the system and the test amount.

For further work, beyond this thesis, this model can be tested for more cases from the offshore industry. This can give answers if the model is sufficient for OSVs and the offshore industry. New decision variables should also be included, such as decisions for new buildings and scrapping of vessels. Moreover, the compatibility constraint should be further developed to include more capacity properties for both possible ship designs and contract types.