Imperial College London

DEMAND-DRIVEN DESIGN OF PASSENGER FERRY SERVICES IN DENSE ISLAND GROUPS

T3

Alexandros Abadjis

Department of Civil and Environmental Engineering, Imperial College London

1. INTRODUCTION

The global service of shipping is considered to be the backbone of international trade. Maritime transport guarantees the supply of energy, food and commodities and drives trading activity. Furthermore, the quality of life on islands and in peripheral maritime regions is greatly dependent on the quality of maritime transport services. Traditionally, the shipping industry is categorized in two major sectors: the bulk shipping sector and the liner shipping, however it has one more branch, the ferry business – part of the wider short-sea shipping. The aim of this study is to develop a model for the demand-driven optimal design of passenger ferry services in dense island groups.

SHIPPING…

90% international world trade

90% EU freight trade

SHORT-SEA SHIPPING…

40% **intra-EU exchange**

2. METHODOLOGY

In the model developed, a random route generator creates the initial solution population. Flows are assigned to the routes and the Key Performance Index (KPI) of the potential solution is evaluated. Then with the use of Genetic Algorithms the optimal design is achieved.

**The method is time-based and the Key Performance Index (KPI) is equal to the total travel time of the system.*

RANDROM ROUTE GENERATOR

In the model, a random route generator creates the initial solution population. The routes are represented as string of ports i.e. chromosomes. When formed a number of constraints have to be satisfied:

1. **Closed form** routes
2. Distance travel **autonomy** per vessel
3. All ports visited
4. Network **interconnectivity**

FLOW ASSIGNMENT

To assign passenger flows to links a method developed by Bell et al. (2011) is adopted. These passenger flows are then used for the calculation of the KPI. The passengers are carried by shipping lines operating strings (or port routes) with given service frequencies. An origin–destination matrix of passenger demand is assigned to these strings to minimize sailing time and passenger dwell/waiting time at the origin port and any intermediate transhipment ports (Bell et al., 2011).

GENETIC ALGORITHM

The Genetic Algorithm is a search heuristic – also called metaheuristic – that mimics the process of natural selection, part of the larger class of evolutionary algorithms. Techniques used by the algorithm are inspired by natural evolution: inheritance, crossover and mutation (Li et al., 2014).

MUTATION The operation of altering one or more gene values in a chromosome from its initial state

[7 4 1 5] [5 3 2 6] ⟷ [7 4 1] [5 3 4 6]

CROSSOVER The operation of exchanging partial chromosomes at positionally independent locations

[7 4 1 5] [5 3 2 6] ⟷ [7 3 2 5] [5 4 1 6]

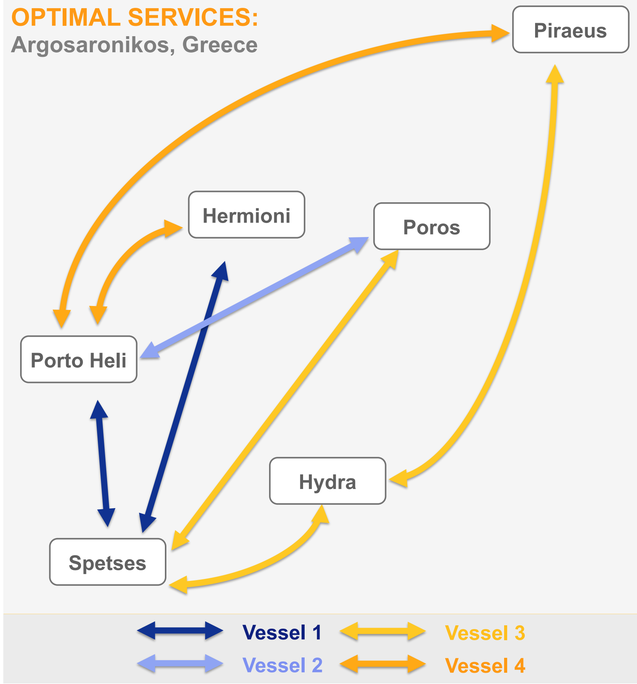
4. ANALYSIS & RESULTS

For the model analysis first the GA performance is assessed and calibrated before a number of scenarios are examined:

- The proposed method is applied to a real case that of the Argosaronic Islands, in Greece
- The model reaction is assessed in the presence of smaller and slower vessels:
  1. One of the existing vessels is replaced by another smaller and slower one
  2. Two smaller and slower vessels are added to the existing fleet of vessels
- The effects of changes in the passenger demand are monitored and potential ways of action are being discussed

All results of the analysis are justifiable. In cases where the proposed optimal solution does not appear to be the expected best, it is in majority the case that the time rather than cost-base approach of the model is the responsible.

OPTIMAL SERVICES:
Argosaronikos, Greece



5. NEXT STEPS

The model could be further developed and have an increased number of applications. First, **the model should be extended to account for vehicles**. Furthermore, if the **model** is **to become cost-based** rather than time/ frequency-based, then the potential applications of the model would include the following:

- **Operational & Strategic Planning:** **Ferry companies and Operation authorities benefit**
- **Network Redundancy:** **Assessment of network response under e.g. bad weather conditions**
- **Environmental Impacts:** **Evaluation of the environmental costs of ferry network**
- **Subsidies Programmes:** **Planning & evaluation of government subsidy schemes**

ACKNOWLEDGEMENTS

For the completion of this project I would like to thank for their help and support Dr. Panagiotis Angeloudis, Pablo E. Achurra - Gonzalez and Thalis Zis.

REFERENCES

Bell, M. G., Liu, X., Angeloudis, P., Fonzone, A. & Hosseinloo, S. H. (2011) A frequency-based maritime container assignment model. Transportation Research Part B: Methodological. 45 (8), 1152-1161.

Li, Y., Li, M., Zhang, N. & Jia, H. (2014) UAV flight controller design method based on genetic algorithm. Control Engineering and Information Systems. , 121.