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POPULAR SCIENTIFIC ABSTRACT

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Autonomous Ships from the Perspective of Operation and Maintenance

Autonomous ships have been projected to revolutionise maritime transport in the same way as autonomous or driverless cars or trucks are expected to transform road transport. Proposed benefits of autonomous ships include reduced fuel consumption, larger cargo capacity, increased safety, improved operational efficiency, and reduced operational costs. If realised to its full potential, autonomous operation could revolutionise the shipping industry. However, as with all new concepts, there are significant uncertainties about its potential and which challenges will arise in the course of its development.

This thesis addresses issues regarding the operation and maintenance of autonomous ships, which will significantly impact their implementation. The thesis is positioned in the technical sciences but also includes non-technical elements. A multi-method approach is used, which includes documentary analyses, field work, interviews, case studies, and mixed-method research. In this thesis, the subject of study is tangible aspects of ship operation, which are often, but not always, associated with autonomous ships – namely increased automation and unmanned operation.

The use of the Reliability Centered Maintenance (RCM) method as a tool for evaluating maintenance and reliability needs on unmanned ships is evaluated, and amendments to the method are proposed. Through case studies, the thesis shows that increased redundancy in machinery systems can significantly reduce the probability of failure on unmanned ships, but redundancy also has its limits. It is found that the uncertain nature of failures, the limiting effect of dependent failures on reliability, and the severely restricted possibilities of corrective maintenance at sea make reliability a very serious obstacle for unmanned ships.

Using data on crew sizes of ships and through interviews with crewing specialists, the thesis finds that the single limiting factor in further reductions in crew sizes is the workload required for operating the ships. Through the analysis of planned maintenance and work time distribution data from conventional ships, maintenance is identified as a poor candidate for automation. The workload related to maintenance is found to be substantial on large ships, and this workload will not be affected significantly by unmanned operation.

The thesis combines data on, e.g. work time and maintenance to identify different aspects of merchant ship operation that affect the potential for increased automation and unmanned operation. Maintenance is less of a barrier on small ships than on large ships. Transport of passengers is problematic in relation to safety, which makes cargo ships better suited for unmanned operation. Ships on fixed routes are easier to automate than those that do not operate on a fixed route. Overall, the potential for automation is considerable for small ships, whereas it is limited for large ships.

Commercial shipping is currently facing important challenges relating to, amongst other things, restrictions on environmental emissions and a shortage of qualified labour. This thesis provides knowledge on the potential and limitations of autonomous operation of ships as a solution to these challenges.