Saving Costs in Container Shipping through Reliability-Centred Maintenance

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Introduction

As the growth in the global economy has been lower than expected, the amount of traded goods has also halted. A consequence has been that the intense competition in the container shipping market has reduced the revenues for the involved actors, forcing them to find areas where they can cut costs. The focus has normally been on fuel consumption and logistics. However, most ship-owners have a somewhat old-fashioned approach to maintenance, and it is believed that there is a potential of savings related to the maintenance management as well.

To investigate the abovementioned potential, this study will calculate the life-cycle costs related to a maintenance schedule based on both Reliability-Centred Maintenance (RCM) and the plan currently used by the Norwegian ship operator Klaveness Ship Management (KSM), and compare the results. Plans will be developed by the use of the RCM process described by Moubray (1997) and Smith and Hinchcliffe (2004), and their performance will be evaluated by simulating them over the expected lifetime of the vessel.

It is expected that the ship-owner can save considerable costs by performing the correct maintenance as suggested from the RCM process, while still keeping the system reliability at the required level.

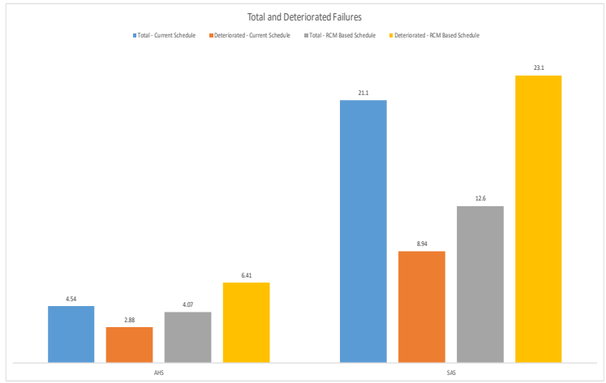
Research Questions

Even though it is believed that implementing modern maintenance ideas can help operators achieve substantial cost reductions, there is a shortage of values backing the theory. This study therefore aims to quantify the economic effect of using the RCM method for a ship-owner. Specifically, the thesis will answer two research questions:

- How will RCM affect the ship system reliability?

Results

All four maintenance schedules have been simulated 100 000 times. The results indicate that RCM may actually increase the number of failures. However, as RCM prefers condition monitoring techniques over other maintenance activities, the method will most likely find the failures at an earlier stage, which will cause a reduction of critical failures. The following figure shows the difference between the schedules in total and deteriorated failures. AHS and SAS means Anti-Heeling System and Starting Air System.



The economic effect is summarised in the following table.

Schedule	Mean LCC [kUSD]	LCC 95 % Upper Bound [kUSD]
AHS: Current	48.6	83.7
AHS: RCM	37.9	72.4
SAS: Current	63.2	65.9
SAS: RCM	15.9	18.8

- How will the maintenance related life-cycle costs change by implementing RCM on maritime vessels?

To be able to answer these questions, the study will first use RCM to develop a maintenance plan for two shipboard systems: the anti-heeling system and the starting air system. These schedules, as well as the present strategy, will then be simulated over a ship's life-time, and their performance will be evaluated against each other.

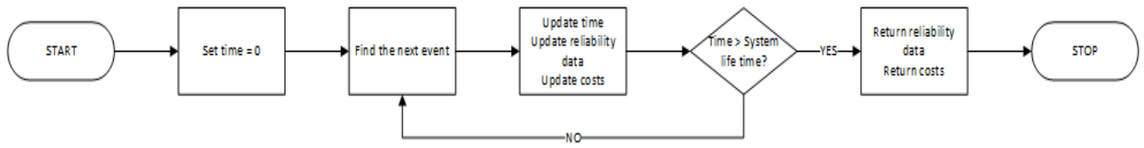
Method

The RCM method asks seven basic questions, in which the answers can result in a well-reasoned maintenance plan:

1. What is the asset's functions and at what levels is it required to perform in the current operating context?
2. How can it fail to do what the user requires?
3. What causes these failures?
4. What is the effect of these failures?
5. What are the consequences?
6. Can the failures be predicted or prevented?
7. If not, what should be done?

The following figure shows how these questions can be answered by executing three steps.

More details about the RCM methodology used in the study can be found in Moubray (1997) and Smith and Hinchcliffe (2004). The behaviour of the different maintenance schedules is to be analysed by using Monte Carlo Simulation (MCS). This means that random numbers and probability distributions are used to evaluate what will happen next in the system's lifetime: will it fail, or will it operate as wanted in the interval between maintenance activities. The simulation returns cost and reliability data. The following figure depicts the simulation flow chart.



The data in the table suggest that a ship-owner may reduce costs by implementing RCM. The mean LCC is reduced with 22.0 and 74.8 % for the AHS and SAS respectively. Similar numbers are valid for the upper bound values.

Sensitivity analyses have been performed to evaluate the importance of downtime costs. These analyses show that the relative savings of implementing RCM increases with higher downtime costs.

Conclusions and Further Work

This study provides quantified values to qualitative theories. It shows that some systems onboard a maritime vessel is over-maintained, and that a ship-owner may save costs by allowing more failures. Based on the two systems analysed, a trend is seen where the reliability is actually worsened by implementing RCM. However, due to the high level of redundancy related to, and the limited criticality of, the analysed systems, this reduction of reliability is encouraged by the achieved cost-reduction.

To further improve the understanding related to the effect of RCM in a maritime setting, analyses of more critical systems should be executed. These analyses should also include how RCM affects the safety level and environmental integrity of the vessel.

References

Moubray, J. 1997. Reliability-centred Maintenance, Oxford, Butterworth-Heinemann.

Smith, A. M. & Hinchlcliffe, G. R. 2004. RCM: Gateway to world class maintenance, Oxford, Butterworth Heinemann

A complete list of references is available in the master thesis.

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