IDENTIFYING DIFFERENCES BETWEEN POWER SYSTEM OF CONVENTIONAL AND AUTONOMOUS SHIP WITH RESPECT TO THEIR SAFETY ASSESSMENT

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Abstract. Digitalization, artificial intelligence, and awareness of climate change are the driving forces behind the rapid development of the transportation industry. The maritime sector is exploring the applicability of alternative powering options and ways to implement new technologies to increase safety and efficiency, to meet the regulations set by the International Maritime Organisation (IMO) and growth of the seaborne trade. Autonomous shipping is recognized by IMO as a path towards the implementation of new technologies with benefits in terms of safety, costs, and environmental impact. Autonomous shipping aims to operate commercially with a promise of safe, smart, green, and sustainable shipping of the future, while similarly eliminating negative externalities from shipping (noise, pollution, oil spills, congestion in ports, etc.). Based on the literature review, a research gap related to design requirements for power systems of autonomous ships is identified. Although the literature indicates that autonomous vessels are expected to be as safe as the conventional ones, it is obvious that absence of crew leads to savings in operative costs, but at the same time it significantly reduces possibility for corrective maintenance during the voyage. Therefore, it is necessary to analyse key activities of the crew related to the operation of ship power system and to define effect of lack of crew on the safety level. The aim of this paper is to analyse differences between power systems of conventional and autonomous ships and their role in the safety assessment, as well as to provide a set of solutions for successful transition from manned to unmanned ship power system.

Keywords: Autonomous and unmanned shipping, maritime safety, power system, ship crew.

INTRODUCTION

Nowadays, autonomous and unmanned ships, belong to the the most researched maritime topics, but the majority of research papers are focused on navigation, communication and cyber security. The research indicates that autonomous short sea shipping is feasible from economic and environmental point of view and provides opportunity to successfully introduce alternative powering options (battery and fuel cells) into commercial shipping [1]. It is of crucial importance that machinery plant in unmanned engine room can operate safely for extended periods of time. Abaei et al. (2021) [2] investigated reliability of unattended machinery plant using Multinomial Process Tree and Hierarchical Bayesian Interface. The other important aspect of autonomous ships is that their unattended machinery plant should be resilient enough to survive and recover from unexpected disruptions [3]. BahooToroody et al. (2022) [4] provided a probabilistic reliability assessment methodology to estimate how long present ship machinery plants can be left unattended in event of semi or fully autonomous operations.

METHODOLOGY

In order to analyse the difference between power systems of conventional and autonomous ships it is important to identify week points in ship machinery plant and consider failures that are prevented by crew interference. Taking into account that breakdown records do not document failures that are solved by crew on site [5], identifying all week points is difficult task. In this paper, system breakdown of typical machinery plant, Fig. 1, is conducted and risk index is calculated, Table 1. In this analysis crew influence on ship power plant safety will be assessed through required planned and unplanned maintenance of different machinery parts. Alternative solutions for parts that require regular planned and unplanned maintenance will be offered and discussed. In literature there is a lack of data on crew job, and it would be beneficial to know what types of failures they prevent but also what types of failures they induce.

Table 1. Risk index [5]

Risk index (RI)						
FI	Frequency	Severity (SI)				
		1	2	3	4	5

		Negligible	Minor	Significant	Severe	Catastrophic
5	Frequent	6	7	8	9	10
4	Reasonably probable	5	6	7	8	9
3	Somewhat probable	4	5	6	7	8
2	Remote	3	4	5	6	7
1	Extremely remote	2	3	4	5	6

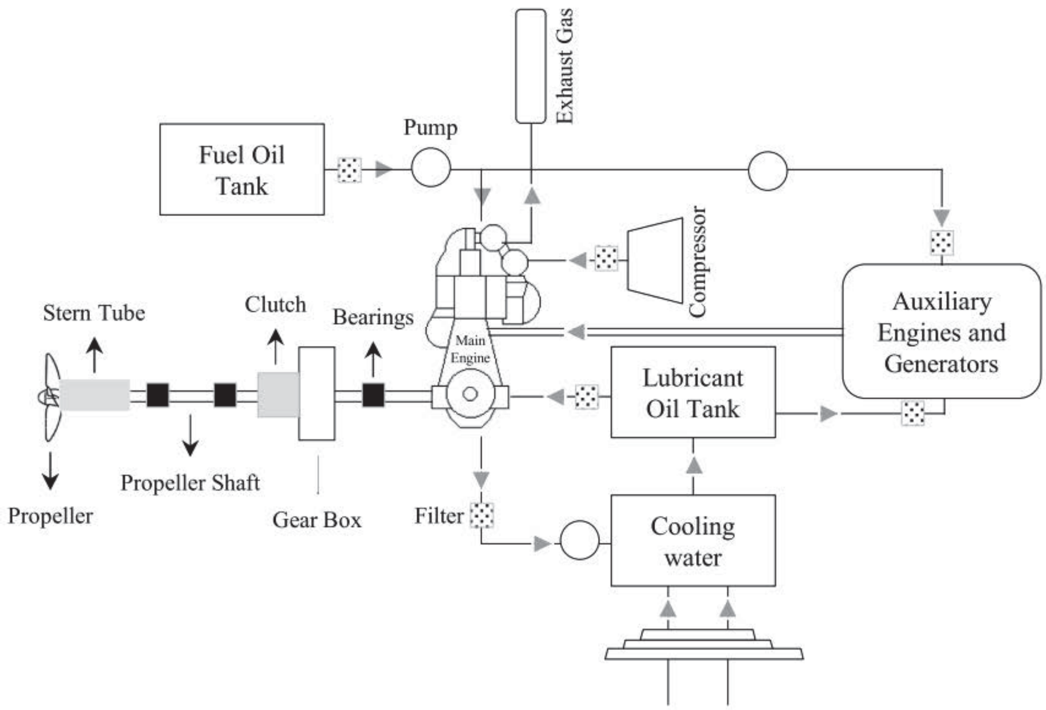

Figure 1. General overview of Machinery Plant on-board [4].

CONCLUSIONS

For successful implementation of autonomous and unmanned ships in commercial shipping it is of crucial importance to research reliability of autonomous power plant with regards to human interface. Future work important to research redundancy to build up recovery strategy, design of Digital Twins, machine learning to predict critical events, and onboard online risk models. It is also important to discuss actions in event that fatal technical failure occurs close to the shore and far offshore.

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