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Systems-Theoretic Process Analysis of maritime traffic safety management in the Gulf of Finland (Baltic Sea)

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Abstract

According to International Maritime Organization (IMO), the Baltic Sea Area has some of the densest maritime traffic in the world. The Baltic Sea was designated a Particularly Sensitive Sea Area (PSSA) at IMO Marine Environment Protection Committee's 53rd session in July 2005. The Mandatory Ship Reporting System in the Gulf of Finland Traffic Area (GOFREP) was established by IMO in 2003 and has been in operation since 2004. The objective of this study in progress is 1) to outline the hierarchical structure of the maritime navigation safety management system from European to ship onboard level and 2) to apply the Systems-Theoretic Process Analysis (STPA) to identify system level hazards and potentially unsafe ship speed and maneuvering control actions with respect to IMO Collision Regulations (COLREGs) Rules on ship safe speed, ship safe separation distances and the Traffic Separation Schemes requirements with the aim of evaluating the effective hazard control options to enable efficient updating of ship level situational awareness and the enforcement of safety constraints in real time.

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Keywords: Systems-Theoretic Process Analysis (STPA), system level hazards, maritime navigation safety, situation awareness, Gulf of Finland, Baltic Sea

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1. Introduction

According to International Maritime Organization (IMO) [1], the Baltic Sea Area has some of the densest maritime traffic in the world. The Baltic Sea was designated a Particularly Sensitive Sea Area (PSSA) at IMO Marine Environment Protection Committee's 53rd session in July 2005. The Mandatory Ship Reporting System in the Gulf of Finland Traffic Area (GOFREP) was established by IMO [2, 3] in 2003 and has been in effective operation since 2004.

The Systems-Theoretic Accident Model and Processes (STAMP) approach considers safety an emergent property of the system, arising from the interaction of system components within a given environment [4]. The STAMP methodology has been used to map the hierarchical regulatory levels - from global to local - of the maritime transportation and environment safety management system [5]. The STAMP-Mar approach has been recommended as a basis for safety management of a sustainable eco-socio-technical maritime transportation system [6]. The STAMP based Systems-Theoretic Process Analysis (STPA) - a powerful new hazard analysis method designed to surpass traditional safety techniques [4, 7] - has been successfully applied e.g. to space engineering applications [8, 9]. However, the application of STPA hazard analysis to safety management of maritime navigation has so far attracted less attention.

The objective of this study in progress is 1) to outline the hierarchical structure of maritime navigation safety management system from European to ship onboard level and 2) to apply the Systems-Theoretic Process Analysis (STPA) to identify the system level hazards and potentially unsafe ship speed and maneuvering control actions in relation to IMO Collision Regulations (COLREGs) Rules [10] on ship safe speed, ship safe separation distances and the Traffic Separation Schemes requirements with the aim of evaluating the effective hazard control options to enable efficient updating of ship level situational awareness and the enforcement of safety constraints in real time.

2. Hierarchical structure of maritime navigation safety management

The hierarchical structure of maritime navigation safety management from European to ship onboard level is presented in Fig. 1. The levels of the maritime navigation safety management structure are connected by communication channels. According to [4], "… a downward reference channel is providing the information necessary to impose safety constraints on the level below and an upward measuring channel to provide feedback about how effectively the constraints are being satisfied".

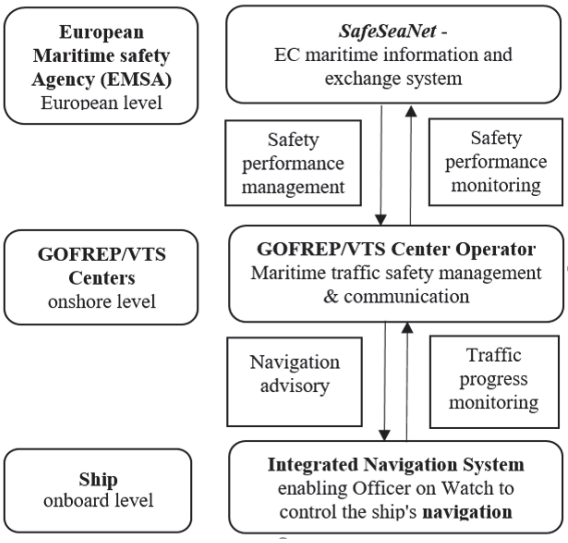

Fig. 1. Hierarchical structure of maritime navigation safety management from European to ship onboard level (modified from [4]).

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