Seafarers Work and Rest Hour-Logging

Adjustment in the systems

Bachelor thesis for Marine Engineering Program

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CHALMERS UNIVERSITY OF TECHNOLOGY
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PREFACE

This thesis was conducted as a final part of the authors examination for their bachelor's degree in marine engineering at Chalmers University of Technology.

As we both have done time as engine cadets on various vessels in the merchant navy, we have observed that there is a large problem concerning manipulation of the time reports. Therefore, we took the initiative to investigate this issue further, and investigate what the consequences of manipulation can result in, and if a new system could be designed to benefit the seafarers.

We would like to extend our deepest gratitude to the participants for their involvement in this study, without their help it would not have been possible.

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SAMMANDRAG (in Swedish)

Tidigare forskning visar att manipulering av arbets- och vilotidstimmar ombord fartyg är ett problem inom sjöfartsbranschen. Rapporten undersöker utsträckningen av problemet genom intervjuer med sjöfarare, och hur dom upplever systemen som är i bruk, samt för- och nackdelarna med dom. Vidare kommer den undersöka hur besättningen kan gynnas av ett system där manipulation inte är möjlig.

Det finns problem inom sjöfarten som omfattar stress, utmattning, och andra hälsoproblem, därför är det viktigt att besättningen får sin vila, för att förhindra dessa problem. Eftersom sjöfarten är en 24-timmars industri så finns det speciella regelverk för sjöfarare gällande arbets- och vilotimmar för att säkerställa tillräcklig vila.

Semi-strukturerade intervjuer genomfördes med sjöfararna över videosamtal, på grund av den rådande situation med Covid-19, för att få deras synpunkter på systemen som används, och svara på undersökningsfrågorna. Undersökningspopulationen är begränsad till maskinpersonal.

Rapporten visar tydliga bevis på att manipulering är ett markant problem, och att det i vissa fall sker dagligen. Resultaten visar att rederierna är den betydande faktorn till varför manipulering förekommer eller ej, eftersom manipuleringen görs för att undvika repressalier från kontoret. Detta indikerar att nuvarande system inte fungerar tillräckligt bra för att tillfredsställa regelverken gällande arbets- och vilotidstimmar. Resultaten föreslår att ett nytt system för rapporteringen av arbets- och vilotidstimmar behövs för att efterfölja regelverken, och för att säkerställa sjöfararnas välmående och hälsa, samt se till att fartygen är tillräckligt bemannade.

Den här rapporten skrevs på Chalmers Tekniska högskola i Göteborg.

Nyckelord: Tidsrapportering, utmattning, stress, manipulering, justering, arbets- och vilotidstimmar

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ABSTRACT

Previous research has shown that manipulation of the work and rest hours on board vessels is a major issue, and this report investigates how widespread the problems are. By conducting interviews with seafarers, this report will also investigate which systems are in use, their strengths and flaws, and how the crew experiences them. Furthermore, it will investigate how the crew members could benefit from a new system where manipulation is not possible.

There are significant problems in the maritime industry regarding stress, fatigue, and other health issues. Therefore, it is essential that the crew members get their rest hours to prevent these problems. Since the maritime industry is a 24-hour business, special regulations are created for the seafarer's work and rest hours to ensure sufficient rest.

Semi-structured interviews were conducted with seafarers over video calls, due to the current situation with Covid-19, in order to get their view of the systems and answer the research questions. The interviewees were limited to the engine crew.

The report showed clear evidence that manipulation is a significant issue and that it occurs daily in some cases. It also highlighted that the company is the deciding factor whether manipulation occurs or not since the crew manipulates the logs to avoid reprimands from the office. The results thereby indicate that the current systems are not functioning appropriately in accordance with the regulations for work and rest hours. The results also suggest that a new system for recording work and rest hours is needed to comply with STCW´s regulation VIII/I Fitness for duty and MLC regulation 2.3. It is also needed to ensure the well-being and health of the seafarers, as well as to ensure that the vessels are adequately manned.

The report was written at Chalmers University of Technology in Gothenburg.

Keywords: Fatigue, stress, time logging, manipulation, adjustment, work and rest hours

INNEHÅLL

ACRONYMS AND TERMINOLOGY

ECA	Emission Controlled Area
SOLAS	Safety Of Life At Sea
HCD	Human-Centered Design
ILO	International Labor Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization
MLC	Maritime Labor Convention
STCW	Standards of Training, Certification and Watchkeeping

1. INTRODUCTION

Working at sea is regarded as one of the most dangerous occupations globally (Çakir, 2019), and it is a high-risk job with more accidents and a higher mortality rate than other professions (Rinne et al., 2020). In the last decades, work has rapidly changed, and due to technological advances, the size of the crew has lessened (Rydstedt & Lundh, 2010). Administrative work has increased significantly, adding further to the workload (Lundh & Rydstedt, 2016). These changes combined, could risk causing stress, anxiety, and reduced sleep, and in addition to this, working in an engine room, with constant noise, vibrations, a hot environment, and heavy physical work inevitably leads to fatigue, which has shown to be a huge contributor to accidents at sea (Bal et al., 2015). Monitoring and minimizing the crew's risk of becoming fatigued and monitoring the work hours is therefore crucial to minimize the risk of accidents occurring due to fatigue.

To minimize the risks of accidents, there are several different legislations and laws to ensure a safe environment for seafarers. One of those is the STCW regulation VIII/1(Fitness for Duty) which covers work and rest hours, and it regulates the number of hours the crew shall work per day and how many hours of rest the crew must have between work periods. The work and rest hours are reported and logged using an administrative system on board. Research has shown that the systems can be and are manipulated (Baumler et al., 2020). The purpose of the logging system is lost if the actual workload is not reflected due to manipulation. To ensure that the vessels are adequately manned and to ensure the well-being and health of the seafarers, modern technology could be used to register the work hours of the crew automatically, and at the same time, reduce the administrative burden.

1.1 Background

Our world is dependent on seafarers for the transportation of goods all around the globe. They ensure connections between continents and thus provide billions of people with necessities and luxuries in life. More than one million seafarers´ worldwide secure trades and transportation needs, despite being classified as one of the worlds´ most dangerous occupations (Çakir, 2019). It is a high-risk occupation where accidents can occur far out at sea and help may be far out of reach. At the same time, dangers are posed by pirates (Liwång, et al., 2013) and harsh weather, but greater risks also lay in mental health problems that may arise when seafarers are far away from loved ones for long periods (Mellbye & Carter, 2017). In addition to being dangerous, the profession can be very demanding and safety-oriented, as seafarers often are faced with irregular and prolonged working hours during their time onboard. These factors can be very stressful, and in the long run, they can increase the risk of accidents occurring due to fatigue. As our generations' technology has developed in recent decades, things such as internet connection allow daily contact with loved ones (Katz & Rice, 2002), or automated technology, which has replaced humans in many industries. However, problems still evolve, Lundh & Rydstedt (2016) reported that new technology onboard entails more administrative tasks at the same time as the usual tasks remain. New established technology onboard has proven to be one of the factors leading to a reduction in the size of the crew, which increases the workload for existing crews (Bloor et al., 2000).

In a recently published study (Baumler et al., 2020), where 20 seafarers of different ranks and nationalities took part, excessive workload due to small crews proved to be the main reason why seafarers underreport their working hours on board, and in the long run to avoid problems with third parties. Furthermore, as Baumler et al. (2020) and Smith et al. (2006) proposed, new

methods for recording work and rest hours should be investigated as it is proven that current systems are easy to manipulate.

Manipulation violates the statutory regulations on work- and rest hour reporting, and the main purpose behind the regulations, which is primarily to avoid fatigue, is therefore lost (STCW regulation VIII/1(Fitness for Duty) MLC Regulation 2.3). Manipulation also violates the principles of the minimum safe manning resolution (Resolution A. 1047 (27) [A 27/ Res.1047], 2011), which purpose is to ensure that vessels are adequately and efficiently manned to provide the ships´ safety, safe navigation and operation at sea, safe operation in port, prevention of human life or loss of life, avoidance of damage to the marine environment and property. The resolution also ensures the well-being and health of seafarers by avoiding fatigue. Furthermore, the regulations (STCW regulation VIII/1(Fitness for duty) and MLC Regulation 2.3) state the maximum hours of work and rest the seafarers shall have between shifts. All countries must comply with these regulations, and it is up to each country to decide whether to use the maximum work hours, or minimum rest hours. To comply with these regulations, all ships use some type of system where crewmembers record their hours. Usually, it is a computer-based program where rest hours are manually reported. Current systems allow the person to write whatever he or she wants, which gives leeway for adjustment in accordance with the regulations, even though the person has worked more than allowed. Baumler et al. (2020) found that all participants in their study reported violations where they had adjusted the hours, either by themselves or by someone else. One participant even reported having adjusted up to 12 days in a month. This demonstrates an obvious problem with the current systems that are used.

Forgery of work and rest hour documentation due to heavy workload reduces or even eliminates the possibility of detecting understaffed ships. This highly increases the risk for accidents involving seafarers, ships, and the environment. Heavy workload has shown to be the leading cause for fatigue, which has been pointed out as the factor that directly leads to accidents caused by human error (Uğurlu et al., 2015). Numerous studies have been conducted addressing fatigue, but not addressing the problems behind its occurrence (Hystad et al., 2017; Wadsworth et al., 2008; Smith et al., 2006). Fatigue has been shown to be a factor behind a large number of accidents involving seafarers (Raby & Mccallum, 1997), as well as the cause of grounding accidents (Uğurlu et al., 2015), and has been linked to major shipping accidents with catastrophic environmental consequences such as the Exxon Valdez accident (National Transportation Safety Board; Marine accident report, [NTSB/MAR], 1990).

1.2 Aim of the study

The purpose of this report is to investigate how widespread manipulation of work and rest hours onboard vessels are. It will also investigate from the crew's perspective, how the current systems are experienced, what their strengths and flaws are, if there are any desired functions they would like to add, and if the manipulation increases the risk of fatigue and stress. Further on, it will investigate what the seafarer's thoughts are about a new system, where manipulation cannot occur, how they could benefit from it, and what functions such system could have.

1.3 Research questions

How extensive is the problem with manipulation of the reported work- and rest-hours onboard vessels?
Could the crew benefit from a new and stricter logging system, where manipulating cannot occur?
How could such a system be designed?

1.4 Delimitations

This report only interviewed crewmembers from the engine department, who works or have worked at sea within the last two years. The report therefore only investigates the manipulation within the engine department. It also only investigated the research questions through the crew's perspective, and not by using any other studies or data to give answers.

2. THEORY

2.1 Increase workload

The pursuit of economic profitability has resulted in, among other things, flagging out ships, employment of multinational seafarers, and the reduction in the number of crew members on board (Bloor et al., 2000). Reduction in crewmembers is also a result of the adoption of new technology. Bloor et al. (2000) mentions an example where the removal of radio officers due to changes in the communication systems has resulted in extra workload for existing crews. Other technical developments such as computers allow internet access and have resulted in more administrative tasks, such as frequent email conversations with shipping companies and port facilities. As well as the adoption of computerised maintenance systems such as Amos, where all maintenance tasks are logged, and spare parts listed (Lundh & Rydstedt, 2016). Håvold (2015) and Lundh & Rydstedt (2016) reported that unauthorised shortcuts through job tasks are often performed as there is an excessive workload onboard. Skipping certain safety steps during tasks can lead to a higher risk of accidents among those involved.

Akamangwan (2016) found that compliance with environmental legislations leads to more tasks for seafarers onboard, and that it has intensified during recent years as legislation has developed and become more extensive. Garbage management was proven to be one such task that contributed to a greater workload amongst the crew, as the task requires additional efforts in waste sorting and planning. Compliance behaviour in preventing pollution from oil and chemical spills was another such task that contributed to greater workload onboard. Bunkering procedures require a risk assessment and parts of the crew to be on standby during the procedure (Akamangwa, 2016). In addition, crewmembers must take part during mooring procedures if the bunkering operation is carried out from ship to ship, as well as planning and preparation that are required in advance. Further on, Akamangwa (2016) found that compliance with emission legislation is another task that brings forth extra workload for the seafarers. Planning and preparation in advance are required before entering sulphur emission control areas, such as ECA. Newly enforced ballast water treatment legislation was a concern by the crew members who participated in the study. In his study, Akamangwa, (2016) found that ballast water treatment was recently introduced and challenging due to some specific country's legal requirements. The extra workload the ballast water treatment required were things such as documentation and test procedures that conflicted with crew rest hours.

In his study, Pauksztat (2017) pointed out the direct and indirect causes of fatigue to be a heavy workload and high job demands in short sea shipping cargo lines with frequent port calls. Interviews revealed that the causes were, among other things, high demands during port time schedules, irregular working hours, which often broke the circadian rhythm amongst the seafarers, and job demands related to cargo operations. Job demands from third parties were evident factors that increased the crew's workload during port visits, whereas weather conditions could disturb the schedules. The crew perceived the night to be the worst time to work, as the hours were long, and the workload was high. Lack of information from third parties regarding cargo could require re-planning and even re-stowing, increasing the workload further. Work demands during port visits affect time intended for routine tasks onboard, such as maintenance and administrative tasks. Port visits could as well prohibit certain maintenance tasks to be conducted in the engine room. Furthermore, Pauksztat (2017) found that heavy workload could affect the working climate onboard as the participating seafarers mentioned that they could easily get aggregated, annoyed, and frustrated due to the high job demands, and it could increase the levels of stress.

2.2 Human errors

Even though the maritime industry is considered to have a safety culture today, accidents still occur at sea. Despite having a world fleet of over 100,000 ships (Allianz Global Corporate & Specialty, 2012), the losses of ships have gone down significantly since the implementation of SOLAS back in 1914. In 2009, one ship per 670 was lost per year, compared to one in 100 in 1912. The fatalities have declined as well, in 1919, the UK reported 358 deaths per 100,000 seafarers, and between 1996 - 2005 those numbers had declined to 11 per 100,000. However, it is still 12 times higher than the general workforce (Allianz Global Corporate & Specialty, 2012). Even though most of those accidents back in historic times were due to human errors, when advanced technology was almost non-existent, this has not changed significantly in present time. Most of the accidents in present time are also due to the human factor (Che Isak et al., 2019; Pyc 2020; Rothblum, 2000), and some estimations say that 75-96% of the accidents and fatalities in the maritime industry are due to human errors (Rothblum, 2000). Human errors can appear in different aspects, for example, incorrect decisions, poorly performed actions, not being aware of surroundings, improper communications etc. One of the worst oil spill catastrophes in the world happened when Exxon Valdez ran aground outside the Alaskan coast. Numerous different factors caused the accident to happen, several of them were human factors (NTSB/MAR, 1990). The Herald of the Free Enterprise is another tragic accident that resulted in 193 deaths, where the investigation afterwards (Department of Transport (DoT), 1987) revealed that the human factor was the source of the accident. Therefore, it is crucial to avoid any factor that affects the human mind and body negatively in any way. Two of the main contributors to human errors are fatigue and stress.

2.2.1 Fatigue

Fatigue is the medical term for exhaustion or the feeling of being extremely tired, or as IMO defines it, “A reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including strength, speed, reaction time, coordination, decision making, or balance” (IMO, 2001). The mental-fatigue is a consequence of long periods of demanding cognitive activity (Marcora et al., 2009), but several more factors may result in fatigue, such as having poor quality or a lack of sleep, working long periods, excessive workloads, insufficient rest between periods of work, working at time of low alertness, noise, vibration, and motion, as well as medical conditions (Project Horizon, 2011). A person who suffers from mental fatigue can have various symptoms such as lack of energy, unusual tiredness, problems falling asleep, anxiety, dizziness, increased heartbeat, problem remembering things, difficulties performing duties and tasks, and overall difficulties with everyday tasks (1177 Vårdguiden, 2020). While mental fatigue can affect the body both physically and mentally, physical fatigue leads to feelings of tiredness in the body, and reduces energy and power, and does not affect the mental state in the same way (Barker & Nussbaum, 2011). Even though research on fatigue began in the 19th century (Mental & By, 1896), research is still ongoing in present time, as fatigue is a widespread problem in all professions.

One study (Oluseye & Ogunseye, 2016) ranked fatigue as the second most frequent cause of marine accidents. Therefore, it is essential to decrease the fatigue spread amongst seafarers and the marine industry to minimise the risk of accidents. Fatigue is a phenomenon that becomes increasingly more common in our society, which not only affects the people, but also the economy. A study in the US workforce (Ricci et al., 2007) revealed that health-related issues due to fatigue cost employers over 100 billion dollars annually in lost productivity.

Fatigue has been addressed in other transport sectors as well, in the trucking sector it was linked to being the major contributing factor in accidents involving trucks (Cantor et al., 2009). Truck drivers are exposed to long working days, usually several consecutive hours, without stopping. Therefore, the truck drivers were previously required to keep a logbook of work and rest hours to ensure sufficient rest time between the permitted intervals for driving to avoid fatigue. However, manipulation of the logbooks allowed the drivers to drive longer distances and thus achieve more runs, resulting in higher wages. Furthermore, due to various circumstances, certain trucks were equipped with electronic logging devices which, among other things, record the time the engine had been running and how long it had been switched off, and in this way, manipulation of work and rest hours was minimised according to Cantor et al. (2009). On December 18, 2017, a mandatory requirement was introduced for the vast majority of large commercial trucks operating in the United States. It became mandatory to equip trucks with electronic logging devices to improve commercial motor vehicle safety and reduce the overall administrative burden that earlier logging devices required and thus improve compliance with work and rest hours, according to the Department of Transportations Federal Register (2015).

2.2.2 Stress

Stress is a major problem in today´s society, an increasing amount of people feel stressed, and in Sweden, 14% of the population between ages 16-84 reported that they felt stressed in 2020 (Folkhälsomyndigheten [FHM], 2021). There are two types of stress, acute and chronic. Acute stress is a result of being stressed by a specific occurrence, for example speaking in front of people or almost getting in a car accident. Chronic stress results from prolonged exposure to situations where the body release stress hormones (Centre for Studies on Human Stress, [CSHS], 2019). Acute stress can, in some ways, be good for the body since it prepares the body and the immune system for what might be an injury or infection, but chronic stress is far more dangerous. The long-term stress keeps the body and immune system alert, which will wear down the system after a while (Segerstrom & Miller, 2004). Stress can also cause several other diseases such as depression, gastrointestinal diseases, cardiovascular- and heart diseases (Salleh MR, 2008). Some studies even show that stress could contribute to the development of schizophrenia (Bujara, 2019) and dementia (Alzheimer´s Society, 2017).

Onboard, the seafarers regularly expose themselves to a psychosocial and physical work environment which is stressful in different ways and to different extents among those on board. Psychosocial stress consists of various factors, such as long working days, lack of sleep, irregular working days, separation from families, and high job demands, to name a few (Oldenburg et al., 2009). Regular mandatory visits from classification societies, vetting surveys, cargo owners, and flag states contribute to more administrative tasks for seafarers, requiring planning and preparation in advance (Ljung, 2010). In addition to this, working in an environment with high noise and temperatures, constant vibrations, and ship movements are some of the elements that can drain the seafarers of their mental and physical energy (Lundh & Rydstedt, 2016; Oldenburg et al., 2009; Oldenburg et al., 2020). Together with reducing the crew size and increased workload (Lundh & Rydstedt, 2016), the stress has a probability of increasing. One way to reduce stress is socialising with other people, therefore reducing the crew size could further contribute to stress. Port calls can also be stressful as they differ depending on the type of ship and where it operates. Some have the same specific routes every time, and some have different routes where they are introduced to new ports. Port calls can occur at any time during the 24 hours of the day, where entry and exit make demands on both deck and machine personnel, which often breaks the normal circadian rhythm.

An investigative study (Håvold, 2015) found that amongst Norwegian bridge personnel on offshore vessels, lack of sleep and pressure from work increased the stress of the personnel. Oldenburg & Jensen (2019) conducted a study in which 383 participants on board 22 container vessels participated. They found that, despite working in the engine or deck department, where different time schedules and tasks occur, the average sleep duration was 5 hours per day.

In a recently published study (Oldenburg et al., 2020), four scientific researchers accompanied four different container vessels during six sea voyages to perform noise and vibration measurements in different areas of the vessels. The average decibel number in the engine room was measured at 104 dB, 72 dB in the engine control room, 62 dB in the recreational room, 57 dB on the bridge and in the cabins, and 77 dB on deck. In addition, the study also issued a questionnaire where the results showed that noise was the second largest contributing factor to physical stress onboard after vibrations (Oldenburg et al., 2020). In another study (Forsell et al., 2017), in which 1962 Swedish citizens participated with various positions onboard different types of ships, noise and vibrations were shown to be the biggest problems, and unexplained fatigue was reported by some participants. The Swedish Work Environment Authority (2005) states that the daily noise exposure level for eight hours must not exceed 80 dB if hearing protection is not used. They also state that noise effects are both psychological and physical, where the psychological effects can cause fatigue, which humans often do not link to noise exposure. Furthermore, noise can lead to certain physiological reactions in humans, such as increased heart rate, elevated blood pressure, and secretion of stress hormones.

2.2.3 Health Issues

The lack of sleep is known to increase the risk of several diseases such as obesity (Cappuccio et al., 2008), type 2 diabetes (Spiegel et al., 2005; Touma & Pannain, 2011), Alzheimer's disease (Wen et al., 2017), Parkinson´s disease (Wirdefeldt et al., 2017), decreased immune system (Bryant et al., 2004), cardiovascular diseases (Meerlo et al., 2008), depression, and anxiety (Taylor et al., 2005). Several studies have also shown that it is associated with a higher mortality rate (Grandner et al., 2010).

Stress may also cause various health issues, many of them similar to those caused by lack of sleep. Short term memory loss and high blood pressure (Physiologic & To, 1998), learning and memory impairments and depression (Lupien et al., 2009) are just a few other issues. Ironically, as lack of sleep causes stress, stress may also cause lack of sleep or insomnia. Chronic work stress may even cause burnout syndrome, a state where the person experience exhaustion, anxiety, depression and low self-esteem (Maslach et al., 2001).

2.2.4 Project Horizon

Project Horizon (2011) was a research project that brought together eleven different shipping industry organisations and academic institutions with the mutual goal of delivering empirical data to offer a clearer understanding of how the watchkeepers onboard a ship are affected by the working hours and patterns. The wide spread of the involved participants guaranteed that the project and its results are objective. The project's goal was to use different simulators for cargo, engine room, and bridge in various seagoing scenarios to measure fatigue in the participants. The project also captured empirical data of the watchkeepers cognitive performances while they worked in the different scenarios. It also assessed how fatigue impacted the watchkeepers decision-making performance and determined how to minimise risk to the ships, seafarers, passengers, cargoes, and the marine environment. The results showed that the watchkeepers were the most tired during the night and afternoon. During the night,

sleepiness and slow reaction time were the highest, and most of the incidents occurred during the night and early mornings. The study revealed that 6 hours-on/6-off watches were more tiring, resulting in less sleep than 4-on/8-off. An interesting finding was that “disturbed” off-watch periods resulted in a significantly higher level of tiredness. The research used simulators, and therefore some factors are not included, such as weather conditions, noises, vibrations, staying long periods at sea, working with a different crew, etc.

2.3 Regulations

The maritime industry is considered to have a safety culture, with thorough regulations and training such as STCW, founded in 1978 to establish basic requirements for seafarers on certifications, training and watchkeeping. The most prominent part of maritime safety is the SOLAS Convention. It is a result of the loss of the RMS Titanic in 1912. The disaster resulted in the creation of a convention, where the main objective was to specify a minimum standard for different aspects of the construction, design, and operation regarding safety. This has given way to most of the safety manuals and documents used in the marine industry today.

Being able to rest to recover is essential to a safe work environment onboard a vessel. Therefore, there are regulations on the minimum amount of rest hours for a certain period. IMO has formed STCW regulation VIII/I, “fitness for duty”, which states that all crew members should be provided with; 77 hours of rest in any 7-day period, and a minimum of 10 hours of rest in any 24-hour period. The 10 hours may be divided into two periods, one which must be at least 6 hours. The Maritime Labour Convention (2006) also states these minimum rest hours, as well as a maximum of work hours, which should not exceed 72 hours in any 7-day period.

2.4 User centralised design.

Since there is already an excess of other administrational tasks to do, having a system that will not take up unnecessary time is an aspect that needs to be taken into consideration. In a study (Baumler et al., 2020), a few participants stated that the recording of the work and rest hours is merely a paper exercise that is corrected when reporting it in to the computer. Therefore, the system ought to be user friendly and not time-consuming nor stressful and simultaneously registering the true hours of work and rest.

Human-centred design (HCD) is a practice where the system’s design is interactive and made to be more user-friendly through ergonomics and usability knowledge (Kataria et al., 2015). The purpose is to have the system-performance increased, so less training will be needed to use it, as well as increase the usability and reduce the stress and discomfort it may cause. It will emphasise the need for effectiveness, efficiency and the specific use or process of the product. The ISO defines HCD as an approach to design and develop interactive systems that are easier to use, focusing on how the system is used, applying the human factors and ergonomics, the knowledge of the user, as well as the techniques of the system (Costa, 2018). Four main elements are the base of this approach; a) to recognise and specify the use for the relevant users and what their goals are for the system; b) identify and specify what the user’s requirements and needs are, what the current standards are and what the objective of the system is, and solve potential conflicts between the users concerning the requirements; c) creating solutions for the design in forms of prototypes, simulations, together with the users tasks and systems interactions, in order to foresee the use and requirements of the system by the user; and d) assessing these designs against the requirements together with the user and different inspections methods for the usability (ISO, 2010).

CyClaDes (2015) (Crew-Centred Design and Operation of ships and ship systems) was a project funded by the EU. The purpose is to increase the influence of the human element in the design and operations of the shipping industry. It brought together a team that focused on the key stages in the shipping industry, the stakeholders, identifying where the human element barriers occur, and apply the human element knowledge best. The project's first step was to analyse how the current HCD domain was used and what potential for innovation it had. It also investigated if the shipyards and ship operators used HCD and to what extent. The result showed that all the participants regarded HCD to be important, and nearly all stated that they used HCD, but it was inadequately formalised and only applied moderately. There was high interest in the topic, and there was a lot of envisioned framework. The participants also expressed that demands for methods, guidelines, and tools were highly welcomed. The participants agreed that the most effective way for increased HCD in the maritime industry would be introducing rules to support it. The conclusion was that the HCD framework developed by CyClaDes is certainly interesting for the maritime industry and that it will tackle a subject that presently lacks a satisfying solution. It is of the utmost importance to consider all potential users (operators, ship designers, system designers, and class societies) while the development is ongoing as it will guarantee that the users all benefit from this framework.

3. METHODS

For this report, semi-structured interviews were conducted with personnel who works or has worked onboard vessels within the last two years. The interviews were based on eight main questions, with a few possible follow-up questions (See appendix 2). Due to Covid-19, the interviews were held through videocalls on Zoom, Teams, or Facebook, and the length of the interviews ranged between 15-30 minutes. The interviews were audio-recorded and transcribed, which was later inserted into the software program NVivo 12 for coding. After that, a thematic analysis was carried out by following guidelines generated by Nowell et al. (2017). The method of thematic analysis is often used in qualitative research and can be adaptable to a broad range of research questions, and therefore the approach gave the report trustworthiness and validity, as any author can repeat it. The guidelines established by Nowell et al. (2017) were followed, which enabled the transcribed data to be structured after similarities and differences.

1. Familiarisation with the data. – Finding out what the data means, are there any patterns that can be found?
2. Generating initial codes. – When familiar with the data, codes are produced to focus on specific data that is relevant to the topics. All data is given equal attention, and interesting aspects are identified to produce themes.
3. Searching for themes. – As all data has been analysed and codes have been produced, the codes are sorted out to find the different themes which are relevant.
4. Reviewing themes. – When the themes are created, they will need some refinement. This can potentially need recoding and new codes.
5. Defining and naming themes. – It is important to give relevant names to the themes, and names that quickly give the reader information about the theme.
6. Producing the report. – As the themes and codes have been produced, the final phase will begin by writing the results. It is important that the results provide information that is interesting, coherent, concise, logical, and non-repetitive across the themes.

In chapter 4, “Results”, the initial part was written to describe the current systems and how the seafarers experience the system. Following this, the finding of violations of the regulations and occurrence of manipulation was presented, and lastly, the crew’s thoughts about a new system were described. The results were written as a summary of the participants answers, and some quotes were presented to back up claims of importance.

The interviews were overall successful, and the answers were satisfactory. Though, there were a few things that could have gone better, for example, the topic of stress and fatigue. This is further explained in chapter 5.7.

3.1 Validity of the study

Semi-structured interviews followed by a thematic analysis are some of the most used practices in qualitative research, and therefore gives the study trustworthiness in the results. The reasons of why the research used these practices are further discussed in chapter 5.6.

3.2 Demography

Convenience sampling was used for the selection of the participants. The six participants, ranging from 26-64 years of age, were all male seafarers whom the authors had previously

worked with during their time as cadets. All participants worked for Swedish companies, except one, and all were of Swedish nationality except for one.

3.3 Ethics

Before conducting the interviews, a consent form was given to the participants where they were informed of the terms of their participation together with information to why the research is performed (See appendix 1). The form stated that the participants were guaranteed anonymity, that they had the right to withdraw their participation at any point, and that the data would be presented without any connection to the person, company, or vessel.

4. RESULTS

4.1 Flaws of the system

The participants reactions were that sometimes the system is just something to show the inspectors and has nothing to do with reality. One participant, who had worked as a third engineer on a cruise ship, stated that:

> "It is only a masquerade, nothing else, it is just something that needs to be done to satisfy the inspectors and port state. It had nothing to do with reality, and it was just cheating from the beginning to the end".

The participants either used the system "Sea manager", or a similar computer-based program, and one noted the hours on a paper that was later given to a superior officer for logging in to the computer. The basis of the systems was similar, it is a graphical system, where one square represents one hour of work, and the squares are filled based on how much work has been done. The participant who reported in paper form gave it to a superior officer who then used the same systems as mentioned above. There were many comments, both positive and negative, of the functions in the systems. Several participants pointed to the fact that the system did not allow for logging minor working periods. The system only allowed to note a minimum of 30 minutes per working period. Two participants explained that working a few minutes here and there added up in the long run. Chief Engineer - 1 stated:

> "I could get an alarm 10 minutes past 9 and be finished by 20 minutes past. But I still have to report 30 minutes of work."

Another flaw of computer systems is that they often contain software bugs and are not always easy to manage, and therefore can be frustrating to work with. One participant stated that the system he used blocked the users from reporting any violations. When a crew member worked overtime, and a violation were made, the system would not allow the crew member to report the overtime hours if they breached the regulations. It is still possible to write a report and explain what happened, but this will result in a lot of extra work. Therefore, it seems as the system encourages the users to adjust the hours, as it is much easier and does not require any extra work, instead of just being a tool for reporting hours. If the crew member is blocked from reporting more hours that day, the hours are usually reported on other days where it is okay to do so, and sometimes they are not reported at all.

4.2 Strengths of the systems

The comments from the participants about the strengths of the systems they used were not as many as the comments of the flaws. However, the common experiences were that the system was relatively easy to use. The system shows an overview of the working hours, and it is easy to see if any violations have been made. Since it is graphs with square boxes, it is easy to fill out and see how much work has been done. As a senior officer, it is possible to have all the crewmembers on the same screen and easily report their hours by dragging and releasing in the boxes and see how much each person have worked. It is also easy to plan ahead, for example, when a pilot arrives. It is then possible to see a few days ahead that it is needed to end the day earlier to get the sufficient rest hours and be ready for the pilot and manoeuvring. The users can also see beforehand how much they will work each month and know approximately how their salary will turn out, provided that they have an hourly based salary.

4.3 Desired functions in their current systems

A function that many participants wanted was a system where it is possible to be more exact. As previously mentioned, the systems only allowed for a minimum of 30 minutes to be registered in one work period. A system that would allow reporting down to work periods of 5 minutes would be appreciated. If the crewmember would work ten or fifteen minutes over the lunch break, they rarely report it since it will result in extra work. Nevertheless, as these 10 minutes add up, over a month or a year, it will end up in many hours of unreported work. This is a problem for the rest hours, as well as the crew salary if it is hourly based. The same goes for an alarm during the night. Even though it only requires 5 minutes of work, it needs to be reported as 30 minutes, as the inspectors will wonder why none worked during the alarm.

> "It would be that we could write the exact time. 5 minutes to, or 5 minutes after 12." (Chief engineer - 2)
> "If you have lunch at 12, and you work 20 minutes extra, often you will not write this down in a time journal. […] But when you add all these minutes in a year, it is a lot of time just thrown away." (Motorman)

Another function for the system that is preferable is the possibility to write notes directly in the system and explain what happened during an alarm and what actions had to be made to rectify it. As of now, this is not possible, so when an inspector boards the vessel at a later time and asks what happened during an alarm, the crew will have to rely on their memory to explain what happened.

Another topic of discussion was the possibility of disregarding if one day had violated the regulations, but the total rest hours of the week were within the regulations. However, this is not something the system itself can manage, it is the regulations which must be changed. Overall, what is wanted is a system that does not take time of an already busy day to satisfy the system.

4.4 Violating the regulations

The participants all reported that they had violated and exceeded the work and rest hours regulations and gave their different reasons as to why. Commonly, the six hours of consecutive rest is violated, and it is usual during duty and night alarms when the engine room is unmanned that this happens. When this type of violation happens, it must be recorded in the system, and the crew member needs to rest for a longer period to receive the six consecutive hours. However, in reality, this is not the case. The hours are instead adjusted or not reported at all, and no report has to be written. In that way, they comply with the regulations if the company or an inspector were to look at it, and it looks like the crew member got his or her sufficient rest. Meanwhile, in reality, the crew member did not receive six consecutive hours of rest. It is also usual during port calls and manoeuvring, especially during the night. Provision handling and vetting's during lunch breaks and the afternoon after normal working hours are also situations where violations are made. It is also hard to prioritise rest hours during these situations. To leave a vetting inspector waiting while the crew is resting is not something that is appreciated.

> "Under manning and demands that we do the same job with fewer people. But that is nothing I can affect, it is a bad company culture." (Third Engineer – 2)

If a violation of the rest and work hour regulation occurs, it should be reported, according to the participants. However, that was not always how it is handled. All cases except one stated that violations are reported to a certain extent. Some participants stated that they were allowed to violate the regulations two times per month without writing a report. This resulted in all the violations after the second one was adjusted to be hidden, if possible. However, in one case, with the third engineer – 2, he stated that they were not allowed to write anything if they had violated the regulations:

> "No no, we were not allowed. […] The second engineer ordered us."

How the crew copes with working too much differed between the participants. Some stated that they were not affected at all. One participant stated that he does not need that many hours of sleep to handle the day well. Others commented that they could sleep longer in the morning or end the day earlier. However, in some situations, it is not possible to do this. If an alarm occurs in the middle of the night, and external personnel arrives early in the morning, it will have a negative effect. Others stated that they were tired or worn more frequently:

> "I feel unwell, and I am not in the mood to work. Sometimes I feel slower. […] Sometimes this will affect my performance in my work. Especially if I do not have enough rest." (Third Engineer – 1)

> "Both stress and fatigue. I also got heart problems. […] Incidents occurred sometimes. But during the time onboard I was constantly tired. […] You always had to little sleep." (Third Engineer – 2)

It is not always the work that made the crewmembers feel tired or worn. The weather at sea can be hard sometimes. Even though the crewmember has the correct rest hours and does not violate any regulations, the rolling of the vessel can keep them awake and not grant them any real rest and therefore result in greater danger than violating the regulations with a few hours of extra work. One participant stated that he rarely gets affected by the work, but the weather is what makes him tired and fatigued:

> "Yes, when it is a storm and rough weather, not else. It is not because of a high workload, just a sleep deficit (due to the heavy rolling). We do not violate the regulations, but we still will not get any rest. How can it count as rest when the vessel is rolling as hell? […] Both vibrations and noise contribute to less rest."

4.5 Occurrence of manipulation

All the participants agreed that manipulation of the system occurs. The participants have experienced that manipulation is a common occurrence on board and that everyone who has worked onboard a vessel must have experienced it. Some stated that the manipulation was a daily occurrence, as the crew had to work overtime every day to manage the work tasked that they were assigned. One participant also stated that it was forbidden to write any violations of the system, and at the same time, they violated it daily, and therefore every single day had to be manipulated.

> "The record should say 10 hours of work and 14 hours of rest every day, you were not allowed to write anything else. […] Usually, it was the opposite, 14 hours of work and 10 hours of rest. […] We were not allowed to write any violations. If we did, we were

called to the second engineer and got a scolding together with a new timesheet" (Third Engineer – 2)

The participants all agreed that there is one main reason why manipulation is made from the beginning. That is to not officially violate the regulations of work and rest hours. This is to avoid getting any reprimands and backlash from the company, as well as having fewer administrative tasks. The crew member manipulates the time logs so that the violations disappear, either by adjusting the time in a previous or upcoming day. It seems that the companies do not understand that even though careful planning is being done, it is impossible to schedule for alarms. If the company allows for two violations, after the second one, they contact the vessel and ask them to make a better schedule, where violations will not occur. This is an impossible task since unwanted alarms occur daily, and sometimes it will demand that the crew violate the regulations. During storms, it is common that there is a lot of alarms with tank levels, clogged filter, etc. Another reason for the manipulation is to reduce the risk of getting deeper investigations made by the inspector, where they might find other violations.

The participants had both positive and negative views on a system where manipulation can be done. It is negative in the aspect of hiding all the overtime that is needed. If the crew works a lot beyond the regular working hours, it points to a need for more crew in the form of a motorman or an engineer. However, due to the manipulations, this information will never reach the company, and reveal that the vessel is understaffed. In the end, it affects the crewmembers negatively, as they are the ones who work more to handle the daily tasks. The offices are based at shore, and there is a risk that the personnel have never worked at sea, and thus they do not understand how life onboard a ship is. If the vessel then demands more personnel, the overtime hours can prove that this is needed.

On the other hand, the possibility to manipulate the hours can be a good thing. However, it should be perceived more as a possibility to rectify wrongfully logs, than to see it as a possibility for manipulation. It is easy to write a number wrong, and therefore it should be possible to rectify this mistake. It can also be a good thing since the violations can be a rare occurrence, and instead of having an extra engineer who is only needed for a few hours once a week, it is better to adjust the hours instead.
However, the third engineer – 2 seemed sceptic to the idea since there will always be a way to manipulate every system:

"To come up with a system where manipulation is not possible, I do not know. It is a cultural thing for the marine industry [it is not possible], I think."

4.6 Policy

The common view of the reasons why manipulation is done is based on the mindset of either the company or the master/Chief engineer. Suppose either the master or chief engineer demands that overtime is needed. By law, the crew members are not obligated to do so if their rest hours will be violated, unless an emergency situation occurs. Since the chief engineer gets a bonus, based on how much or how little work has been done in the engine room, he can set the rule of how much work needs to be done. If he orders the crew to work long hours every day, it can be hard for the crew members to decline this due to fear of reprimands later, either from him or the office, if he chooses to report the crew for bad behaviour.

The third engineer – 2 explained that the problems of always working overtime had its roots in

"A crooked company culture, and a crooked culture onboard."

However, ultimately it is the company that sets the rules of how much one will work. As the companies are stationed ashore, and there is a risk that many of the employees in the office

have never worked at sea, they do not grasp how life at sea really is. Working at sea is not a 9-5 job, it can be viewed as a 24-hour work, where if something happens, it is not possible to wait until the next day to fix it.

> "It is a problem that the companies do not understand that we cannot, or maybe it is both the shipping company and oil company who does not understand that we cannot make alarms disappear when it is a storm." (Chief engineer - 2)

4.7 Crews thoughts about a new system

Different suggestions for a new system were made by the crew, where they were allowed to have any functions they would like. A few participants pointed out that a system similar to a stamp clock would be a good solution, as it would register the hours of work without being able to change it manually. Therefore, if a crew member had worked 3 hours of overtime, it would not be able to hide this in any way. However, one participant stated that this would not help the issue of manipulation in any way. He said:

> "You would have to go to the clock at the correct time, punch out, and then go back down and continue working, so it would only slow you down. And if I had to punch out at the correct time, I would have to go to the clock 5 minutes earlier, wait, and punch out at the correct time. And then everyone else is there and it will be a queue."

The participants believed that an automatic system could work, and one participant gave a suggestion of some type of wristwatch that logs when the crew members enter the engine room. Another one mentioned a controller that is pressed when the crew member walks down to the engine room, much like a stamp clock or a tag system. Though it could become a problem when an urgent issue occurs somewhere else than in the engine room, and there is no time to go down and press the button. Two participants suggested an interesting idea of a time logging system which is integrated in the engine room's alarm system. The system would be used when the engine room is unmanned. When an alarm occurs, working hours will automatically be logged as soon as the alarm is acknowledged, and when the crew member leaves the engine room a button is pressed to stop the logging of the hours.

One participant did not want it to be automated, as this would be too much surveillance. He would rather handle it manually by himself.

4.8 Benefits for the crew

The collected opinion of a new system where manipulation is not possible is that it will show the office the true working hours and the effort that is being put down by the crew. It would remove the possibility to hide the violations that take place now, and therefore it could prove if there are not enough crew members to cope with all workloads. This would therefore benefit the crew by enabling the possibility to add an extra engineer or motorman since the violations would be visible during inspections and port state controls and result in non-conformities. It would also ensure that the crew is not reduced further.

> "The office will see how much we work. Because what is being manipulated is that we decrease the reported hours. You never write more hours than you work. […] It will show that an extra motorman or engineer is needed." (Chief Engineer – 1)

> "If there are a lot of work hours for the crew and you go to the office and say that we need an extra motorman or whatever. […] Then you can prove by your work hours that everyone works 3-4 extra hours every day to make things work. Then it is a good example that you need an extra man." (Motorman)

It would also benefit the crew regarding their health. If the company added an extra crew member, the rest of the crew would not have to work in the same extent and reduce their overtime hours. It would then result in less work for the crew and more time for them to rest and recover. The crew would therefore be healthier, more alert, less tired, and perhaps be able to solve their task more efficient.

5. DISCUSSION

5.1 Manipulation of current systems

The purpose of the systems is to help and protect the crew members and mitigate problems such as stress, fatigue, and tiredness. However, the results in this study suggest that this is not the case. The participants all reported that they had manipulated or adjusted their work and rest hours. Some stated that manipulation occurred daily, while others stated that it occurred a few times per month, which is in line with what earlier research has shown (Baumler et al., 2020). Fear of reprimands from both company and inspections drives the crew members to manipulate their logs and therefore endanger their health and safety of the vessel. Some companies allow the crew to breach the violations one or two times per month without writing a report. The issue with this is that after the second breach, the crew will manipulate the logs in order to comply with the companies' directives. The report writing will only lead to more administrative work, which already exists to a great extent on board, which gives even less motivation to report violations. A system like this influences the users to rectify the logs instead of dealing with the consequences of violating the regulations. This indicates that even though the company officially states that they implement the work and rest hours regulations in their company and vessels, they do not follow them in practice. Inspections were the other reason that the crew manipulated the time logs. This leads back to how the company reacts to the non-conformities the inspectors will note concerning the violations of the rest hours. In some companies, the crew members are not allowed to write any violations, as it will result in reprimands from the superior officers onboard. This completely undermines the employees' health and well-being, as well as the safety of the ship, its crew, the environment, and the passengers. In a company with a mindset like this, it would be hard to eliminate the problem no matter what system they would use. As stated in A 27/ Res.1047 (2011), responsibilities of companies are to ensure that recording of work and rest hours are implemented and guarantee that minimum safe manning is adequate at all times and in all respects, including meeting peak workload situations, conditions and requirements in accordance with the principles, recommendations, and guidelines contained in the resolution. As manipulation is needed to hide the fact that violations occur, the companies are not guaranteeing safe manning at all times. A system and company mindset that encourages manipulation of the rest hours, showing more than what is true, could therefore endanger the seafarers and the surroundings. To erase the practice of manipulation, it is essential that the companies encourage the crew members to report violations in the regulations, to be able to solve the root cause of the problem. This means that the company policy will ultimately decide what the outcome will look like concerning manipulation.

There were comments about feeling limited and restricted in the system and not being able to log the actual hours of work. The systems are inaccurate in many cases, where it is only possible to report a minimum of 30 minutes. This provides an unrealistic picture. Sometimes 15 minutes of work was not reported at all, and if that frequently occurs, in the end, it could add up to many hours. On the opposite, if an alarm occurs at night, and the crew member carries out 10 minutes of work, it needs to be reported as 30 minutes. Otherwise, the inspectors will ask why nobody worked during an alarm at night. Therefore, it is a crucial factor to have a system that can log the exact time. If the system cannot log the exact time, it is vital that the crew members use the current systems in their advantage. They should report 30 minutes, even though they only worked 10 minutes, in this way it will ensure them that they will not violate the rest hours without knowing so. This could also motivate the company to adopt a better and more correct system.

One positive feature of the system that all participants agreed with was that the system was rather easy to work with and understand. It is a simple yet important detail since the crew already have lots of other tasks and administerial work to do during the day. Having a complicated and time-consuming system would likely results in the crew's unwillingness to use the system.

5.2 New system

As stated earlier, a new system is needed to comply with the regulations for work and rest hours, as well as removing the possibility to manipulate the system to hide the fact that violations have been made. To design a system that is not possible to manipulate can be considered impossible. The system must be unchangeable, at the same time, it must be able to correct mistakes and errors. Here lies the problem, if it should be possible to rectify mistakes, it could be abused to manipulate the work hours. A system similar to the oil logbook, where the error is not deleted but noted, could be a way to go. At least it will ensure that manipulation is not made back in time.

Chapter 2 mentioned the logging of the rest hours in the trucking sectors. A system like this is great for this purpose since it will log the engine's running hours. However, adopting a similar system onboard a vessel could be difficult. A possible solution could be some system that tracks the crew members whereabouts, like a wristwatch of some sort that registers work hours if the user is in the engine room and rest hours when the seafarer is located in the cabin or within the mess. However, this could jeopardise the personal integrity of the crew member, as it would constantly survey them. On the other hand, on cruise ships, it is normal for CCTV surveillance to be monitoring every part of the vessel.

A stamp clock could be another solution, but this is easy to work beyond. Again, this traces back to the companies' attitudes against the problems. If they wanted to adopt a stamp clock system and still want the crew to work overtime, they could punch out and go back to work.
A system that automatically logs work hours when alarms during UMS occurs should be further investigated. Several cases where violations are made is during the night when the duty engineer gets disturbed by an alarm. It is also during these cases where the manipulation is conducted according to the results.

One of the most important aspects to keep in mind if a new system were created is to use HCD, and perhaps work similar to what they did in the CyClaDes project. As described in chapter 2.4, HCD is a practice where the users work together with the developers and assess the product. In a case like this, it may be hard for the developers to grasp how life at sea works. Hence, it is crucial that the users are allowed to be involved in the project and share their thoughts about the system and what functions they want to see in a system for time reporting. The crew members must give their reflections and ideas on what the new system should contain and how it should operate. If the design is made by system designers who only work regular shore based 9-5 job, it is impossible to capture all of the important aspects life at sea can bring. The new system should therefore be designed together with seafarers and system designers from the beginning, and constantly be evaluated by the seafarers who will give opinions and comments of what is working well, and what is not. To erase the practice of manipulation, it is essential that the companies encourage the crew members to report violations in the regulations, to be able to solve the root cause of the problem. This means that the company policy will ultimately decide how the outcome will look like concerning manipulation.

5.3 Regulations

Even though the vessel and company implement the regulations officially, this research shows that the STCW regulation VIII/1 Fitness for Duty and MLC regulations 2.3 are not implemented in practice. The main purpose of the regulations, which is to prevent fatigue by restricting the maximum work hours, is therefore neglected. Neither are the guidelines for determining the minimum safe manning A 27/ Res.1047 (2011) followed, as applicable work hour limits and rest requirements are not established. As all the participants mentioned that violations and manipulations occur onboard, the results show that the regulations and resolutions are not followed in practice.

There were some comments from the interviews that are worth giving attention to and discuss further regarding the regulations. It is worth further investigating whether to view the total rest hours during the whole week instead of each day. If the violation only occurs one day, it should be possible to disregard that incident if the total rest hours for the week is correct. Perhaps the regulation should be able to make an exception for one or two days in a 10-day period if the total rest hours for the week is correct.

One participant mentioned that the environment onboard a vessel is a crucial part of the quality of the rest. He explained that he is not affected by the heavy workload. Instead, he said that the environment was the most significant contributor to the lack of sleep. This raises the question of how rest is defined. The MLC defines rest time as “time outside hours of work”. However, that does not automatically mean that the crew member is resting. If he or she cannot relax and regain energy, it could be debated whether this can be considered as rest. It is merely a break from physical work rather than a time for rest. The environmental factors on board, such as noises, vibrations, and the weather can greatly affect how the person experience life at sea. Noise has been connected to fatigue, and some vessels have a noisy environment in all parts of the ship. The weather can heavily affect the resting period. If the vessel is rolling during the night, this could result in no sleep at all. On paper, the crew member has been resting, but could be completely exhausted in reality. Therefore, the regulations should perhaps consider other factors like the weather when defining rest hours.

Another major issue connected to watchkeeping is the 6-on/6-off schedule. As time will be consumed for eating, showering, etc., this will result in four or five hours of rest. Therefore, realistically the crew member will never get six consecutive hours of rest. This can be compared to a situation where a duty engineer gets five hours of sleep, then has an alarm that is quickly resolved, and then goes back to sleep for another five hours before another alarm. He would not have gotten his six hours of consecutive rest and therefore violated the regulations. However, he would probably feel more rested than the person who works the 6-on/6-off schedule who perhaps only got 4 hours of sleep but got his 6 hours of consecutive rest.

5.4 Health issues

The results regarding health issues in this study were somewhat unexpected. Previous research has shown that stress and fatigue are major issues for crewmember working onboard. However, most of the participants in this study stated that stress and fatigue was not a significant issue for them. In retrospect, the questions asked to the participants could have been more thorough and focused more on the health issue factor to get deeper data on that specific subject. The results did show that systems do not increase stress, fatigue, or any health issues in any way. However, it did not reveal that it mitigates them in any way. What regulates the crew members well-being is the superiors and their attitude. If a crew member feels tired due to a period of high workload, it is evident that it is not up to the system to mitigate this. If the superior allows the crew member

to take a rest, he or she may do so. If denied, the crew member would work as usual and then adjust the working hours in the system later to satisfy the regulations.
Only one participant explained that he experienced major problems during his time at sea. The key factor here is what type of vessel they are working on. He worked for a cruise line company that is notorious for its working conditions, while the others worked on tankers, car carriers and ferries in Swedish companies. Swedish companies, in general, seem to have another view of their employees. This could be because it is a different culture in Sweden compared to other countries, especially in other parts of the world such as Asia. As stated earlier, how the company handles the issues of violations will decide how the crewmember will be affected. If they prioritise keeping a good record on inspections and give a small amount of consideration to the crewmember's health and wellbeing, it will only hurt the crewmembers. Since stress is a significant problem in the maritime industry, it should be mandatory to learn about the severity of the consequences of stress.

5.5 Benefits for the crew

One of the research questions in this study is to find out what the benefits for the crew could be by adopting a new system for time reporting where manipulation is not possible. Since human errors are estimated to be the reason for as high as 96% of all maritime accidents, it is crucial to reduce all risk factors connected to the reduced cognitive ability of the crew. The most significant benefit will be that it shows if the vessel is sufficiently staffed or not. Even though resolution A 27/ Res.1047 (2011) demands minimum staffing for all situations, this is not fulfilled. Even if the crew only works overtime during port calls on a few occasions, the staffing is insufficient for peak workloads.

A system where manipulation is not possible could benefit the crew members by showing the company the actual workload. Even though there is careful planning behind the schedule onboard vessels, there will always be unexpected alarms and situations. This can be hard for the office to grasp, and therefore they may wonder why violations are being made, resulting in the crew hiding it instead of explaining to the office why it happened. If the system would register the true hours of work, it could explain why violations occur and that even though careful planning was done, it could not meet the expectations in real life. This would also give indications of whether the vessel is properly manned. As mentioned in chapter 2.1, the workload has increased in the last few decades. Therefore, it is important that the crew size will not be reduced further in order to decrease the workload for each crew member. If there are a lot of breaches in the rest hours, it will point to a need for more personnel. If the system were to be automatic, it could also decrease the administrational workload for the crew as the extra work of logging and adjusting hours would not be needed.
It would also help mitigate problems of fatigue and stress. Even though this study did not point to a large issue with stress and fatigue, other studies have shown that it is a major problem. The crew would not have to work overtime to the same extent, as the system would show these violations, and the company would have to address them by hiring more crew members. This will lead to a lesser workload for the crew, and therefore it would mitigate the problems of stress and fatigue.

5.6 Method discussion

This is a qualitative research, and interviews were therefore the primary source of data collection. The interviews were crucial for the data collection that was analysed in order to answer any of the research questions. There are different ways of conducting interviews, but there are three fundamental forms, structured, semi-structured, and unstructured.

Structured interviews are essentially questionnaires where there is no room for development and further elaboration. The interviewees will not be able to explain their thoughts and questions of their own, therefore limiting the data that can be obtained. The data will also not be impartial since the questions will lead the interviewee into a specific path.

Unstructured interviews are not prepared beforehand and can make it hard when comparing answers from other interviews. There is also a risk of not obtaining the relevant data if the interviewee does not fully understand what the study seeks to answer, and therefore can be very time-consuming and hard to administrate (Gill et al., 2008).

The semi-structured interview technique is the most frequently used format to collect data for qualitative research (DiCicco-Bloom & Crabtree, 2006). Semi-structured interviews are the most commonly used type because it has proven to be adaptable and versatile (Kallio et al., 2016). The semi-structured interviews generally have open-ended questions that allow the answers to deviate, be developed and be more spontaneous in which new questions may emerge to develop the interview further and improve data collection. A semi-structured interview is a mix between structured and unstructured, which can give advantages from both. However, there are a few disadvantages to these types of interviews. First of all, they require time and effort to be put together. It takes time to sit down with the participants and conduct the interviews, and the questions need preparation, and at the same time, they are not allowed to be leading, as this could bias the interview. The interviews can also fail to go into specific questions and topics if the interview is carried away in other conversations.

Nevertheless, these flaws are far outweighed by the advantages. Therefore, this research paper used this technique, so the open-ended questions could give the interviewee a chance to develop and build his or her answers to give a broader view of the problem. It will also truly reveal if there is a problem with manipulation of the work and rest hours and reveal if there are problems with the current time-logging systems or not, and perhaps give answers to questions that the authors may not previously have had.

After conducting the interviews, a thematic analysis was performed. Firstly, the data were coded by using the software program NVivo 12. The data were then analysed, and reflections were made; what does the data mean, what are the participants trying to say, the context of the statements etc. After that, various themes were created so the codes could be categorised. After completion, the results were written following the themes and codes. There were a lot of the data from the interviews that were irrelevant and left out, but the results gave answers to all the research questions and aims of this research.

5.7 Weaknesses of the study

Since this was the first qualitative research made by the authors, there are some possible deficiencies in the result of this report. Unfortunately, the number of participants in this study were low, as there was an issue of getting crew members to participate.

As the study commenced, there was much focus on fatigue and stress and how these are major contributing factors to accidents in the marine industry. Unfortunately, when the interviews were conducted, these topics were not explored as thoroughly as planned from the beginning. As mentioned in the method discussion, one disadvantage of semi-structured interviews is that the conversation could get carried away from important topics, which happened in these interviews. However, there were data collected about the topics, and it showed that most of the participants did not experience any fatigue or stress during their work.

6. CONCLUSION

The result of this study suggests that there is a widespread problem with manipulation of the work and rest hours logging onboard vessels in the merchant navy. The systematic use of manipulation is a major issue, and the crew members see it as a suitable alternative to hide the violations. This suggests that a new system for recording work and rest hours is needed to comply with the current STCW regulation VIII/1 Fitness for Duty, MLC regulation 2.3, and resolution A 27/ Res.1047. The main issue with manipulation of the work and rest hours is that it can conceal the fact that the vessel could be undermanned. It seems like the root cause of the problem lies within the attitude of the company. They want the crew members to report violations, at the same time, they do not want any non-conformities on inspections. The company then blames the vessel and the crew for not making correct scheduling when a violation occurs, but the problem is under manning, which the company is responsible for. The results also suggests that the currently used systems do not sufficiently mitigate the problems of fatigue and stress.

There are a lot of issues with these systems, and therefore it would be useful to further investigate how a new system could be designed in order to cope with the current problems.
The results in this study gave various interesting answers. The participants gave several suggestions, such as using a wristwatch that will track the crew members, stamp clocks, automatic systems that registers work hours during alarms etc. However, the results were inconclusive on this specific topic as the participants gave different answers and did not agree on all solutions. Therefore, no definitive solution of how a system could be designed were given, but the different answers are worth further consideration and research to create a new system.

The results also suggest that the crew could benefit from a new system where manipulation is not possible, as it will show the companies if the vessels are understaffed. Even though the participants were few, the answers were conclusive, the currents systems are not satisfactory.

6.1 Recommendations for further research

Further investigation on how a system could be designed to cope with the problems of manipulation is needed. It is also worth to further investigate how the companies can help reducing the extent of manipulation by changing their attitude against violations of the regulations. This study was limited to the engine crew, therefore a study where the bridge personnel is included should be further investigated.

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APPENDIX

Appendix 1, Consent form

Informed consent for participation in Bachelor thesis project ("Seafarers Work and Rest Hour-Logging")

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We invite you to take part in our research study for our bachelor thesis in marine engineering. Before you decide whether to participate, you should understand why the research is being done and what it will involve. Please take your time to read the following information.

The aim with the interviews is to investigate how seafarers experience the systems, if it is working in a satisfactory way. Or, if there are any existing problems, and if manipulation occurs. By conducting semi-structured interviews with seafarers, we aim to, from the perspective of the crew, investigate how current logging systems onboard work, if improvement is needed and if so how.

The Interview will take place over a video call in Zoom or Teams, and is estimated to take approximately 30 minutes. The interview will be audio-recorded and afterwards transcribed. The audio recordings will not be stored after completion of the project and will be destroyed (2021/05-30). The study is completely anonymous and collected data will be reported without connection to person, vessel, or company / Shipping Company.

If you want more information about the project, you are welcome to contact the supervisor and/or the students.

Before we ask for your participation, we want to inform you about the ethical rules that apply in the project.

- *I have read the information about participating in the study and am aware of how the data collection is performed and the estimated time it takes.*
- *I have had the opportunity to ask questions regarding the study and have them answered beforehand.*
- *I participate in this study completely voluntarily and have been informed about why I have been asked and what the purpose of my participation is.*

- *I am aware that I can cancel my participation at any time during the study without having to give a reason for this.*
- *I give my consent to Chalmers University of Technology.*
- *I give this consent provided that no one other than the student/-s / supervisor / researchers associated with the study will take part of the collected material.*
- *I am aware that the study is completely anonymous and collected data will be reported without connection to person, vessel or company / shipping company.*

By signing this form, you give your so-called informed consent to participate in the study under these conditions and that you have read the information presented.

☐ I agree that the interview will be recorded for analysis purposes.

Place:	***Date:***
Signature:	
Name clarification:	
Contact information: VOLUNTARY	

Appendix 2, Interview questions

Interview questions

The purpose of the study is to investigate how current work and rest-hour logging systems function onboard vessels, and if manipulation of the hours occurs. It will also investigate, from the crew´s perspective, how the system is experienced, what the flaws and strengths are, and does it mitigate problems such as risk of fatigue and stress which are large contributors to accidents onboard vessels. If the vessel is understaffed, could this be hidden by manipulating the true work- and rest-hours in the current system?

The aim with the interviews is to investigate how seafarers experience the systems, if it is working in a satisfactory way. Or, if there are any existing problems, and if manipulation occurs. By conducting semi-structured interviews with seafarers, we aim to, from the perspective of the crew, investigate how current logging systems onboard work, if improvement is needed and if so how.

How extensive is the problem with manipulation of the reported work- and rest-hours onboard vessels?
Could the crew benefit from a new and stricter logging system, where manipulating cannot occur?
How could such a system be designed?

- **Could you describe your current system for reporting work and rest hours?**
  (How are the record kept?)
  (Who records?)
  (How often are the recordings made?)
  (What are the flaws of the system?)
  (What are the strengths of the system?)
- **Have you ever exceeded the work and rest-hours limits stated in SOLAS and MLC? (Minimum of 77 hours of rest per week, or 10 hours per 24 hours period, maximum of 72 hours of work per week) If so, please describe what happened.**
  (How was this dealt with?)
  (In what situation does this occur?)
  (What happens when there is a non-compliance in the system?)
  (How do you deal with a non-compliance?)
  (How has this affected your sleep/rest?)
  (How did it affect you? Fatigue, tiredness, stress, accidents?)
- **If you have ever heard of adjustment in the system, could you tell us about your experience with it?**
  (Why did you do it?)
  (When did you do it?)
  (Do you know if and why someone else have done it?)
- **Describe why you think that it is a positive or negative factor that you can adjust the hours?**
- **If you could change anything in your current system, what would that be?**

- **If you were to use technology to create a new or improved system, how would that design look like?**
  (What functions would that system have? (E.g., Automatic/manual logging)
  (What problems could occur with implementing a new system?)
- **What are your thoughts about a system where manipulation is not possible?**
  (Would the master/company have any objections with this?)
- **How can you benefit from a strict system, where manipulation is not possible?**
  (For example, during port calls, emergency repair, alarms during duty, cargo operations, provisions etc)
  (Could it point to the need of more staff?)
- **Is there anything you would like to add?**

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