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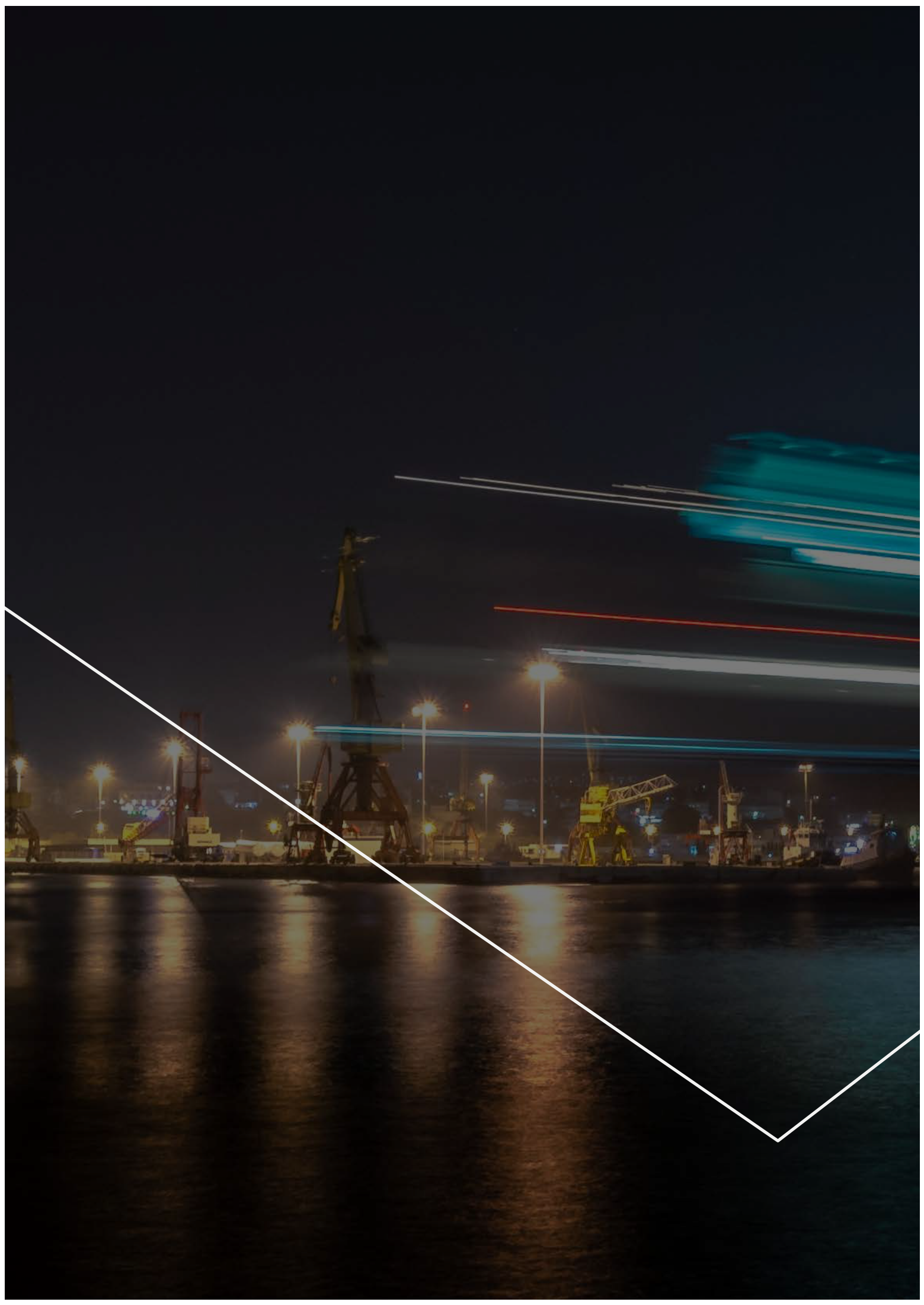
SEAFARERS IN THE DIGITAL AGE

Prioritising The Human Element
in Maritime Digital Transformation

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Research
Programme



This report... asks, how can digital transformation and the human element develop harmoniously, supporting crew health and welfare, career opportunities, training, and development, and improve human performance while keeping the needs of the human front and centre as an integral part of a complex socio-technical system?

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FOREWORD

Few attending shipping events after the hiatus brought by Covid-19 through 2022 have allowed them to pass without acknowledging how good it has felt to meet clients and strategic partners once again in person. However, those returning to face to face engagement remain fully aware of a profound shift in maritime sector attitudes.



Far from replacing seafarers, Thetius emphasises the growing role for connected automation in enhancing safety and in assisting watchkeepers to handle routine, repetitive tasks.

Whether discussing Covid-19, geopolitical instability or global warming, the topic of digitalisation is now never far from the top of any shipping agenda. Increasingly, IoT-based connectivity offers ways of responding to multiple challenges: connecting crew stranded on board by coronavirus to the outside world; helping maritime insurers to report fast-evolving sanctions scenarios; and enabling owners to calculate carbon intensity.

Coinciding with the IMO's International Day of the Seafarer, it is therefore a great pleasure to introduce the report enclosed - Seafarers in the Digital Age - Prioritising The Human Element in Maritime Digital Transformation.

Published as part of the Inmarsat Research Programme and authored by Thetius Consulting, this timely report focuses on the critical relationship between digital connectivity and those working and living at sea. It is based on testimony gathered from the maritime professionals.

Covid-19 forcefully underlined how crucial seafarers are to the global economy, but also that crew connectivity is a critical welfare issue. In May 2022, updates to the Maritime Labour Convention 2006 (MLC) made social connectivity for crews mandatory - including internet access.

Inmarsat customers include the most progressive owners and managers in shipping where crew connectivity is concerned.

The enclosed report indicates that shipping as a whole is taking its responsibilities on board: seventy-eight per cent of ship operators surveyed have installed internet connectivity on their vessels for the personal use of crew over the last five years.

For those of a different persuasion, another finding jumps out, at a time of a 26,000 deficit in certified officers (BIMCO figure). Thetius records over 1 in 3 seafarers choosing access to digital technology as the most important factor in considering a new employer. In short, internet access now ranks higher than pay (chosen by fewer than 1 in 4 as first priority), in a finding speaking volumes for the digital engagement of modern crews.

A close reading is therefore recommended of the report's exploration of the standardisation, security, cultural and other challenges which remain if digitalisation is to realise its potential to enable more efficient, safer maritime operations, drive decarbonisation and assure crew welfare.

Far from replacing seafarers, Thetius emphasises the growing role for connected automation in enhancing safety and in assisting watchkeepers to handle routine, repetitive tasks.

One other finding suggests that seafarers may be more ready for change than many imagine: 2 in 5 crew members (40%) working with digital technology at sea today point to shortcomings in systems design and lack of user friendliness. The figure suggests a group of users with frustrated expectations and a progressive mindset which owners seeking to retain maritime professionals would do well to consider.

For Inmarsat, and for all of us with a stake in maritime, getting it right holds the key to transforming an industry.

Ben Palmer OBE

President, Inmarsat Maritime



INTRODUCTION

What value should the maritime sector place on human element when considering the digital transformation of the shipping industry? What role does human performance play in building a lean, competitive, digitalised, and profitable merchant shipping operation? And how do human factors interrelate with digital processes, procedures, and technologies to create a ship that delivers the right outcomes for its owners and a safe and stimulating environment for its crew?



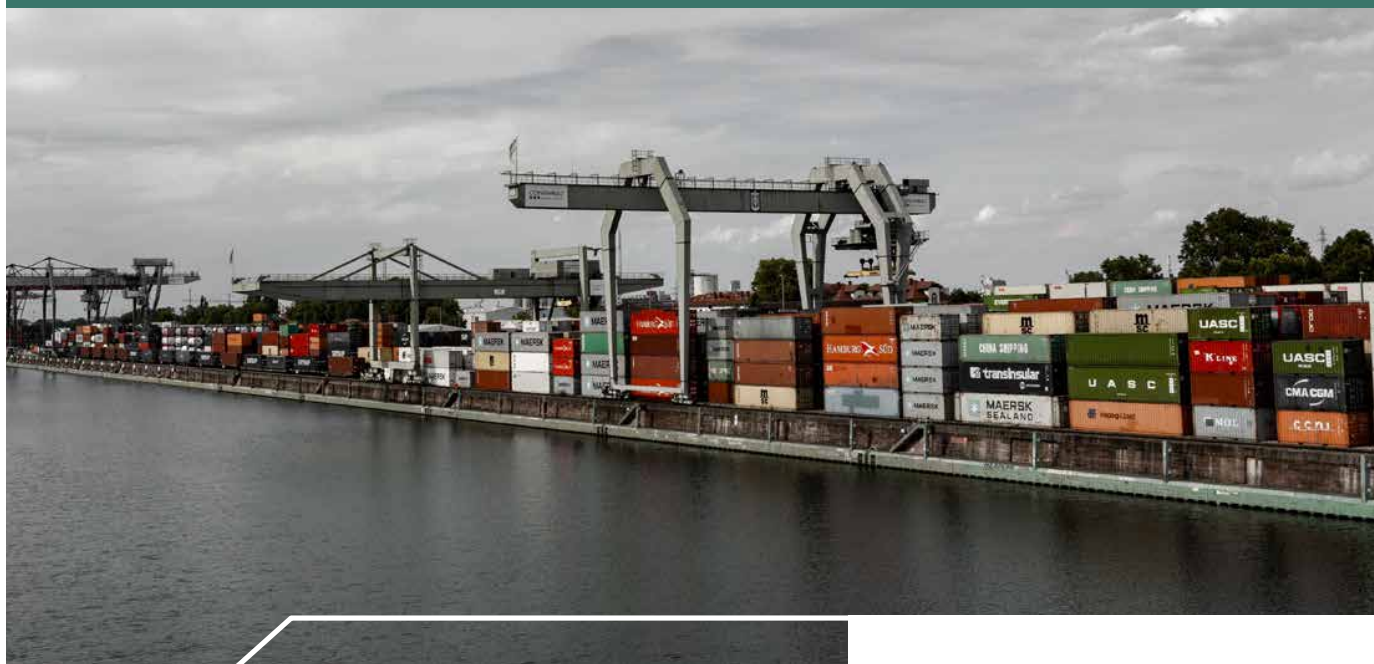
Without seafarers, ships don't sail and global trade grinds to a catastrophic halt.

Since humankind first put to sea thousands of years ago, seafaring and the maritime sector has offered people the opportunity of a unique, challenging, and rewarding career. Shipping today is motivated by the same central purpose that drew our ancient ancestors offshore - the desire to trade with foreign lands and perhaps to find adventure along the way. While it is true that the drivers for sending ships to sea remain largely unchanged, the complexity of ships and the demands they place on their crew are worlds apart.

Today's maritime sector makes considerable and often misunderstood demands on seafarers. While investment in better regulations and new technologies have revolutionised living conditions for many over the last century, the complexity of shipping has increased exponentially, placing greater demands on seafarer competence and raising the expectations of ship owners to new heights.

In February of this year, four United Nations organisations, the ILO, the IMO, UNCTAD, and the WHO, put out a joint statement that urged governments to do more to tackle the COVID-19 'crew change crisis' that was ravaging the global seafaring community. At the time, 400,000 seafarers were stranded at sea when their reliefs were unable to reach the ship. In many cases, seafarers were forced by circumstances to remain onboard over the 11-month maximum term allowed by ILO regulations.

What this crisis demonstrated to the world was the indispensable role that our seafarers play in maintaining the bonds that hold the global economy together. Without seafarers, ships don't sail and global trade grinds to a catastrophic halt.



In the coming decades, digital and emerging technologies will proliferate in shipping. The challenges the sector faces to decarbonise, find unprecedented levels of efficiency, and continue to attract a skilled and talented workforce, are so great that without the help of innovative technological aids, the outlook is critically uncertain. While digitalisation will, without question, become a ubiquitous force in maritime, this is often considered synonymous with automation and the displacement of human seafarers. Put simply, this is a mistake. While it is improbable that digitalisation will have no displacing effect on seafarers in the short and medium term, the coming years will be characterised by a closer and more intimate cooperation between human and machine - not the displacement of one by the other.

Consider the bridge of a merchant vessel. Since the introduction of ECDIS in the 1990's, technology has evolved to better support the human watchkeeping officer. With the advent of artificial intelligence and machine learning, this decision support function will increase, unlocking new potentials in reducing seafarer fatigue, job-related stress, and cognitive overload, resulting in safer and more efficient bridge operations.

The coming years will be characterised by a closer and more intimate cooperation between human and machine - not the displacement of one by the other.

These changes will have wide ranging effects on career progression, training, and industry retention. Not only are digital platforms and connectivity providing new ways to deliver training and conduct examinations, but the digitalised ship will require the learning of new skills. The industry may begin to appeal to new generations of seafarers. Consider the way that the pool of astronaut candidates for global space programs has expanded from a select group of military fighter pilots: Greater technological support in space operations now allows for a larger and more diverse workforce in space, including scientists and engineers.



Thetius canvassed 200 maritime professionals including seagoing and shorebased staff from shipping companies and industry service providers.

In conducting the research for this report, Thetius canvassed 200 maritime professionals including seagoing and shorebased staff from shipping companies and industry service providers. We asked them to describe their experience of human factors in digitalisation, which we divided into the three pillars of this report - crew health and welfare; career, training and retention; and human performance. The results shine a light on the industry's perceptions of digitalisation and reveal what proportion of digital transformations in maritime companies are cognisant and inclusive of the human element in their design and execution. While the picture painted by the results show a broadly positive relationship between the seafaring community and emerging digital technologies at sea, there are some areas where more must be done by shipping companies and technology developers. It is vital to ensure that digital transformation is developed on behalf of - and in lock-step with - maritime professionals and seagoing crew.

Above all, how can we protect and nurture our seafarers in the face of unprecedented technological change?

This report investigates the state and trajectory of this relationship and asks, how can digital transformation and the human element develop harmoniously, supporting crew health and welfare, career opportunities, training, and development, and improve human performance while keeping the needs of the human front and centre as an integral part of a complex socio-technical system? Above all, how can we protect and nurture our seafarers in the face of unprecedented technological change?

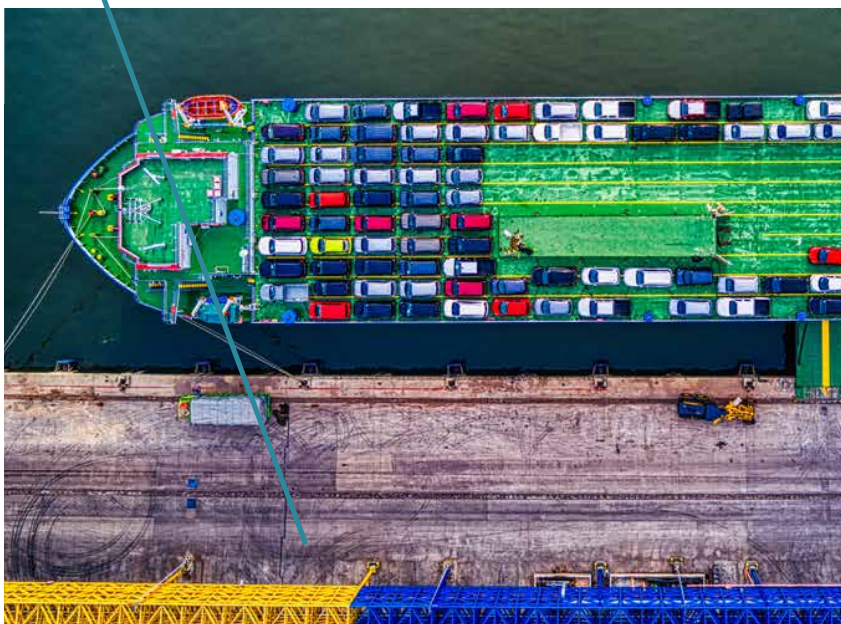
WHAT FACTORS IMPACT CREW HEALTH AND WELLBEING?

IT is useful to begin here with a definition. A person's welfare, or well-being, is their overall physical and mental health and happiness. As the World Health Organization (WHO) explains, "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being..."¹

In 2019, Cardiff University's Seafarers International Research Centre (SIRC) published a study on seafarers' mental health and wellbeing.² To improve seafarer welfare, SIRC's recommendations include:

SEAFARER WELFARE RECOMMENDATIONS

- ▶ Free and unlimited internet access
- ▶ Varied recreational activities
- ▶ Comfortable mattresses and furnishings within cabins
- ▶ Shore leave at every opportunity and for all ranks
- ▶ Good quality food
- ▶ Self-help guidance on improving mental resilience
- ▶ Contracts that balance work and leave time in a ratio which is not worse than 2:1 and with an upper limit of six months on board
- ▶ Anti-bullying and harassment policies introduced and enforced
- ▶ Officers should receive training in creating a positive atmosphere on board
- ▶ Confidential counselling services



1 World Health Organization. (1948). WHO Constitution. Retrieved 1 June 2022, from <https://www.who.int/about/governance/constitution>

2 Sampson, H., & Ellis, N. (2019). Seafarers' mental health and wellbeing. Cardiff University. <https://iosh.com/media/6306/seafarers-mental-health-wellbeing-full-report.pdf>

Unfortunately, the Seafarers Happiness Index (SHI) for Q1 2022 found that seafarer happiness has plummeted to its lowest level since the SHI was founded in 2015.

Unfortunately, the Seafarers Happiness Index (SHI) for Q1 2022 found that seafarer happiness has plummeted to its lowest level since the SHI was founded in 2015. The report³ blames, “Hectic work schedules, no social life (and) getting a basic internet connection is still a luxury for most seafarers when it’s almost a basic necessity these days.” The report continues to state that, “The workload is getting increasingly high with minimum crews on board, rest hours are only complied with on paper, yet none of the authorities pay heed.” In extreme cases, the report suggests that shipping could “become a floating jail, where you’re just expected to work endlessly like robots...”

It is clear that digital technology and connectivity is a key potential enabler of enrichment for seafaring personnel. Modern ships must strive to create a positive and welcoming working environment that feels more like a ‘home from home’ and not the ‘floating jail’ depicted in the SHI report. From the outset, it becomes clear that human needs must remain central to digital transformation in shipping. A healthy and happy human crew is not only desirable, but it

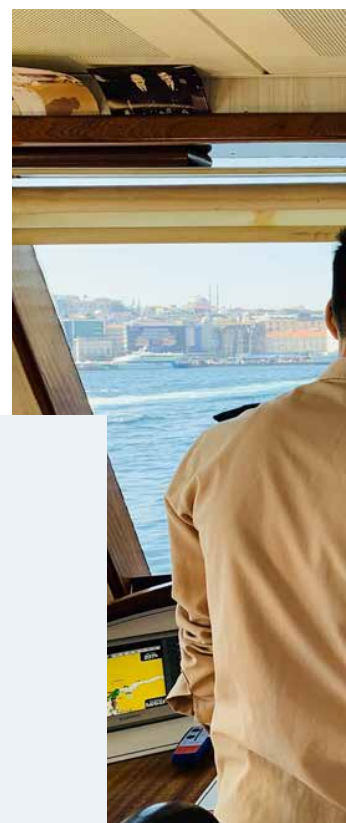
is vital to ensure that the industry continues to attract skilled people away from other evolving sectors.

According to the SHI, it is not all bad news and some seafarers report much higher levels of contentment. The SHI regularly finds several common factors among happier seafarers, including:

COMMON FACTORS AMONG HAPPIER SEAFARERS

- ▶ Affordable and reliable crew internet and wi-fi
- ▶ Funds and management support for on-board wellbeing events and activities
- ▶ Good on-board relationships
- ▶ Shore leave
- ▶ Manageable workloads
- ▶ Wages received on time
- ▶ Crew confidence in being able to return home at the end of their contracts
- ▶ Provision for a healthy lifestyle, including good food, rest, medical care, mental health support, and fitness and recreational facilities
- ▶ Privacy
- ▶ Meaningful training

Most of these closely match SIRC’s findings. While technology and digitalisation is unlikely to solve all of the underlying problems in the near term, technology can help to mitigate some of the drivers of discontentment.



3 The Mission to Seafarers. (2022). Seafarers Happiness Index (Quarter 1 2022). <https://www.happyatsea.org/wp-content/uploads/2022/04/Seafarers-Happiness-Index-Q1-2022.pdf>



With internet access, seafarers can share in the positive effects of improved mental health awareness and services ashore.

The general rule of thumb is that, the further you are from land, the more expensive internet access becomes. Keeping crew connected is the keystone of supporting seafarer mental health, wellbeing, productivity, and retention. Digital connective technology has the power to recreate bonds between seafaring crew and their family, friends and support networks back home. The sense of wellbeing that results from wishing a child a happy birthday and sharing in moments of happiness and joy; or connecting with a trusted friend or family member during more difficult times, reflects basic human needs in us all. But too often for seafarers, the isolation of long months away at sea can precipitate deep visceral challenges to wellbeing and risk causing significant mental health issues. The reality for many is that, even when the ship is alongside, where there is a lack of internet access, those feelings of isolation continue.

INTERNET ACCESS

As recent changes to the Maritime Labour Convention (MLC) acknowledge,⁴ Internet access is essential in the modern world, even, or perhaps especially, for seafarers. This is because, like telephones, it is an enabling technology—it lets seafarers access the online services that the general public take for granted ashore.

If you have ever left your mobile data enabled while on holiday overseas, you may appreciate why personal connectivity is rarely a viable option for seafarers operating outside their home country, even if they are in range of the coast. Local SIM cards, while sometimes affordable, are mostly inaccessible without shore leave and roaming data charges from some providers can be prohibitive.

⁴ International Labour Organization (ILO). (2022). Amendments to the Code relating to Regulations 1.4, 2.5, 3.1, 3.2, 4.1 and 4.3 and to appendices A2-I and A4- I of the MLC, 2006. https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---normes/documents/meetingdocument/wcms_845316.pdf

"We recognise that staying connected with friends, family, and the outside world is a necessity for seafarer welfare"

Ben Palmer OBE
Inmarsat Maritime's President,

Inmarsat is a pioneer and high-profile champion of crew internet services. Their Fleet Hotspot system for example presents a flexible and easy-to-manage wifi hotspot onboard the ship, allowing crew to log in and access the internet from their personal devices. Powered by their Fleet Xpress satellite service, Fleet Hotspot brings seafarers high speed internet connectivity that is owned and managed by them - removing the need for crew to queue for dedicated PCs or request to use company bandwidth.

The connection supports download and streaming services and provides crew with dedicated bandwidth, separating it from the operational needs of the vessel. In response to the May 2022 announcement of eight stepchange amendments to the Maritime Labour Convention (MLC) that make crew connectivity mandatory, Inmarsat Maritime's President, Ben Palmer, said, "We recognise that staying connected with



friends, family, and the outside world is a necessity for seafarer welfare - a fact that is now recognised in the recent amendments to the Maritime Labour Convention. Fleet Hotspot uptake and usage have shown extraordinary growth over the past few months. Operators who have trialled the solution have gone on to roll it out across their entire fleet, which illustrates that it is meeting both owner and crew expectations."

With internet access comes the ability to access the growing range of online services, from training classes to travel bookings.

ACCESS TO REMOTE /ONLINE SERVICES

With internet access comes the ability to access the growing range of online services, from training classes to travel bookings. Although few of these are seafarer-specific at this stage, almost all online services have the potential to offer improvement opportunities to seafarer health and wellbeing. Let's take a look at some of the main ones:

Telehealth

During the COVID-19 pandemic, the poor provision of seafarers' medical care finally came to the fore,⁵ with many countries refusing to allow seafarers ashore for medical treatment for fear of opening new pathways for infection. While the recent Maritime Labour Convention (MLC) amendments⁶ make attempts to address this, digital and online tools can also help.

Ashore, the pandemic triggered the swift and widespread adoption of telehealth services.⁷ At sea, telehealth helps to plug gaps in access to medical care. While several companies already operate in this space, with modern technology and internet connectivity, remote medical staff can use connected tools to monitor patients and give treatment instructions in real time.

Vsee⁸ and Evitalz⁹ both provide kits containing digitally-connected medical equipment, such as Electrocardiogram (ECGs) and blood glucose monitors to ships. Digigone¹⁰ and MedAssist go a step further and include access to an augmented reality¹¹ (AR) system. With AR, qualified medical staff ashore can provide real-time visual instructions to crew, allowing more effective treatment of conditions that require more specialist

5 International Labour Organization (ILO). (2021). Seafarers desperately need prompt access to medical care say ILO and International Maritime Organization. Retrieved 1 June 2022, from https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_822132/lang-en/index.htm

6 International Labour Organization (ILO). (2022). Amendments to the Code relating to Regulations 1.4, 2.5, 3.1, 3.2, 4.1 and 4.3 and to appendices A2-I and A4-I of the MLC, 2006. https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---normes/documents/meetingdocument/wcms_845316.pdf

7 Nature Medicine. (2021). Telehealth is here to stay. Nature Medicine, 27(7), 1121. <https://doi.org/10.1038/s41591-021-01447-x>

8 VSee. (2022). Telemedicine Kits, Carts + Digital Medical Devices + Software. Retrieved 2 June 2022, from <https://vsee.com/hardware>

9 Evitalz. (n.d.). Telemedicine Solution Providers | Remote Patient Monitoring. Retrieved 2 June 2022, from <https://www.evitalz.com/telehealth-kit.html>

10 Digigone. (n.d.). Digigone: Commercial Maritime | Your Walk-In Clinic at Sea. Retrieved 2 June 2022, from <https://www.digigone.com/commercialmaritime>

11 Gardner, N. (2021, February 22). Brief guide to extended reality in the maritime industry. Thetius. Retrieved 2 June 2022, from <https://thetius.com/brief-guide-to-extended-reality-in-the-maritime-industry/>

With internet access, seafarers can share in the positive effects of improved mental health awareness and services ashore.

intervention. Inmarsat Certified Application Provider, VIKAND HealthNet, is the first all-inclusive healthcare platform for the shipping industry, providing seafarers global access to online healthcare services. These include urgent care, monthly house doctor calls, chronic disease management, customised mental health programs, and even technical support for medical equipment.

Of course, good health is more than just physical health. With internet access, seafarers can share in the positive effects of improved mental health awareness and services ashore. From free counselling organisations such as Hunterlink's employee assistance program¹² and Seafarer Help,¹³ through to free automated online courses and learning games such as Moodgym's¹⁴ interactive cognitive behavioural therapy (CBT) training program, there are too many services to list. Even the emergence of online religious and pastoral services can help to reduce seafarers' isolation and have a positive mental health impact.

Reporting

Most companies, both inside and outside shipping, want to do the right thing by their employees. The reality however, can be a disconnect between shore based leadership and seagoing staff. It can be the case that head office staff might rarely visit their ships; even if they do, feelings of mistrust between ship and shore can mean few on board will talk freely to "the people from the office." This makes it difficult for companies to identify problems, and impossible to fix them. Reporting programs are one solution.

While it doesn't specifically target seafarers, the "Talk to Spot" reporting program¹⁵ allows people to compile reports of harassment, assault, and other abuse. These reports can be sent to the company, or saved locally as contemporaneous evidence. While not perfect, this system returns some power to the potential victims of workplace abuse, without tipping off the abuser or forcing them to raise their concern in a way that makes them uncomfortable or fearful.

Other solutions focus on safety or incident reporting. Non-profit programs, such as CHIRP,¹⁶ are well-known in the industry; commercial platforms, such as Scoutbase¹⁷ give participating companies' seafarers a safe way to report anonymously to "the office". This can improve seafarer welfare in meaningful ways, by giving the company a chance to address problems early and in receipt of all the facts.



12 Hunterlink. (2021). Hunterlink Employee Assistance Provider - Employee & Workplace Wellbeing. Hunterlink Employee Assistance Provider. Retrieved 2 June 2022, from <https://hunterlink.org.au/>

13 Seafarer Help. (2020). Seafarer Help. Retrieved 2 June 2022, from <https://www.seafarerhelp.org/>

14 Moodgym. (n.d.). Moodgym - Interactive skills training for depression and anxiety. Retrieved 2 June 2022, from <https://moodgym.com.au/>

15 Spot. (n.d.). Spot - HR workplace incident tool and modern DEI training. Retrieved 2 June 2022, from <https://talktospot.com/index>

16 CHIRP Maritime. (n.d.). CHIRP Maritime. Retrieved 2 June 2022, from <https://www.chirpmaritime.org/>

17 Scoutbase. (n.d.). Scoutbase. Retrieved 2 June 2022, from <https://scoutbase.com/>

Fatigue is a long-running industry issue that straddles the gap between safety, welfare, and financial and operational realities.

Facilitate relationships

A ship is a unique environment, where individuals are forced to live together with few opportunities to distance themselves from one another. This can easily turn into a pressure cooker scenario as things like polarisation, misunderstandings, and disinformation fan the flames of interpersonal conflict.

This is a difficult problem everywhere, not just on ships; however, the ability to contact family and friends ashore, and gain access to accurate factual news and clear, up-to-date information about key topics can help to reduce uncertainty. This applies particularly to situations that may increase racial or religious tensions, such as the COVID-19 pandemic, or the Ukraine invasion, where affected crew may fear for their homes and their relatives' safety.

FATIGUE

Fatigue is a long-running industry issue that straddles the gap between safety, welfare, and financial and operational realities.¹⁸ Fatigued seafarers become less motivated, are more irritable, and are more likely to make potentially serious mistakes.

Fatigue requires a holistic approach to its management and reduction among seafaring staff, but here we take a look at some of the digital technologies that are poised to make a significant improvement:

Automation

Despite the fact that marine autonomous surface ships (MASS) face mixed reactions from seafarers, many on-board tasks are routine, repetitive, and prime targets for automation. Just as the autopilot reduces the bridge workload, as MASS technology matures, it will become economical—maybe even essential—to install certain automated systems to assist watchkeepers and handle routine, repetitive tasks on board.

Digital logbooks

Record keeping is routinely identified by both seafarers and researchers as a contributing factor in fatigue.^{19 20 21 22} In contrast, logging accurate data is a strength of computers and, unlike other cutting-edge automated systems, digital logbooks are already available.

18 Baumler, R., de Klerk, Y., Manuel, M., & Carballo Piñeiro, L. (2020). A culture of adjustment, evaluating the implementation of the current maritime regulatory framework on rest and work hours (EVREST). World Maritime University. <https://doi.org/10.21677/wmu20201108>

19 Smith, A., Allen, P., & Wadsworth, E. (2006). Seafarer Fatigue: The Cardiff Research Program. VDKS. https://www.vdks.org/pdf/seafarer_fatigue.pdf

20 Smith, Andrew. (2003). Seafarers' fatigue, health and safety. Personalführung. 2. 46-52.

21 Vincent, L. (2020, May 14). Seafarers becoming unhappy with extended contracts, fatigue and burnout: Survey. Merchant Sea Life. Retrieved 3 June 2022, from <https://merchantsealife.com/seafarers-becoming-unhappy-with-extended-contracts-fatigue-and-burnoutsurvey/>

22 The Mission to Seafarers. (2019). Seafarers Happiness Index (Quarter 1 2019). <https://www.missiontoseafarers.org/wp-content/uploads/Seafarers-Happiness-Index-Report-Q1-2019.pdf>

Wider adoption of digital logbooks would reduce workload—particularly among officers—and free seafarers to focus on the tasks where humans excel.

A growing number of companies offer compliant electronic logbooks, from Classification Societies such as RINA,²³ to industry giants like Kongsberg.²⁴ The main adoption delay is uncertainty about the legal implications: some countries still don't accept electronic record-keeping. With luck and lobbying, this will change, reducing workload and fatigue in the process.

Fatigue management systems

At sea, some degree of fatigue is inevitable, especially when exacerbated by the side effects of some preventative seasickness remedies, or by the condition itself. As the name suggests, fatigue management systems help to identify and manage fatigue. The simplest systems consist of calculators and planners, which predict fatigue based on work schedules. More complex systems such as *Seasolutions*,²⁵ *safr*,²⁶ and *Fatigue Science*²⁷ use facial scanning or wearables to identify real-time fatigue markers and alert supervisors.

As with most technological solutions, implementation and adequate resources are the key. Technology can identify fatigue, but it can't yet solve under manning or unreasonable workloads—for that, ships need effective management.

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Shore Leave

The SHI regularly finds that lack of shore leave is a common complaint for seafarers. This was exacerbated by COVID-19.²⁸ Although many legal and operational factors restrict shore leave, the *ITF Shore Leave App*²⁹ lets seafarers plan their leave and find the nearest seafarers' centre, even while offline. While this can't solve government or company bans, it can give seafarers a slightly better chance of escaping ashore, even for short periods.

23 Electronic Logbook. (n.d.). RINA. Retrieved 4 June 2022, from <https://www.rina.org/en/electroniclogbook>

24 Kongsberg. (n.d.). K-Fleet logbook, Marine electronic logbooks. Retrieved 4 June 2022, from <https://www.kongsberg.com/maritime/products/information-management-system/applications/marine-electronic-logbooks>

25 Mitchell, C. D., & Sharma, C. M. (n.d.). Rest Manager. Seasolutions. Retrieved 4 June 2022, from <https://www.seasolutions.dk/restmanager/>

26 SAFR. (n.d.). Safety and Fatigue Research. Retrieved 4 June 2022, from <https://safr.org.uk/>

27 Fatigue Science. (2022). Predictive Fatigue Management Software for Mining, Transportation & Heavy Industry. Retrieved 4 June 2022, from <https://fatiguescience.com/>

28 Hebbar, A. A., & Mukesh, N. (2020). COVID-19 and seafarers' rights to shore leave, repatriation and medical assistance: a pilot study. *International Maritime Health*, 71(4), 217–228. <https://doi.org/10.5603/imh.2020.0040>

29 ITF Seafarers. (n.d.). Shore Leave App. Retrieved 4 June 2022, from <https://www.itfseafarers.org/en/look-up/shore-leave-app>

HOW CAN DIGITAL TOOLS ENHANCE PERFORMANCE MANAGEMENT AT SEA?

A central benefit to digitalisation at sea is its ability to support and promote human performance. In this context, 'performance management' is about creating a working environment and providing a set of tools that support seafarers to operate and maintain a vessel efficiently and effectively.

As we have already seen, digital technologies are available that aim to improve both the working environment and provide the tools that help seafarers reduce cognitive burdens to help them focus on performing safety- and mission-critical tasks; or support job functions by improving the ergonomics and usability of the working environment.

The IMO's e-Navigation concept gives us a framework for understanding the importance of the digital-human interface as it relates to bridge procedures and navigation. The strategy is worth consideration as it defines the high level direction of travel that regulators are taking to ensure that user needs predominate as humans and machines become more integrated at sea.

The IMO adopted standards in electronic charting back in the 1990's, which brought about an evolution in 'primary source' chart information on the bridge from paper charts to electronic, with Electronic Chart Display and Information Systems (ECDIS) becoming mandatory on merchant vessels in 2011. Arguably, the announcement of the

e-navigation concept by the IMO in 2006 formed the nucleus for digital transformation underway in shipping today. If we consider this framework a governing principle, then the IMO have set out the rules of the game. The extract below is from the 85th session of the Marine Safety Committee, which describes the development and implementation strategy for e-navigation within three governing principles:

1. ensure that the technological developments adopted are conducive to enhancing maritime safety, security and protection of the environment, and take into account the need for their global application;
2. ensure the proper application of information technology within the Organization and to provide enhanced access to that information for the shipping industry and others; and
3. ensure that new equipment for use on board ships is designed and manufactured with the needs, skills and abilities of all users in mind.



The message here is clear: Digital technology must be developed to enhance the human seafarer, without assuming that digital technologies will displace them. It is therefore vital for the needs of seafarers to be fully considered in digital transformation strategies. Let's look at those needs in more detail:

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SEAFARER NEEDS

The first objective of the IMO's e-Navigation strategy implementation plan is '*improved, harmonized and user-friendly bridge design*'.

The list of user needs that the IMO have used to anchor their regulatory approach to e-navigation provides an excellent overview of the problems faced by seafaring navigators and the wider maritime sector. A comprehensive list of shipboard user needs and priorities is given in annex 3 of the IMO's e-navigation strategy implementation plan³⁰. These are:

SEAFARER NEEDS

01. Improved Ergonomics - seafarers have expressed a desire for bridge layouts, equipment and systems to be better designed from an ergonomics and user-friendliness perspective.

02. Standard Interfacing - seafarers want greater standardisation of functionality for navigation displays (human-machine interface or 'HMI').

03. Familiarisation Requirements - seafarers need all safety-related equipment to be provided with familiarisation material specific to the model and installation.

04. User-selectable presentation of information received via satellite communication equipment - seafarers want to be able to present user-selectable information received via communications equipment on their navigation displays (e.g. ship in distress, wind speed / direction, AtoN status, restricted areas etc.) and to be able to filter the information received to make it more relevant.

05. Maritime Safety Information (MSI) - seafarers want to see, sort, and action MSI more effectively. For example, integrating NAVTEX information into the navigation display instead of the standalone device.

30 International Maritime Organization (2018) MSC.1/Circ. 1595 e-Navigation Strategy Implementation Plan - Update 1. P.39. Retrieved from <https://iho.int/en/imo-e-navigation-documents>

06. Alert Management - bridge alerts including emergency alarms, warnings, and cautions etc. need to be coordinated, weighted, and support decision making without undue distraction. The IMO states that it is not uncommon for bridges to have in excess of 500 separate alarm sources including navigation, propulsion, cargo, and communications systems. Providing decision support to sort, prioritise, and make recommendations on appropriate actions is important to seafarers.

07. Indication of data reliability - officers are concerned with certainty values on the information they are given. For example, ECDIS displays the vessel's position as an absolute, leaving the watchkeeper to determine the accuracy of the position indicated. Seafarers want systems to assess the accuracy and integrity of hydrographic data, position fixes, radar, and other sensors and return a geographical indication of the assessment. An example might be the rendering of a margin of uncertainty around the fix, or restricting zoom areas to the limit of the certainty factor.

08. Improved system reliability - in 2018, seafarers reported concerns over the reliability of their e-navigation equipment. Failures and errors were reported as commonplace. Issues such as poor radar performance, ENC faults, incorrect AIS data, or loss of position can cause major disruption for the watchkeeper and even an uptime of 99% means that 1 in 100 voyages will encounter a failure of critical bridge equipment. Thetius believes this picture is improving, but still causes a significant issue.

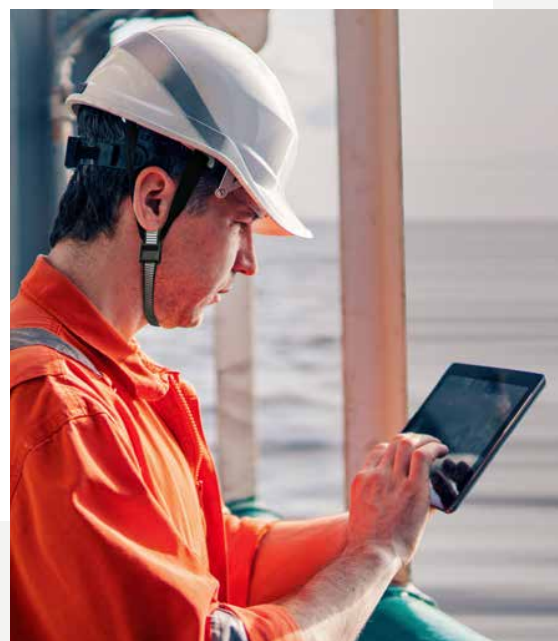
09. Standardised and automated reporting and the reduction of administrative burdens - seafarers want to reduce the administrative burden on them in order to focus more on the mission critical aspects of voyage execution. In particular, the repeated reporting of static and dynamic information such as cargo information, persons onboard, bunker 'remaining onboard' figures, and position, to shore based authorities causes frustration.

10. Improved target detection - seafarers need extra support with the identification of small targets at sea, such as fishing vessels, pleasure craft, pirates, and flotsam/jetsam.

11. Guard Zones - seafarers want the dynamic and real-time rendering of guard zones to alert watchkeepers to hazards such as grounding that takes into account real time under keel clearance (UKC) information, or a developing risk of collision with another vessel or fixed structure.

12. Automated updating of baseline data and documentation - charts, voyage planning publications, and other data sources are updated frequently, causing seafarers an administrative burden and increasing the possibility of human error resulting in outdated information being used for decision making. Automating updates to these information sources would remove this human error factor.

13. Effective and robust connectivity between ship and shore - seafarers want communications with the shore at sea to be as easy and accessible as terrestrial services.



A list of user needs are also identified for shore based users and SAR authorities. These reflect similar patterns around greater sharing of information and simplification of data processing and decision support.

Since international convention requires digital technology to be user-centric, the technologies that address these needs of the user are likely to be the most influential. Work is well underway in the public and private sectors to address these issues and find technological, regulatory, and policy solutions to them.

One example is the work in the Sub-Committee on Navigation, Communications, Search and Rescue (NCSR) at the IMO to address position accuracy by developing performance standards for Satellite-Based Augmentation Systems (SBAS) to complement GPS³¹. Current augmentation systems such as radio beacon Differential GPS (DGPS) is analogue technology and will eventually be phased out. SBAS will use geostationary satellites to provide a correctional vector to GPS positions on a global scale, rather than just in coastal waters.

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Cybernetics is the study of feedback and control systems in humans and machines.

MARITIME CYBERNETICS

Cybernetics is the study of feedback and control systems in humans and machines. While it might be alien to many in the maritime industry, the term actually has seafaring origins. Cybernetics is derived from the Greek word 'kybernetikos' which referred to the art of good helmsmanship. In the days of voyaging under sail, helming required the seamless flow of information from the sea surface through the hull and rudder, and from the wind through the rigging to the helmsperson, who would make the control inputs necessary to keep the vessel on course and sailing efficiently. Maritime cybernetics can be thought of in a similar way: the collaborative flow of data between human and machine that results in the desired outcome - in this case, the safe and efficient operation of a modern ship.

³¹ International Maritime Organization (IMO). (2021). Recognition of the Japanese Regional Navigation Satellite System Quasi-Zenith Satellite System (QZSS) and Development of Performance Standards for Shipborne Satellite Navigation System Receiver Equipment. (NCSR 8/4/2)

Where the human was once the end user of digital information, increasingly, we will become a component of a much larger and more powerful decision making ecosystem.

The maritime industry is a good example of what academics refer to as a 'complex socio-technical system'.³² From a human element perspective, this means that the interactions between human and machine are evolving and it is vital that operators realise the implications.

Complex socio-technical systems like those created aboard a ship, require an effective appreciation of 'cybernetic interaction' or the symbiotic relationship between human and machine. The traditional scenario where a human monitors individual machines with narrow outputs and makes autonomous decisions based on the information provided is rapidly becoming outdated. The emerging picture is one where each digital system communicates with one or more other systems, significantly enhancing the sophistication of the end result. Where the human was once the end user of digital information, increasingly, we will become a component of a much larger and more powerful decision making ecosystem.

It's important to understand some of the ways that seafaring crew may increasingly become an integral part of a larger digital system; interacting and contributing to digital decision systems at sea, rather than simply using digital data to make a more informed decision themselves. Here we take a look at some of the ways digital technology can be used to maximise the value of human skills such as reasoning and morality while moving more binary and mundane tasks to the digital domain:

Seeing the big picture

Technology empowers humans to work smarter when relevant information is accessible, and easy to grasp. Informed decisions help balance operational safety with efficiency. Many of the digital products or solutions available to ship operators today have one of three primary functions: quantifying risk, managing errors, and promoting efficiency.

There is a range of tools available to assess and manage risks, asset health and compliance. For example, IBM's Maximo is an example of a management solution that streamlines processes in detail, bringing thousands of information strands together to form a coherent picture of a businesses' socio-technical structure.³³ Kongsberg's Kognifai offers a similar capability, with a slew of other marine applications.³⁴ As stand-alone technologies, these offer only a static overall view however. To make data more visible, add-on systems are required. This means that there is still a need for other solutions which help move information from single sources - afterall, it is only actionable information that can deliver increases in human performance at sea.

³² Mallam, S., Nazir, S. and Sharma, A., 2019. The human element in future Maritime Operations - perceived impact of autonomous shipping. *Ergonomics*, 63(3), pp.334-345.

³³ Offshore Engineer Magazine. 2022. DNV GL Approves IBM's Maximo Software for Maritime and Offshore Sectors. [online] Available at: <<https://www.oedigital.com/news/484641-dnv-gl-approves-ibm-s-maximo-software-for-maritime-and-offshore-sectors>> [Accessed 8 June 2022].

³⁴ Kongsberg.com. 2022. KONGSBERG DIGITAL PARTNER UP WITH LAB021 TO OFFER VESSEL LINK AS AN INTEGRATED PART OF VESSEL INSIGHT. [online] Available at: <<https://www.kongsberg.com/no/digital/resources/news-archive/2022/lab021/>> [Accessed 8 June 2022].

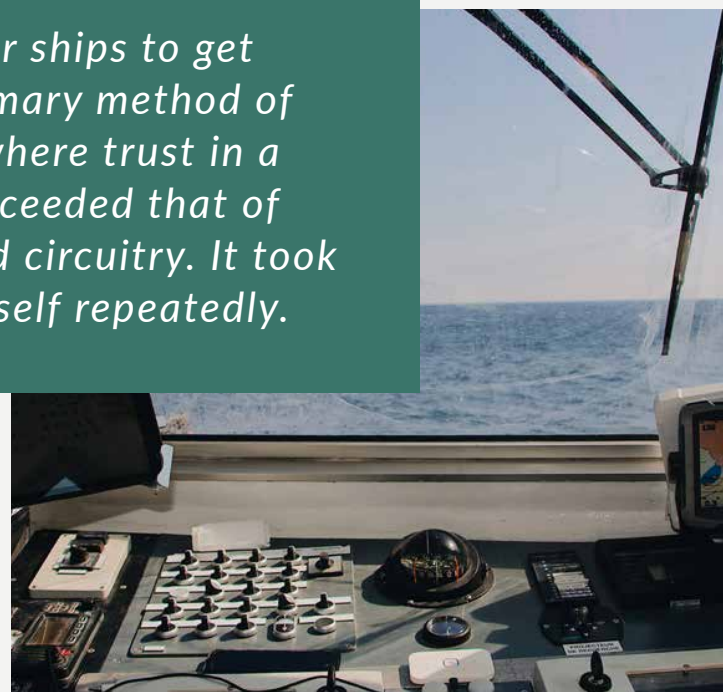
It took a period of acquaintance for ships to get comfortable making ECDIS the primary method of navigation, starting from a place where trust in a human with a pencil and a ruler exceeded that of the system of satellites and printed circuitry. It took time for the technology to prove itself repeatedly.

Human-system relationships

Technology can excel in tasks the human mind is less suited to. The speed and precision of digital processing today ensures output information is timely and reliable. However, there are still many cases where computer-generated information needs human verification. It took a period of acquaintance for ships to get comfortable making ECDIS the primary method of navigation, starting from a place where trust in a human with a pencil and a ruler exceeded that of the system of satellites and printed circuitry. It took time for the technology to prove itself repeatedly.

Even today, general attitudes to digital technology place humans in governance over machines. We still place the responsibility on officers and crew for the success or failure of digital outputs, hence the mantra 'poor data in, poor data out'. The need to understand what relevant and correct input information is, forms a large part of the human workload. Being able to recognise system information which is wrong is just as important.

Sometimes the way this information is displayed is hard for a human to process however. Intuition, foresight, creative thinking and sensemaking are areas where people



win out over computers. So while AI proves itself, technology needs to retain a human-centred approach to empower seafarers to conduct their executive role in the operation.

So long as it is the human that holds responsibility, it is the human that is at risk of being the limiting factor. In the US, NASA based their approach to performance³⁵ on well-established theories: 1.) Situational Awareness³⁶, 2) Model of Internal Human Malfunction³⁷, 3) Model of Unsafe Acts³⁸, and 4) Information Processing Model³⁹. For decades, this understanding of humans as components of a complex technological system has only increased in relevance for the ships of today. Solutions which aid understanding, heighten situational awareness, and prevent mistakes, improves human performance and empowers humans to shoulder their responsibility in receipt of the full facts.

35 A Review of Human Performance Models for the Prediction of Human Error. 2001. [online] Available at: <<https://humanfactors.arc.nasa.gov/groups/hcsl/publications/HumanErrorModels.pdf>> [Accessed 8 June 2022].

36 Endsley, M.R. (1998). Design and evaluation for situation awareness enhancement. Proceedings of the Human Factors Society 32nd Annual Meeting (pp. 97-101). Santa Monica, CA: Human Factors Society.

37 Rasmussen, J. (1982). Human Errors: A Taxonomy for Describing Human Malfunctions in Industrial Installations. Journal of Occupational Accidents. Vol. 4: 311-335.

38 Reason, J. (1990). Human Error. New York: Cambridge Press.

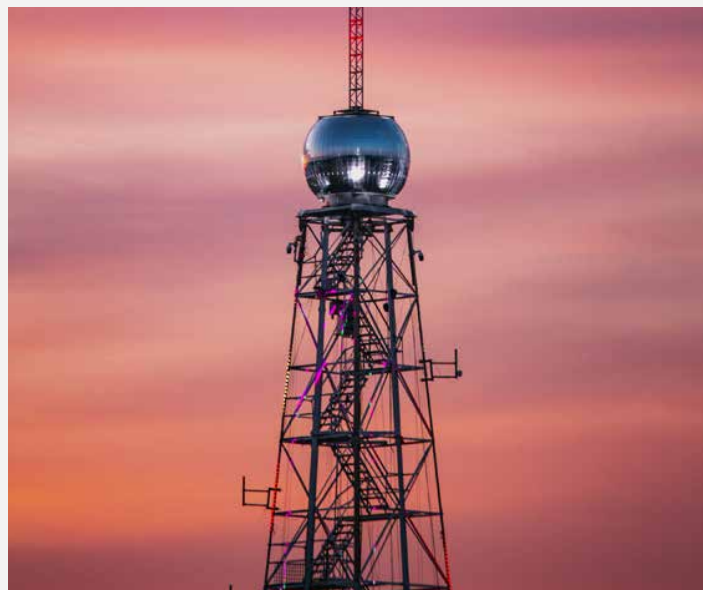
39 Wickens, C.D. and Flach, J.M. (1988). Information Processing. In E.L. Weiner & D.C. Nagel (Eds.), Human Factors in Aviation. (pp.111-155). San Diego, CA: Academic Press.

Vision, Situation Awareness and Mental Model

Most ships still operate with limited bandwidth for external communications. This has been a barrier to unlocking new ways for people on ships to stay in touch with the outside world and this can have a negative impact on crew wellbeing and performance. Distraction, crew fatigue, and confusion are human limitations that can lead to mistakes or accidents.⁴⁰

Ships in transit are at risk of navigation hazards that are hard to see by normal means. Targets without an automatic identification system (AIS), obstacles not detected by RADAR, or difficult environmental conditions make safe navigation even more difficult. These latent risks in routine operations are issues that technology could minimise or engineer out completely.

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Collision and Obstacle Avoidance

Sea Machines is one company that aims to solve some of the challenges navigators face at sea. AI-powered vessel vision combines real-time data from sensors to produce intelligent decision support systems and something the company calls 'collaborative autonomy'. There is a rapidly growing space for solutions that combine AI, vision tools, and sensor information to create an enhanced view for the benefit of the watchkeeper.

Another company using sensor fusion technology is **Luminbird**. Using laser scanners and advanced software tools, their products make object recognition easier and quicker for a navigator to process. LiDAR stands for light detection and ranging.⁴¹ *It is a remote sensing method which scans the earth's surface and builds highly accurate digital representations. The OPAL™ LiDAR works well with RADAR, camera, AIS and electronic charts. Compared to maritime RADAR, OPAL shows reduced clutter and greater precision.*⁴² This technology also outperforms standard equipment when gauging distances.

⁴⁰ Sea Machines - Enhancing vessel safety, efficiency, and capability. 2022. Marine Collision Avoidance Technology - Sea Machines. Available at: <https://sea-machines.com/collision-avoidance/>

⁴¹ Oceanservice.noaa.gov. 2022. What is lidar?. Available at: <https://oceanservice.noaa.gov/facts/lidar.html>

⁴² Neptec Technologies Corp. 2022. Marine LiDAR - Neptec Technologies Corp. Available at: <https://www.neptectechnologies.com/marine-lidar/>

Onboard Connected Safety

The internet of things (IoT) is like the connecting tissue for complex socio-technical ecosystems. These systems work like communities, with things interacting with one another within a focussed environment. Onboard a ship, crew with different responsibilities operate in different locations at different times and for different reasons. What IoT makes possible is understanding the way the crew interact with equipment during this multitude of system actions. The potential to get intelligent insights with IoT is virtually limitless. Almost any data point can be connected to the system through smart devices. What IoT does is build a comprehensive picture of a ship and its connected machinery, rendering a high-resolution picture of ecosystem health and performance.

There are other use cases where IoT tech improves links between humans and digital/mechanical systems. Routine work requires a basic overview of resource utilisation and risk. It is important to know where people are to keep people safe on the job. A control point for work on ships means someone has a general overview of crew whereabouts. It also offers opportunities for crew to be informed of work going on around them.

Thinking of seafaring crew as a part of a complex socio-technical system and harnessing new digital technologies to facilitate and manage that relationship means that risks that were previously accepted can now be improved on, while enhancing human performance.

Location technology enables decision makers to focus on safety more effectively. Knowing where to send resources, to the right places, via the most optimal route, can save lives. Working in this way also shows promise for increasing worker productivity.

The potential to get intelligent insights with IoT is virtually limitless. Almost any data point can be connected to the system through smart devices.

Rombit is another company with a plug and play IoT solution. Working like a track and trace system, the technology is adapted to different needs in maritime. Connected with wearable technology, human and machine location data is generated by the system to provide a number of benefits from lone worker support to infection management during high risk public health outbreaks. Arrow Labs also combines wearables with a Software and a Service (SaaS) product. The company claims that their core technology can increase worker efficiency by 30%, business efficiency by 40% and a reduction in operating costs 20%.

Visualising the human workforce on digitally-enabled ships as an integral part of a complex socio-technological system and selecting digital tools that maximise the role that humans will play in retaining responsibility and contributing human traits such as reasoning and moral judgement is a powerful way of understanding optimisation.



HOW CAN DIGITAL TOOLS BE USED TO IMPROVE CAREER PROSPECTS, TRAINING, AND INDUSTRY RETENTION?

With shipping considered to be the key industry spurring global trade, the important role of seafarers as the industry's front liners becomes even more in evidence upon knowing that there is a deficit of over 26,000 certified officers according to BIMCO.⁴⁹

Despite the positive retention rates observed in the past five years, the need for promoting careers at sea, creating conducive workplaces onboard ships, and improving the state of maritime education and training continue to be critical factors in ensuring the sustainability of the maritime industry.

The digital transformation of the industry is now affecting multiple stakeholders and is beginning to disrupt traditional operations. The adoption of emerging technologies means that the maritime industry will have to face concerns regarding the management and operation of these new types of equipment and digital systems.

The development of the maritime industry will require the continuous upskilling of the maritime workforce and will also require industry stakeholders to close the gap in the training, development, and retention of seafarers.

Technologies such as artificial intelligence and cloud computing will require new skills in disciplines such as data management and cybersecurity. The development of the maritime industry will require the continuous upskilling of the maritime workforce and will also require industry stakeholders to close the gap in the training, development, and retention of seafarers.

43 BIMCO (2021) Seafarer Workforce Report, with the International Chamber of Shipping, published July 2021, sourced from <https://www.ics-shipping.org/publication/seafarer-workforce-report-2021-edition/>

Digital technologies are disrupting the way the maritime industry operates and the training of seafarers should be correspondingly developed according to the changing designs of new vessels and the evolving requirements of the market.

TRAINING

Maritime education and training primarily operates on the basis of a learner being able to display the competent skill to perform the task required. In the age where the availability of information and the accessibility of digital technology is continuously improving, the delivery of maritime education and training solutions are also evolving with the changing competencies required by the industry. The focus on skills such as in cybersecurity, energy management, and data literacy will be needed by seafarers in order to cater to the changing technological landscape of the market within the next 5 years.

Maritime's increasing reliance on electronic and automated systems also presents the need for seafarers to obtain a better understanding of how these systems operate and how they can further develop along with the improvements being made in vessel connectivity and the adoption of 'cyber-physical' systems. The effort to match the digital transformation of the industry must reflect on the skills of the next generation of seafarers. From experiential learning methods to more personalised and on-demand training approaches, digital technologies are not only creating new reasons for upskilling,

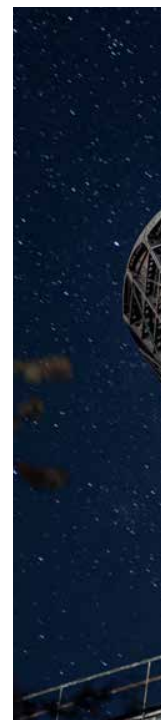
but are also allowing seafarers access to new and engaging training solutions.

Swedish training platform provider *Seably* took notice of this and has developed their product to address the changing training needs of seafarers.⁴⁴ The company does this by ensuring that the training materials are always updated every month. These courses are also designed to fit the learning styles of any organisation by allowing companies and seafarers to develop the training courses themselves. This changes the outdated approach of many shipping companies who use a standardised approach in their training needs. The company's digital platform also reduces the friction for seafarers in accessing the learning materials by making them available through a desktop computer or any mobile device.

Beyond these training solutions, emerging forms of digital technology such as virtual reality and augmented reality are transforming the delivery of maritime training and education solutions with their level of technical advancement. Through highly realistic simulations, current and future seafarers are able to experience the environments at sea, whether on a ship's bridge or in the engine room, and allows them to participate in a wide variety of scenarios that can help them learn new skills and test their knowledge in a more effective and interactive manner.


Companies such as *Wartsila* have introduced digital technologies such as virtual reality and augmented reality to introduce seafarers and maritime students to a whole new level of experiential learning.⁴⁵ Their solution allows students and professionals to be actively involved and engaged in a simulated environment preparing them for the real-life setting.

Digital technologies are disrupting the way the maritime industry operates and the training of seafarers should be correspondingly developed according to the changing designs of new vessels and the evolving requirements of the market.



⁴⁴ Seably, website accessed May 2022, sourced from <https://www.seably.com/>

⁴⁵ Wartsila Smart Realities, website accessed May 2022, sourced from <https://www.wartsila.com/voyage/simulation-and-training/smart-realities>



The next generation of maritime professionals will be operating in an environment driven by data and technology. The digital transition of the entire value chain will also generate the need for new skills and create more opportunities for new roles within the industry.

CAREER DEVELOPMENT

The advancements being made in maritime technology play a prominent role in the evolution of the seafaring profession. Technologies such as artificial intelligence and data analytics are challenging the industry to adapt to changes in ship operations and management. At the same time, the adoption of technologies such as blockchain and cloud-based platforms are giving seafarers access to more professional opportunities, helping them to further their careers within the industry.

The next generation of maritime professionals will be operating in an environment driven by data and technology. The digital transition of the entire value chain will also generate the need for new skills and create more opportunities for new roles within the industry. According to a survey conducted by the International Association of Maritime Universities in 2018, the focus on technical competencies; technological awareness; adaptation and flexibility; computing and informatics skills; and teamwork, comprise the perceived requirements that a seafarer needs to have in the developing state of the maritime industry.⁴⁶ These skills fit well with the increasing usage of automation systems onboard ships and seafarers' increasing exposure to 'human-machine interfaces'. These changes do not only focus on technical skills, but the behavioural competencies. Focusing on adaptability, communication and teamwork will be vital in ensuring an evolved safety culture on digitally-enhanced ships. The development of the seafarer's role will be evident in disciplines such as electronics and cyber-physical systems, especially with the increasing investments being made in artificial intelligence, analytics, and computing technology.

A study published by the HSBA Hamburg School of Business Administration cites that the future of the seafaring profession will not be lost but would rather create new roles.⁴⁷ With the majority of technology providers focusing on the ship operations and management sector,⁴⁸ these potential roles may largely focus on remote operations and analytics offering new avenues for seafarers in integrating themselves in the digitally-enabled maritime ecosystem.

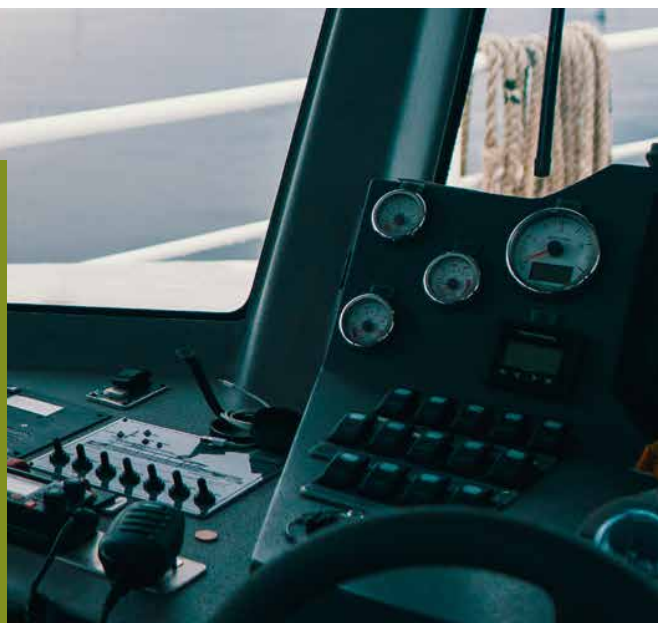
⁴⁶ International Association of Maritime Universities [IAMU]. (2018). A future Global Maritime Professional: Competencies, Knowledge Domains, Skills, Attitudes & Others

⁴⁷ HSBA Hamburg School of Business Administration. (2018). Seafarers and digital disruption

⁴⁸ Internal analysis shows the ship operations and management sector is comprised of 612 companies, Thetius Intelligence Platform, accessed May 2022

The transition towards a digitally-enabled future affects the roles required of seafarers, but is also creating a more sustainable environment that can appeal to the next generation of maritime professionals.

The integration of digital technology in many processes and systems in the maritime industry has not only disrupted the dynamic roles of seafarers, but has also opened up areas for innovation. The use of electronic documentation and blockchain technology are use cases where digital technology is able to help in streamlining the manually intensive process of data collection and verification of crew certifications. Incorporating these technologies also supports the development of a more collaborative and transparent data infrastructure in the seafaring community which can ultimately benefit the lives of seafarers globally. The availability of cloud-based digital platforms aimed at offering seafarers more exposure within the industry either through recruitment or professional development has also paved the way for them to seek and make use of opportunities that allow them to progress their current skill set or even to expand beyond their role at sea. The transition towards a digitally-enabled future affects the roles required of seafarers, but is also creating a more sustainable environment that can appeal to the next generation of maritime professionals.



EMPLOYEE RETENTION

The factors that affect employee retention in the maritime industry are complex given that it is common for seafarers to experience long periods of isolation, rough weather conditions, and in high-pressure working environments. Past studies that have explored the motivating factors for the retention of seafarers have generally attributed it to three key influences: job satisfaction, opportunities for career progression, and good working conditions.⁴⁹ These factors encompass a large variety of components that effectively dictate the range of issues that allow seafarers to continue on in their careers, such as social interaction and communication, professionally rewarding responsibilities, manageable contract durations, and many more. However, some of these factors could be changing as we will see in a later chapter.

⁴⁹ Caesar, L.D., Cahoon, S. & Fei, J. Exploring the range of retention issues for seafarers in global shipping: opportunities for further research. WMU J Marit Affairs 14, 141–157 (2015). <https://doi.org/10.1007/s13437-015-0078-0>

Improving the state of technology for crew connectivity and communication onboard ships is one of the most important ways an employer can retain their staff.

During the current period of digital technology adoption, many of these concerns are being tackled head on through the development of improved connectivity solutions, through advancements in computing and satellite technologies, and more efficient crew management-related processes enabled by digital technologies like people analytics and artificial intelligence. As they evolve, these developments will determine how the maritime industry, both ashore and at sea, stack up as an attractive career option. It is worth noting that in the past five years, BIMCO and the International Chamber of Shipping have reported that the turnover rates for qualified seafarers has reduced by 2%, indicating that seafarers are choosing to serve more years at sea.⁵⁰

As we will see in our latest survey results, improving the state of technology for crew connectivity and communication onboard ships is one of the most important ways an employer can retain their staff. Access to the Internet is an important factor for attracting and retaining seafarers, with 92% saying that it strongly influences their decision of where to work. The International Maritime Organization itself has addressed the importance of Internet accessibility

for seafarers citing it as a key factor in the attractiveness of the profession to young people.⁵¹ Moreover, the recent updates to the Maritime Labour Convention have also included the mandatory right of seafarers to social connectivity which includes internet access.⁵² By creating an atmosphere that is close to that of land-based workspaces, employers are able to offer seafarers an environment that will make the duration of their stay in a ship more bearable.

Developing healthy working environments allows seafarers to make better decisions

Developing healthy working environments allows seafarers to make better decisions, and this has become the area of focus for the maritime technology company, SOL-X. According to the European Maritime Safety Agency, 66% of maritime incidents and casualties that occurred in 2019 were caused by human actions.⁵³ The Singaporean company combines technologies such as IoT (Internet of Things), cloud computing, and analytics to change this statistic.⁵⁴ The company takes advantage of process automation and operational visibility solutions to ensure that tasks are conducted safely and efficiently.

⁵⁰ IBID 49

⁵¹ International Maritime Organization (IMO), published September 2015, Internet on ships a key to recruiting and retaining seafarers, IMO symposium told, sourced from <https://www.imo.org/en/MediaCentre/PressBriefings/Pages/40-WMD-symposium.aspx>

⁵² ITF Seafarers, published 16 May 2022, Seafarers win commitment to mandatory internet access in international law, sourced from <https://www.itfseafarers.org/en/news/seafarers-win-commitment-mandatory-internet-access-international-law>

⁵³ European Maritime Safety Agency (EMSA), published 2019, Annual Overview of Marine Casualties and Incidents 2019

⁵⁴ SOL-X, website accessed May 2022, sourced from <https://www.sol-x.co/>

There are multiple opportunities for digital technologies to be adopted in the preservation of the seafaring profession.

By creating an environment that allows seafarers to work safely and in sync with digital technologies, it makes their lives easier and promotes the sustainability of the industry through safer operations. This is one scenario where automation proves to be a positive force in uplifting the working conditions of seafarers onboard ships.

The rapid advancement of technological resources and the exponential production of data have been key factors in making digital technologies impactful in crew retention. By focusing on issues such as ensuring a safe environment for seafarers, managing elaborate crew changes, and empowering their voices opens up shipping companies to new and engaging ways of connecting with their staff and identifying their motivations.

There are multiple opportunities for digital technologies to be adopted in the preservation of the seafaring profession. For example, the growing field of analytics can be focused on human resources and social data. Often referred to as 'people analytics', it describes the approach of using statistical insights from employee data to manage an organisation's talent resource. Applying this form of technology in the maritime industry, opens up employers to an increased level of visibility and understanding on the workplace dynamics onboard and ashore.⁵⁵

CHALLENGES TO THE ADOPTION OF DIGITAL TECHNOLOGIES

Adopting digital technologies for training, career development and retention of seafarers comes with a unique set of challenges. These include the readiness and availability of the infrastructure to cater for digital products, the critical need for highly accessible connectivity solutions, and the receptivity of seafarers and shore-based staff to emerging technologies.

The development of digital infrastructure on ships is expected to accelerate in the coming years, given that the barriers for maritime technology innovation have been reduced, encouraging over US\$ 300 million dollars of venture capital funding to be injected into the sector as far back as 2018.⁵⁶ The increased attention from stakeholders outside the industry is a good indicator of the maritime industry's progression into a more open and digitally-enabled market sector.

However, this development also translates to an increased need to train and develop the world's seafarers to use these new technologies and understand how they can affect the outlook and shape of their careers. The growth of the industry will rely on the ability of maritime professionals to have access and to use these technologies. If friction points continue to exist between operators and crews over digital technology and autonomy, the maritime industry will continue to risk widening knowledge gaps, training deficits and negative perceptions towards technologies that is likely to constitute a drag on the industry's shift towards cleaner and more efficient operations.

⁵⁵ Thetius (2021) Can people analytics improve crew management?, Available at <https://thetius.com/can-people-analytics-improve-crew-management/>

⁵⁶ PwC, Venture capital investment in maritime technology, published November 2019, sourced from https://pwc.blogs.com/industry_perspectives/2019/11/venture-capital-investment-in-maritime-technology.html



The emergence of autonomous ships and a disruptive digital transformation of the industry won't destroy all seafaring roles, but will create new roles and will introduce to the industry new responsibilities such as operating remotely-controlled vessels from ashore and create a dynamically changing talent pool of maritime professionals who will go on to play a significant role in supporting this transition.

THE FUTURE OF THE SEAFARING CAREER

The future of seafaring is entering the stage where information is being produced exponentially and being consumed continuously. The availability of digital technologies will require the next generation of seafarers to focus on their soft skills as much as they will have to upskill themselves in the use of digital tools. The transition of the industry into a hyperconnected ecosystem will require seafarers and shore-based staff to be more adaptable and flexible with the new and evolving operational paradigms that may soon develop.

The emergence of autonomous ships and a disruptive digital transformation of the industry won't destroy all seafaring roles, but will create new roles and will introduce to the industry new responsibilities such as operating remotely-controlled vessels from ashore and create a dynamically changing talent pool of maritime professionals who will go on to play a significant role in supporting this transition. Seafarers will continue to be critical drivers of the industry and the adoption of technology in the areas of crew training, development, and retention will only continue to expand as it grows to match the tools and equipment being introduced into the industry as well. It is crucial to the sustainability of the seafaring profession that the continuous upskilling should go beyond competencies in seamanship, but also focus on skills centred around digital technologies and systems as well. As technological changes continue to find their way around various facets of the maritime industry, the continued uptake of these technological trends will soon create a change in the motivations and interests of the next generation of maritime professionals. Whether at sea or ashore, the growth of the industry will be dependent on how these technologies are utilised for the betterment of the future maritime workforce.

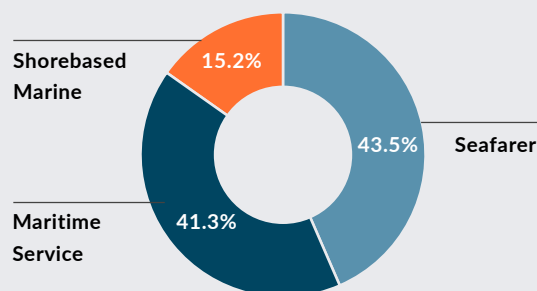
SURVEY RESULTS

As part of this report, Thetius canvassed over 200 maritime professionals including seagoing and shorebased staff from shipping companies and industry service providers. We asked them to describe their experience of human factors in digitalisation split into the three pillars of this report - crew health and welfare; career, training, and retention; and human performance. The results help us to understand industry perceptions of digitalisation and estimate the proportion of digital transformations within maritime that consider the human element in their design and execution.

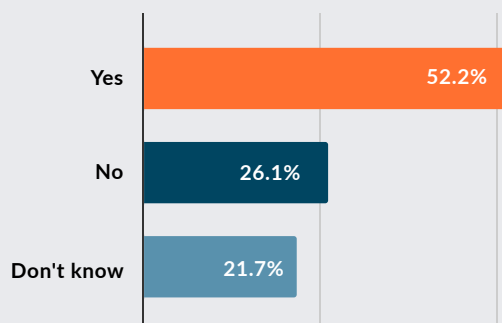
Over 52% of the businesses surveyed have a digital transformation strategy already in place and over 88% of respondents believed that digitalisation will result in major or significant new ways of operating vessel fleets within five years.

It is clear that digitalisation is considered to be transformative and a disruptive force, even over the near term. As we have established, digital transformation is not synonymous with automation. While automation is an integral part of the future for the maritime industry, it is clear that human operatives will continue to play a pivotal role in ship operations and management. So, understanding how digital tools need to be shaped around the human element is crucial to ensuring digitalisation can make a positive impact towards helping shipping to modernise and meet its environmental and humanitarian obligations.

SURVEY RESPONDENTS



DOES YOUR SHIPPING COMPANY HAVE A DIGITAL TRANSFORMATION STRATEGY?



52%

of the businesses surveyed have a digital transformation strategy already in place and...

88%

of respondents believed that digitalisation will result in major or significant new ways of operating vessel fleets within five years.

CREW HEALTH AND WELFARE INSIGHTS

Among ship operators, nearly 78% reported that in the last 5 years their companies had installed internet connectivity or WIFI onboard for the personal use of the crew. 30% had also begun providing software platforms or apps that are designed to improve seafarer health and wellbeing - these included company chat forums and online access to consultant healthcare professionals.

The same figure - 30% - now also provides streaming entertainment services in communal areas on the ship such as movie and music streaming services. In contrast, direct health monitoring has seen the least popular uptake, with wearables and other monitoring devices that monitor seafarer health and wellbeing being implemented by less than 4% of respondent organisations.

Of those operators who have yet to implement any digital facilities aimed at improving seafarer health and welfare directly, nearly 41% had already planned to provide internet connectivity for crew personal use prior to the announcement of mandatory measures in the Maritime Labour Convention on the 13th May 2022.

When asked if their employers worked hard to ensure that officers and crew were healthy, respondents gave a broad mix of responses. The majority tended towards believing that their employer did work hard in this respect, but just over 39% disagreed.

80%

of respondents felt that communication and support between ship and shore had improved in recent years.

HUMAN PERFORMANCE

74% of maritime employees felt well supported by managers and senior officers to improve their job performance. While more can evidently be done by employers in this regard, nearly 80% of respondents felt that communication and support between ship and shore had improved in recent years, and a similar proportion believed that accommodation and living conditions on their ships now fully met the needs of the officers and crew.

Fatigue remains an issue among seafarers, with 76% of seafarers reporting that they regularly feel fatigued at work.

CAREER DEVELOPMENT, TRAINING, AND RETENTION

It is perhaps not surprising given the traditional rank structure among seafaring crews that over 78% of respondents felt that they had a clear understanding of their future career path and nearly 72% were given the education and training they need to progress in their careers. As a result, indications are that retention rates are predominantly healthy, with 74% planning to be working for the same employer in 12 months time, with a slightly lower number of respondents (67%) planning to be working for the same employer in 5 years time. They also felt that their employers were generally keen to retain them for the long term.

More than 1 in 3 seafarers chose access to digital technology as the most important factor when considering working for a new employer, which may be a reflection of the changing priorities of younger generations entering the maritime workforce. Interestingly, this ranked higher than pay, which was a primary factor for slightly less than 1 in 4.

Despite generally positive results in this area, it is clear that the industry wants employers to use digitalisation to do more, with over 42% of respondents believing that their employer needed to make the most immediate improvements to career development, training, and retention, ahead of crew health and wellbeing (33%) and human performance management (25%).

As we have seen, digitalisation offers a number of new possibilities for the delivery of training and the facilitation of exams. The majority of maritime professionals believe that up to 75% of training and examinations will be delivered digitally within 5 years and 1 in 5 believe that this figure could be even higher.

However, digitalisation is not just a facilitator of training, it will require training in itself. Over 65% of respondents believe that new training needs will emerge within the next five years in:

- ▶ Autonomy and remote control/supervision
- ▶ Satellite communications and enhanced connectivity at sea
- ▶ e-Navigation and digital decision support for bridge operations.

Overall, sentiment is positive towards the emergence of digital technology in the seafaring profession. The vast majority of respondents (87%) believe that digital transformation will have a positive or net-neutral effect on crew and employee retention, with some people leaving to avoid managing the changes that the digital era will bring to their profession, being replaced with more tech-positive people, or encouraging greater retention by enhancing living and working conditions and making job roles more fulfilling.



1 IN 3

More than 1 in 3 seafarers chose access to digital technology as the most important factor when considering working for a new employer.



GENERAL TRENDS

Crucially, 2 in 5 crew members (40%) who worked with digital technology at sea did not believe that it had been well designed for their needs, or considered it 'user friendly'. While this shows us that the majority of crew do believe they use well-designed digital tools, the message is clear - considering the user fully is critical to providing value-adding digital resources. This is especially true for data collection tools that require human input, such as GHG reporting software. If the interface is poorly designed, the system is not intuitive, or is time consuming or complicated to understand, there is a much greater risk of reducing data quality. In many cases, reliance on low quality data can be catastrophic to achieving the core aims of a digital transformation strategy.

2 IN 5

crew members (40%) who worked with digital technology at sea did not believe that it had been well designed for their needs.

More may also need to be done to reassure maritime professionals that they have a secure long term future by choosing maritime as a career. 50% believe that upto 1 in 4 jobs could be replaced by digital technology or automation within 5 years, with nearly 1 in 20 professionals believing that humans will be entirely replaced onboard over the same period. Skilled, committed, and high-performing staff will remain critical to successful ship operations for the foreseeable future and the industry may face even greater skills shortages if seafaring and the maritime profession doesn't paint a clear picture of longevity and future relevance.

50%

believe that upto 1 in 4 jobs could be replaced by digital technology or automation within 5 years, with nearly 1 in 20 professionals believing that humans will be entirely replaced onboard over the same period.

CONCLUSION

This report opened with three important questions to industry:

- What value should the maritime sector place on human factors when considering the digital transformation of the shipping industry?
- What role does human performance play in building a lean, competitive, digitalised, and profitable merchant shipping operation? And how do human factors interrelate with digital processes, procedures, and technologies to create a ship that delivers the right outcomes for its owners and a safe and stimulating environment for its crew?

The importance of the global maritime workforce cannot be overstated and the trajectory of development in the shipping industry makes it clear that skilled, motivated, and well cared for seafarers will be pivotal to its ability to meet its environmental, social, and governance obligations through digital transformation of processes.

Instead of allowing maritime professionals to become distrustful or even fearful of digital and emerging technologies, the sector must recognise the continued importance of human capital and work hard to bring crews along on the journey. Newer, better ways of working are possible. Digital tools and connectivity can create happier and more productive ships. Entirely new and exciting roles are there and growing rapidly. However, if half of our seafarers believe that there will be a 25% reduction in job opportunities within 5 years, this suggests that more needs to be done to highlight how those roles will be evolved or replaced.

Skilled, motivated, and well cared for seafarers will be pivotal to its ability to meet its environmental, social, and governance obligations through digital transformation of processes.

The challenge is made greater by the fact that seafarer happiness is at an all time low. Societal and generational expectations and ambitions are changing, but life at sea has stagnated for many. But change is underway. The addition of internet connectivity requirements in the MLC is a paradigm shift, addressing one of the key concerns of today's maritime professionals. Getting online is now ubiquitous in developed nations and seafarers from around the world can now look forward to keeping in touch with family and friends and accessing an array of platforms and digital services that have the potential to revolutionise their lives at sea.

The benefits of a connected seagoing workforce are evident to owners and operators too. In addition to benefiting from happier and more motivated crews, the possibility to gather more data from their fleet provides the visibility needed to build effective strategies for decarbonisation and other complex compliance requirements.

More needs to be done to ensure that human factors are considered properly in the design of digital maritime systems and the seafaring workforce is properly invested into the digitisation process.

The challenge is made greater by the fact that seafarer happiness is at an all time low.

A key message is that digital transformation is not synonymous with autonomous or uncrewed ships. Digitalisation offers an enrichment of seafaring job roles and humans will remain at the very centre of the digital era in shipping. Digital and connected tools can boost human performance and compliment human skills such as reasoning and morality. We have seen how human and machine will be working closer together and why maritime cybernetics will become a pivotal topic in designing the optimal digital fleet transformation.

By aligning digital tools with the needs of the seafarer, the process of technology-led improvements in decarbonisation and crew management will develop quicker and be more effective. When operators realise that the modern ship is a complex socio-technical system that requires the cooperation of human and machine, we can see the bigger picture - when liberated from their routine and mundane tasks,

humans can better focus on more complex decision making and make judgements with the help of better situational awareness.

For any of this to happen however, the industry must continue to attract talented and dedicated people. Digital transformation will provide new ways of delivering training and encourage retention through better working conditions, but will also require training new skills and expertise.

What is clear from our survey is that more needs to be done to ensure that human factors are considered properly in the design of digital maritime systems and the seafaring workforce is properly invested into the digitisation process. The cost of not doing so could prove catastrophic to the global economy, but the rewards to industry for getting this right are extraordinary.



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