STEER
Seafarer Technology Engagement
Empowerment and Resilience

#ListeningToSeafarers

The evidence, the gaps and the way forward

A report into understanding how technology impacts seafarers

The Nautical Institute

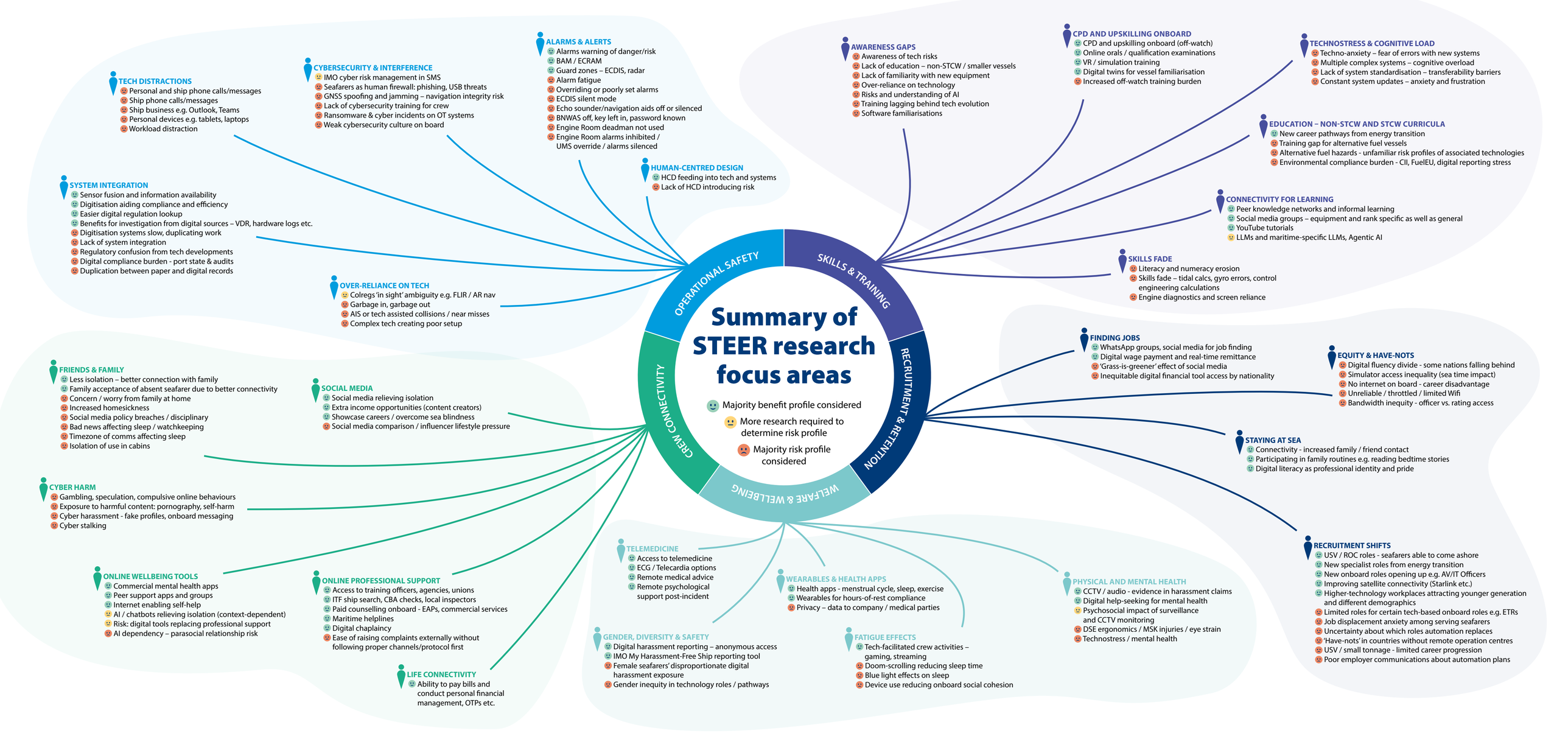
In collaboration with LR Foundation

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STEER
Seafarer Technology Engagement Empowerment and Resilience


Summary of STEER research focus areas
Majority benefit profile considered
More research required to determine risk profile
Majority risk profile considered
OPERATIONAL SAFETY
SKILLS & TRAINING
RECRUITMENT & RETENTION
WELFARE & WELLBEING
CREW CONNECTIVITY
TECH DISTRACTIONS
Personal and ship phone calls/messages
Ship phone calls/messages
Ship business e.g. Outlook, Teams
Personal devices e.g. tablets, laptops
Workload distraction
CYBERSECURITY & INTERFERENCE
IMO cyber risk management in SMS
Seafarers as human firewall: phishing, USB threats
GNSS spoofing and jamming – navigation integrity risk
Lack of cybersecurity training for crew
Ransomware & cyber incidents on OT systems
Weak cybersecurity culture on board
ALARMS & ALERTS
Alarms warning of danger/risk
BAM / ECRAM
Guard zones – ECDIS, radar
Alarm fatigue
Overriding or poorly set alarms
ECDIS silent mode
Echo sounder/navigation aids off or silenced
BNWAS off, key left in, password known
Engine Room deadman not used
Engine Room alarms inhibited / UMS override / alarms silenced
HUMAN-CENTRED DESIGN
HCD feeding into tech and systems
Lack of HCD introducing risk
SYSTEM INTEGRATION
Sensor fusion and information availability
Digitisation aiding compliance and efficiency
Easier digital regulation lookup
Benefits for investigation from digital sources – VDR, hardware logs etc.
Digitisation systems slow, duplicating work
Lack of system integration
Regulatory confusion from tech developments
Digital compliance burden - port state & audits
Duplication between paper and digital records
OVER-RELIANCE ON TECH
Colregs 'in sight' ambiguity e.g. FLIR / AR nav
Garbage in, garbage out
AIS or tech assisted collisions / near misses
Complex tech creating poor setup
AWARENESS GAPS
Awareness of tech risks
Lack of education – non-STCW / smaller vessels
Lack of familiarity with new equipment
Over-reliance on technology
Risks and understanding of AI
Training lagging behind tech evolution
Software familiarisations
CPD AND UPSKILLING ONBOARD
CPD and upskilling onboard (off-watch)
Online orals / qualification examinations
VR / simulation training
Digital twins for vessel familiarisation
Increased off-watch training burden
TECHNOSTRESS & COGNITIVE LOAD
Techno-anxiety – fear of errors with new systems
Multiple complex systems – cognitive overload
Lack of system standardisation – transferability barriers
Constant system updates – anxiety and frustration
EDUCATION – NON-STCW AND STCW CURRICULA
New career pathways from energy transition
Training gap for alternative fuel vessels
Alternative fuel hazards - unfamiliar risk profiles of associated technologies
Environmental compliance burden - CII, FuelEU, digital reporting stress
CONNECTIVITY FOR LEARNING
Peer knowledge networks and informal learning
Social media groups – equipment and rank specific as well as general
YouTube tutorials
LLMs and maritime-specific LLMs, Agentic AI
SKILLS FADE
Literacy and numeracy erosion
Skills fade – tidal calcs, gyro errors, control engineering calculations
Engine diagnostics and screen reliance
FINDING JOBS
WhatsApp groups, social media for job finding
Digital wage payment and real-time remittance
'Grass-is-greener' effect of social media
Inequitable digital financial tool access by nationality
EQUITY & HAVE-NOTS
Digital fluency divide - some nations falling behind
Simulator access inequality (sea time impact)
No internet on board - career disadvantage
Unreliable / throttled / limited Wifi
Bandwidth inequity - officer vs. rating access
STAYING AT SEA
Connectivity - increased family / friend contact
Participating in family routines e.g. reading bedtime stories
Digital literacy as professional identity and pride
RECRUITMENT SHIFTS
USV / ROC roles - seafarers able to come ashore
New specialist roles from energy transition
New onboard roles opening up e.g. AV/IT Officers
Improving satellite connectivity (Starlink etc.)
Higher-technology workplaces attracting younger generation and different demographics
Limited roles for certain tech-based onboard roles e.g. ETRs
Job displacement anxiety among serving seafarers
Uncertainty about which roles automation replaces
'Have-nots' in countries without remote operation centres
USV / small tonnage - limited career progression
Poor employer communications about automation plans
FRIENDS & FAMILY
Less isolation – better connection with family
Family acceptance of absent seafarer due to better connectivity
Concern / worry from family at home
Increased homesickness
Social media policy breaches / disciplinary
Bad news affecting sleep / watchkeeping
Timezone of comms affecting sleep
Isolation of use in cabins
SOCIAL MEDIA
Social media relieving isolation
Extra income opportunities (content creators)
Showcase careers / overcome sea blindness
Social media comparison / influencer lifestyle pressure
CYBER HARM
Gambling, speculation, compulsive online behaviours
Exposure to harmful content: pornography, self-harm
Cyber harassment - fake profiles, onboard messaging
Cyber stalking
ONLINE WELLBEING TOOLS
Commercial mental health apps
Peer support apps and groups
Internet enabling self-help
AI / chatbots relieving isolation (context-dependent)
Risk: digital tools replacing professional support
AI dependency – parasocial relationship risk
ONLINE PROFESSIONAL SUPPORT
Access to training officers, agencies, unions
ITF ship search, CBA checks, local inspectors
Paid counselling onboard - EAPs, commercial services
Maritime helplines
Digital chaplaincy
Ease of raising complaints externally without following proper channels/protocol first
LIFE CONNECTIVITY
Ability to pay bills and conduct personal financial management, OTPs etc.
TELEMEDICINE
Access to telemedicine
ECG / Telecardia options
Remote medical advice
Remote psychological support post-incident
WEARABLES & HEALTH APPS
Health apps - menstrual cycle, sleep, exercise
Wearables for hours-of-rest compliance
Privacy – data to company / medical parties
GENDER, DIVERSITY & SAFETY
Digital harassment reporting – anonymous access
IMO My Harassment-Free Ship reporting tool
Female seafarers' disproportionate digital harassment exposure
Gender inequity in technology roles / pathways
FATIGUE EFFECTS
Tech-facilitated crew activities – gaming, streaming
Doom-scrolling reducing sleep time
Blue light effects on sleep
Device use reducing onboard social cohesion
PHYSICAL AND MENTAL HEALTH
CCTV / audio - evidence in harassment claims
Digital help-seeking for mental health
Psychosocial impact of surveillance and CCTV monitoring
DSE ergonomics / MSK injuries / eye strain
Technostress / mental health

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Executive summary

The importance of active listening

Improving safety at sea by listening to seafarers' experiences with technology before acting on them is the principle that guides this report and the STEER Project as a whole.

Maritime technology is transforming faster than at any time since the shift from sail to steam. Yet, the industry's understanding of this change has largely been shaped by narratives other than those of the seafarers who operate these systems day to day. The project aims to improve safety by collecting real experiences, including both challenges and successes, and sharing the lessons learned through practical tools and guidance.

First, we must establish what we know: the strengths and knowledge gaps. Without a credible evidence base, and without hearing from as wide a range of seafarers as possible about their experiences and what would help them in their daily tasks, we risk acting on assumptions rather than facts. Regardless of how technology performs in controlled laboratory conditions ashore, effectiveness can only truly be measured by how seafarers cope during vessel operations.

The STEER Project is led by The Nautical Institute and funded by Lloyd's Register Foundation. This initial report marks the end of the project's foundational phase and draws together a systematic review of academic papers, industry publications and casualty investigation reports, alongside direct seafarer engagement through interviews, ship visits, workshops, international webinars, surveys and social media analysis. The evidence is accompanied by initial and interim recommendations based on the research so far. These recommendations are intended as 'food for thought' and as a catalyst for discussion and debate between seafarers and relevant stakeholders, rather than as an attempt to impose solutions.

One consistent finding has emerged: technology does not operate in isolation. Effects on safety, workload, skills and wellbeing depend heavily on how that technology is designed, introduced, supported and maintained. These impacts are examined through the lenses of safety and operational risk, skills and competence, workload and manning, welfare and wellbeing as well as inequality and inclusion. The report also highlights what remains unknown – particularly the effects on ratings, non-officer roles and smaller vessel sectors, as well as regional differences and the welfare-related effects of everyday connectivity.

This report is not a standalone document but the first in a series that will run throughout the STEER Project's lifecycle. The goal is not only to expand industry knowledge and contribute to the research base, but to translate existing evidence and seafarer experiences into practical tools and validated guidance that deliver real improvements in maritime safety. This report begins the process of turning evidence into tangible impact and lasting change in how technology is used at sea.

“ If technology is intended to improve safety, life and work at sea, the experiences of seafarers who operate it every day must be heard ”

STEER Project foundational principle

Foreword



Dr Tim Slingsby

The maritime industry is undergoing a fundamental, technology-driven transformation. Artificial intelligence, automated navigation systems, smart shipping solutions, digital logistics platforms and online training tools are reshaping how ships are designed, operated and regulated. According to research firm Thetius, 36 shipping companies announced plans to purchase or deploy AI-enabled technologies on board ships in 2024 alone. Additionally, market intelligence suggests that the global autonomous ships market was valued at about US$6.1 billion in 2023, and is projected to reach over US$13 billion by 2032, growing at a rate of 13.5% each year.

Despite this, work from around the world shows that digitalisation is operationally embedded but not yet strategic. For example, in the eastern Mediterranean, evidence indicates that 79% of seafarers rate digital transition and basic digital awareness training as extremely necessary, yet digital and cybersecurity skills as a core seafarer competency are prioritised by only 17% of shipping companies and 16% of seafarers. Additionally, more than 80% of seafarers receive digital skills training rarely or not at all, and 72% of seafarers report having insufficient time onboard to learn new digital systems, highlighting a growing gap between technology deployment and workforce readiness.

Weaker transition capacity in the seafaring workforce can have massive implications for worker safety and the resilience of the maritime industry at large. Upskilling and reskilling thus present a major opportunity for the maritime sector. Research shows that 67% of seafarers are willing to improve their digital skills, highlighting a strong appetite for digital transformation. By investing in people as well as technology, actors throughout the maritime system can equip the workforce to embrace new tools, unlock greater productivity, and help ensure that no one is left behind as the sector evolves.

However, maritime education and training must evolve quickly to keep pace with the rate of technological innovation. Not only must content of seafarer training change to reflect contemporary and future requirements; accepted approaches to training and certification would also benefit from embracing and digital and data-driven methods.

At the same time, the maritime industry should be aware of the risks of creating skills gaps between seafarers in comparatively wealthy or poorer regions, where digital infrastructures and access to training are not of consistent high quality, and where opportunities for safer and more efficient operations at sea might be missed.

Therefore, we are proud to partner with The Nautical Institute and the STEER Project. Only through participatory engagement with those who are directly impacted by the adoption of technologies on ships can we ensure people-centric decision making and enable seafarers to support the equitable transition to a decarbonised, digitalised ocean economy that is safe and sustainable.

Foreword



Capt David Patraiko FNI

How exciting! When we started the STEER Project to assess the impact of technology on seafarers, we knew it would be a huge undertaking, not least because we first needed to define what we mean by technology and seafarers – something covered in this report.

We then wanted to benefit from existing knowledge both from the shipping industry and other industries facing similar challenges. This led us to undertake a literature review, the results of which are presented in this report. This initial work has now allowed us to move to the next phase of the STEER Project, with a greater focus on research that will 'Listen to Seafarers'.

This initial review has identified some clear gaps that we shall now focus on. Not least is the question of how some technologies have become so essential that they could now be considered safety-critical systems, where a fault in the technology could create a serious risk. How prepared are seafarers for this?

We have also seen how technology can add great value to seafarers' personal lives – but what does 'great' really look like? It is also clear that, for the next generation of seafarers, technology will have an impact on recruitment and retention in a career at sea.

We live in interesting times, and The Nautical Institute is grateful for this opportunity to be proactive in addressing these important questions!

Abbreviations

AI	Artificial Intelligence
AIS	Automatic Identification System
AR	Augmented reality
ARPA	Automatic Radar Plotting Aid
BAM	Bridge Alert Management
BNWAS	Bridge Navigational Watch Alarm System
BWTS	Ballast Water Treatment System
CBA	Collective Bargaining Agreement
CHIRP	Confidential Human Factors Incident Reporting Programme
CII	Carbon Intensity Indicator
DEI	Diversity, Equality and Inclusion
DP	Dynamic Positioning
EAP	Employee Assistance Programme
ECDIS	Electronic Chart Display and Information System
ECG	Electrocardiogram
ECS	Electronic Chart System
ECRAM	Engine Control Room Alert Management
FLIR	Forward-looking infrared (camera)
GISIS	IMO Global Integrated Shipping Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HCD	Human-Centred Design
IMO	International Maritime Organisation
ITF	International Transport Workers' Federation
LLM	Large language model
MARS	Mariners' Alerting and Reporting Scheme
MASS	Maritime Autonomous Surface Ship(s)
MET	Maritime Education and Training
MOB	Man Overboard
MSK	Musculoskeletal
OOW	Officer of the Watch
OSV	Offshore Support Vessel
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
ROC	Remote Operations Centre
SMS	Safety Management System
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TMAS	Telemedical Assistance Services
UMS	Unattended Machinery Space
VR	Virtual reality
USV	Unmanned Surface Vessel



Introduction

The transformation at sea

Understanding technology's impact on seafarers requires an appreciation of how radically the modern vessel has changed.

Technology is delivering immense benefits for seafarers and vessel safety alike, as the literature provided by equipment manufacturers rarely fails to remind us. ECDIS systems have greatly enhanced maritime safety by providing real-time navigation and automated hazard alerts. Camera detection systems fitted onboard vessels and powered by artificial intelligence (AI) have been seen to speed up the response times to some man overboard situations. Meanwhile, greater access to high-quality broadband has enabled crew members to stay connected with family, enhancing morale.

Yet, we also hear of bridge teams overwhelmed by alarm fatigue, engineers resorting to search engines for diagnostics or social media to resolve machinery error codes and officers having to sift through dozens or even hundreds of daily emails. The long-term impact of automation on seafarers' careers remains frustratingly unclear. Additionally, some seafarers have expressed concern that messroom camaraderie has been fractured by individuals glued to personal devices alone in their cabins.

Each industrial revolution ashore has had its equivalent afloat. The sextant gave way to the gyrocompass, analogue radar to solid-state systems and paper charts to electronic displays. Shipboard operations have come to increasingly rely on integrated, digital and automated systems, and the gap between the most and least advanced vessels has arguably not been as wide since the transition from sail to steam propulsion.

> **"On the bridge, during a manoeuvre, you go with the pilot to bring the vessel alongside and your fingers dance between buzzers and buttons. Cancel, silence, acknowledge . . . again and again. You must switch off the bridge watch alarm, silence the ECDIS, mute the radar, confirm the alerts from every system that thinks it is saving you. But what it really does is drown you in noise. The Master no longer listens to the ship; he listens to the alarms. We live in a permanent state of alert, always surrounded by warnings that no longer mean danger but habit."**
>
> Greek port captain, bulk carrier, 2025

How technology has progressed over time

Table adapted by the STEER Project from "*Industrial revolutions and transition of the maritime industry: The case of Seafarer's role in autonomous shipping*" (Mehrangiz Shahbakhsh, Gholam Reza Emad, Stephen Cahoon)





	INDUSTRY 1.0	INDUSTRY 2.0
Time:	Late 18th to early 19th century	Late 19th to early 20th century
Feature:	Mechanised production, steam engine	Mass production (Ford's production line), electricity, assembly lines
Economic progress:	Economy 1.0 (the capability of labour and physical fitness)	Economy 2.0 (improving working processes through energy resources)
Maritime equivalent:	Engine telegraph, derricks, sextant-based celestial navigation	Radar, gyrocompass, wireless telegraphy, echo sounders





	INDUSTRY 3.0	INDUSTRY 4.0	INDUSTRY 5.0
Time:	Second half of 20th century	Early 21st century	Future
Feature:	Information age (computers), automated production	ICT technology, cyber-physical systems, Internet of Things, networking	Human-robot cooperation, high level of personalisation
Economic progress:	Economy 3.0 (developing performance through fast exchange of information and communication networks)	Economy 4.0 (an unprecedented era of change driven by innovative knowledge)	Economy 5.0 (creating value through competitiveness, creativity and innovation)
Maritime equivalent:	Decca navigation, stability computer, electronic manuals, word processing, unmanned machinery spaces	Digital logbooks, AIS, ECDIS, fuel monitoring systems, scrubbers	Remotely operated ships, AI route optimisation

The Age of Sail
Approximately 16th to mid-19th century

- Dominance of wind-powered vessels
- Exploration of oceans, as well as introducing and increasing chart accuracy
- Growth of maritime trade routes
- Technological advancements in ship design (caravel, galleon, clipper ships)
- Improvement in navigation techniques (astrolabe, sextant)
- Rise of global trade networks and initial international maritime law

The Age of Steam
Approximately mid-19th to early 20th century

- Introduction of steam-powered ships
- Replacement of sailing ships for commercial and military uses
- Steam engines allow for faster, more reliable travel without wind
- Opening of major canals like the Suez Canal
- Acceleration of globalisation and industrialisation

The Age of Motors
Early to mid-20th century

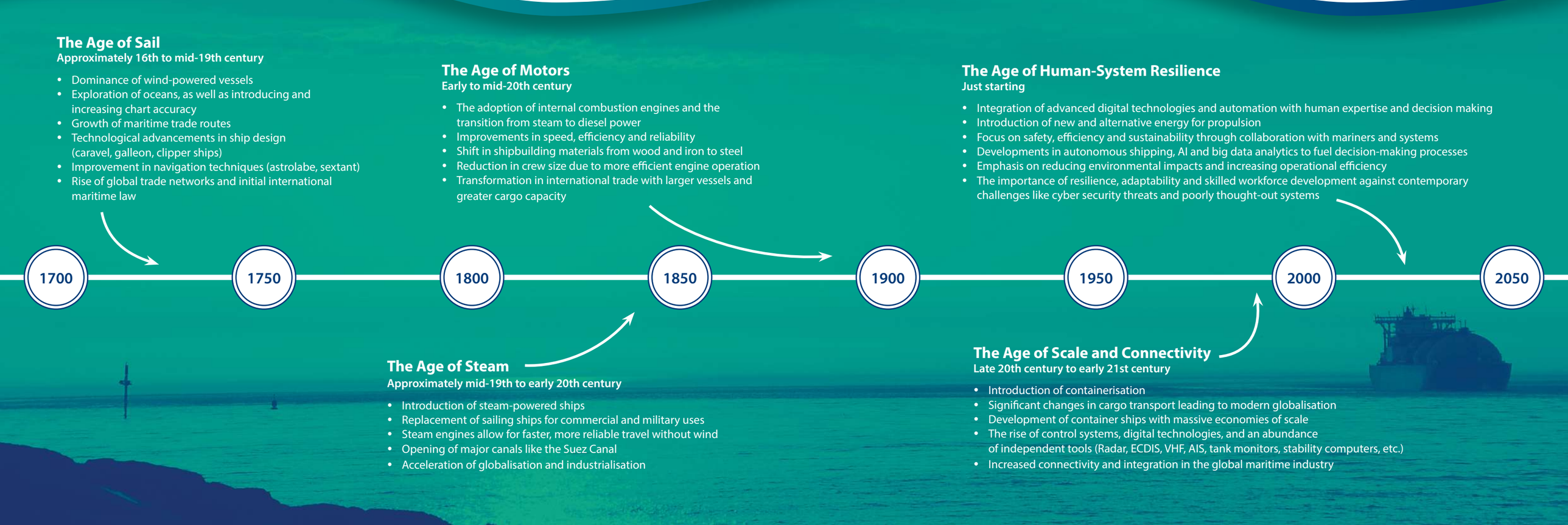
- The adoption of internal combustion engines and the transition from steam to diesel power
- Improvements in speed, efficiency and reliability
- Shift in shipbuilding materials from wood and iron to steel
- Reduction in crew size due to more efficient engine operation
- Transformation in international trade with larger vessels and greater cargo capacity

The Age of Scale and Connectivity
Late 20th century to early 21st century

- Introduction of containerisation
- Significant changes in cargo transport leading to modern globalisation
- Development of container ships with massive economies of scale
- The rise of control systems, digital technologies, and an abundance of independent tools (Radar, ECDIS, VHF, AIS, tank monitors, stability computers, etc.)
- Increased connectivity and integration in the global maritime industry

The Age of Human-System Resilience
Just starting

- Integration of advanced digital technologies and automation with human expertise and decision making
- Introduction of new and alternative energy for propulsion
- Focus on safety, efficiency and sustainability through collaboration with mariners and systems
- Developments in autonomous shipping, AI and big data analytics to fuel decision-making processes
- Emphasis on reducing environmental impacts and increasing operational efficiency
- The importance of resilience, adaptability and skilled workforce development against contemporary challenges like cyber security threats and poorly thought-out systems



From manual to assisted to automated

The same task can now be performed by seafarers in different ways across vessel types. They can handle steering manually, by autopilot, through automated track control or via dynamic positioning (DP). Seafarers can radar plot manually, using ARPA or with automatic acquisition via guard zones. Certain core skills do not disappear as systems evolve but they change in nature, making skill fade a key operational risk that must be actively managed.

The operational drivers

Three forces are enabling this change: digitisation, automation and remote operation, all enabled by advances in onboard connectivity. To meet tightening regulatory frameworks, environmental aims and efficiency objectives, operations are shifting away from reliance on static data and periodic reporting toward dynamic, near-real-time data flows. This technological transformation directly impacts seafarers as they adapt to new software, hardware and interfaces.

> **“We can spend more time on the computer in a watch than actually watchkeeping, especially at busy times with lots of drills, training or SMS reporting.”**
>
> Azerbaijani second officer, offshore vessel, 2026

Seafarer-centred design

To be built for human-led vessel operations, maritime technology must be designed with seafarer input at the conceptual, testing and validation stages. Yet there appears to be a disconnect between manufacturers designing systems for market and the operational realities at sea.

A human-centred approach is critical. By involving seafarers and other operational users through two-way feedback and iterative design processes, technology can be made to better reflect real working conditions and accurate workload and decision-making constraints. Technology use must also be considered throughout the ship’s entire lifecycle, from installation through to obsolescence management and eventual replacement.

Listening to seafarers is the first step in human-centred design. Effective human-centred design also requires ongoing testing, validation and feedback throughout the technology’s lifecycle. This approach depends on active participation from seafarers themselves, who must be given opportunities to share operational experience and challenge assumptions. While such engagement requires time and resources, these costs are often far lower than those associated with redesign, additional training, operational workarounds or operational incidents after implementation.

A design approach that focuses on the end user also benefits system designers, developers and equipment manufacturers by delivering greater usability, reliability and operational relevance, while reducing the risk of added complexity, distraction, fatigue or new error-producing conditions.

Today’s seafarers interact with technology not just as users but as data managers and system auditors. Whether overseeing automated logbook entries or transmitting real-time vessel information ashore, seafarers are essential to safeguarding data accuracy. They must, therefore, understand not only how to operate these technologies but also how to identify and rectify faults, erroneous data or off-nominal conditions.

Manual	Semi-automated	Automated
Helmsman	Autopilot	Track pilot or DP autopilot
Manual radar plotting	Manual ARPA acquisition	Guard zone auto ARPA acquisition
Manual manoeuvring	Joystick with heading control	DP auto-position
Paper-chart fixing	Mixed electronic and paper	Automatic GNSS, cross-referenced with radar overlay
Ballast water exchange	BWTS operated by officers	Automated BWTS



Technology and the seafarer

Why technology matters

Evidence from seafarers, and particularly younger personnel, reveals an appetite for technology. Senior officers respond well to digitisation technologies that reduce repetitive administrative tasks, improve access to compliance and regulatory information and strengthen communication with shore management and external shore-based support services, while simplifying workstreams.

> **“Generally speaking, the introduction of technology makes our lives easier.”**
>
> British chief officer, dredger, 2026

Connectivity

Connectivity enables many of the technological benefits on board, from cloud-based computing systems to the capability to widen the support structures available for workplace decisions. As well as being seen as an incentive for seafarer recruitment, connectivity is now an essential element of shipboard life, boosting seafarer wellbeing, family connection and resilience.

> **“On my previous contract on an LNG tanker, we had Starlink installed on board. Even in the middle of the Pacific Ocean, I could play World of Warcraft online with a latency of 90 ping, which was smooth enough to run dungeons, raids and player-versus-player combat without issues. Starlink really is a game changer.”**
>
> European deck officer, tanker, 2025

Increased connectivity can also bring direct healthcare benefits for seafarers. For example, enhanced connectivity has led to the rise of telemedical solutions, expanding diagnostic-based seafarer health assistance even in the middle of the world’s oceans. Since 2004, all French vessels certified for unrestricted navigation (and all French passenger vessels since 2007) have carried Telecardia devices, which enable direct transmission of electrocardiogram data to telemedical assistance services (TMAS) for faster diagnosis and treatment of cardiovascular symptoms. Empirical studies reveal that this faster relay of data improves treatment outcomes and survivability. Other remote medical assistance tools include digital stethoscopes, which transmit heart and lung sounds to shore-based clinicians, and seafarer-doctor consultations via messaging platforms such as WhatsApp or videoconferencing software.

Remote telemedical assistance also includes the use of mental health apps, online and tele-counselling and digital channels for trauma support.

While degraded or lost connectivity can occur for many reasons, both internal and external to the ship, the impact on ship operations, business activities and seafarer welfare requires investigation. Further research is also needed to understand how ships can cope during periods of degraded or lost connectivity, particularly as modern ships and new systems increasingly rely on being continuously connected. This takes us to an important question: what happens to ship business activities, ship operations and seafarer welfare when connectivity is degraded or lost?

Bridge and technical operations

In recent decades, ECDIS and integrated navigation systems have fundamentally changed bridge operations, voyage planning and situational awareness. Deck officers who lack access to ECDIS frequently view it as their top desired upgrade, while current users highlight its positive impact on workload and awareness. Risks remain, though. Overreliance on automated position fixing and alarms threatens traditional navigational skills, while rising geopolitical tensions and GNSS spoofing/jamming have exposed vulnerabilities in ECDIS resilience.

> **“ECDIS makes the work easier; without it, I would never be able to keep up with all those chart updates.”**
>
> Danish second officer, offshore support vessel, 2026

The benefits of technological advancement are not limited to the bridge. Technical crew, including electro-technical officers and engineers, have also shared how technology has had an impact on routine watchkeeping and more complex tasks.

> **“Automatic readouts and sensors give us better comparisons of machinery pressures and temperatures, alerting us when things start to fail. On complex systems, like those on this cruise ship, they also simplify watchkeeping and help us catch problems earlier.”**
>
> Mauritian third engineer, cruise ship, 2026

Career development

Technology might also create new career pathways, both at sea and ashore. Emerging roles in remote operations, data analysis, digital systems support, cybersecurity and technology management could provide opportunities for seafarers to extend their careers and transfer operational expertise into new areas of maritime employment. As operations become increasingly digital and connected, technology may be able to attract new entrants to the profession or retain experienced maritime professionals either at sea, in remote vessel operation or onshore maritime technological roles.

Digital familiarisation

Several companies and maritime educational establishments have started to roll out virtual reality (VR) familiarisation programmes that enable new seafarers to virtually ‘walk



through' the vessel, learn its layout (especially important on the bridge and in the engine room) and locate safety equipment and escape routes prior to embarkation. Such familiarisation is especially valuable for trainees yet to join their first ship and in the case of series-built vessels, where a single VR environment can prepare crew for multiple sister vessels. Studies have proven that VR familiarisation is as effective as traditional methods. VR can also be used for crew transfer training, requiring only a headset and motion controllers to practise correct techniques on board before making the actual physical transfer. Additionally, VR is increasingly used in shore-based safety training for higher-risk operations, such as survival and rescue craft launching.

Software packages have become increasingly vital to onboard operations, even though they commonly receive little focus in maritime academy training and lack standardised design. Some companies have introduced familiarisation tutorials, with accompanying records, to ensure crew are fully cognisant with operationally critical features.

Standardisation of equipment also aids familiarisation for seafarers moving between vessels and fleets. Open-source design standards are increasingly being developed for incorporation into system design, building on earlier work such as the 'Guidelines for the Standardization of User Interface Design for Navigation Equipment' (IMO, 2019), commonly known as S-Mode Guidelines, with encouraging signs that standardisation is starting to become more widespread in places.

Computer vision and robotics

Computer vision shows promise in a variety of real-world use cases for improved accuracy and safety, and for limiting seafarer exposure to hazardous environments. Computer vision applications are not restricted to high-end hardware. For example, a seafarer can use a free smartphone app or a shipboard camera to record a short video of a vessel's draught and upload it to obtain accurate readings via computer vision, even in rough seas or when the draught marks are obscured by algae or corrosion. This can also improve accuracy while reducing risk, especially when combined with remote options – for instance, lowering a camera down the side of the hull instead of leaning over the bulwark.

Surveys using unmanned aerial vehicles fitted with AI-powered cameras have started to be accepted by Classification Societies for inspecting shipboard areas such as tanks, cargo holds and other confined or hazardous onboard spaces without putting seafarers or surveyors at risk. Meanwhile, object detection and advances in deep learning have given rise to various solutions for automated man overboard (MOB) detection, especially on passenger ships and offshore units. These MOB detection systems can be integrated with other data, such as from GNSS and AIS feeds.

Despite the potential for safety and operational benefits offered by emerging technologies, the key lesson emerging across all evidence streams is that positive outcomes depend not just on the specifics of the technology used but especially on how it is implemented, supported and integrated into daily operations on board.



Why the seafarer matters

Maritime technology designed for safety should be designed with seafarers involved in the concept, design, testing and validation stages. The STEER Project begins from the conviction that the lived experience of those who operate ships is essential evidence for understanding and delivering optimum technology design and implementation.

Listening to seafarers is vital to understanding how technology impacts work and life at sea. Preferences differ widely between individuals. The purpose is to understand what seafarers need to work safely, effectively and sustainably throughout their careers.

Research from psychology, human factors, occupational health and safety science provides a strong evidence base regarding how people make decisions, manage workload, respond to stress and maintain performance. Seafarers contribute the operational reality against which this knowledge can be tested and applied. Their lived experience helps ensure that technology is aligned not only with technical requirements but with the realities of human capability and limitation at sea.

Many of these disciplines have developed through research conducted in other safety-critical sectors, including aviation, nuclear energy, rail transportation and process industries. The lessons learned from these environments continue to inform how emerging technologies are assessed, implemented and managed within maritime operations.

Manufacturers, owners, classification societies and regulators all shape the technology of the modern ship, in terms of what is fitted and how it is used. Only the people who live and work with that technology can truly understand its impact. Publicly shared discourse from seafarers, as well as industry analysis, returns repeatedly to the same theme: technology should support, not replace, their judgement.

Academic literature primarily explains how technology should function under controlled conditions; industry reports show how technology can deliver organisational value; but seafarer accounts reveal how technology works in practice. All three aspects of shipboard technology are vital for safe and efficient maritime operations and to effectively mitigate risk.

“If we are serious about making AI work for mariners, let us start by consulting those on the front lines: the seafarers. What challenges do they face? What tools would truly help them?”

Australian maritime pilot, 2025

From the initial responses to the project, a clear and uncomfortable pattern has begun to emerge. Seafarers frequently feel that technology has not been designed with real use cases in mind and that a gap has opened between practical operational realities and the assumptions of those who design equipment for vessels. A seafarer-centred approach matters because technology must work for the people who use it in real shipboard environments throughout a vessel’s operational life. This approach is essential for reducing human error and mitigating impacts from human–machine interaction. In addition, changes to technology, including new functionalities, must also be appropriately communicated during development and implementation stages.

“Are we looking at the possibility that automation and AI will replace seafarers’ jobs in the near future?”

Filipino navigating officer, 2026

Seafarers are not immune to anxiety about the future. Across all departments, ranks and vessel types, they are asking how their roles and workloads will change, what skills they will need and whether their jobs will even survive.

“How does a seafarer, who spends most of the time sailing, keep up with these technological advancements? Will companies create courses or train people in them?”

Indian third officer, tanker, 2026

Seafarer feedback consistently highlights the lived human experience far more than the existing literature, particularly regarding rest, family contact, support networks and equipment familiarisation struggles. While the literature frequently addresses skill requirements, less focus is put on seafarers’ concerns about technology’s impact on their career prospects.

“Technology should not replace seafarers. It should amplify their experience.”

Indian navigating officer, tanker, 2026



The STEER Project

2.5
year project

5
research focus areas

1
constant: the seafarer's lived experiences

Led by The Nautical Institute and funded by Lloyd's Register Foundation, the STEER Project essentially asks: what does technology transformation truly mean for the seafarers at its centre?

This initial report marks the completion of the foundational phase of the STEER Project, summarising the current state of knowledge and highlighting what the evidence shows and where it falls short. The report is built around five research focus areas for these strengths and gaps, and forthcoming project phases will add to a wide, representative and inclusive evidence base.

During the development of this report, the research team has carefully defined the scope of two key concepts: 'seafarers' and 'technology'.

Seafarers

The project's focus is on seafarers who form part of a vessel's operational crew and hold safety and emergency responsibilities. This group includes all deck, engineering and catering personnel as well as those in specialist roles (e.g., onboard medical and security teams) across all commercial or charitable vessel types, including yachts, fishing vessels, small craft and remotely operated vessels.

While our focus is on serving seafarers, former seafarers who retain direct operational involvement and hold valid seagoing certificates have also been included, due to their relevant expertise.

Technology

We have kept the definition of 'technology' broad to ensure our research captures the widest range of impacts. The project recognises technology as including information technology

(IT), operational technology (OT) and off-watch technologies such as personal electronic devices.

In a maritime context, IT covers onboard computers and software used to store, process and transmit information. This includes administrative systems (such as planned maintenance and crew management software), the ship's email and cloud tools and the connectivity that supports them.

OT refers to the hardware, software and sensors that directly monitor, control and automate physical ship systems. This ranges from navigation systems such as ECDIS and radar through to machinery control and cargo systems, whether operated on board or remotely from a shore-based centre.

Off-watch technologies are a relatively recent yet significant development. While this technology type was typically limited to a mess room stereo and television set, seafarers now commonly bring on board personal electronic devices, including phones, tablets, gaming consoles, laptops and wearables.

The convergence of IT and OT has enabled remote monitoring, data-driven decision making and enhanced operational efficiency, but has also introduced cybersecurity vulnerabilities and potential impacts to seafarer mental health. The STEER project focuses on technologies primarily through their impact on seafarers' working practices and wellbeing.

> **"Internet on board is no longer a luxury but a force that transforms a vessel into a floating office with 24/7 work time."**
>
> Ukrainian Master, Pure Car and Truck Carrier, 2026

That said, not all vessels are high-tech, and some seafarers still lack access to reliable internet connectivity at sea. Our research considers both connected and unconnected vessels.

Evidence-gathering methodology

General methodology

The first phase of the STEER Project adopted a mixed-methods research approach, comprising four key evidence streams:

Academic findings
105 academic papers
2000-2026

Industry reports review
55 publications
2015-2026

Casualty reports analysis
471 reports
15 deep-dive accidents analysis
2005-2025

Seafarer feedback
13 interviews
7 ship visits (24 seafarers)
5 workshops (114 stakeholders)
2 webinars
68 survey responses
Social media analysis

Phase 1 **Evidence Foundation**	Phase 2 **Global Seafarer and Stakeholder Engagement**	Phase 3 **Co-Creation and Validation**	Phase 4 **Dissemination and Industry Influence**
• Literature review • Social media review • Accident and casualty review • Knowledge gap identification	• Workshops • Interviews • Vessel visits	• Practical tools • Guidance • Recommendations • Validation through groups established by The Nautical Institute	• Publications • Webinars and briefings • IMO dialogue • Final report
Foundation phase output Knowledge gap identification Determination of focus areas for engagement	**Engagement phase output** Stakeholder engagement providing validated lived-experience evidence	**Development phase output** Seafarer-centred toolkit and recommendations	**Industry impact** Behavioural change that improves safe use of technology

Academic literature

A systematic literature review was completed April–May 2026, following an approach aligned with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which provides guidance on how to report a systematic review, the methods used and results found. Supported by an academic librarian, reviewers used 'Covidence' software to manage the review process and conducted an initial search across multiple scientific databases, including Scopus, Web of Science, PsycINFO, Dissertations & Theses Citation Index (ProQuest), IEEE Xplore and Google Scholar.

The search was limited to English-language publications published between 2000–26. A total of 5,927 records were identified through database searching and were then whittled down to a final sample of 105 studies. Figure 1 details how this process was managed.

Eligible studies included those involving participants or crew members that reported human-factor outcomes, such as safety, workload, cognitive load, situational awareness, decision making, skills, behaviour, fatigue, stress or wellbeing. Both empirical and review studies were considered. Studies were excluded if they: focused solely on technical or engineering development without human or operational impacts; operated fully autonomously, without human-in-loop control or monitoring; addressed only ports or logistics; were conducted outside the maritime sector; or consisted of opinion pieces.

Whilst the project focuses on maritime operations, the literature review also considered insights from other safety-critical, highly automated sectors, including aviation, rail, nuclear energy, mining and process industries, all of which have accumulated experience over decades of technological transition. Areas of significant overlap with maritime include impacts in human

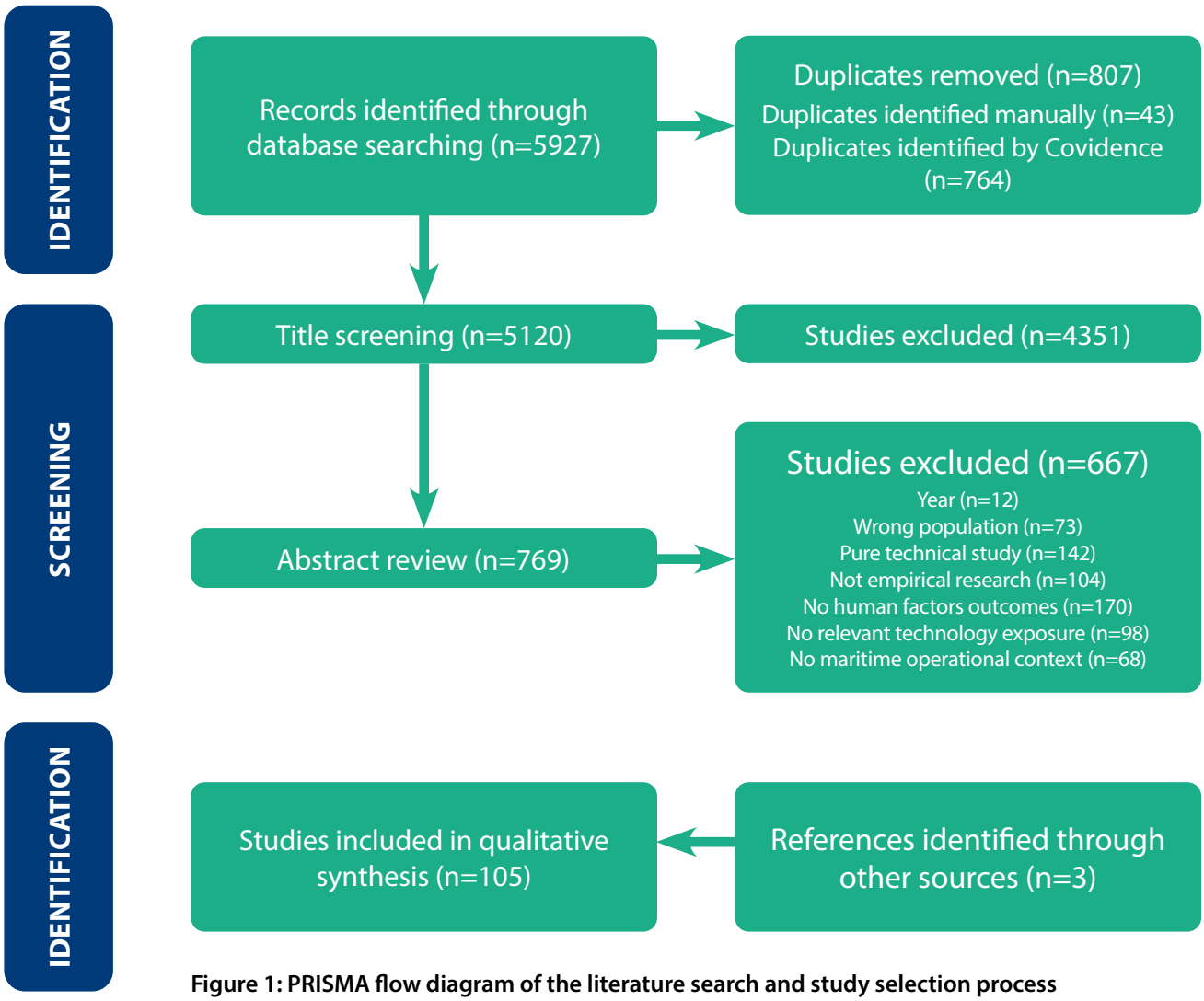


Figure 1: PRISMA flow diagram of the literature search and study selection process

oversight, situational awareness, workload management and the changing skills requirements of those in the affected sectors. This evolution has, as with shipboard technology, been influenced heavily by increased levels of automation, system design and digitalisation. Where relevant, these insights provide useful context for understanding both the opportunities and potential unintended consequences of maritime digitalisation. Studies examining future autonomous shipping have similarly drawn on evidence from these sectors to address gaps in the maritime evidence base and to identify approaches that may support safe human–technology integration.



Industry literature

The industry literature review compensates for academic publication bias and captures the discourse, priorities and concerns of the key maritime policymakers and governance bodies. Drawing on larger samples of seafarers and ships, these reports offer practical insights beyond theoretical academic literature.

Reports by classification societies, welfare organisations, trade unions, professional organisations and maritime regulatory bodies were assessed (the full list is provided in Appendix 3). Academic and industry literature were analysed using the project's customised thematic framework, which was developed through initial literature reviews and stakeholder consultations and then refined by the seven-person STEER Project team at a dedicated workshop.

The STEER partners evaluated a wide range of key focus areas in their research, including human-centred design and ergonomics, situational awareness, digital fluency and human-machine interaction. An overview of the primary focus areas is provided at the beginning of the report.



Casualty investigation reports

The STEER Project commissioned a report entitled *Technology-Related Factors in Maritime Safety Incidents*, which examines maritime accident and incident evidence in which onboard technology was deemed a significant causal or contributory factor. The casualty review process combined quantitative analysis of maritime accident data with qualitative case study analysis.

In 2022, Stroeve et al. established SHIELD (Safety Human Incident and Error Learning Database), which compiles hundreds of accident investigation reports published since 2005 by the Maritime Human Factors Centre (MHFC) accident database at the University of Strathclyde. The reports were analysed using a human-factor taxonomy that classifies incidents using a four-level scale to distinguish between causal and contributory factors (Stroeve et al. 2023). The first level is the front line, where human acts directly contribute to a safety occurrence; the next layer comprises preconditions that affect human performance; the third layer is operational, involving decisions or policies that affect practices or conditions; and the final layer describes the effect of decisions, policies or methods adopted at an organisational level.

Evidence was drawn from accident investigation reports published by various national maritime authorities, including the UK's Marine Accident Investigation Branch, the US National Transportation Safety Board, the Norwegian Safety Investigation Authority, the Danish Maritime Accident Investigation Board, the Japan Transport Safety Board and the US Coast Guard. This evidence was supplemented by confidential safety reports from the Confidential Human Factors Incident Reporting Programme (CHIRP Maritime), The Nautical Institute's Mariners' Alerting and Reporting Scheme (MARS), the IMO Global Integrated Shipping Information System (GISIS) database and other accident investigation websites.

Out of the 203 cases, 15 representative cases were selected for further analysis, 13 of which included onboard technology as a significant causal or contributory factor.

Name of ship / case	Result / outcome
CFL Performer	Grounded on Haisborough Sands, UK. No fatalities and no pollution. ECDIS training and configuration failures were major factors.
Kaami	Grounded on rocks near the Isle of Skye, UK. Constructive total loss, no fatalities. ECDIS alarms and safety functions were not effective.
Scot Carrier / Karin Høj	Fatal collision in the Baltic Sea. *Karin Høj* capsized and was lost; two fatalities. Safety alarms and BNWAS were disabled.
Viking Sky	Loss of propulsion and near-grounding off Norway. 479 people evacuated and serious injuries reported. Alarm overload affected emergency response.
USS *John S. McCain / Alnic MC*	Collision in the Singapore Strait. 10 fatalities, 48 injuries, and major damage. Touchscreen steering/control design and training failures contributed.
Red Falcon / Greylag	Collision with moored yacht and grounding in Cowes Harbour, UK. *Greylag* was a total loss, no fatalities. Technology fixation and poor bridge layout were key issues.
El Faro	Sank in Hurricane Joaquin. 33 fatalities and vessel total loss. Weather-routing software limitations and poor decision making contributed.
BBC Marmara	Grounded near Eilean Trodday, UK. Substantial hull damage, no fatalities. BNWAS was disabled and passage monitoring failed.
HNoMS *Helge Ingstad / Sola TS*	Collision outside Sture Terminal, Norway. Frigate total loss and pollution. Radar/ARPA and AIS/VTS detection layers failed.
Priscilla	Grounded on Pentland Skerries, UK. Substantial hull damage, no fatalities. Mobile phone distraction, ECDIS non-use and disabled BNWAS contributed.
Sapphire Stone / Karen	Fatal collision in the Humber River, UK. Fishing vessel sank; single fatality. Over-reliance on AIS and lack of active radar monitoring were key factors.
Wakashio	Grounded on Pointe d'Esny reef, Mauritius. Vessel broke in two and caused major oil pollution. Mobile phone use, coastal deviation and poor ECDIS monitoring contributed.
Ever Forward	Grounded in Chesapeake Bay, USA. No fatalities; vessel remained aground for 35 days. Pilot mobile phone distraction, PPU reliance and weak bridge assertiveness contributed.
MARS 202601	Near-miss in fog. Collision avoided; vessels passed at approximately 7 metres. Radar use by Ship B acted as the last effective safety barrier.
Maersk Elba	Engine-room fire managed without fatalities. Early fire detection and effective bridge-engineering response helped control the emergency.

Seafarer feedback

The seafarer feedback component combined six complementary sources of evidence to explore their experiences, perceptions and lived experiences relating to emerging technologies.

Thirteen semi-structured interviews were conducted February–June 2026, comprising face-to-face, remote and telephone interviews and including Masters, chief mates, second mates, chief engineers, third engineers, workboat skippers and a bosun. The interviewees represented a broad range of nationalities and were drawn from various vessel types, including platform supply vessels, crew transfer vessels, buoy tenders, dredgers, cruise ships and offshore support vessels (OSVs).

Seven ship visits were conducted across the UK, Denmark, Ireland, Angola and Togo, covering ferries, harbour tugs, OSVs and buoy tenders. The visits included 24 interactions with seafarers representing 13 nationalities, spanning various departments, ranks and levels of experience. Researchers spent up to five days on board (including sea time on three vessels), observing how seafarers interacted with systems and software.

Five workshops engaged 114 participants: 77 superyacht crew, 13 experienced cadets, eight pre-sea cadets, five officers of the watch (deck) and 11 representatives from the Greek maritime community, including maritime academies and industry stakeholders.

Two international webinars analysed the impact of technology on seafarers, with an emphasis on voyage planning and bridge resource management. The webinars engaged more than 500 maritime professionals across 58 countries.

An online survey captured seafarers' perceptions and experiences of emerging technologies, using closed and open-ended questions to gather quantitative and qualitative data. In total, 68 people responded.

A social media listening exercise reviewed approximately 60 public posts and discussion threads on LinkedIn, Reddit and Facebook. Using inductive thematic coding, the analysis identified recurring themes in seafarers' conversations about technology; discussions concerning welfare and safety were most prominent.



Interviews

13
interviews conducted with all ranks



Ship visits

24 interactions
with seafarers

13
nationalities represented



Webinars

500
maritime professionals engaged

58
countries



Surveys

68 people
responded to an online survey



Workshops

114 participants

77
superyacht crew

13
experienced cadets

8
pre-sea cadets

5
officers of the watch



Social media

60 posts
reviewed



The evidence

What we have learned so far

Technology is transforming seafaring across the ecosystem of ship operations, from the bridge to the engine room, from the crane cab to the cargo holds, and even into messrooms and cabins during off-watch hours. This report explores what technological transformation means for the global seafaring population.

One key finding has emerged: technology does not operate in isolation. Effects on safety, performance, skills and wellbeing depends on how that technology is designed, introduced, supported and maintained.

Automation, digitisation, connectivity, AI and continuous monitoring are reshaping operational duties, but this change is uneven. These technologies typically advance the fastest aboard new vessels and in high-margin trades but reach many of the global fleet's seafarers more slowly and unequally. How this technology is selected and implemented determines its impact on safety and risk. The same tools can reduce workload and improve wellbeing on one vessel but have the opposite effect on another.

> **"Technology that supports decision making and reduces cognitive overload is not optional anymore – it's essential for safety, retention and long-term performance."**
>
> Senegalese Master, workboat, 2026

Even when technology reduces workloads, seafarers often view it as a 'double-edged sword' that can prompt or precede manning cuts. Consequently, technology is frequently perceived as a means of replacing rather than assisting crew, leaving remaining seafarers with increased workloads even when systems are well-designed.

> **"Let's stop this minimum manning certificate and have a minimum tech certificate instead. No amount of technology can really make up for person who is being replaced; it only increases the workload for the remaining people on board."**
>
> Indian pilot, 2026

	Safety and operational risk	Skills and competence	Workload and manning	Welfare and wellbeing	Inequality and inclusion
Academic findings	• Poor interface design impairs situational awareness and emergency intervention. • Mismanaged technology undermines safety and increases rather than reduces risk.	• Technology adoption relies on effective training and familiarisation. • Growing automation heightens the risk of skill degradation.	• Automation can shift work behaviours from routine execution into high-stress monitoring and intervention. • Workload and fatigue stem from manning levels and admin, not just technology. • Poorly connected software forces crew to act as manual bridges, raising error risk.	• Reliable connectivity boosts wellbeing by enabling seafarers to maintain social support networks at sea. • Continuous availability risks blurring boundaries between duty and rest. • Constant access to shore life can bring onshore stressors (family, finances) and harmful cyber practices (gambling, harassment) into rest hours.	• Benefits and burdens are unevenly distributed across the workforce. • Seafarers can face high personal and financial costs to stay competent.
Industry findings	• Technology should find the 'sweet spot' across safety, performance and job satisfaction. • Safety is a function of technology quality, relevance and resilience. • Technology alone has limited ability to reduce human error, which requires complex tools to redistribute rather than eliminate risk.	• Equipment refresher training and familiarisation are essential, if not always accessible. • Formal maritime education struggles to keep pace with technology. • Seafaring now demands analytical thinking, problem solving and digital literacy.	• Crews are forced to manually link incompatible systems rather than focusing on core duties. • The 'efficiency paradox' shows that cutting crew sizes alongside increased tech adoption can negate expected efficiency gains.	• Internet access is no longer seen as a fringe benefit but as a vital welfare necessity driving job choice and improving retention rates in organisations and the seagoing workforce. • Digitisation introduces new harms, including intrusive surveillance that blurs the lines between work and private life.	• Transformation focuses on supply, retention and skills, often leaving equality unaddressed. • Roles requiring higher or more specialised qualifications benefit from the demand for digital, analytical and advanced technical skills which can be impacted by inequalities. • Less-qualified seafarers are vulnerable to automation and restructuring of crew complements.
Casualty evidence	• Critical gaps exist between equipment design and real-world use. • Smaller vessel sectors can have less training and operational support frameworks to manage new digital risks effectively. • The industry lacks mechanisms to capture seafarers' practical, safety-relevant insights.	• More casualties stem from misused systems and ignored alarms than from broken hardware. • Type-specific practice and realistic simulations beat generic familiarisation training. • Distractions such as mobile phones require clear operational boundaries.	• Alert spikes during emergencies make fault diagnosis nearly impossible with standard operational manning. • Crew levels must be reevaluated across normal, degraded and emergency states.	• Investigating incidents solely through published casualty reports can obscure the human reality. • Accident reports usually omit psychological factors such as fatigue, isolation, family pressure and anxiety. • Stress and poor system design quietly degrade seafarers' decision making.	• Feelings of group exclusion impact morale and team cohesion, weakening onboard safety. • Reduced opportunities for career development could add barriers for safety-conscious seafarers from excelling or speaking up with concerns.
Seafarer feedback	• Seafarers are not anti-technology; they dislike unintuitive and poorly supported systems. • Poor integration and inconsistent interfaces create constant practical barriers for crew. • Automation bias, distraction and system unreliability make it harder to maintain a clear operational picture.	• Seafarers often favour simulator-based, vessel-specific training over generic compliance exercises. • Concerns centre on rushed handovers of unfamiliar systems and the erosion of core seafaring skills.	• Digital tools can add reporting layers rather than reducing administrative burdens. • Lack of platform integration can create duplicate work and requires regular troubleshooting. • Bureaucracy distracts from core maritime tasks and blurs work–rest boundaries..	• Digital access and shrinking crews risk replacing shipboard camaraderie with screen-based loneliness. • Technostress and cyberbullying can affect seafarers' mental health.	• Competence expectations are surging without consistent support for equitable training and upskilling opportunities. • Requirements to self-fund professional development restricts career growth into more specialised or technologically advanced roles. • Shore-based/remote operations raise concerns about future job access for today's seafarers.

The evidence in detail

Across literature, seafarer discourse, seafarer engagement and in casualty investigation reports, recurring themes consistently emerged:

- safety and operational risk;
- skills and competence;
- workload and manning;
- welfare and wellbeing; and
- inequality and inclusion.

These themes are presented separately but, in practice, none exist in isolation.



Safety and operational risk

What the evidence says

Safety impacts dominate existing maritime technology research. Safety benefits, however, are neither automatic nor guaranteed, depending heavily on system design quality, implementation, training and organisational context. The evidence promotes safety as an outcome of effective human–technology collaboration, where technology helps to find the 'sweet spot' across safety, performance and crew satisfaction. Seafarer feedback confirms that much of their frustration is directed at difficult, poorly supported or ill-adapted systems rather than at technology itself.

Academic literature presents maritime safety as a socio-technical outcome shaped by the interplay between technology, organisational systems and human capability. Industry reports further acknowledge that technology frequently redistributes risk rather than eliminating it entirely, particularly where alarm systems, decision-support tools or complex digital environments create new operational vulnerabilities.

Distraction is also widely acknowledged in industry literature. For instance, *Transport 2040: Automation, Technology, Employment – The Future of Work* (World Maritime University, 2019) stated that15% of respondents reported distractions as an issue, while a further 10% indicated that distractions had contributed to some form of work-related accident.

Mobile phone and personal device-related incidents show that seafarers' social needs can contribute to accidents. The 2020 Wakashio grounding is a prime example: the passage was altered without suitable detailed charts and that the master and chief officer continued towards shoal water with attention drawn to smartphone transmission. Social uses of technology cannot be treated in isolation from safety at sea. Effective responses should avoid total prohibition and instead focus on clear procedures for critical operations, structured access to connectivity, distraction/attention training and SMS policies that address personal device use.

Complementing these perspectives, five safety-related themes emerged consistently from the casualty evidence reviewed (see Table , page 24). Technology is frequently designed and approved for safety purposes yet not always used, configured

Theme	Principal sub-patterns	Representative cases
Electronic navigation system failures	(i) alarm configuration failure; (ii) training and familiarisation deficiency; (iii) over-reliance and loss of cross-checking	*CFL Performer, Kaami, BBC Marmara, Priscilla, Wakashio, Sapphire Stone / Karen*
Alarm management breakdown	(i) deliberate deactivation in response to nuisance;(ii) inadequate alarm system design	*Scot Carrier, BBC Marmara, Ruyter, Viking Sky, Maersk Elba* (alarms had a positive impact)
Personal and consumer device distraction	(i) personal engagement (social, recreational); (ii) work engagement (bridge admin, computer-based tasks)	*Priscilla, Scot Carrier, Wakashio, Ever Forward, Seagate / Timor Stream, Seatruck Progress*
Automation bias and loss of manual skill	(i) excessive confidence in automated outputs; (ii) loss of manual skill under sustained automation	*Royal Majesty, El Faro, Golden Ray, USS John S. McCain, Savannah Express, Aurora Explorer*
Intersectional and connected system risks	(i) alarm-cascade cognitive overload; (ii) cross-system dependency cascades	*Helge Ingstad / Sola TS, CMA CGM Florida / Chou Shan, Queen Mary 2*, CHIRP M2692

The five key safety-related themes extracted from the casualty evidence when the project assessed safety and operational risk

or monitored as intended in practice. Officers and crew often hold only generic certification and tend to lack type-specific familiarisation for the actual onboard equipment.

Frequent, unclear or nuisance alarms can prompt operators to silence, disable or ignore these systems, weakening their effectiveness as safety barriers. Standard ISM, flag or port state and other audit and inspection processes typically confirm that equipment is present but rarely verify its effective operational use. Smaller vessel sectors (such as fishing vessels, survey vessels, tugs, coastal cargo vessels and crew transfer vessels) face comparable technology risks yet receive far less regulatory, training and operational support than do larger commercial ships.

Most problematically, there is no routine mechanism for feeding seafarers' practical experience back into design, training, procedures and regulation, while formal investigations focus mainly on failures, disregarding successful preventive uses of technology and the lessons learned.

Evidence gaps

Important gaps remain regarding the long-term effects of automation on operator vigilance, the cumulative impact of alarm-rich environments and the resilience of highly connected systems during failures, cyber incidents or degraded operating conditions. Most industry evidence focuses on expected outcomes, with little evidence yet to confirm actual safety improvements.

Additionally, negligent or careless behaviours should be distinguished from distractions stemming from poorly designed, unintuitive technology or personal stressors.

Key takeaway

Technology does not remove risk but changes where it resides and how it must be managed.



Skills and competence

What the evidence says

Accident investigation outcomes show that technology-related casualties are rarely the result of equipment failure alone. In many cases, the equipment was available and functional but personnel either showed over-reliance on a single system, lacked the competence to use systems correctly, failed to identify when errors affected system output or failed to apply required safeguards or barriers within operational technology systems.

ECDIS usage, for instance, shows repeated instances of functions not being used, alarms being disabled or ignored, automated systems being trusted without sufficient cross-checking and bridge teams failing to intervene effectively when situations degrade. This points to a competence gap, not only in operating individual systems but in understanding how technology changes the watchkeeper's role. Incorrect decisions at the sharp end often stem from wider organisational conditions, including poor training and supervision, inadequate procedures and ineffective audits.

Across all evidence streams, there is strong agreement that competence remains central to safe ship operations regardless of technological sophistication. Literature consistently shows that successful adoption of autonomous systems, digital tools, cybersecurity and AI depends heavily on training, familiarisation and competence. Yet a growing gap exists between rapid technological development and formal maritime education. Equipment-specific familiarisation and refresher training are repeatedly cited as the most requested but least available forms of instruction.

Concerns are also emerging regarding skill degradation and reduced opportunities to practice manual competencies. There is limited evidence on how technology affects long-term skill retention, how effective e-learning is, and what skills will be needed as operations become more automated. Training must move beyond generic compliance to include type-specific system use adapted for real-life operations.

Evidence gaps

Limited evidence exists on how technological change affects long-term skill retention, particularly where automation reduces opportunities to practise manual or fallback competencies and in identifying erroneous outputs. Further research is also needed to establish which approaches to training, familiarisation and ongoing support are most

effective in practice for seafarers, including the effectiveness of e-learning and how competency requirements will evolve as automated and digital operations increase.

Key takeaway

The challenge is not simply adopting new technology but making sure people develop the skills to use it effectively.

“One of the key challenges lies in balancing technological innovation with human factors. Seafarers must not only adapt to new systems but also maintain situational awareness, decision-making authority and confidence in increasingly automated environments.”

Filipino Master, Cable Lay Vessel, 2026



Workload and manning

What the evidence says

Maritime technology solutions are intended to boost efficiency and streamline processes, but seafarers’ experiences can vary wildly.

Improved tracking, electronic navigation systems and portable pilot units have enabled pilots to handle larger ships in the same ports, approaches and channels; while incurring less risk, dynamic positioning enables vessels to conduct complex offshore operations with a level of precision and control that would otherwise be unachievable. Technology has not simply reduced workload risk and increased precision, however. In many cases, technology has enabled the industry to ask seafarers to do more, manage more information and take on tasks requiring higher levels of monitoring, verification and system understanding.

There is broad agreement across all evidence streams that workload outcomes are shaped less by individual technologies than by how technologies are integrated into wider operational systems. When systems are well-designed, effectively integrated and supported by appropriate manning levels, technology reduces burden. Yet, when systems are fragmented, poorly integrated or introduced primarily as a cost-reduction measure, technology might increase workload and create new operational pressures.

Research consistently demonstrates that technological change often redistributes rather than eliminates work. A recurring finding is the automation paradox in which as systems become more capable, routine tasks are reduced but the remaining tasks become more cognitively demanding, causing increased mental workload. Cognitive overload occurs when a person’s brain is given more information that it can process at once, causing mental fatigue, reduced focus, greater likelihood of error and increased frustration.

Many senior-ranked seafarers describe spending increasing amounts of time responding to digital communication from shore management, commercial entities and operational stakeholders. Officers of all ranks report a significant number of duties requiring interfacing with multiple digital platforms to maintain regulatory and organisational compliance. They frequently express frustration at having to transfer information between systems, deal with slow cloud-based applications, manage software failures or troubleshoot systems during already demanding operational periods. The administrative burden associated with digitisation mirrors concerns about workload-related stress, reduced job satisfaction and diminished opportunities to focus on core seafaring tasks. Some seafarers express sentiments that they spend more time managing computers than operating vessels.

In emergency situations, technology transforms workload into high-stress alarm management and system diagnosis. During the 2019 *Viking Sky* blackout, for example, the cruise ship’s engineering team faced approximately 1,000 alarms in the integrated automation system in the 10 seconds after blackout, making fault diagnosis extremely difficult. New technology must be assessed for the real operational workload it creates, highlighting the efficiency paradox: automation can reduce crew numbers but also increases the responsibility and cognitive load carried by those who remain on board.

Evidence gaps

Existing research provides limited insight into the cumulative effects of system monitoring, digital administration and information management on long-term performance, wellbeing and safety outcomes. There is also limited evidence regarding how different manning models interact with technological complexity, and whether workload reductions achieved through automation are sustained over time.

Key takeaway

Technology can reduce workload but only when design and implementation focus on reducing operational burden rather than simply increasing efficiency. Without careful attention to integration, manning and administrative demands, digitisation risks replacing physical workload with cognitive and administrative overload.



Welfare and wellbeing

What the evidence says

Across all evidence streams, access to family, friends and support networks is viewed as essential for morale, resilience and mental health, making internet access a major factor in recruitment and retention. Many seafarers describe connectivity as a lifeline and a right rather than a luxury.

At the same time, the evidence demonstrates that wellbeing outcomes cannot be evaluated solely through access to technology. The same technologies that support welfare may also contribute to challenging seafarer wellbeing. Constant access to shore life introduces new stressors, as seafarers experience anxiety over family or financial problems that they cannot influence while at sea.

Connectivity also impacts onboard cohesion. While strengthening relationships with those ashore, such connectivity cannot replace social relationships on board. Shrinking crew sizes and increased screen-based activities can contribute to loneliness, reduced social interaction and accelerate feelings of isolation.

Furthermore, living at the workplace means technology blurs the boundary between work and personal life, creating the perception that crew should always be contactable and making ships feel like extensions of shore offices. Some seafarers frequently refer to increasing levels of monitoring and express concerns that pervasive digital systems, including CCTV, cloud-based data collection and communication platforms, create a sense that 'the office knows everything'. Because work and private life occur in the same physical space, this degree of surveillance and privacy erosion could be seen as less acceptable in shore-based workplaces.

The combined evidence streams point to the need to prioritise identification of potential welfare and wellbeing factors in accident investigations. Fatigue, isolation, family pressure and anxiety quietly impair attention, decision making and the confidence to challenge unsafe acts. Accident investigations typically focus on immediate technical and procedural failures, failing to capture the everyday conditions in which seafarers manage emotional pressures.

Evidence gaps

Gaps remain regarding the long-term effects of constant connectivity on recovery, rest and mental wellbeing. Limited evidence exists on the scale and impact of cyberbullying, online harassment, social media addiction, work–life boundary erosion and digital surveillance at sea. Similarly, relatively little is known about how monitoring technologies influence trust, reporting culture, autonomy and relationships between ship and shore personnel. These topics will form part of the focus area for ongoing research with seafarers in the next phase of the STEER Project.

Key takeaway

While connectivity and digital technologies can significantly improve wellbeing, their benefits are not automatic. Positive outcomes depend on balancing access, support, privacy, autonomy and protection of the boundaries between work and personal life.

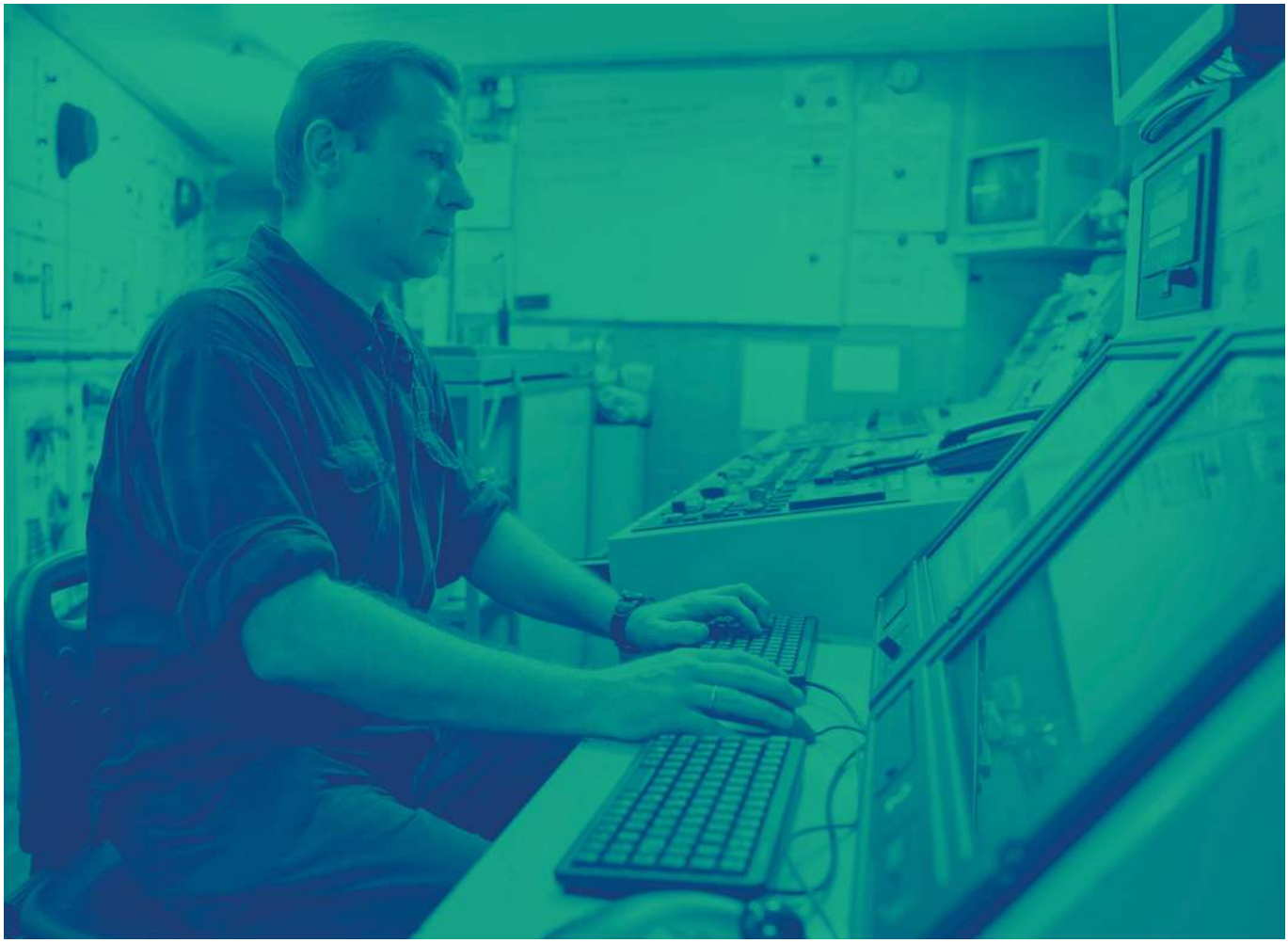


Inequality and inclusion

What the evidence says

A clear picture is emerging that access to technological advancements, plus associated training and career opportunities, is not experienced equally across the maritime workforce. The benefits of technological innovation are unevenly distributed, with some groups carrying a disproportionate share of the associated costs and adaptation burdens.

Access to connectivity is far from universal. Questions also remain regarding how evolving technologies impact different seafarer groups, with significant underrepresentation in current literature of those from Africa and the 'Global South'.



Both the literature and seafarer feedback highlight concerns over training affordability, unequal access to technology-specific familiarisation and the burden of continuous upskilling. These challenges disproportionately affect seafarers without stable employment, as well as those working for smaller companies with limited resources. Many seafarers worry that competence development expectations are rising while institutional support for training remains lacking and inconsistent. Academic research also raises questions about the future distribution of maritime work, particularly as automation shifts traditional seagoing roles ashore.

Industry discourse focuses more on workforce supply, recruitment, retention and future skills than on diversity, equality and inclusion (DEI) as explicit goals. It acknowledges that higher-qualified personnel are likely to benefit from demand for advanced digital competencies, while lower-qualified seafarers may face greater vulnerability to automation.

Technology should not be viewed solely as a technical or operational issue but as a workforce issue, with implications for fairness, opportunity, employability and social sustainability.

Evidence gaps

Most existing research focuses on officers and internationally trading commercial vessels, while comparatively little attention has been given to ratings and fishing vessels, smaller tonnage such as coastal vessels and domestic/smaller fleets. Further research into these roles and sectors is required.

Issues relating to DEI remain underdeveloped in both academic and industry literature. Existing discussions focus on the potential for remote operations and technology-enabled work to improve female participation, but broader issues such as accessibility, neurodiversity, disability inclusion and technology-enabled workforce inclusion remain largely unexplored.

Key takeaway

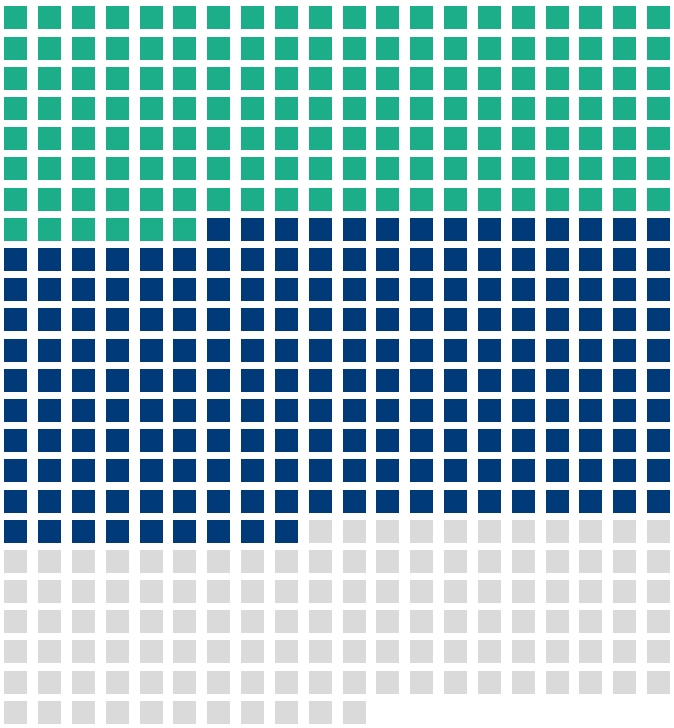
Technological change does not affect all seafarers in the same way. Its long-term success depends not only on how well new technologies work but on whether the opportunities and benefits they create are accessible across the diverse global maritime workforce.

Bringing the evidence streams together

In reviewing the evidence, three trends emerged:

1 Technology is a pathway for, not the root cause of, most casualties or harm.

Of 471 investigated cases between 2005 and 2025, 43.1% involved at least one human factor cause related to equipment and workplace conditions. In most cases, technology failure was not the source nor primary cause of the accident. Deeper weaknesses related to technology use, including inadequate training, poor procedures, weak supervision and gaps in safety management, have been involved in many maritime accidents.



471 investigated cases reviewed

- **146 of these cases were assessed with technology pre-conditions having causal or major impact**
- **203 involved at least one human factor cause**

Across the 35 cases where technology was the direct cause, safety management failures were present in 89% and inadequate resourcing in 77%. The reality is that incorrect decisions can be made not due to incompetence but because conditions for correct decision making were weakened or removed.

Technology is rarely the root cause. It is consistently the pathway through which deeper organisational failures reach operational consequence.

Technology-Related Factors in Maritime Safety Incidents: Influence Pathways, University of Strathclyde

2 Evidence is consistent and strong on well-researched topics yet sparse and fragmented elsewhere.

Academic and industry literature findings regarding established operational technologies are consistently reinforced by seafarer feedback. Nevertheless, emerging technologies, such as remote monitoring, AI-enabled systems, shipboard connectivity and shore-based command centres, remain significantly under-researched and rarely focused on seafarer use.

These research gaps serve as a guiding light for the project's focus areas moving forward. Seafarer perspectives provide vital safety intelligence on everyday workarounds, system mistrust and cognitive overload – all precursors to incidents that traditional accident investigations often miss.

> **“Research into the impact of technology on seafarers should ultimately lead to industry-wide standards that ensure technology serves the seafarer, not the other way around.”**
>
> Nigerian chief officer SDPO, offshore support vessel, 2026

3 Human impacts are under-researched yet highly discussed by seafarers.

Technical performance, system capabilities and operational efficiency are well researched but the impacts on seafarers themselves and how they interact with various technologies are not, indicating that technological development has often prioritised system performance over human experience. Seafarer testimony rarely covered technical performance; for seafarers, how technology is used is as important as its technical capabilities.

Seafarers have been telling us about impacts on their levels of workload, fatigue, stress, confidence, competence, professional autonomy and trust in systems. Many accounts have also emphasised the pressures of interacting with several

different systems, often single-handedly during a bridge or engine room watch.

“My biggest challenge is to juggle between constant alarms, loads of paperwork and proper navigational watch. You must be able to multi-task to thrive in this field.”

Indian deck officer, 2026

Human and social impacts discussed by seafarers also include privacy, social connection, isolation, the relationship between ship and shore and whether their seafaring expertise will hold value. These perspectives relate to the shifting and emerging landscape of ‘Maritime 5.0’ but have not received much prominence in the available literature. As we board the fifth industrial era (Maritime 5.0), there is hope that human factors will be at its centre, from design to integrated decision making and operation.

“Having access to technology at sea means the ship never truly leaves the office, and the seafarer never truly leaves the ship.”

Nigerian SDPO, offshore support vessel, 2026

If the maritime industry does not actively improve how it captures the effects of technology on seafarers’ work, decision making, welfare and even their identity, we risk seeing those impacts surface as retention issues and hidden safety risks. In several areas, seafarer concerns are already running ahead of the published studies.

“While automation enhances safety, it often creates a ‘cognitive gap’ where the navigator becomes a passive monitor rather than an active operator. Maintaining traditional seafaring ‘intuition’ while managing complex digital interfaces is the primary hurdle for modern bridge teams.”

Ukrainian deck officer, 2026

What remains uncertain

Most existing research focuses on bridge operations, particularly navigational watchkeeping, with noticeably less coverage of technology impacts on machinery spaces, deck cargo and support operations. Evidence of impacts is weakest for ratings and other non-officer roles, within fishing and small-vessel sectors, for seafarers from the Global South and for the everyday welfare effects of living inside an increasingly connected and monitored environment.

These gaps indicate that the existing evidence base does not fully reflect the diversity of technological impacts across the global maritime workforce. Many technology impact studies show only niche coverage of limited geographical or fleet types.

Phase two of the STEER Project, focusing on seafarer engagement, aims to address these impact knowledge gaps.

In interviews and workshops, seafarers frequently raised concerns that include disparity and lack of technology maintenance when things go wrong, though these receive little attention in academic or industry literature. Ships rely on many connected systems, but the IT and operational technology (OT) support behind them does not always seem to be given the same level of importance.

“The so-called ‘advanced’ technologies only add value as long as they function perfectly. In reality, many of these critical systems lack proper redundancy. When they fail, ships are forced to rely on remote troubleshooting by shore staff who work standard 8-to-5 hours and are often unavailable during nights, weekends or holidays. This places an additional operational burden on the crew and directly undermines safety. A 24/7 industry like shipping cannot be sustainably supported by 8-to-5 shore-based operations.”

Bangladeshi Master, container ship, 2026

The current literature favours measurable operational outcomes such as safety and automation over seafarers’ lived experiences. Psychosocial factors, including privacy, surveillance, digital harassment and DEI, remain largely underexplored, relying on small-scale exploratory studies rather than large-scale empirical evidence.



Methodologically, seafarers' input tends to be complementary to stakeholder perspectives rather than central to research design. Studies are predominantly steered by surveys rather than qualitative focus groups, observations and interviews.

A classic causality dilemma exists among stakeholders (European Maritime Safety Agency, 2024): Regulators delay standards awaiting industry initiative, while maritime education and training bodies and socially oriented organisations await regulatory mandates or lack the resources to advocate for seafarer-centred perspectives. Addressing this dilemma requires meaningful social dialogue among stakeholders.

There is also conflicting evidence regarding the level and value of training and seafarers' competence. Industry stakeholders frequently emphasise the need for additional training and often portray seafarers as 'the weakest link of the socio-technical system on board' (Baumler, 2024). Although willing, however, seafarers themselves do not generally perceive an urgent need for further training. Consequently, the question of competency and training requirements remains unresolved.

Another gap concerns the limited attention given to familiarisation and ongoing support for new technologies beyond formal training, particularly how such support can be effectively delivered within the operational realities of seafaring. Further research is also needed to better understand how the adoption of new technologies might create financial burdens or inadvertently exclude certain groups of seafarers, particularly those employed on temporary contracts or by employers with limited capacity to support upskilling and reskilling.

The impact of technology on women and other underrepresented groups on board, including neurodivergent seafarers, also remains insufficiently explored and warrants further investigation. Similarly, so does how shipping's digital and technological transformation affect career choices among younger seafarers, particularly with reference to family considerations, work–life balance, career security and opportunities for career progression.

Technology, connectivity and continuous shore-based monitoring have both positive and negative impacts on decision making on board. They can support better-informed decisions by providing access to additional information, expertise and different perspectives. They can also have negative effects in some circumstances, particularly on the independence and authority of onboard decision makers.

While most ships now need to remain connected to conduct routine business, and some operations are supported by remote monitoring systems, it remains unclear how this is affecting the decision-making process and authority on board. In particular, the impact of being continuously monitored and supported externally has not been widely discussed.



Recommendations

Initial practical recommendations

Ahead of the main research phase, evidence already points to an urgent need for clearer technology-related guidance for shipowners/managers, technology developers, regulators, maritime education and training institutions and the seafarers themselves. The common thread is that the seafarer must be designed into technological advancement and implementation instead of seafarer considerations being overlooked, dismissed or worked around. Technology implementation should also be considered holistically, considering the wider ecosystem of shipboard systems and the different needs of seafarer groups.

The following interim recommendations have already emerged from the first phase of the STEER Project:

Shipowners and ship managers

Shipowners and ship managers should consider technology implementation as a safety management responsibility.

- Trust seafarer feedback about onboard OT as critical safety intelligence to proactively manage operational risk.
- Encourage reporting technology concerns in safety meetings, vessel audits, near-miss logs and SMS reviews.
- Apply management of change processes before and after installing new technology, to assess impacts on workload, competence and procedures.
- Review SMS procedures against actual onboard usage, manufacturer guidance and best practice.
- Provide vessel-specific familiarisation for operational IT software.
- Assess whether technology has increased administration or created duplication of workflows, then streamline processes as appropriate.
- Act on early warning signs, such as workaround, system mistrust, alarm fatigue and frequent overrides, engaging manufacturers when necessary.
- As part of the management of change process, review technology applicability and use after onboarding with user input and feed findings into future implementation at fleet level.

Technology developers and manufacturers

Technology developers should treat seafarers as expert end-users and seek their input at all stages of the iterative product development cycle, through to final deployment and product upgrades.

- Test systems in realistic onboard environmental conditions, incorporating human limitations such as fatigue, unfamiliarity, time pressure and sub-optimal connectivity.
- Prioritise the human–machine interface designs that reduce cognitive workload, including alarm prioritisation and the removal of unnecessary alerts.
- Include clear guidance in operating manuals for degraded-mode operation, failure recovery and manual operation where applicable.
- Provide practical, scenario-based training and familiarisation material that is free to access and available offline or via low-bandwidth solutions.
- Establish accessible feedback loops so seafarers can contribute feedback to improve future developments and treat operator usability as a critical safety requirement.

Regulators

Regulators should ensure that maritime technology is assessed not only for technical performance, but for its human and operational impact.

- Strengthen human factors requirements in technology approval and implementation, especially addressing workload, training, usability and accountability.
- Improve consistency in capturing technology-related human factors across casualty investigations and reporting of incidents and near-misses.
- Consider the safety impact of remote monitoring and shore-based intervention.
- Ensure seafarer perspectives are included in regulatory consultation and promote a just transition for seafarers affected by automation and digitisation.
- Support guidance on safe technology change management.

MET institutions

MET institutions should prioritise the preparation of seafarers to interact with digital, automated and data-driven systems in both a critical and confident way.

- Integrate critical and robust use of technologies as an integral part of modern-day seamanship, engineering judgement and watchkeeping training.
- Integrate automation bias, over-reliance and appropriate trust in automated systems within existing technical, bridge, engine room theoretical and simulation training throughout STCW and non-STCW level maritime officer education.
- Utilise simulation for training response to situations of alarm overload, data conflict, degraded modes and equipment failure.
- Encourage students in training scenarios to challenge system outputs that conflict with professional judgement, and cover in leadership courses how to report and escalate such cases to stakeholders beyond the vessel.
- Maintain regular interactions with industry to ensure training is aligned with equipment already entering service, including emerging technologies and new system features.
- Invest in the continuous professional development of instructors and lecturers, including first-hand exposure to technology in use on board, to ensure they can keep pace with rapidly developing technologies and changing operational demands on board.

Seafarers

Seafarers should not have to compensate for, nor manage the consequences of, poorly designed, maintained or implemented technology. Their judgement, experience and feedback are central to safe technology use. Seafarers themselves have responsibilities to support their involvement in these processes.

- Report confusing interfaces, excessive alarms, unclear procedures and unsafe workarounds through proactive safety reports and near-miss reporting.
- Treat repeated overrides, nuisance alarms and operator mistrust of systems as safety indicators that require attention to prevent potential incidents.
- Share practical learning among crew, among departments and with other vessels in the fleet, using company feedback mechanisms when appropriate.
- Record instances when technology adds workload or duplicates existing tasks, using SMS processes to document issues and secure corrective action.
- Actively contribute to technology trials, surveys, consultations and feedback requests, and regularly practise manual and core professional skills alongside digital competence to minimise skills fade.
- Taken together, the findings indicate that the key challenge is not technological capability but the alignment between technology, people and organisational systems. When this alignment is achieved, technology can enhance safety, performance and wellbeing. When it is not, technology can introduce new risks, increase workload and reduce seafarer confidence.



Conclusion

Keeping seafarer experience at the centre

Human capability cannot be fully replaced by automation but can be effectively augmented by automation and advanced technologies. The central question is not whether technology brings benefits, but how it should be adopted to best support safety and seafarer wellbeing.

Evidence shows that the same technologies can either support or harm seafarers. Outcomes ultimately depend on the specifics of technology implementation: system design, operational relevance, supporting management processes and whether seafarers are properly designed into the whole process.

Also important to consider are the consequences of non-adoption. Technology cannot be considered solely in isolation around emerging technologies and the advanced systems on some vessels; the lack of technology that can make vessel operations safer and improve seafarer wellbeing must also be understood.

Seafarer input is vital at all stages, from design and operation through to system upgrades and development. The STEER Project takes a holistic approach by examining seafarers' lived experiences, best practices, casualty data and perspectives to identify what helps and what hinders.

The STEER Project acknowledges that seafarers' suggestions are not always the most appropriate and sometimes there are a variety of reasons why certain improvements cannot be fully met. Individual preferences vary widely and often reflect specific circumstances, vessel types and personal experiences. Instead, the STEER Project seeks to understand what seafarers across a variety of trades and demographics need to work safely, remain healthy and maintain sustainable maritime careers.

By combining the lived experience of seafarers with established knowledge from human factors, psychology, occupational health and safety research, the project aims to identify where technology genuinely supports human performance and wellbeing. The purpose of listening is therefore not to validate preferences but to ensure that technological transformation remains aligned with the realities of human capability, limitation and professional practice at sea.



Evidence indicates that technology often shifts rather than eliminates risk and can increase or reduce workloads depending on design and system integration. While the impacts on skills and welfare are mixed and understudied, engagement with seafarers suggests that building the technology around the seafarer makes for a safer, more accessible and healthier industry.

The STEER Project begins, and will continue, by listening to seafarers. If technology is to improve life at sea and make ships safer, then the people who operate it must be heard. That is the premise of this report, the purpose of the STEER Project phases to follow and the measure against which the project will be judged.

Biographies

Captain Ann Pletschke CMMar FNI, STEER Project Lead
Ann is a master mariner with more than 10 years of industry and command experience. In her career, she has developed safety standards and overseen autonomous ship operations, accident investigations and vessel inspections. She holds a Master's in engineering in autonomous maritime operations and a Master's in science in shipping operations. Her work combines recent operational experience at sea with research, industry engagement and practical recommendations to support safer, more seafarer-centred maritime technology design and implementation worldwide.

Captain Aly Elsayed AFNI, Senior Technical Manager, The Nautical Institute
Aly is a master mariner who spent two decades at sea aboard tankers and other vessel types. His expertise covers vessel operations, STS, shiphandling, pilotage, tug training and port simulation research; he also has 10 years' experience as a simulation instructor and consultant. Aly is currently Senior Technical Manager for The Nautical Institute, playing an integral role in the STEER Project. Previously, he led research for the OCEAN project (Operator-Centred Enhancement of Awareness in Navigation), funded by the European Union. Aly was a technical editor on *Bridge Resource Management, Volume 1: The human element* (The Nautical Institute, 2025).

Sanny Shamoun, Lead Researcher, STEER Project
Sanny holds a PhD in psychology and has extensive experience in human factors; man, technology and organisation (MTO); and occupational health, safety and applied research across high-risk industries. Within the STEER Project, Sanny led the systematic review of academic literature on seafarers, technology and human factors, synthesising current knowledge and identifying key research gaps. She has also contributed to OCEAN.

Alina Prylipko, Research Consultant, STEER Project
Alina has more than 20 years of experience in seafarer education, training and professional development. Her research focuses on seafarers' voices and stakeholder salience in the maritime sector. Within the STEER Project, Alina supported the analysis of industry reports and contributed to the research methodology and data collection strategies.

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Appendices

Appendix 1

List of seafarer engagement activities during initial research phase

Workshops:
Pre-Sea Cadets (Ireland),
Final semester OOW Deck Cadets (Ireland),
Chief Officer preparation class (Ireland),
Superyacht Crew (Middle East),
Maritime Stakeholders (Greece)

Conferences:
Maritime Week Africa (South Africa)
Seafarer Conference (Ireland)
Ethics in Maritime (UK)

Exhibitions:
Posidonia (Greece), Seawork (UK)

Research Project Meetings:
CUED (Norway), SocialShip (Norway)
OpenDesign (Norway)
Centre for Assuring Autonomy (UK)

The Nautical Institute Events:
Southern Africa Branch Conference (South Africa)
Southwest of England branch event (UK)
Human Factors Conference (UK)
Impact of Technology STEER Project Webinar (Global)
Bridge Resource Management Webinar (Global)

Delegations and Visits:
Oman,
Philippines
WMU MET specialisation students

MET Establishments Visited:
NMCI (Ireland)
East Coast College (UK)
Empire State (US Cadet Training Ship)

Surveys:
Deck MET Students
MET Lecturers
General Seafarer Survey
Dynamic Positioning Operators or Dynamic Positioning Vessel Maintainers

Appendix 2

Academic papers related to the impact of technology on seafarers

Appendix 3

Maritime industry reports and publications related to the impact of technology on seafarers



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