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Investigating Proactive Measures Towards MET Development With Respect To 4IR

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Abstract

Purpose: *The increasing technological advancement in the maritime industry imposed by the Fourth Industrial Revolution (4IR) contributes significantly to changing the nature of jobs, which according to the World Economic Forum, might lead to massive job losses owing to either redundancy or skills mismatch. Nevertheless, the maritime workforce can endure the adverse effects of this transformation by adopting proactively responsive measures for boosting the potential role of seafarers through sustaining an appropriate level of Maritime Education and Training (MET) that comprehends the dynamic evolution of the industry and addresses its future needs. Despite the fact that the IMO has taken several global initiatives in support of the 4IR, it appears that further measures are still urgently required. This implies obligations upon both the national maritime authorities and the maritime educational organizations to tackle this challenge. It is well acknowledged that the primary responsibility of MET Institutions is to equip graduates with future competencies and skills needed for employment. Such duty involves a set of challenges that the MET system needs to address effectively in order to continue delivering a relevant education to the current technological revolution.*

Design/Methodology/Approach: *This research aims to demonstrate indicative examples of global proactive measures adopted at international, national and institutional levels in addition to future skills requirements concerning 4IR.*

Findings: *The research concludes with a key approach to the transformation strategy for enabling MET Institutions to maintain the sustainable development of MET.*

Key-words:
MET, Maritime Industry, 4IR, Seafarers, Competences, Measures.

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1.INTRODUCTION

Nearly all modes of transportation have recently been influenced to varying degrees by the current technological revolution (Outay et al, 2020). This includes various maritime domains that have significantly advanced and still growing to rely heavily on cutting-edge technologies brought by the Fourth Industrial Revolution (4IR) (Ichimura, et al, 2022). Since the human element's involvement in maritime operations has been continually transformed and redefined by technological advancements (Steven C. M. et al, 2020), the impending transformation of the maritime industry necessitates a need for a comprehensive proactive approach to address the future seafarers' role in the industry including their relevant education and training.

The 4IR is globally recognized as the current developing living and working environment in which a set of technological innovations and trends such as the Internet of Things/Services (IoT) & (IoS), Artificial Intelligence (AI), Autonomous Vehicles, Blockchain, Robotic systems, Drones, Augmented/ Virtual reality (AR) & (VR) are evolving the way people live and work (Hermann et al., 2016). Furthermore, according to Schwab, (2016), and Oztemel & Gursev, (2020), there are other important 4IR-related topics including real-time big data transfer, human-machine interface, cyber-physical systems, digital twin, 3D-printing, cloud technology, smart sensors, and cyber-security. From a historical background, the world has gone through four industrial revolutions; the first started when mechanical manufacturing driven by steam-powered engines was introduced; the second, when mass production was made possible by the discovery of electricity, then the third, when production become automated thanks to the renaissance of information technology (IT) and electronics. Eventually, the fourth is primarily centred on digitalization and innovative cyber-physical systems offering novel lifestyles for humans and highly advanced capabilities for machines (Liao et al., 2018). Currently, the 4IR contributes to the maritime industry development as well as the previous three revolutions did. Figure (1) shows the impact and time frame during which the four revolutions commenced taking place in shipping.

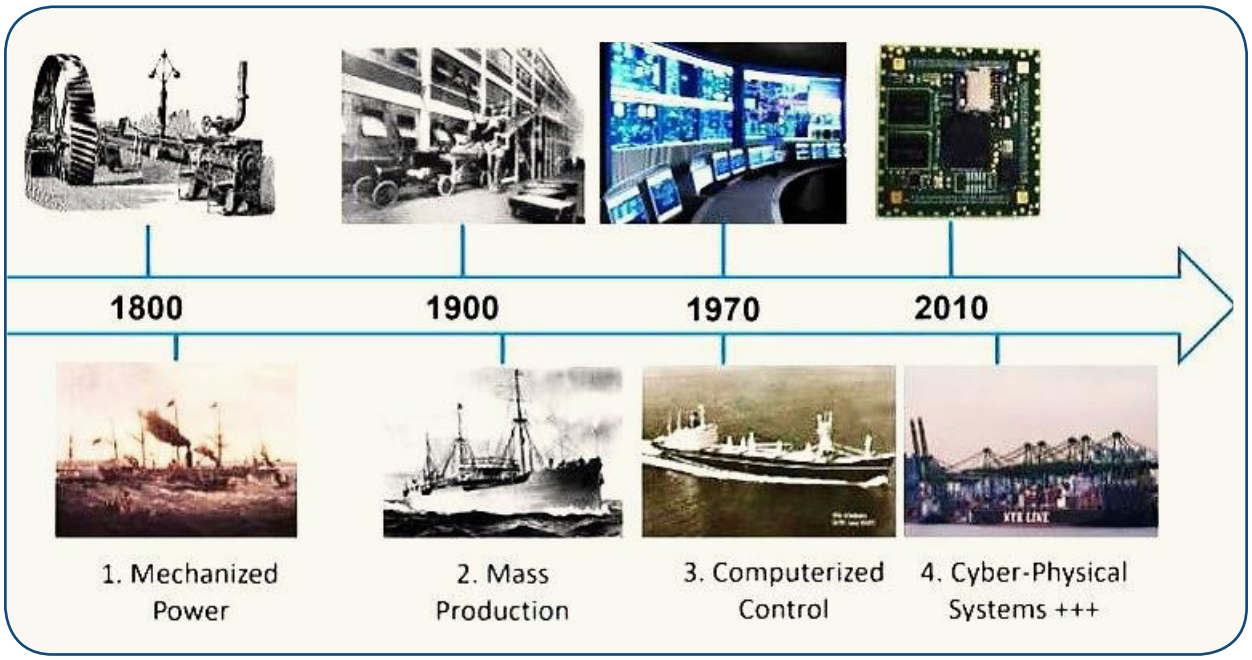

Fig. 1. Impact of the four IRs on the maritime industry
Source: Stanic Venesa et al. 2018

As technology, infrastructure, processes, competitiveness, and interactions with multiple modes of transportation evolve, new emphasis is placed on the future demands of the maritime industry. These evolutions have the potential to transform the nature of present professions and introduce new skills and competencies that could be entirely generic to the existing paradigm of the industry. Evolving maritime

education and training (MET) with adequate knowledge and skills for current and future innovation development is a key component in preparing the maritime workforce to cope with the upcoming shifts (Bogusławski et al, 2022).

In this research, with the aim to demonstrate multiple indicative examples of global measures adopted at international, national and institutional levels, the author intended to highlight the implications of the 4IR on the maritime workforce with a particular focus on investigating future skills that should be addressed by the MET outcomes.

2. THE CONSEQUENT IMPACT OF THE 4IR ON THE MARITIME WORKFORCE

The maritime workforce cannot stay aloof from the impact of 4IR since the rapidly changing nature of the industry due to automation and technological innovation is permanently changing everything with consequent implications on demands for seafarers. The maritime industry, which contributes to the transportation of 80% of global trade (UNCTAD, 2020), is currently backed by a substantial front-line workforce of 1.89 million seafarers serving the world fleet and running more than 74,000 merchant ships across the world (BIMCO & ICS, 2021).

There are multiple examples of innovative technologies that have been deployed already in the industry with encouraging results and promising futures such as the use of IoT by the Maersk Group to track containers and monitor reefers on shore and at sea (Cross et al., 2017). Currently, by utilizing artificial AI, several maritime corporations are widely investing in the creation and development of autonomous ships that are controlled by innovative systems capable of making decisions (Steven et al, 2020). Rolls-Royce Plc, (2016) revealed that the maritime industry should widely invest in autonomous ships for improving ships' safety and efficiency by eliminating human error, as well as increasing profits by allocating additional space for cargo, and lowering operation costs by cutting down crew expenses including wages and provisions, besides conserving fuel needed for accommodation and ultimately minimizing emissions. According to Poornikoo et al, (2022), the current progress of Maritime Autonomous Surface Ships (MASS) would introduce a new age in the maritime industry leading to a paradigm shift in terms of effectiveness, safety, security, and environmental protection.

On the shoreside, an increasing number of ports started to adopt a strategy for creating smart ports which according to Min, H., (2022) constitute more viable and rational replacements for conventional ports, particularly with the advent of digital technology prompted by the 4IR. However, from a distinctive viewpoint, the World Economic Forum (WEF) has drawn attention to the disruptive effects of 4IR which could directly impact the global workforce employment by highlighting serious concerns regarding the potential future loss of jobs, either because of mismatch with the needed skills or due to significant changes in the nature of jobs induced by technology advances and innovative manufacturing techniques (WEF, 2018).

In parallel, when seafarers consider shifting careers to shore-based jobs they confront considerably reduced employment opportunities since they are not adequately equipped with the relevant competencies. This is agreed with the findings of the research project titled "Mapping of Career Paths in the Maritime Industries" which was carried out by Southampton Solent University and funded by the European Commission (EU, 2020). The study revealed that shore-based jobs cannot currently be fulfilled by seafarers as the present MET systems heavily emphasize operational and technical competencies at the expense of soft, managerial, and administrative skills, including commercial and business management.

There is an urgent need for developing dynamically responsive strategies to address the threats and possibilities associated with this transition according to the conclusion of the joint report "Transport 2040: Automation Technology Employment and Future of Work" produced by the World Maritime University (WMU) and the International Transport Workers Federation (ITF). The study reveals that automation and technologies can result in a higher risk of redundant low-skilled and medium-skilled jobs. Nevertheless, high-

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skilled professions like Masters and officers, as well as Pilots are not included in the linearly positive relationship between present and future automation (WMU, 2019).

Figure (2) demonstrates that tasks carried out by low and middle-skilled individuals have higher levels of automation, whereas those performed by high-skilled groups are least vulnerable to automation. Automation and technology are frequently used to assist high-task professions, provided that they acquire the appropriate education and training so that they can attain the optimum performance outcomes in their fundamental jobs. Therefore, the idea is to prepare them on how to make use of technology in their core tasks.

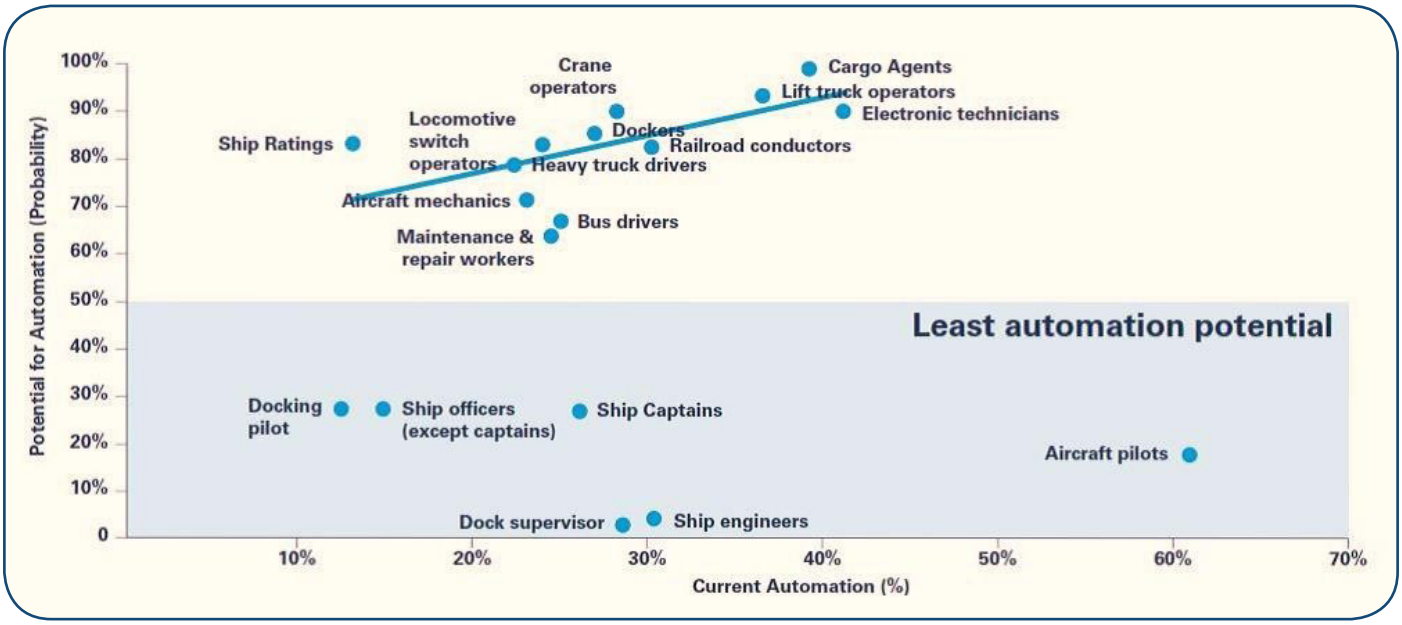

Fig. 2. Potential for automation in maritime professions

Source: WMU (2019)

In order to address multiple aspects of the challenges associated with the changing nature of work resulting from the fast technological advances and innovation in the industry, several leading nations implemented policies and initiatives to promote the integration of innovative technologies of information, communication, and cybersecurity in the educational systems. This is in addition to adopting the necessary legislation for ensuring adequate preparation of the maritime workforce to satisfy future labour market demands (UNCTAD, 2020), which according to Ziarati et al, (2010) is ultimately the most important and essential goal of MET institutions.

3. THE MARITIME INTERNATIONAL LEGAL FRAMEWORK TOWARDS 4IR

There has been a remarkable improvement in the global MET approach since the International Maritime Organization (IMO) presented the concept of Electronic Navigation in 2006 as "the harmonized collecting, integrating, exchanging, presenting, and analyzing of maritime information on ships and ashore throughout digital means". Recently, the development of Information and Communication (IC) infrastructure is giving a solid foundation for the evolution of autonomous and unmanned vessels. As a responsive measure, a framework for the administrative scope was agreed upon during the 99th meeting of the Maritime Safety Committee (MSC) in May 2018 to determine the safety, security, and environmental aspects of autonomous ships and how they can be addressed in the requirements of IMO (IMO, 2018).

The Standards of Training, Certification, and Watchkeeping (STCW) convention, being the IMO's key instrument addressing the seafarers' competencies, adopted major amendments in 1995 to assure the emphasis on competencies comprising "knowledge", "skills" and "attitudes". The present STCW, as amended by Manila 2010, is incorporating newer soft skills in

addition to the fundamental technical competencies, such as "teamwork", "leadership", "decision-making", "problem-solving", and "effective resources management" (IMO, 2017).

Despite all IMO's efforts, there are growing doubts about whether the currently produced skills are now adequate for a seafarer to be considered highly qualified under the 4IR era.

In this regard, Kitada et al. (2018) claim that IMO legislative frameworks related to MET and established by STCW for seafarers to cope with the 4IR needs are still in the initial stages of development and cannot be regarded as sufficient in their current state.

Similarly to that though, the IMO Sub-Committee on Human element, Training and Watchkeeping (HTW) received a report from the International Chamber of Shipping (ICS) outlining maritime employers' concerns regarding the current STCW regime and requesting a comprehensive review to reformate the STCW Convention (ICS, 2019). This is attributable to ICS's belief that the current IMO STCW regime might not remain adequate for purpose in the third decade of the twenty-first century, while only a completely revised convention could enable a further flexible platform for competency accumulation and certification than is currently feasible, and would provide a framework with a certain flexibility in a way that satisfies the future needs of maritime industry stakeholders (ICS, 2020).

These given facts highlight the necessity for more efficient initiatives by both National Maritime Authorities and MET Institutions to proactively respond to 4IR's needs and to share the responsibility with the IMO in achieving this goal.

4. EXAMPLES OF STRATEGIES AND PROACTIVE MEASURES AT THE NATIONAL LEVEL

Looking at several leading maritime countries within the European Union such as Denmark, Norway, the UK and the Netherlands; it can be noted that there is early recognition of the rapidly changing nature of the maritime industry.

For example, the Danish government established a maritime strategy in 2018 to create a "Blue Denmark" development plan with the aim of transforming Denmark into a major maritime power hub in 2025. Through an appealing framework, the plan outlines the necessary steps that authorities should undertake in collaboration with all interested parties to turn Denmark into a knowledge and digitalization hub. Furthermore, by outlining the necessary MET components to keep up with future technological advancement, the plan contributes to the evolution of the MET system and facilitates the ability of MET institutions to adapt and tackle the 4IR challenges while offering state funds for undergraduate maritime professionals to attain a Bachelor's degree (DMA, 2018).

As another illustration, the Norwegian Maritime Authority in collaboration with the Coastal Administration and the Norwegian Industries Federation launched the "National Forum for Autonomous Ships (NFAS)", with the goal to examine every element of autonomous ships' operations, as well as anticipating the changes related to the required skills and knowledge owing to changing nature of jobs that is a major concern for MET. The forum's outcomes demonstrated a vital need for industry-wide collaboration in overcoming the challenge and supporting maritime authorities in obtaining a good comprehension of how future administration can be improved. The technical director of the Norwegian Maritime Authority, Mr Lasse Karlsen, declared during the autonomous shipping test-bed debuted in 2017 by Kongsberg; "We ought to recognize what these new technologies offer, as we also must ensure following this evolution firmly" (Kongsberg, 2018).

The Dutch maritime administration addressed the progressive shipping's digitalization and the expanding technological possibilities by motivating the development of maritime simulation to provide adequate students' preparation for the most innovative technology advancements while tackling also the industry's reduced opportunities for onboard training on advanced ships, which is an effective strategy to accomplish multiple goals simultaneously (Maung, 2019).

On the other hand, governmental funds are provided to almost all public maritime institutions in Europe depending

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on each country's legislative requirements, and although there are several funding models, the performance-based funding system is increasingly growing popular according to the Norwegian Higher Education Authority, (2017). For instance, the University of South-Eastern Norway (USN) is entitled to receive certain amounts of state funds for each participant in a Bachelor's, Master's, or Doctorate. This gives organizations the ability to develop educational simulations and encourages scholarly exchange, information sharing, and research collaborations amongst maritime institutions, industry, and governmental entities through projects and forums.

In summary, it can be noted that these strategies have been developed at the national scale as cited and had been implanted only in a few EU countries, which might be viewed as limited proactive measures for assisting MET Institutes to effectively cope with the rapid evolution of the industry. Improving the technical-competency training to maintain it in line with technological advancements needs to be acknowledged by national executive bodies responsible for supervising maritime matters such as maritime administrations or authorities. Their functions should no longer be confined solely to administrative duties but instead should entail active work to support their countries' growth in the maritime field by promoting MET and fostering interrelations with the academic, industrial, and governmental sectors for achieving this ultimate objective.

5. THE PROACTIVE MET PRACTICE AT THE INSTITUTIONAL LEVEL

As per the seafarers' supply and demand report 2021 produced by the Baltic & International Maritime Council (BIMCO) and ICS, there would be an estimated serious shortage of 89,510 seafaring officers by the year 2026. Therefore, in order to cope with this future demand for seafarers, the maritime industry must actively promote training and employment levels by enhancing the current MET globally, with a special emphasis on providing the innovative knowledge and skills that will be strongly needed to maintain a sustainable and better digitally advanced industry (BIMCO & ICS, 2021).

This implies obligations upon MET Institutions to investigate the range of skills that will be needed during the upcoming years. In March 2018, The International Association of Maritime Universities (IAMU) performed a survey titled "A future Global Maritime Professional" that involved participants from all world regions who represent a diversity of maritime sector professions (IAMU, 2018). The survey results indicated 15 competencies that are deemed to be particularly crucial in the future of the maritime industry as shown in Table (1). The survey referred to a scale of changes in the importance of each competency by numbers from 1 to 15 within time frames of a short period of up to five years, a medium period of five to ten years, in addition to a long period of twenty years.

Table 1: Change Scale for Vital 15 Maritime Competencies.

Competency	Short	Med.	Long
Technical competencies	1	2	2
Technological awareness	3	1	1
Adaptability and flexibility	7	4	4
Computing & informatics skills	9	3	3
Teamwork	2	7	8
Communication skills	4	6	8
Leadership	6	5	7
Discipline	3	9	10
Environmental/sustainability awareness/concern	12	5	5
Learning and self-development skills	9	9	6
Complexity and critical thinking	8	7	11
Language ability	5	8	14
Professionalism and ethical behavior	9	9	9
Responsibility	5	11	13
Inter-personal and social skills	14	9	10

Source: IAMU, 2018.

When analyzing Table (1), it can be observed that "Technical Competencies" are still recognized as the primary needed skills within the short period and the secondary ones during both the medium and long-term periods. Although this implies the continued essential role of technical skills throughout the industry's future, technological awareness shall be promoted in priority from the third needed skill within the short period to the foremost vital skill of the future. Other skills that are highly addressed within the short period such as teamwork, communication, discipline, complexity, critical thinking, language ability, and responsibility appear to be decreasing in importance through the medium and long term period.

Regarding emerging skills, further attention is given to adaptability, flexibility, and self-development, as their importance is increasing and will eventually become crucial throughout a long-term period. Following the IAMU report, none of these skills is presently underlined in the current skills addressed by the STCW convention.

Given these findings, the 4IR is creating a necessity for additional knowledge and skills needed by seafarers that aren't yet adequately addressed by STCW. It seems that it is time for MET Institutions to consider modifying their MET system beyond the current STCW requirements and address the needed skills to prepare their delegates for the 4IR impact.

As a proactive response driven by the need for a reskilling revolution to close the gap between what is needed and what is currently produced by MET, the IAMU established the Global Maritime Professional-Body of Knowledge (GMP-BoK) initiative to entail a wide range of educational outcomes well above the requirements of the STCW Convention. This initiative has been made in partnership with the Nippon Foundation to provide comprehensive academic programs that cover the STCW requirements while also incorporating a set of knowledge and skills that suits the demands of the industry and other stakeholders (IAMU, 2019).

The BoK's defined learning outcomes are based on learning outcome taxonomies for three domains of learning: the cognitive domain (knowledge), the affective domain (attitudes), and the psychomotor domain (skills), as demonstrated in Figure (3) which have been presented in the workshop for the implementation of GMP-BoK by the AASTMT GMP team during the period from 6th to 8th April 2021.

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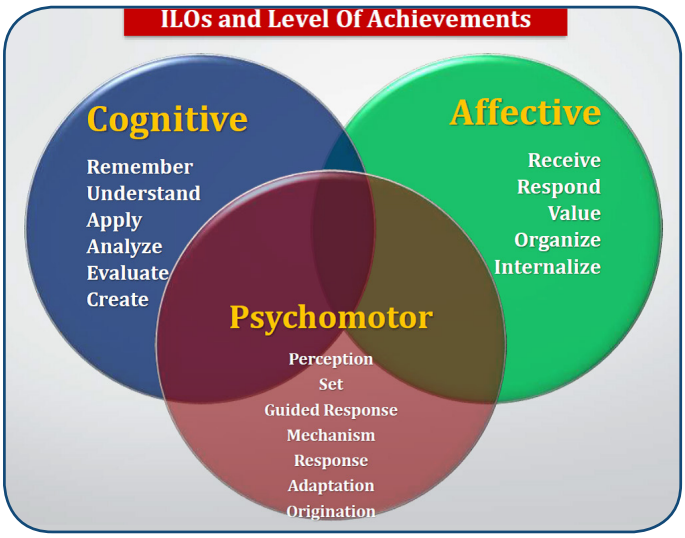

Fig. 3. Learning domains of GMP-BoK
Source: Ghalwash et al, (2021)

The IAMU initiative represents a significant proactive step taken by MET Institutions to address the effective preparation of maritime officers to cope with the current demands and future needs of the industry while also increasing their employment opportunities ashore.

6. THE FUTURE PROSPECTS OF MET IN THE 4IR ERA

Since technological innovations could lead to creative educational techniques, the teaching process must adapt quickly to incorporate digital advancements and trends. MET must refine its strategic plans to address the challenges of delivering the desired skills as cited previously. In addition, the following approaches could be adopted in parallel.

6.1. Implementing Effective Human Resources Development (HRD) Plans

The maritime industry, where students will eventually seek jobs, will likely perform differently from how it used to do. In this manner, the current global shortfall of adequately qualified Teachers is one of the biggest obstacles to producing seafarers with essential extensive knowledge and practical skills (BIMCO, 2015). For example, although maritime simulation is widely utilized by several MET institutions, the lack of professional instructors with the necessary qualifications to conduct training efficiently is limiting its potential benefits. As a response to this concern, "HR Development" is becoming crucial and must be viewed as a critical component of success. As per this viewpoint, MET Universities must address HRD comprehensively.

One of the examples that exemplifies this approach is the case of the UK Maritime College of Blackpool and the Flyde College (B&FC) in which HRD is established in line with the employee's needs and the organizational goals. Annually, each staff member is required to consult his direct senior management to develop a distinguished Sustained Professionalism Development (CPD) plan that takes into account both the strategic goals of the College and the individual desires (STC Group, 2016). It's crucial to note that while CPD programs at B&FC College have unique key performance indicators, however, they are reasonably adaptable and can be customized for each staff member. The primary goal of CPD would be to improve an individual or group's capabilities concerning the job they are performing. If the goal is not fulfilled, the reasons would be looked into and properly addressed. While obtaining competent teachers is tough, retaining them is even getting more difficult. Through the use of such an approach among lecturers and instructors, a systematic future career path can be ensured which isn't solely motivating them but also leads to extending their engagement with the organization.

6.2. Revising the MET Curricula to Fit for Purpose

The curriculum in schools and colleges has to be continuously modified to produce highly educated and skilled individuals with new abilities (UN, 2017). According to Obilo et al. (2012), the curriculum is the tool that controls any educational system's activities and is regarded as the medium via which knowledge and other learning processes are disseminated.

There are examples of some practices for modifying the MET curriculum as in Norway where one of the MET Institutions incorporated commercial studies into the MET curriculum, believing that ships' staff members need to be empowered with a certain level of academic competencies in commerce to begin taking over certain commercial functions from management staff ashore (Kitada et al., 2018).

Similarly, the innovative curriculum can incorporate the needed knowledge, skills, and attitudes concerning 4IR, such as computer and information skills with an advanced degree of technological awareness. The maritime educational processes can transmit the additional new skills listed in the IAMU report, such as adaptation, complexity, and critical thinking. For this purpose, MET's curriculum developers need to maintain the curriculum sustainment in line with the 4IR skills transformation.

6.3. Strengthening Cooperation with the Maritime Industry

The fast modification of technologies, being used already or expected to be utilized soon, is making it harder for MET providers to keep the education and training system fit for purpose unless kept acquainted with the new technology applications resulting from the industry's vision towards the future. Ensuring an adequate level of collaboration with industry, especially in research fields of innovation, applications and knowledge transfer can be a vital approach for MET institutions to target the learning outcomes that align with the desired skills.

A noteworthy example is a collaboration between "Kongsberg" and the University of Southeast Norway (USN) on a project titled "Innovating Maritime Training Simulators Using Virtual and Augmented Reality", in addition to further research study concerning autonomous ships. Through similar initiatives, MET institutions can have the opportunity to maintain updated with technological advancements, improve technology awareness among their staff members, and incorporate pertinent knowledge into their curriculum. Furthermore, through joint projects, MET Institutions can receive industry investments for research like the case of the USN when obtained an advanced training simulator for a Titan-class ship, which is a very specific class vessel for seismic operation, through its collaboration with the Norway Petroleum Geo-Services (PGS) and Kongsberg (Kongsberg, 2017).

For the MET system to be modernized adequately in the 4IR era, it is now more important than ever to foster collaboration with the industry that would empower MET institutions to enhance current training facilities and staff resources sustainably while also allowing institutions to keep updating the curricula.

6.4. Creating the Appropriate Infrastructure and Facility

The condition of the educational facility and the level of faculty members have a great influence on how students learn and get educated. In this context, new technologies that have recently received attention linked to 4IR, such as Virtual and Augmented Reality (VR/AR) along with conventional MET resources like training vessels, laboratories, simulators, workshops, and classes, might also view a bright potential for simulation combined with E-learning applications and services.

6.4.1. Incorporating VR/AR technologies in Simulation

In addition to existing simulators for a wide range of missions involving limited, multi, and full mission tasks that have been integrated into MET and require high financial ability, maritime simulation can be significantly improved by incorporating a 3D simulated environment that can closely imitate real-world tasks with multiple senses as being offered nowadays by the advanced VR and AR technologies. VR is a term that refers to a "near reality" wherein a virtual environment is employed. Technically speaking, it applies to 3D computer-generated surroundings that a person can explore and interact with. Different from VR technology, AR is based on integrating both real and virtual elements in a real-world setting while operating interactively in real-time in addition to connecting and aligning both the real and virtual objects together (VR Society, 2022).

By incorporating VR into MET and creating a platform for virtually simulated ship equipment and its associated operational process, maritime students can get engaged with an array of cutting-edge technologies and genuine ship equipment that they might not be given the chance to explore throughout their onboard training. According to Yanliang, & Zhiqiang, (2020) embedding VR-based simulation into MET may broaden the horizon of the practical training outcomes since it can boost the operation skills of maritime personnel. Furthermore, it might be seen as a viable approach to overcome limited funding resources for conventional simulators that need considerably expensive hardware and facilities.

6.4.2. Establishing a digital learning platform

E-learning platforms are regarded as one of the 4IR's accomplishments and can serve as an effective tool for integrating the 4IR needed skills as part of the MET system. The fact that e-learning promotes innovative interactions between educators and learners which contributes to improving the effectiveness and the adaptability of the learning environment in an appealing manner, will make it gain a larger popularity scale amongst students in colleges and universities (Alrawashdeh et al, 2021).

In reality, conventional classrooms that involve face-to-face interaction between teachers and learners would still be crucial in the future education domain. However, it should be reinforced with enhanced digital innovative techniques to effectively prepare seafarers for future paradigms of knowledge and skills. For example, to enhance soft skills like critical thinking, communication skills, teamwork skills, and self-development abilities, a flipping classroom has been implemented as one of the utilized techniques in higher education where digital contents are available to students at any time through videos, online worksheets and quizzes which suits the way they use today to acquire knowledge through their phones, laptops and electronics (Tores C. et al, 2022). Multimedia with highly interactive methods, among several types of e-learning, can replace traditional knowledge transfer or at least change the way education is delivered. If students have the opportunity to spend more time on a guided self-study program through E-Learning at home, then they can make better use of time during classroom hours and dedicate it to questions and discussions with lecturers.

Furthermore, the current advancement in E-learning offers a wide range of effective instructional methods involving online practice with associated feedback from teachers, combining collaboration activities with self-paced studies, while identifying and personalizing learning tracks based on the delegates' desired skills. In addition, it can facilitate using simulation remotely for learners who have difficulty attending conventional classroom training (NETP, 2017).

Given these characteristics, a platform for web-based learning should be developed to enable effective interaction between students and lecturers, as well as to better coordinate and actively manage the necessary knowledge and skills. The digital format offers the possibility to produce automated, adaptable education in which the student has the capacity to extend, replicate, and take control of their education beyond classrooms.

CONCLUSION

The introduction of highly advanced and emerging technologies imposed by the 4IR affects the maritime industry workforce by changing the nature of future jobs. This necessitates a need for a global proactive response to avoid skills mismatches and job-redundancy risks that can end in massive job losses in future. The responsibility is now shifted towards national maritime authorities and MET Institutions to contribute to the contamination of the 4IR consequent impacts in line with the IMO efforts. Creating a framework for industry-government-institution partnership is the most efficient way to preserve knowledge exchange and future vision sharing.

The effectiveness of preparing the maritime workforce for the longer-term transformation relies on the innovative development of MET which can be attained by implementing efficient plans for the development of human resources, revising the currently delivered curriculum in light of anticipated future skills, and strengthening industry collaboration. Integrating technology with these key elements can create a holistic approach to the transformational strategy for enabling MET Institutions to maintain the sustainable development of MET.

The inclusion of digital tools and immersive technology in MET provides a wide variety of teaching and learning possibilities. If the 4IR-related technologies are well employed and used under appropriate intellectual guidance and technical support, they may facilitate and complement various educational techniques for achieving the needed 4IR skills. When it comes to strengthening and systemically building up an effective delivery of the digitalized MET contents, a comprehensive professional preparation plan for maritime educators and instructors regarding innovative digital educational skills is vital.

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