

# Maritime Education and Training in the Digital Era

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**Abstract** As a result of technologic improvement, the shipping is rapidly changing. Digitalization and high level automation lead important changes in the operation of maritime business and subsequently the reconsideration of the role of seafarers. The shipping business becomes more technical and it demands highly skilled and specialized crew ready to embrace continuously evolving technology. The mission of the education institutes is not preparing the people for today but also for future requirements. It requires them to understand effect of digitalization on industry and adopt new programmes as well as benefits from IT technology to improve their teaching and learning methods. It is also necessary to establish a close cooperation and collaboration between industry and education institutes and evaluate missing points in the education system. A teaching system is required to rebound ability to learners to use information and understand abilities of automated systems. Traditional seafarer training is a part of applied science and focus on practical and cognitive skills. But since 1990s seafaring officer training reshaped to cover academic competencies to breed officers endowed with the ability to use highly improved technology. This study discusses how we can improve our education systems to prepare young seafaring officer for the future as well as how we can get benefits from the digitalization to appreciate our teaching and learning activities.

**Keywords** MET in Digital Age, Vocational and Academic Education, New Trends in the Education, Industry and University Cooperation

## 1. Introduction

As a result of technologic improvement, the shipping is rapidly changing. Digitalization and high level automation lead important changes in the operation of maritime business and subsequently the reconsideration of the role of seafarers. The shipping business becomes more technical and it demands highly skilled and specialized crew ready to embrace continuously evolving technology.

Traditional seafarer training is a part of applied science and focus on practical and cognitive skills. But since 1990s seafaring officer training reshaped to cover academic competencies to breed officers endowed with the ability to use highly improved technology.

The mission of the education institutes is not preparing the people for today but also for future requirements. It requires them to understand effect of digitalization on industry and adopt new programmes as well as benefits from IT technology to improve their teaching and learning methods. It is also necessary to establish a close cooperation and collaboration between industry and education institutes and evaluate missing points in the education system. A teaching system is required to provide ability to learners to use information and understand abilities of automated system.

### 1.1. What is Digitalization?

Futurist Gert Leonhard [1] explains "disruptive technology" which has a significant impact as the five essential elements of the digitalization as follows:

- Automation of knowledge work

- Advance Robotics
- Autonomous vehicles
- The internet of Things
- Mobile internet

It is clear that all above mentioned elements directly related to the maritime industry and all are applicable on board.

Leonhard also summaries the characteristics of the digital era as follow;

- Change is increasingly ‘gradually then suddenly’
- Expect: exponential, combinatorial, and interdependent
- Interdependence: think hyper-collaboration, ecosystems
- Machines are for answers humans are for questions
- Examine the areas where you are ‘digitally contestable’

All these characteristics of digital era enforce us to take

‘speedy actions’ to catch the benefits of digital era and not miss its advantages. More importantly, the growth of technology and its impacts are not linear but exponential in the era we live in. The disruption between linear and exponential growth is identical and this requires taking immediate action in all areas of our life (Figure 1). The systems on board are quickly changing and this trend will continue.

This rapid change will also cause continuous and rapid changes in MET (Maritime Education and Training) system. The following Figure 2 shows close relations between education and technologic improvements. The important steps laid down from internet to robotics have already been outreached and will continue with an exponential manner. The “Next Generation Education” has already been started in many sectors. The maritime industry being in close relations with technology needs to consider this new education concept.

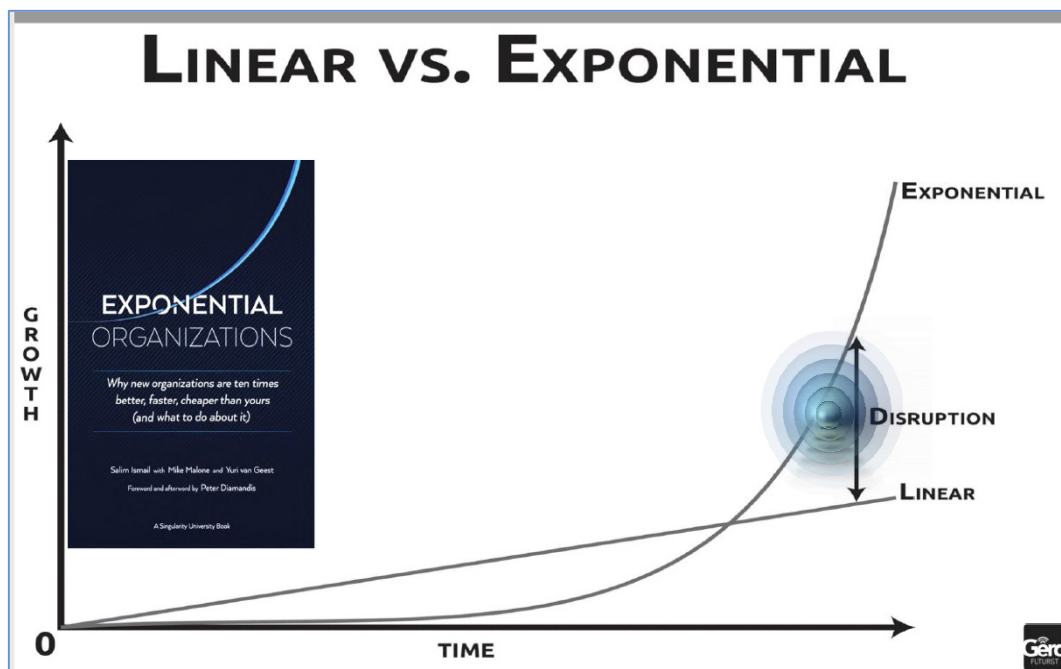


Figure 1. Linear versus Exponential (Source: Exponential Organizations, 2014 [2])

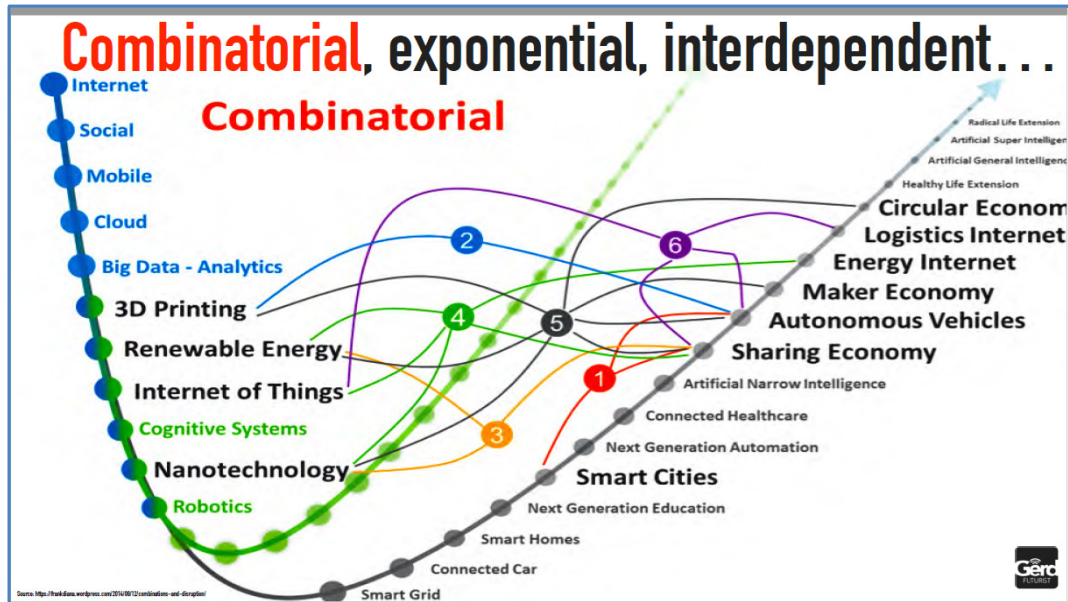


Figure 2. Technologic improvements and its effect on our life (Source: Leonhard, 2016 [1])

## 1.2. Matching Traditional Seafarer Training and Academic Training

Traditional seafarer training has always focused on the acquisition and use of practical skills. The prevailing view is that, while this approach addresses a degree of cognitive skills, it focuses on and gives much more emphasis the acquisition of hands-on practical skills for the performance of specific tasks. On the other hand, academic education has been seen to be much more focused on the development of in-depth analytical and critical thinking skills; cognitive skills that are less reliant on hands-on task-oriented training, but stress critical reading and discussion. The global trend in maritime education and training is increasingly to link an essentially vocational education that provides specific and restricted competence outcomes with more general or deeper academic components leading to an academic qualification [3].

Manuel [3] explains his solutions to this subject for maritime industry as; "It allows for an easier migration of seafarer experience and talent to other parts of the maritime industry. At the national level, it has significantly enhanced the exposure and reputation of MET (Maritime Education and Training) and seafaring as a career option as it aligns more with the main expression of higher education in many jurisdictions. Furthermore, with the enhanced role of technology in the world, such education allows for the industry as a whole to have more versatile professionals in place for future changes in ship operation.

Both navigation (deck) and marine engineering programmes are designed as engineering programmes and both requires delivery of basic science and fundamental engineering courses such as mechanics, stability, fluid mechanics, strength of materials, electric and electronics etc. The basic science courses are 'sine qua non' for

engineering education. The technologic development will make engineering courses rather weighed in these programmes.

## 1.3. Change of Business Methods

Following significant changes in technology, business methods in the highly technology-dependent sectors have been drastically changed starting from the last two decades of the 20<sup>th</sup> century. The main factors which cause this change are as follows: Development of communication facilities, Increased IT capabilities and Interfaces, Development of Robotic Technologies, Reflection of Space technology in the classical industry.

Not only the business methods changed but also some new jobs appeared as some jobs disappears or changes their formation to meet new requirements. During this transition new job in particular at shore facilities are increased. The seafaring officers should consider new knowledge and skill requirements when they make career plans to adopt new roles and expected new professions.

The ships, shipping company, manufacturers and shipyards are now connected by IT and online data transfer is available for 24/7. Ship management functions became fully automated.

## 1.4. Competencies in the Digital Era

If we look common characteristics of digitalization, these are; availability of huge data; data mining to use huge data banks; artificial intelligence to facilitate decision making; high level of automation; high speed on-line data transfer.

These applications and expectations of the new form of business shaped the new role of the human being at work.

Most of the researcher have described most important human competencies needed in the near future are as follows:

- Leadership
- Expressing himself well
- Processing large amounts of data from various human-machine interfaces
- Focus on critical issues rather than details.
- Working with teams in remote locations
- Understand automation and its limitations
- Manage change
- Continuous learning
- Coping with increased stress
- Ability to communicate effectively

The seafaring officers should be prepared as a high technology system user, able to work in group(s), bear to increased stress, capable to communicate in different level of people from different nations as well as a leader. All these expected competencies should be considered when arranging MET.

### 1.5. IMO Policy

Lim Ki-tack has announced a four pronged approach for his tenure as IMO Secretary General. One of them “Focus on implementation: Looking application and implementation of IMO regulations”. This makes a significant change in IMO policy; IMO has acted as a regulatory authority and application and implementation have been delivered to the maritime administration. Lim Ki-tack’s statement introduces a new initiative which aims “looking application and implementation of IMO regulations” as well as being a regulatory international body.

One of the IMO Secretary General’s new policy initiatives is “Greater visibility, transparency and communication with industry and media and public”. In the existing system the role of the industry in the MET is very limited and covers some responsibility in the sea training. The numbers of the cadets are increasing and many maritime schools are suffering to find suitable ships for sea training. It is strongly believed that the shipping companies should be included in MET planning and conducting activities as stakeholders.

Additionally the shipping business becomes more technical and it demands highly skilled and specialized crew ready to embrace continuously evolving technology. The failures of complex automated systems cause fatal and

very high costs. We should be ensuring that man-machine interface is fully achieved and crew is well trained on this state of arts systems. Constant revisions to system and IMO functions require staying relevant in the light of the new policy. This will also require inclusion of maritime industry in MET as a stakeholder.

### 1.6. Digitalization in Shipping

The reflection of technology to shipping industry is shown in the Figure 3. All these developments are directly related ship operation as well as duties on board which should be conducted by the ship crew. This is the main reason why the MET should be reviewed to meet the requirements of technological development. If the competencies of the crew are not sufficient to match these technologies, it is impossible to handle the ships effectively and safely.

One of the main aims of digitalization is to connect all respective parts of the systems. Not only the systems but also human being should be connected. That means we should also work on not only interface and interoperability among the systems but also between the systems and human being. When the technology takes grand steps to improve the existing shipping systems, it is also required to improve the quality of crew by the way of education and training. There is a strong need to make the crew eligible to work the state of arts systems on board effectively.

Hamburg School of Business Administration [4] made a comprehensive study on “Seafarers and Digital Disruption” in 2018. Dealing with the “human element” on board, this study revealed some first answers to the initial questions:

- Digital transformation will be a seamless process rather than a disruptive one.
- There will be no shortage of jobs for seafarers in the foreseeable future.
- There will be considerable additional jobs ashore.
- There will be significant training needs

In order to fit the seafarers into evolving requirements of their profession, their education system should be revised and updated. Today seafarers are not deployed on board the ships but also at shipyards, ports and marinas, shipping and logistics companies which require very similar skills and competencies. MET providers should take into consideration this fact when they plan MET programs. This will also offer a bunch of job opportunities at shore for seafarer.

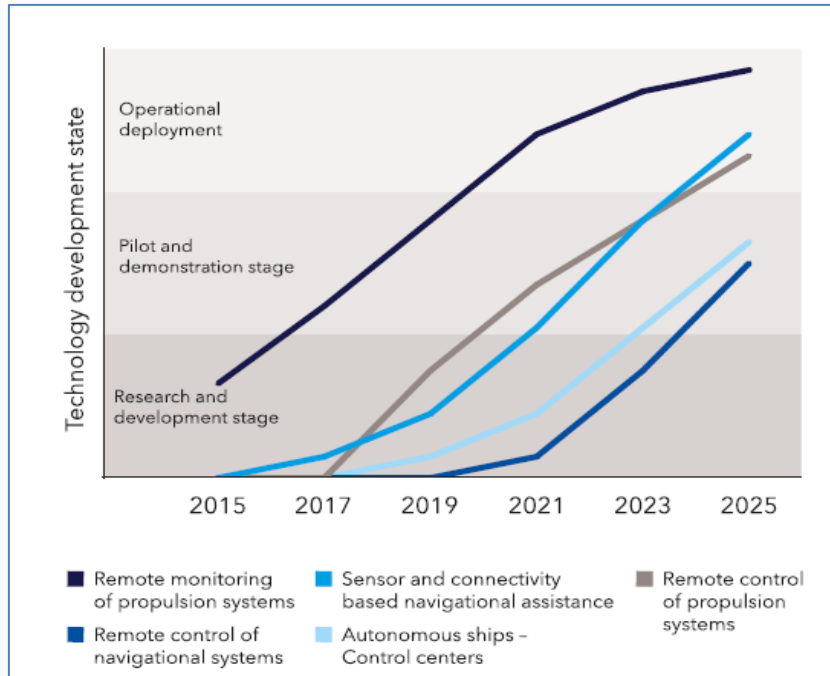


Figure 3. Technological development in ship operation

**1.6. International Maritime Organization (IMO) Policy**

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Constant revisions to STCW (Standards for Training and Watchkeeping for Seafarer) which regulates MET system should be conducted by IMO in the light of the new

policy. The inclusion of major maritime industry representatives in both international and national MET related forum will produce best solutions. Representatives of maritime industry should also take a place as a stakeholder in MET institutions as an application of strategic management.

**2. Materials and Method**

The aim of this study is to define the posture of the maritime business by reviewing possible significant changes in the digital era and to produce some proposals to develop a suitable MET system which responds the existing and future requirements for seafaring officers in the light of the expectations of digital age.

The objectives of this study are;

- To understand effects of technologic development on maritime sector
- To evaluate new knowledge, skills and competency requirements for seafaring officers
- To analyze the reflection of existing and future requirements to academic programmes
- To revise MET academic programmes without overloading class hours (The courses to be added, deleted or reshaped)

Analysis of qualitative research data method is used. This analysis aims to understand the meaning of the data collected and also aims to facilitate understanding of the content through a systematic classification that can be divided into categories or included in the responses by counting words and term. A content analysis can be made

as a basis for qualitative analysis.

The meta-syntheses method is used to make a forecast for the future based on the studies made by reliable education researchers and futurists. A meta-synthesis is bringing together qualitative data to form a new interpretation of the research field. It helps to build new theories and ideas. It primarily generates theory such as program theory, implementation theory, or an explanatory theory of why the intervention works. Meta-syntheses are best designed to re-interpret meaning across many qualitative studies.

The study starts with the review of related literature which is mainly based on researches made by academic institutions, internationally recognized governmental and non-governmental organizations concerning forecasts on the requirements of digital era in particular for maritime industry. After summarizing new improvements in the technology, it is intended to make an evaluation on the impacts of the seafaring professions. As result of this evaluation some proposal will be produced to adopt these improvements into MET (Maritime Education and Training) system to assist seafarers to adopt themselves to new working conditions and having job opportunities for the emerging professions, in particular for deck officers.

This study is based on the future expectations and requirements in the maritime environment. In order to define best prediction, the conference paper and citations published by famous futurists based on qualitative and quantitative analyses and, researches made by internationally recognized maritime institutes such as IMO (International Maritime Organization), ICS (International Chamber of Shipping), BIMCO (Baltic and International Maritime Council) etc. in cooperation with universities and research centers are reviewed.

The result of this study will assist the MET institutes and maritime sector to realize the new posture of the digitalized world and reconsider education requirements and delivery methods. This study may also help the maritime industry to understand why they should be stakeholders of MET for their mutual benefits.

### 3. Discussion and Results

#### 3.1. Breakthrough Technologies and New Trends

Ismail et al [2] has made an estimate on “Likely Breakthrough Technologies” in their famous book, Exponential Organization;

- Sensors and Internet of Things (IoT): Potential new business models due to connected products will be the main result of this improvement
- Artificial Intelligence (AI), Data Science & Analytics: This will empower the use of Machine Learning and use of Deep Learning algorithms to process vast amounts of information
- Virtual & Augmented Reality: This will provide potential for remote viewing while centrally located

experts provide guidance and direction as well as improve quality and training

- Bitcoin and Block Chain: Extremely low-cost transactions that are secure powered by a public ledger that logs everything will be provided.
- Neuro-Feedback: Feedback loops will enhance the brain to a high level of precision and reduce stress

Ismail et al [2] has also introduced Likely Meta-Trends as:

- Perfect Knowledge on IoT and sensors
- Neuro-Feedback, and satellite systems
- Virtual Worlds 3D Printing, virtual working environments
- Exponential Payment Systems replace traditional payment systems
- Autonomous Vehicles

The Figure 4 below shows reflection of new technologic application in our life. This figure is a resume of Development of IT since 1980. The major development areas are AI, IoT, Quantum technologies, IoT and Robotics and significant progress are expected in these fields in the next decade.

The ships and ports are equipped with robot controlled cargo handling systems. The new ships are using IoT systems to transfer ship technical situation data to shipping company, shipyards and manufacturer for quick respond to system failures using IoT system. It is now a indispensable task to furnish seafaring officers with more IT skills who are responsible operation and maintenance of digitalized ships.

#### 3.2. Efficient use of Distance Learning

People were suspicious the efficiency of distance learning probably not having a real classroom environment and teacher. The face to face education is applied since the emerging of very first civilization and it was not easy to convince the people to effectiveness of distance learning.

In line with the measures against New Coronavirus (COVID-19), Turkish elementary medium high schools, high schools and universities started distance education process as of March 23, 2020 [5] in order to ensure that its students continue their education in the most efficient way without any disruption.

Not only Turkey but also many other countries have applied distance learning to continue their education system. Education institutes improved their distance learning system and achieved sustainability of their education in a very short period. A survey made by IAMU highlighted that 96 percent of the maritime higher education institute has delivered their courses using distance learning tools. During application of distant education process, students attended their courses via different learning systems and continued education outside the campus. The lecturers have used distance learning tools effectively.

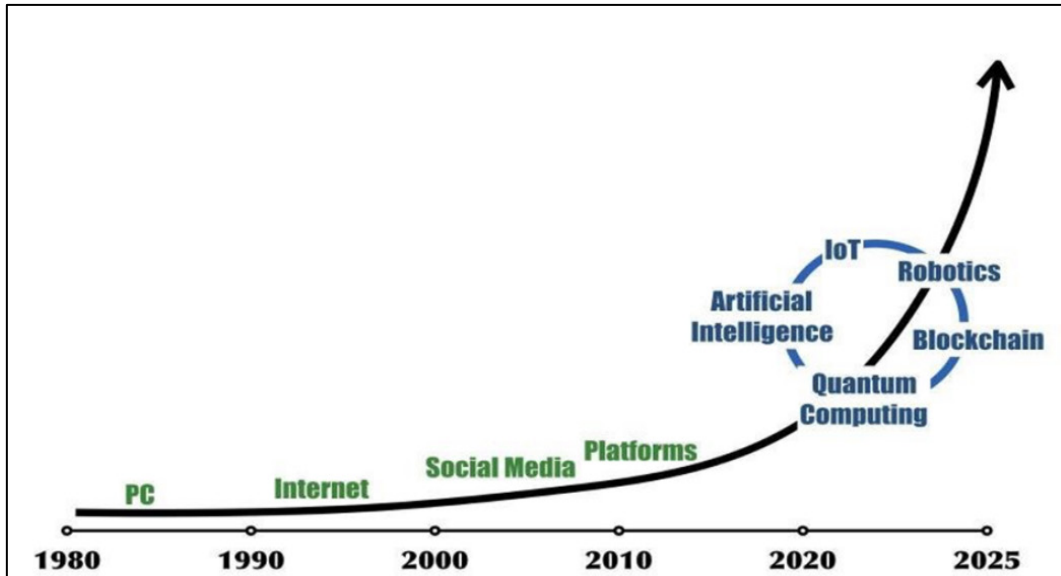


Figure 4. Development of IT since 1980

While countries are at different points in their COVID-19 infection rates, worldwide there are currently more than 1.2 billion children in 186 countries affected by school closures due to the pandemic. With this sudden shift away from the classroom in many parts of the globe, some are wondering whether the adoption of online learning will continue to persist post-pandemic, and how such a shift would impact the worldwide education market [6].

Online learning software applications have made a significant surge in usage since COVID-19 improving online course delivery and examination, virtual tutoring, video conferencing tools etc.

A huge number of students and lecturers in the world used distance learning systems and they have adopted it quickly without any problems. It is believed that there could be a significant increase in use of distance learning after the end of pandemic. The broad use of distance learning will facilitate the application of CPD as being an essential tool for delivery.

- Simulation, to understand and solve important problems, e.g. chemical processes, the development of new materials, as well as fundamental physical theories, by mapping them onto controlled quantum systems in an analogue or digital way;
- Sensing and metrology, to achieve unprecedented sensitivity, accuracy and resolution in measurement and diagnostics, by coherently manipulating quantum objects.

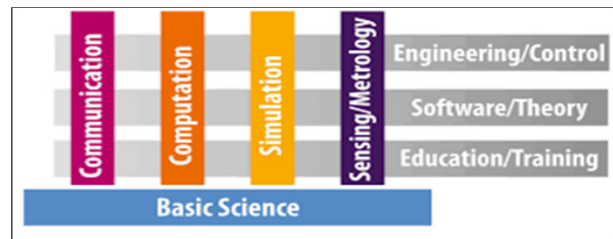


Figure 5. Structure of the Strategic Research Agenda (Source: EU, 2017)

### 3.3. Quantum Technologies (QT)

The Quantum Technologies (QT) Flagship program is established by European Union to prepare the community for adopting future knowledge driven industry. It is based on five domains, each of which should be reflected in a call for proposals.

Four vertical domains address vital application areas (See Figure 5) [7];

- Communication, to guarantee secure data transmission and long-term security for the information society by using quantum resources for communication protocols;
- Computation, to solve problems beyond the reach of current or conceivable classical processors by using programmable quantum machines;

All these subjects are based and supported with basic science. The basic science is necessary to develop novel ideas that can have a major impact on the four application domains ranging from theoretical and experimental fundamental science to proof-of-principle experiments, capable of delivering the concepts, tools, components, materials, methods and processes that will enable the flagship objectives to be realized.

The main layers of the QT are Engineering and Control, Software and Theory and Education and Training which supports both layers. Projects should be positioned within one of the layers and may link to other layers. They should always address Education and Training as well as at least one of the other two enabling aspects.

The data management using information technology became rather important in the digital era. Nowadays

although it is not a requirement in STCW (Standards for Training, Certification and Watchkeeping for Seafarers) Code, 'Introduction to Computers and Programming' courses are delivered at all maritime schools. But this course is not sufficient to fully understand of data collection and management. It is strongly believed that a course covering Data Management which covers collection, control and use of data should be added in the programmes.

Integrated bridge management systems are now improving as decision support systems to assist the watch officers for quick decisions in case of emergency. The watch officers need to understand concept and usage of decision support system. A course on Decision Support Systems is required to make mariners understand specifications and capabilities of such systems.

Automation failures may cause high cost and fatal accidents. Now many ships are equipped with highly complicated automation systems and use of automation on board is expected to be emanated. A course on the 'Concept, Capabilities and Limitation of Automation System is deemed necessary to mitigate automation failures as well as facilitate the passage remote controlled and autonomous ships.

To support the delivery of above mentioned courses seafaring officers are required to be equipped with basic Communication Computation, Simulation and Metrology and Sensing knowledge.

### 3.4. New Skills and Competencies

Future seafarers will experience their vessels becoming more digitalized and thus more reliant on computerized technology. This means that keeping crew trained and ready to "Monitor the machine" will become no less important than it is today for a chief on the main engine. The difference is that their skills will need broadened and also encompass a degree of digital nativism, so that working on computer systems with high quality, and being able to troubleshoot operational issues related to the cyber-physical (Boundary between physical machine and the computer network) will become a part of their role. The future hyper-connected world will offer a collaborative workplace for crew, with access to experts at land from their company and partners ready to assist and collaborate 24/7. Crew might also start working more remotely, with responsibility for several vessels in the fleet through remote operation [8].

In the near future there will be lots of remote controlled and autonomous ships at sea which will require remote controllers at shore. The remote controllers are expected to

be seafarers who are eligible to handle remote systems.

One of the major challenges the industry faces will be in enabling seafarers, shore-staff, charterers, regulators, etc. to work together seamlessly to deliver safety, efficiency and reliability. We are focused not just on how the way we work at sea will change but how all of us in the industry can work differently to enable and support digital change and opportunity [7]. MET institutes should take necessary steps to embrace digitalization and adopt it maritime industry soon.

The ships are equipped with alarm and control systems for safe and feasible operation. The seafarers should be aware of that there could be mistakes on these automatically generated data which might cause serious accidents. The seafarers should have sufficient automation knowledge to define reliable and incorrect data.

There is a lot of debate about how the role of seafarers is going to change in the future and no one can be sure exactly how roles, functions and responsibilities will develop. What seems clear is that increased automation will demand different skill sets at sea, but digitalization will also require new thinking ashore. The days when the ship and its crew were completely self-contained and remote from the rest of the organization are disappearing [9].

### 3.5. Matching requirements of Maritime Sector and MET

Innovation and technology made a sound effect on businesses, organization and management. It has also impressed the marine industry as well as seafarers. In order to understand these effects on seafarers, Meadow et al [10] made a study on 'the expectation of maritime sector from mariners'. In according to survey results "85% of those surveyed agreed that "seafarer skills will remain an essential component in the long term future of the shipping sector (see Figure 6)".

Although autonomous ships are found to be efficient, safety issue is still unreliable. Many of people thinks that human knowledge and power are more reliable than machine in this level of autonomous. Besides, according to Figure 7, the participants of the research said "...human error was being used to create a blame culture towards the workforce at sea in being the only real cause of accidents at sea" [8]. According to results of responses to question related to 'Replacing human operators on-board ship with machines will create a safer industry; but seafarers are very suspicious about replacing human operators on-board ship with machines concerning safety.



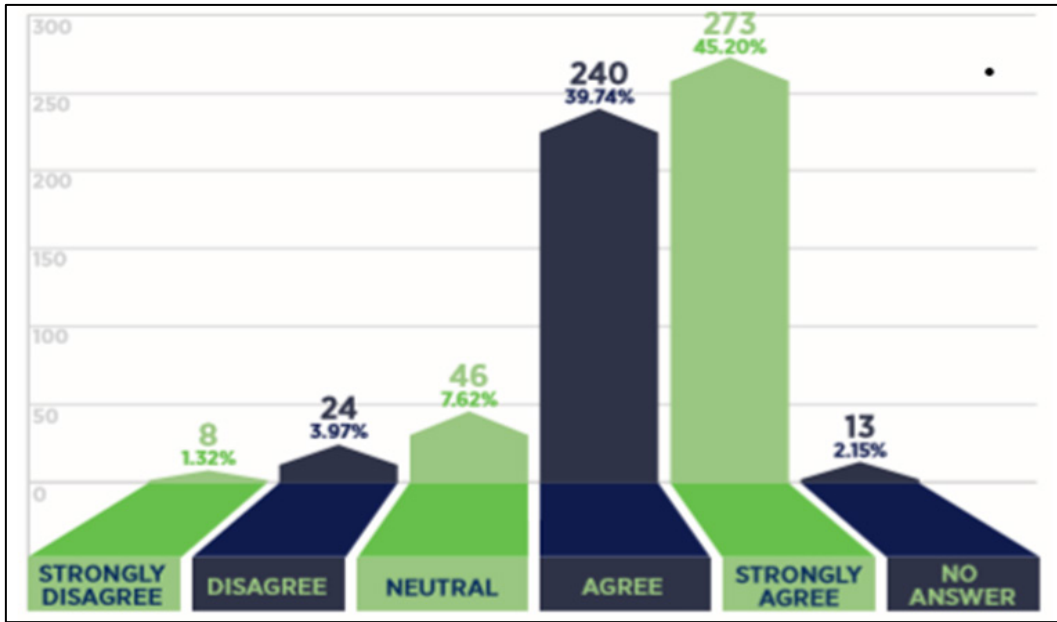


Figure 6. Respond to Question related ‘Seafarers will remain an essential component in the long term future of shipping (Source: Meadow et al.,2018)

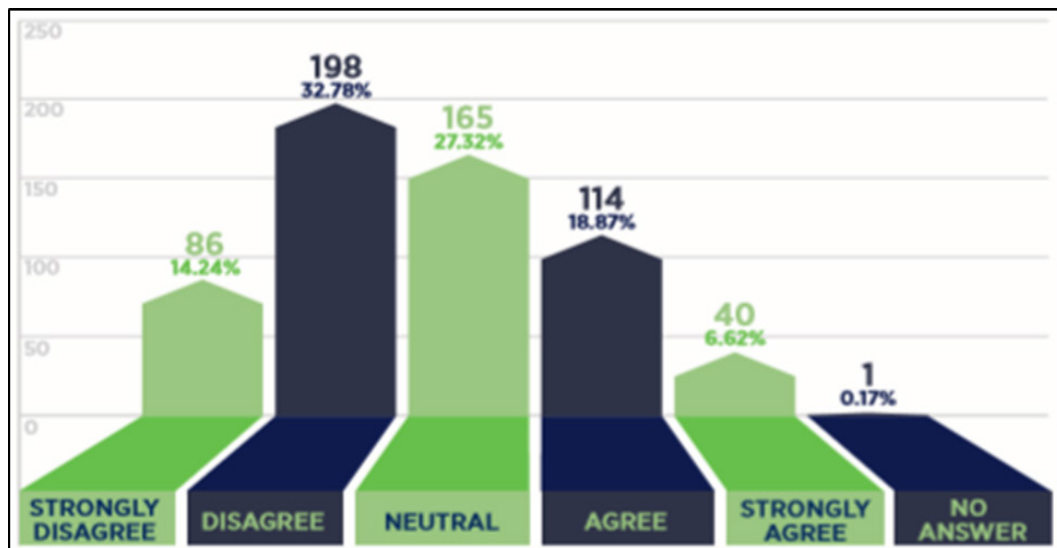


Figure 7. Responds to question related to ‘Replacing human operators on-board ship with machines will create a safer industry (Source: Meadow et al., 2018)

Future maritime industry become more digital and autonomous with Industry 4.0 but that does not mean seafarers will disappear as in every industry, education and training are directly connected with industry and sector requirements (see Figure 8). Also the legal regime is shaped around this. The rules and regulations are modifying and changing continuously as response to the technologic development. This requires a very flexible MET system to assume new legal situation.

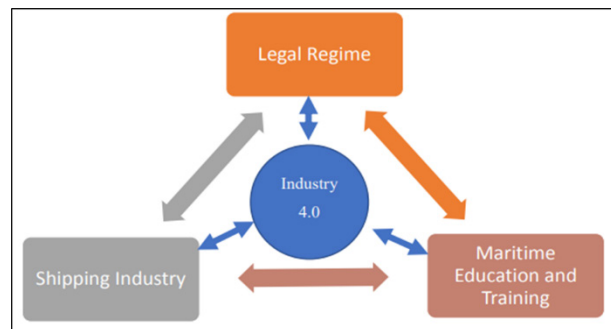


Figure 8. MET, Shipping Industry and Legal regime (Source: Barreto, 2017)

The conclusion is that maritime education and training must develop hand-in-hand with the technical development. New skills and competences are necessary for those who deal with design, operation and maintenance of unmanned ships. Also automated port operations, developing legislation, VTS operations and also interaction between manned and unmanned ships ask for good education and training of many new subjects [11].

Seafaring profession will continue but reshape under the pressure of the technologic improvements. But it will not be easy to adapt new requirements due to seafaring is being a very conservative profession as well as having a rigid culture.

### 3.6. Automation and Ship Operation

Automated systems are very capable to facilitate ship management and are comparably better than manual systems, but they do not have common sense. What this means is that automation systems must be controlled by the human element at all times. These systems are products of high technology and users should be aware of the working principals, limitations and specifications of them in order to be able to avoid any accidents in case of failure in the system. The existing education and training systems do not sufficiently cover the main principles, limitations and weaknesses of automation systems and the students are not capable of understanding this critical knowledge when they meet automated systems on board.

Automation systems failures are significantly important for the ships sailing in dense traffic conditions. Any failure on navigation system may cause the total loss of a ship or ships in the vicinity [12].

The programme to teach automation theory and application should cover the introductory subjects' related basic working principals, capabilities, weaknesses and limitations of the selected automation system. The main part of the training should be constructed on a real time scenario and case studies.

MET institutes need to conduct consistent and meaningful assessment of their academic and training programs to ensure quality and relevance. Given that technology is advancing at an exponential rate and outstripping current workforce capability, our environmental scan and assessment of current programs need to help us anticipate required changes in our curricula and develop new skills and competencies that will meet requirement of the maritime industry. To achieve that;

- Faculty should be capable of integrating technology into the classroom,
- Close partnerships and interactions between faculties and industry is a must,
- Applied learning opportunities and internships that introduce students to the latest technology is important,
- Faculty-student research opportunities is to be increased to ensure quality

Relevance will also require our program and course review processes to change. While shared governance is essential, the process of revising and updating curricula must move from static stability to dynamic stability. As the rate of technological change increases, we must establish new processes that enable us to evolve, change, and deliver “just-in-time” programs and courses [13]. MET providers require collaborating and coordinating with maritime sector when they design programmes to align programme objectives with requirements of industry.

We must identify the current and future adaptive skillsets necessary for our graduates to succeed in the job market of today and thrive in the industries of tomorrow. This will required us to carefully balance and integrate education and training, infusing these important themes and skillsets across our curricula. In short, we must integrate knowledge in a discipline (major), hands-on learning experiences, and adaptive skills from a program of studies in liberal arts and Science Technology Engineering and Math (STEM) disciplines. In this way, we will provide graduates not only immediate employability in a competitive career field but also the character, adaptability and ingenuity to succeed throughout their careers as the nature of the industry changes rapidly [11].

Nasaruddin and Edam [14] made a study on ‘Preparing Maritime Professionals for Their Future Roles in a Digitalized Era’ which also covers ‘Bridging the Blockchain Skills Gap in Maritime Education and Training’. In this article they also refer previous studies.

Inadequate transparency future skills in training and technological content in higher education is also adversely affecting future skills gap [15]. Through in-depth literature review, the implications of digitalization on conventional MET is mostly preliminary and not thoroughly explored by academic research, especially with regard to blockchain development impacting MET methodologies. A recent study showed the propagation of blockchain and crypto-currency courses offered by some universities in the United States [16]. The cultivating of life-long learning principles for continuous development is also essential for adaptation in a rapidly changing technological environment [17]. For this purpose, this paper aims to shed light on the implications of blockchain disruption in the maritime industry accelerating required changes in conventional MET approaches. In this essence, we further add to the topic of blockchain education and training in the MET sphere through analysis of existing academic research regarding blockchain adoption (and other advanced technologies) challenges in organizations. Additionally, we provide recommendations for blockchain talent development among maritime universities.

Smart shipping opens opportunities to grow. This increase in the use of digital elements aboard ships is a key theme used by supporters of technology in shipping such as Martin Stopford in the theory of “Smart Shipping” which advocates the need focus on technology in shipping to help

it grow. As discussed it creates the ability to better monitor performance and the data collected as part of post event forensics may help to prevent future failures and business interruption [17].

There are many queries on the smart ship which are;

- What is the minimum manning level for this type of ships?
- Who will be the remote controllers at shore for smart ships and required qualifications for these controllers?
- Which crew functions may be transferred to remote control stations?
- Who will be legally responsible for smart ship operation?

Some projects are already started to control the navigating areas which manned and unmanned ships operate together. The COMPASS2020 project is expected to achieve a comprehensive solution for maritime surveillance, based on the coordination of assets with enhanced capabilities, which will allow addressing many of the challenges currently faced by authorities and governmental organizations with responsibilities in this domain [18]. The ultimate goal of this solution is to help governments contain, control and effectively respond to a growing number of diverse threats and incidents: from piracy and smuggling of goods and narcotics, to irregular migration and maritime pollution, including Search and Rescue operations.

### 3.7. The Role of the MET Institutes to Meet Seafarer Requirement of the Sector

The role of appropriate education and training in transferring knowledge, maintaining competence, driving necessary change, addressing emerging challenges, and mitigating the negative consequences of previous actions and decisions are imperative and undisputed [19]. To this end, all MET providers should follow the rapidly changing technology and reflect all relative inputs into their programmes.

ICS/BIMCO Manpower Report (2016) concerning seafarer requirements for next decade provides the most authoritative data in this domain. The latest edition of the five-year study was published in 2016 [20].

According to the report, the forecast growth in the world merchant fleet over the next ten years, and its anticipated demand for seafarers, will likely continue the trend of an overall shortage in the supply of officers. This is despite improved recruitment and training levels and reductions in officer wastage rates over the past five years. The report predicts a shortage of 147,500 officers in 2025, which is more than 18% of the global demand for officers on ships.

If by 2025 very optimistically some 1000 ships will be fully autonomous and some further 2000 vessels semi-autonomous, this may possibly reduce demand for seafarers by 30,000 – 50,000. However, at the same time

the need for highly skilled remote-operators, pilots of a new kind and riding gangs will be needed to keep ships operational [4].

As Kevin Tester [21] put it: “Autonomous ships are more likely to alter jobs rather than eliminate them and [...] this, combined with the creation of new types of jobs, will lead to greater prosperity in the long run.”

The MET institutes for educating seafarers should increase the number of cadets to meet the needs of industry as well as develop the quality to provide high quality officers for the future. Additionally they should also consider the new requirements for officers to handle automated and semi-automated ships and the related courses should be added into curriculums.

Maritime higher education institutions (MHEI) build their activities on basis of two different bodies of knowledge: professional knowledge, as outlined in the STCW Convention [Code] and related sources, and academic body of knowledge [22].

The universities should make an education not prepare the students not only for today but also for the future requirements. Today the ships are highly automated, using robot technologies and state of arts IT systems. As a result of this study it is clearly understood that data management, automation, decision support systems related courses should be added to STCW and subsequently MET institutes education seafaring officers should include these courses into their academic programmes.

### 3.8. New Course Requirements

MET system needs to be improved to in sight of new requirements. Obviously, valid MET system is insufficient for future development and it cannot keep up with these developments. It should be revised in the light of new necessity of knowledge, skills, and competencies. Existing curriculum of MET cannot meet requirements of future and this requires adding new course to keep up the technology. It is suggested that these three courses should be added.

- Introduction to automation to understand how it is working, limitations and failures
- Data analysis to understand what data is and how it is collecting
- Decision support systems to understand how data is the processed and used

Changes in technology make the shipboard and fleet management a very complex business not only because of state of arts systems but also quickly changing regulatory arrangements. Broad use of automation systems gave the priority to learn fundamentals of automation theory. In particular commissioning of autonomous and remote control ships in the near future stressed the importance of this subject. It is suggested that these knowledge and skills should be given to seafaring officers in the MET system as a new course. Introduction to automation course should cover capabilities and limitation of automated systems for

enabling them for imminent action in automation failure emergencies.

The data management for better use of information technology will be rather important in the digital era. Today, more than one hundred data reach to Ship Bridge from different sources which are vital for safe ship handling. Data analysis and data control have become important to make a true decision in controlling the ship. Nowadays although it is not a requirement in STCW, 'Introduction to Computers and Programming' courses are delivered at all maritime schools. But this course is not sufficient to understand use of data management. It is strongly believed that a course covering Data Management which covers the collection, control, and use of data should be added in the programme. This course will be also intended to aim that the students learn which data technique will be most appropriate when collecting data in the engineering and management fields on board.

Integrated bridge management systems are now improving as decision support systems (DSS) to assist the officers of the watch (OOW) for quick decisions in case of emergency. There will be a large amount of data flow to DSS, which will assist the action of ship. These systems are highly developed to help decision makers, but they do not have common sense. DSS will assist the OOW in deciding safe and efficient ship handling etc. also warns about possible dangers by making risk assessments. The person benefiting from DSS should easily get benefits from recommendations of DSS for quick decision evaluating whether the recommendations are reasonable or not. Therefore, the watch officers need to understand concept and usage of decision support system to get maximum benefit to decided best course of action. A course on Decision Support Systems is required to make mariners understand specifications and capabilities of such systems.

## 4. Conclusions

The shipping business becomes more technical and it demands highly skilled and specialized crew ready to embrace continuously evolving technology. The failures of complex automated systems cause fatal and very high costs. We should be ensuring that man-machine interface is fully achieved and crew is well trained on these states of art systems.

The STCW (Standards for Training and Watchkeeping for Seafarer) which regulates MET system is mainly based on existing requirements but not for the future. Constant revisions to STCW should be conducted by IMO in the light of the new policy. The inclusion of major maritime industry representatives in both international and national MET related forum will produce best solutions.

The function of MET institutes is not only to prepare the students for today's requirements but also for the future as well as preparing cadets to participate scientific studies on

marine industry. MET institutes should also become a research centers in support of maritime industry. Considering rapid development in technology MET providers should also consider the future requirements to well prepare their students to facilitate their adaptation for roles and skills.

A new era is starting which is named Quantum Technologies (QT). All developed economies are making plans for the creation of future knowledge driven industry based on the application of QT. Maritime industry, playing a crucial role in the trade should also follow the development of QT to survive in challenging world economy.

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Automation failures may cause high cost and fatal accidents at sea. Now many ships are equipped with highly complicated automation systems and use of automation on board is expected to be emanated. A course on the 'Concept, Capabilities and Limitation of Automation System is deemed necessary to mitigate automation failures as well as facilitate the transition to remote controlled and autonomous ships.

The block chain is a reality and it will be used in the transactions for shipping industry. In this essence, the topic of blockchain education and training in the MET sphere should be added regarding pervading blockchain applications in trade and transportation organizations.

Basic Science courses are 'sine qua non' for engineering education. The technology requires delicate measurement to reach correct decision. In many developed countries a course, namely Metrology is added to engineering programmes to teach precise measurements. Such a course is advised to be included in deck and marine engineering programmes to meet the future requirements as well as supporting research activities.

Identification of the current and future adaptive skillsets is necessary for MET students to succeed in the job market of today and thrive in the industries of tomorrow. This will required us to carefully balance and integrate education and training, infusing these important themes and skillsets across our curricula.

The process of revising and updating curricula in the MET institutes must move from static stability to dynamic stability. MET providers require collaborating and coordinating with maritime sector when they design programmes to align programme objectives with industry's requirements. Representatives of maritime industry should also take a place as a stakeholder in MET institutions as an application of strategic management.

The distance learning systems were used extensively during Coronavirus pandemic and are believed that there could be a significant increase in use of distance learning after the end of pandemic. The broad use of distance learning will facilitate the application of Continuing Professional Development (CPD) as being an essential tool for delivery of technologic developments to seafarers deployed at sea and shore in the near future.

As a result, maritime education and training needs to evolve in line with technical development. New skills and competences are required for those interested in the design, operation, and maintenance of unmanned and remote controlled ships. MET institutes generally focus vocational skills based on management and engineering science. However, the important thing is to shape education according to the needs of the sector. Especially, the content of technological courses must be considered to prepare people for cadets for adopting them future knowledge driven industry.

Maritime industry has been a conservative branch of the economy and is slow to accept cultural changes, but the speed of technological development in the 21st century is much rapid than previous centuries. Thus, Maritime sector has started to consider technologic development which rapidly changing its structure and mode of operation. When the time arrives of first commercial unmanned ships in international sea traffic, the maritime community should be ready to handle their jobs professionally. In any case, seafaring profession will not disappear, but it will modify its shape to assume new roles and duties. So, MET institutes should change their approach for programme design and be reshaped their programme by considering the new requirements.

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