IAMU
International Association of Maritime Universities

THE NIPPON FOUNDATION

IAMU 2021 Research Project
(No. YAS202110)

Capacity building Project Challenges of Maritime Digital Leaders in the Algorithmic Age (DIGITAL LEADER)

Theme 1: Needs, challenges and future concepts of the current and new generations of MET

By

Constanta Maritime University (CMU)

August 2022

IAMU
International Association of Maritime Universities

This report is published as part of the 2021 Research Project in the 2021 Capacity Building Project of International Association of Maritime Universities, which is fully supported by The Nippon Foundation.

Published by the International Association of Maritime Universities (IAMU) Secretariat
Meiwa Building 8F, 1-15-10 Toranomon, Minato-ku,
Tokyo 105-0001, JAPAN
TEL : 81-3-6257-1812 E-mail : info@iamu-edu.org URL : http://www.iamu-edu.org

ISBN978-4-907408-42-8

IAMU
International Association of Maritime Universities

THE NIPPON FOUNDATION

IAMU 2021 Research Project
(No. YAS202110)

Capacity building Project Challenges of Maritime Digital Leaders in the Algorithmic Age (DIGITAL LEADER)

Theme 1: Needs, challenges and future concepts of the current and new generations of MET

By
Constanta Maritime University (CMU)

Contractor : Violeta Ciucur
Research Coordinator : Maria Cristina Dragomir

Contents

List of figures

List of tables

List of abbreviations used in the study

American Society for Testing and Materials (ASTM) standards - formal, technical requirements that establish quality specifications for a wide range of materials, products, systems, and services; they serve as the basis for manufacturing, procurement, and regulatory activities worldwide.

Artificial intelligence (AI) - intelligence demonstrated by machines, as opposed to the natural intelligence displayed by animals including humans.

Automatic Identification System (AIS)- automatic tracking system that uses transceivers on ships and is used by vessel traffic services

Azure Information Protection (AIP) - part of Microsoft Purview Information Protection used in discovering, classification, protection and governance of sensitive information.

British Broadcasting Corporation (BBC) - national broadcaster of the United Kingdom.

Central processing unit (CPU) - electronic circuitry that executes instructions comprising a computer program

Chief Technology Officer (CTO) - executive-level position in a company or other entity whose occupation is focused on the scientific and technological issues within an organization

Digital Twin - a real-time virtual representation of a real-world physical system or process (a physical twin) that serves as the indistinguishable digital counterpart of it for practical purposes, such as system simulation, integration, testing, monitoring, and maintenance.

Electronic Chart Display and Information System (ECDIS) - geographic information system used for nautical navigation that complies with International Maritime Organization (IMO) regulations as an alternative to paper nautical charts.

Global Maritime Distress and Safety System (GMDSS) - a worldwide system for automated emergency signal communication for ships at sea

Grade Point Average (GPA) - number that indicates how well how high you scored in your courses on average.

Hard disk drive (HDD) - an electro-mechanical data storage device that stores and retrieves digital data using magnetic storage

High-Definition Multimedia Interface (HDMI) - a proprietary audio/video interface for transmitting uncompressed video data and compressed or uncompressed digital audio data from a compatible source device

HyperText Markup Language (HTML) - the standard markup language for documents designed to be displayed in a web browser.

Information Technology and Communications (ITC or IT&C) - extensional term for information technology (IT) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage and audiovisual, that enable users to access, store, transmit, understand and manipulate information

INMARSAT - British satellite telecommunications company, offering global mobile services.

International Convention for the Prevention of Pollution from Ships (MARPOL)- international convention developed by the IMO (International Maritime Organization) covering all types of marine pollution caused by ships.

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) – international convention appointing minimum qualification standards for masters, officers and watch personnel on seagoing merchant ships and large yachts

International Safety Management (ISM) – a management systems model designed to encourage safety and pollution prevention.

International Transport Forum (ITF) - inter-governmental organization within the OECD system.
Internet of things (IoT) – concept describing physical objects (or groups of such objects) with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.
JPG or JPEG- commonly used method of lossy compression for digital images, particularly for those images produced by digital photography.
Key performance indicators (KPI) - type of performance measurement used to evaluate the success of an organization or of a particular activity.
Key Success Factors (KSF) - management term for an element that is necessary for an organization or project to achieve its mission.
Machine learning (ML) - subfield of computer science and a branch of artificial intelligence whose goal is to develop techniques that enable computers to learn
MS – abbreviation for software produced by Microsoft, an American multinational technology corporation which produces computer software, consumer electronics, personal computers, and related services.
MySQL - open-source relational database management system; SQL is the abbreviation for Structured Query Language.
Organization for Economic Co-operation and Development (OECD) - intergovernmental organisation with the purpose to stimulate economic progress and world trade.
PHP- popular general-purpose scripting language that is especially suited to web development
Planned Maintenance System (PMS) – system that allows shipowners and operators to plan, perform and document vessel maintenance at intervals complying with Class and manufacturer requirements.
Portable Network Graphic (PNG) - type of image file handling graphics with transparent or semi-transparent backgrounds.
Random-access memory (RAM) - short term memory where data is stored as the processor needs it.
Safety Management System (SMS) - formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls
Search engine optimization (SEO) - s the process of getting traffic from free, organic, editorial, or natural search results in search engines.
Social media (SM) - The interactive computer-based technologies that facilitate the creation and sharing of information, ideas, feelings, etc.; group of online tools that allow individuals to network, participate, contribute and collaborate with others through applications
Solid state drive (SSD)- a certain type of electronic storage unit, which does not use moving components
SWOT analysis - a method for identifying and analyzing internal strengths and weaknesses and external opportunities and threats that shape current and future operations and help develop strategic goals.
Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) - multi-criteria decision analysis method.

Capacity building Project

Challenges of Maritime Digital Leaders in the Algorithmic Age

(DIGITAL LEADER)

Theme 1: Needs, challenges and future concepts of the current and new generations of MET

Constanta Maritime University (Contractor)

And

Research Coordinator

Maria Cristina Dragomir

Associate Professor, Constanta Maritime University, cristina.dragomir@cmu-edu.eu

Abstract Algorithmic age is the actual time context where automated technologies and decision-making systems are starting to influence world scale transport economies, affecting directly and indirectly the end users and beneficiaries. The algorithms emerging from Artificial Intelligence (AI) and machine learning (ML) applications are suited to solve demanding problems or to improve the accomplishment of seafarer professionals' time-consuming tasks. However, they raise unique legal, regulatory and ethical challenges, as may result in unintended and harmful behavior if the wrong objective function is specified (or self-specified), if the training data is biased or corrupted, or if the learning process is faulty. A maritime digital leader is defined as the icon person who explores the growing use of digital technologies in the maritime operations landscape, addressing risks in fast-moving digital and real environments, while adapting the role of mentorship for both non-tech and high-tech skilled followers. Maritime digital leaders need to understand and learn how to use advanced digital technology in order to create maritime competitive advantages and welfare. In such context, this research had the aim to answer to what extent is necessary to amend STCW international convention with emerging competences of digitalization and leadership, considering the essential role that leadership has for the safe operation of ships. The project's aim was to build updated maritime capacity and state of the art professional excellence for maritime leaders able to face successfully the challenges of the evolving highly tech digitalized maritime society. In the study were analyzed particular influences of the information society, including cyber and algorithm risks in global MET system. The practical approach of building human capacity is related to finding effective ways of developing digital leadership skills and algorithm literacy culture in shipping. Through effective capacity building and integration of digital leaders, maritime sector will remain sustainable even in conditions of high unanticipated digital risks. Digital leaders have the purpose to share updated perspectives, knowledge and experiences to ensure safety at sea, maritime cyber security and the protection of the environment, while assuring enough employability skills for the dynamic maritime industry.

Keyword: *Professional skills, safety, Safety Management System (SMS)*

1. Introduction

Although at the beginning of the digital revolution, between 1950s and 1970s, digitalization was a topic of technology, after 1990s became a business subject, and today became a subject of leadership knowledge. We are currently living in a challenging, highly tech and digital context known as the "algorithmic age". Digital transformation is no more about technology only. The critical factors of digital transformation are adaptive learning, organizational culture, leadership strategy, capabilities and understanding the digitalization impact for evaluated customer.

The Organization for Economic Co-operation and Development (OECD) - International Transport Forum (ITF), Annual Summit of Transport Ministers in 2019 and the ITF Corporate Partnership Board Workshop in 2018 defined the *algorithmic age* as the current time context where automated technologies and decision-making systems are starting to influence world scale transport economies, affecting directly and indirectly the end users and beneficiaries.

In Fig. 1 below is represented a geographical distribution of artificial intelligence related gains for various regions of the globe. It is expected that all regions of the global economy will have benefits from the innovation, development and commerce of products and services related to artificial intelligence, the highest total impact being related to the China economy. It's estimated artificial intelligence (AI) will add as much as $15.7 trillion to the global economy by 2030. [1]

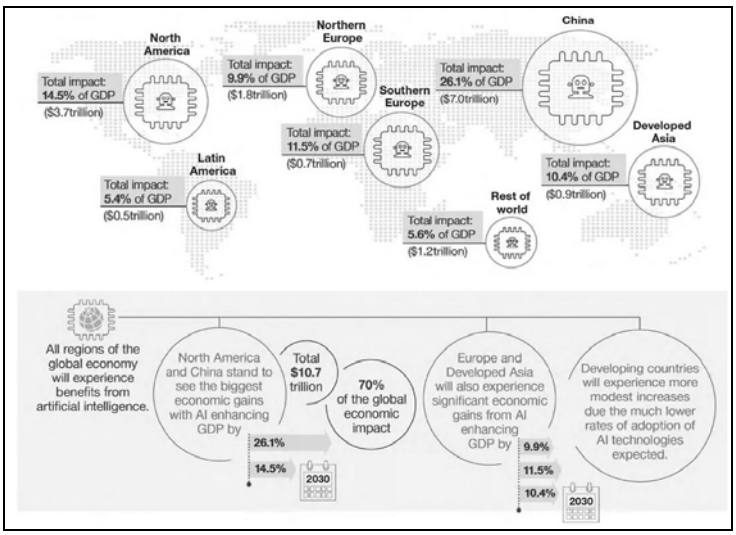

Fig. 1. Regional distribution of artificial intelligence benefits. Source: PricewaterhouseCoopers LLP, 2017[1]

Beside COVID-19 pandemic and post-pandemic challenges in the increased use of online technologies for remote learning and working, the introduction of digital solutions for cargo document flow in the maritime sector is one of the challenges of the algorithmic age that helps to improve "the connectivity and transparency of the performed processes at different stages of the multimodal transport chain. It reduces the inefficiencies of cargo flow through better container utilization, evasion of delays during transportation and congestion at terminals, decrease of CO_2 emissions and preserves the product quality during the carriage and in the storage yard" [2].

While algorithms are sets of defined steps, structured to process both instructions and data to produce an output, a raising challenge is the use of dynamic (non-static) algorithms, designed to

rewrite themselves to improve outcomes. Codes using such dynamic algorithms can evolve so much, that regulatory agencies might no longer be able to understand or predict how they function. This change has an inevitable impact on all modes of transport, including maritime field. The algorithms emerging from Artificial Intelligence (AI) and machine learning (ML) applications are suited to solve demanding problems or improving our ability to accomplish time-consuming tasks. However, they raise unique legal, regulatory and ethical challenges, as may result in unintended and harmful behavior if the wrong objective function is specified (or self-specified), if the training data is biased or corrupted, or if the learning process is faulty. Physical, moral and philosophical hazards might emerge when AI systems are used in areas of human decision-making.

Artificial intelligence is used intensively in automated business, political, decisional and technical systems. In the context of algorithmic age, accelerated development of artificial intelligence and advanced social web technologies lead toward machine-aided participatory communication, boosting processes and updating conventional business of maritime companies.

Over the last decade, marketing strategy and practice in the maritime have undergone major changes due to major technological advances, especially due to the development of the Internet and the artificial intelligence technologies. Like any field, marketing in the maritime continues to keep pace with technological developments. As a result, after invading with advertisements on all traditional channels (audio-visual, written press, events, etc.), it also approaches the virtual environment, in an attempt to attract, but especially to retain new customers.

Evolving so quickly, the consumer of maritime services is accustomed to selecting the media he/she wants to access. Thus, there is a continuous change in the status of consumers from "physical viewers" to "Internet browsers beneficiaries", which has given return to both advertising companies and their customers. Under these conditions, the importance of traditional marketing is not diminished at all, but it is necessary to develop a new component, which is online marketing based on artificial intelligence technologies. In this context, maritime companies that do not neglect their marketing side, aim to be present as much as possible on the virtual market for various actions aimed at launching a new shipping line, strengthening an existing brand or transport service, or their advertising.

In the context of the continuous evolution of web technology, social networks represent an excellent opportunity to establish meaningful relationships and to create ways of social interaction defined by dynamic exchanges between their members.

Social media is booming in terms of the number and variety of platforms and users. In the last two decades, social networks have grown and evolved into something that allows consumers and businesses to engage with each other in a meaningful way.

Thus, you can find audiovisual platforms such as YouTube, Vimeo and SoundCloud; image platforms such as Flikr, Picassa, Pinterest or Instagram; general social networks such as Facebook, Twitter, Google+ or specialized ones such as LinkedIn; news aggregators or bookmarks such as Digg or Delicious; blogs; Wikis and more - a vast digital arena where the new winners of the web in terms of digital marketing stand out.

2. Research objectives

The project had the following 4 research objectives:

1. To understand the particularities of the digital leaders in the maritime field
2. To identify which are the most in-demand skills for maritime digital leadership
3. To propose operational training methods and key performance indicators (KPI) for maritime digital leadership training within STCW

4. To assess the awareness of maritime students, lecturers and professionals concerning the challenges of digitalization and the new algorithmic age.

The objectives of maritime DIGITAL LEADER research contribute to build updated maritime capacity and state of the art professional excellence for maritime leaders able to face up the challenges of the evolving highly tech digitalized maritime society.

Analysis of maritime digital leadership challenges was successfully accomplished through the following four tasks: study on understanding the particularities of the digital leaders in the maritime field; establishing the most in-demand skills for maritime digital leadership; Proposing operational training methods and key performance indicators for maritime digital leadership training and awareness assessment of maritime students, lecturers and maritime professionals concerning the challenges of the new algorithmic age.

3. Research Methodology

The research objectives were accomplished through the following four research tasks:

In Task 1 - *Study on understanding the particularities of the digital leaders in the maritime field* was delivered literature review on maritime digital leadership related topics (algorithmic era, automated technologies, decision-making systems, artificial intelligence, IoT etc.). There were organized email interviews with 10 international researchers and project members from automated vessel innovation projects and a specialized online questionnaire was established for maritime IT&C experts from the global shipping industry and ship masters or officers in leadership positions. Data were processed and the results were analyzed.

In the second task - *Establishing most in-demand skills for maritime digital leadership*, was applied an online questionnaire to a target group of 25 maritime companies to assess their in-demand skills further necessary for maritime digital leadership. After the questionnaire replies were received, data was processed and results were analyzed.

In task 3 - *Proposing operational training methods and key performance indicators (KPI) for maritime digital leadership training-* an online questionnaire tool for proposing training methods for minimum 10 maritime lecturers from and outside MET was prepared and sent to more than 10 shipping or ship management companies.

In the fourth task, *Assessing awareness of maritime students, lecturers and maritime professionals concerning the challenges of the new algorithmic age,* an online questionnaire tool was used to assess awareness concerning the challenges of the new algorithmic age of minimum 40 MET students and 30 MET lecturers and maritime professionals. Two focus groups were organized in March 2022 to assess awareness concerning the challenges of the new algorithmic age

Although the main aim of the study was to discover advanced digital skills and competences needed by maritime digital leaders, the results of the focus group with experienced seafarers and academia indicated critical lack of basic digital competences at the middle age questioned seafarers, suggesting heterogeneity of digital competences and knowledge level for the MET students and many of the graduates. Advanced digital skills, in regard to cybersecurity and safety capabilities, are expected to be learned at Master degree programs, while a major focus should be for Bachelor studies to reach a balance and homogeneity regarding the level of basic digital skills and ITC knowledge shared by students.

4. Main Findings of the Study

During the 4 research tasks of data collection, the following 56 valid responses were obtained, split in the following categories: IT&C respondents (working in IT company related to maritime sector or to maritime projects); maritime academic staff/ maritime lecturers, maritime companies (shipping, ship management, crewing etc.); maritime students and seafarers.

4.1. Opinions collected from IT&C respondents (working in IT company related to maritime sector or to maritime projects)

1. Considering that Covid-19 pandemics has advanced the use of digital technologies in the society, what challenges do you think might emerge in the new digitalized maritime sector?

1	The need for competency in this sector is one, since most players in shipping are not tech savvy and need to be trained or hire externally for these roles to keep a constant connection with technology aspects.
2	The main challenge is the adaptation to the new found tech developments, as we know the industry is a very conservative one, along with the utilization of data science techniques to reduce business time and costs and increase safety and human efficiency.
3	Mindsets adapting to the change

2. What solutions do you think might be useful for such challenges?

1	Companies big and small will need to hire for cto's, or similar alternatives. Perhaps approachable and informal advisers/ consulting companies will be approaching the market to provide their services too.
2	Education can play the most important role in explaining the steps and processes involved for maximizing such benefits.
3	Workshops

3. In your opinion, what are the most in-demand skills for students, that maritime universities should consider for the new digitalized maritime market?

1	Some kind of knowledge of the coding language can be useful.
2	Understanding the benefits of using digital and communications technologies.
3	Introducing digital awareness course

4. What training methods do you think will be necessary for teaching such skills to our students?

1	I am not sure but can be easily found out by looking at what major technology institutes offer and see what is applicable and useful
2	Computer-based training, interactive online courses, gaming, virtual reality.
3	Quiz and projects based

5. What key performance indicators (KPI) do you think will be necessary to evaluate our students' digital knowledge?

1	Same as above
2	Information fluency, communication and collaboration, critical thinking, solving and decision making, technology operation.
3	Involving independent evaluators/3rd party

6. Do you think is necessary to include in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandatory requirements regarding digital competencies for the safe operation of ships?

1	I think training should be mandatory especially for sea men. They need to be put up to speed with what is happening in other sectors, they need to be able to employ software in the day to day, and they need to be allowed to be excited for being part of something modern and technology-oriented. If not I wouldn't be surprised if hiring for seamen will become harder and harder, the sector is not modern enough.
2	Yes, it can be an important step for improving the whole process.
3	Yes, to make it relevant

4.2. Opinions collected from maritime academic staff/ maritime lecturers

1. Considering that Covid-19 pandemics has advanced the use of digital technologies in the society, what challenges do you think might emerge in the new digitalized maritime sector?

1	Cybersecurity challenges
2	Responding to cyber attacks
3	Regulator compliance issues
4	DIGITAL COMMUNICATION
5	The challenges that could arise are related to digital security and the lack of training of people in digitalization.
6	Infrastructure
7	Challenges have appeared in all sectors and I believe we need to adapt to the new changes. In the context of the pandemic, the use of digital technologies in society has advanced and I consider this useful and we must comply
8	Cybersecurity
9	The development of many software solutions without proper training. Several IT solutions remain unknown by possible users.
10	I think the biggest threat will be cyber attacks.
11	On-line technology.
12	Yes new network such as zoom digital meeting program
13	Encreased cyber security risks
14	Yes New types of propulsion technologies for ships // Zero emission of harmful gases
15	Marines will become more attached to electronic devices and away from reality.

16	I think the CHALLENGES are: -Ensuring personnel training and development, -Cyber Security -adaptation to cloud technology -adaptation to augmented reality
17	Considering that the Covid-19 pandemics are advancing the use of digital technologies in society, what CHALLENGES do you think may arise in the new digitalizing maritime industry? During the covid-19 epidemic, remote working methods were applied in many sectors. As a result of Industry 4.0, artificial intelligence applications and deep learning have led to digital developments in many fields. smart ports and smart cities have become a rising trend. For example, the Port of Antwerp has implemented an artificial intelligence-based Digital twin application called APICA. Falling behind the technological applications developed in the maritime sector (especially on the ship side) may cause the adaptation between the land and the sea to deteriorate. Also, it will not be possible for the conventional methods used in maritime to be replaced by digital applications in a short time.
18	During the Covid-19 pandemic period, a lot of students from other counties signed up because of online classes and where physical presence was not necessary. Now they want to continue their classes in the same way: online.
19	I haven't any idea
20	Online Training

2. What solutions do you think might be useful for such challenges?

1	Must be able to adapt regardless of Readiness and competency levels using digital and online platforms while being mindful of govt laws such as data privacy, copyright and intellectual property rights and other relevant regulations
2	Following the regulations
3	New IMO standards
4	Training courses in digital competencies
5	To put more emphasis on information and on education.
6	Financing ressources
7	Training in cybersecurity
8	Good practice collection and sharing
9	Insufficient training in IT and the need for digital skills of the staff working in this field
10	I think safe software practices can be useful.
11	On-line teaching. Using of informational clouds (especial on simulators training).
12	Distance learning systems
13	To move away from the practical aspects
14	High speed internet connection on board and better firewall protection
15	Eco friendly propulsion - wind, sails, mixed propulsion engine-kite, Using LPG as fuel for ships Renewable energy sources Strictly management of garbage on board

16	In the solution of problems, manual solution should be taught and applied instead of electronic solution.
17	The training infrastructure has already been arranged for the possible problems encountered in the maritime sector. The STCW convention should be rearranged according to the realities of digitalised.
18	Every innovation means more adaptation problems and training. For this reason, the personnel should be subjected to both theoretical and practical training on the necessary applications before being sent to the ship. just like the ISM training given with the introduction of ECDIS on ships. In addition, certain standards for digital applications should be determined and documented by STCW by making necessary updates.
19	The university should allow the students to continue their studies online.
20	I have no idea
21	Online Training on platforms

3. In your opinion, what are the most in-demand skills for students, that maritime universities should consider for the new digitalized maritime market?

1	Communication and writing skills, interpersonal skills. Adaptability, creativity and analytical skills
2	Cyber Security
3	The ability to learn
4	ICT SKILLS
5	Digitization skills, IT and Cybersecurity
6	IT skills
7	As SOLUTIONS I believe that digitization is necessary. This could be helpful in dealing with such challenges. The online environment has developed a lot in recent years
8	Cybersecurity
9	Digital skills base on digcomp 2.1
10	Cyber security skills, collaborative working
11	Using advanced computers. Be aware of threats and attacks.
12	The availability, and the capacity of study by-self.
13	Software user
14	To know how to learn
15	It depands on the market requirement.
16	It is necessary to count, to measure the balance between actual needs of the maritime field and training offers from maritime schools (Universities, colleges,etc.)
17	the skills of seafarers that are not needed today but will be needed in the future are listed as follows. -To know logistics and optimization methods - Have advanced skills in analytics and data usage in fleet optimization - Mastering advanced route planning - Knowledge in operating operationally complex hybrid and zero-emission machines

	- To have the ability to calculate and document for sustainable operations - To have knowledge in remote control operation related to optimization services for ships and remote control of autonomous ships - Have in-depth knowledge of complex systems onboard - Ability to interact with computer systems and respond to challenges associated with autonomous systems - Have the ability to transfer knowledge from one value chain to another, both at sea and in shore-based businesses, including using knowledge to make technological innovations
18	Nowadays, young people are very interested in technology. They follow technological developments. For some people, using digital apps can weaken the connection with reality and cause distraction. For this reason, the training to be given to the students should not only be about learning, but should also include psychological competence.
19	Students should know the educational platform of the university and develop their capacity to understand what the teachers present and interract during the courses and seminars.
20	Motor computer based education
21	Flexibility to learn and develop new skills using internet and online training

4. What training methods do you think will be necessary for teaching such skills to our students? (You can give examples)

1	Basic online searching and emailing, use of drone or various free software apps to train them to be comfortable and confident with the use of gadgets, data management so they learn how to organize
2	Scenarios, Case Studies
3	E learning, simulation training and assesments
4	Lessons(during education) and training(after graduate)
5	Combined methods and online and face to face. A lot of attention and training Education is the most important aspect.
6	Practical methods
7	The didactic strategy is a way of combining the didactic methodology and the educational means through which the design, organization and development of a training sequence is ensured. According to the main way of presenting knowledge: • verbal methods, based on the written or spoken word; • intuitive methods, based on direct observations on objects and phenomena. □ According to the degree of employment of the students in the lesson: • expository methods focused on reproductive memory and passive listening; • active methods that trigger the activity of personal exploration of reality. □ According to the didactic function: • teaching and communication; • fixing and consolidating; • verification and assessment of work results. □ Depending on the relationship between machine learning and conscious learning: • methods based on receptive learning (exposition, expository demonstration); • guided discovery methods (heuristic conversation, guided observation, scheduled training, case study, etc.) • methods of actual discovery (independent observation, heuristic exercise, problem solving, brainstorming, etc.).

8	This is not my area of expertise
9	Practical seminars showing the link with real world activities.
10	Simulation-based learning; training courses more accessible from remote locations
11	I think maritime education should have a digital leg. STCW training requirements need to be revised considering digitalization.
12	Power Point presentation, movies, and case study.
13	Computer based training
14	Simulator exercises
15	Face to face training
16	25% on line learning/training (theory, basic knowlenges) 25% face to face training (advanced theory) 50% practice face to face
17	My training recommendations are: Problem Solving Technique ,Brainstorm Technique Observation Technique
18	trainings supported by virtual reality can be given.
19	Youtube tutorials
20	Simulation trainnig
21	Training on a virtual platform for training and practical skills, interactive program.

5. What key performance indicators (KPI) do you think will be necessary to EVALUATE our students' digital knowledge?

1	Their creativity, communication and collaboration with others who benefitted
2	Offering solutions to a given problem emerged
3	They must be aligneg to corporate goals
5	It depends on the profile and the course taken.
6	Specific indicators for each subject
7	In essence, creating successful performance indicators is all about understanding the company's aspirations using a clear and structured process. The development of meaningful performance indicators that clearly track and visualize performance requires some planning. Each KPI must address a specific business objective and provide accurate and timely information to assess progress towards the objectives. A well-constructed set of key performance indicators helps organizations translate visions into strategies and track the impact of initiatives. Companies thus benefit from a number of benefits, such as a better perspective on their business and real-time information to make informed decisions.
8	This is not my area of expertise
9	Ability to use software based on user manual Ability to write reports based on interpreting the digital information from the software display
10	For example the ability to use different digital devices or the number of graduates of advanced digital skills training courses
11	Virtual evaluation modules.
12	To be measurable and realistic.
13	Project homeworks

14	Realize significant errors
15	Extended practical sesions
18	interaction with computer systems, Maritime professional knowledge, English speaking and writing skills
19	solving a given problem with a digital application to be used (creating scenarios by using the program)
20	I have any idea
21	Multiple quiz questions, written test2

6. Do you think is necessary to include in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandatory requirements regarding digital competencies for the safe operation of ships? Please write your reason(s).

1	Yes, because technology is everywhere hence seafarers must be aware, comfortable and competent in this algorithmic era. For safe operation digitally competent decision makers are a must on board as mostly there are high tech equipments with push botton onboard
2	No
3	Yes
4	YES, BASIC
5	Yes, of course.
6	Yes, because we live in a digital era.
7	YES. I believe that improvements can be made in STCW
8	There are enough digital competencies already included (ECDIS, ARPA, etc.)
9	Yes. Because the safe operation include the use and interpretation of electronic data.
10	Yes, because maritime industry is digitizing many day-to-day operations and existing technology on board is connected to Internet, exposing users to many cyber risks.
11	Definitely.
12	Yes. All educational institutions have applied similar training methods. There is no single form of application and it is not regulated.
13	Yes, because STCW has critical impact on training.
14	Yes, because the real economy tends to digitize.
15	Yes
16	Taking into account the fact that on board the ship we usually work with digital and electronic equipment (radar, GMDSS, computers, AIS, loading computers, etc ...) it would be indicated that all personnel who have responsibilities in terms of safety, to go training courses on digital skills.
17	Because STCW does not meet the requirements of the digital age. For example, in part B of the convention, shore-based trainings are very limited.
18	I think mandatory requirements regarding digital competencies should be included in the STCW for the safe operation of ships. Thus, the standards and requirements of digital applications will be determined.
19	I don’t it is necessary because the maritime companies evaluate them from the first contract, as cadets.
20	it is necessary
21	I agree because everyone need digital competencies according with teaching aids.

4.3. Opinions collected from maritime company (shipping, ship management, crewing etc.)

1. Considering that Covid-19 pandemics has advanced the use of digital technologies in the society, what challenges do you think might emerge in the new digitalized maritime sector?

1	Different standards, system which don't talk to each other. Lack of rules and transparency. Lack of collaboration and lack of focused alignment - creating a disperse and scattered network of solutions. As most digital developers are men, I also see a risk that solutions are not taking female needs or preferences into consideration.
2	Lack of human interaction
3	Cybersecurity, competence building for digital skills
4	Cyber security
5	Readiness in terms policies and competence of human resources
6	Supply/demand imbalance for INMARSAT systems pushing up cost and causing degradation of connection quality. Lack of clarity for shipowners on which new digital offerings can add value and which are more nice to have. Difficulty with extracting the full value from increased data flows. Incorrect/incomplete analysis of data flows due to inexperience and/or lack of competent resources. Digital security breaches. SM related reputation related risk due to lack of training, company policy or installation of employment conditions. AIP and other compatibility difficulties between systems. Reliability problems and lack of on board competence. Digital workload not replacing but instead adding to non digital workload due to regulatory and /or company policy lag. Roll out failures and systems ignorance.

2. What solutions do you think might be useful for such challenges?

1	WISTA can play a role in identifying and communicating women's needs and circumstances. How, I'm not sure, but think it should definitely be explored. Otherwise, I have a lot of hope for blockchain technologies, to ensure transparency and accuracy. Open platforms for collaboration, and open digital code.
2	To use digital technologies only when strictly necessary
3	Training and awareness
4	Training
5	Structured and sustainable capacity building programs and adoption of responsive policies
6	This would be a broad and complex answer which I do not have time for. However I can suggest that first and foremost the formulation of an STCW module on this topic can only function in tandem with management education ashore. Otherwise where those with the knowledge are not the ones with the investment decision role, there is high likelihood of frustration.

3. In your opinion, what are the most in-demand skills for students, that maritime universities should consider for the new digitalized maritime market?

1	human factor, understanding how we work and thrive with digital solutions Leadership skills - always underestimated how important this is Storytelling Then, obviously computer science is important for maritime students as well
2	To remain focused

3	Understanding what digitalization really means
4	Use of virtual platforms for communication
5	Digital intelligence, ability to use big data
6	Technical systems installation and maintenance. Digital systems vocabulary in the maritime context. Data engineering concepts.Maritime digital marketplace, technical resources and limitations. Human interface and paper-digital transitions. Regulatory landscape and outlook. Process and technology efficiently improvement concepts and implementation.

4. What TRAINING METHODS do you think will be necessary for teaching such skills to our students? (You can give examples)

1	role play
2	Different ways to keep them active and to encourage interaction
3	Digital training and on the job training.
4	Practical demo
5	Project-based learning, inquiry-based learning, problem-based learning, and other teaching methods referred to as 21st century teaching methods
6	Classroom, case study projects. Real industry project proposals, maritime and non maritime field study's.

5. What key performance indicators (KPI) do you think will be necessary to EVALUATE our students' digital knowledge?

1	Level of comprehension of the subject matter and ability to manage digital systems
2	Specific training completion
3	1. Being able to use technology and digital media safely, responsively and effectively. 2. Being able to create new content and turn ideas into reality using digital tools 3. Being able to create new opportunities and solve global challenges using digital media and technologies
4	Ability to understand the value and limitations of a digital system Ability to test and criticize a digital system Appropriate level of digital security awareness and competency Knowledge of IT project management and rollout KSFs Ability to correctly evaluate a digital workload alternative as viable or unrealistic. Understanding of vocabulary and compatibility criteria.

6. Do you think is necessary to include in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandatory requirements regarding digital competencies for the safe operation of ships? Please write your reason(s).

1	yes
2	Yes
3	Yes. See personnel must understand the advantages and risks of using digital technologies on ships, as well as their proper use.
4	Optional at operational, mandatory at managerial level
5	Yes, seafarers need to know proper use of digital media and technologies, digital security, digital communication among others because ships' operation involved the use of digital media and computing technologies and with the advent of AI and autonomous vessels

6	Yes, particularly with regard to digital security but also for proper implementation and running of efficiency improvement digital solutions.

4.4. Opinions collected from maritime students

1. Considering that Covid-19 pandemics has advanced the use of digital technologies in the society, what challenges do you think might emerge in the new digitalized maritime sector?

1	People being reluctant to the changes / Training the employees / Protecting the equipments for digital / physical scenarios / a too heavy reliability on digital equipments which are prone to the same type of failures (power outage mainly, EMPs, data interception)
2	As a challenge, the development of new innovative jobs, both onshore and offshore, for both women and men.
3	Due to the Covid - 19 pandemic event, the digitization of ships had both, positive and negative influences. For example, in one way, the systems have heavily integrated digitally, with many applications for communication and data transmission and operations performed without a physical contact between people, but also on the other hand, very short time to accommodate people of all ages with this type of integrated features in use, and the most disadvantage present in this time, no time to exit from the ships, without the right to visit the land and take a break from the work environment.

2. What solutions do you think might be useful for such challenges?

1	Trainings and hard evaluations to make sure everyone has a good graps of the technologies, testing the equipment and having teams of ethical hackers analyzing the systems and dedicated IT personnel, backup of the data and of the systems both locally + off site (if network bandwidth allows it), PSUs
2	Developing groups of young people who can share their experience so that those who do not yet want to try this career, can be encouraged.
3	In my opinion, new regulations have been well thought out, but without highlighting the human factor, which for a person who can be stable on a ship for up to a year, is physically and mentally harmful. First and foremost, provide the minimum means of communication in order to keep in touch with those close to you. Another example is arrangements and rights for sailors everywhere to leave the ship for release from the working environment by the states in force.

3. In your opinion, what are the most in-demand skills for students, that maritime universities should consider for the new digitalized maritime market?

1	analytical skills, high adaptability, system understanding
2	To know the equipment on board and thus to learn how to use it in the operation of the ship, to be sociable, open to new, to get involved, to know the legislation and the basic rules.
3	Foremost, the practical environment in different domains for the students to make a basic idea from the working environment and also standardization courses about the applications and programs in use for administration, logistic or engineering branch, were the market have interest.

4. What training methods do you think will be necessary for teaching such skills to our students? (You can give examples)

1	theory + hands on labs
2	To be able to get involved in as many interesting activities as possible in the faculty, to be able to develop their passion for this profession, to be involved in the simulator, to be able to train in the training of knowledge and development skills of digital equipment.
3	For the training method, we can consider the presentation of work environment, what means different trips to large local companies in the field of the university. Another method involves integration into national and international projects for training ideas for students. And a third example, bringing important people involved in the current fields of digitization who can present in more detail the new era of work

5. What key performance indicators (KPI) do you think will be necessary to EVALUATE our students' digital knowledge?

1	General IT / systems understanding, networking, analytic skills, log reading, error understanding, basic troubleshooting, disaster plans
2	Providing moral support during the evaluation, involvement in the development of new groups of students who can share the experience.
3	First think, the evaluation of the students content the involvement in the project and the way in which they took part in achieving the objective, not by classic grades of promotion or rejection of the acquired knowledge. Another factor would be their reception in the new more consistent work environment, gradually, from the basics to the criteria of finesse, not an overview of the course of the special features of work applications

6. Do you think is necessary to include in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandatory requirements regarding digital competencies for the safe operation of ships? Please write your reason(s).

1	Yes, I think they are necessary.
2	Yes, because it is important to operate as safely as possible by a designated person
3	Yes, for integrate the new generations and old generations in the new era of digitization for the ships system and rules.

4.5. Opinions collected from seafarers

1. Considering that Covid-19 pandemics has advanced the use of digital technologies in the society, what challenges do you think might emerge in the new digitalized maritime sector?

1	The need of good speed internet access on board
2	Challenges as observed by me:
3	Especially on the shore personnel: is very hard to get some service onboard the vessels as a lot of people are working from home and the number of technicians is reducing.
4	Digital technology is good. But without having the proper time onboard to perform our duties in safe manner is useless.
5	Also not all personnel are familiar with digitalization.
6	In my personal opinion commercial pressure and digitalization should work in the same time together.

7	Another good thing about digitalization is that a lot of records remain saved in history.
8	Also is good for the environment.
9	adjustment to electronic learning process
10	Autonomous ships.
11	Training under STCW for practical activities using remote technology
12	To upgrade and to implement the crew digitalized level
13	The maritime sector need to improve the quality of the internet on board and, traffic rates and software
14	Facing digital difficulties for those that did not have the opportunity to develop digital skills
15	INCREASE THE USE OF DIGITALISATION
16	Cyber security
17	Challenge for companies to invest in communication equipment
18	The digital divide – unequal access of the population to technology. Uneven development of scientific and technological knowledge in regions and States. Fraudulent behavior Ethical challenges in relation to technology generated by virtual organizations, virtual transactions, remote work. Automated Decision making/bias AI – AI algorithms and the data they collect can be biased, just like humans, because they are also generated by humans. These biases prevent SYSTEMS FROM making the right decisions. Lack of transparency in the use of artificial intelligence – protecting space and privacy. The European Union has regulated our rights to protect our data through the GDPR (2018). General artificial Intelligence (IAG) – a machine with human-like understanding might be a threat to humanity and such an industry should be regulated. Replacement of human control and autonomy at work by automated control.
19	No
20	IT (software, hardware problems), internet connection
21	First of all, not every company provide free internet or enough (100-300 mb), even is with money. In this days communication with your family and friends is very important on-board. In my opinion this is the challenge which Companies must give more importance.
22	The main challenge I believe will be the security of the systems against viruses and hackers against the company the vessel and the crew personal data
23	I did but not enough
24	Yes

2. What solutions do you think might be useful for such challenges?

1	Things are progressing in this way so most of the shipping companies already provide full internet access
2	The best solution will be to increase the number of personnel onboard. For example one additional officer is necessary on board of the vessels. He can do a lot of paper work and in the same time can help and familiarize with the other jobs onboard. Otherwise honestly we cannot perform the job in a safe manner.
3	receiving procedure through personal email for learning
4	IT training
5	VR equipment with realistically simulation software.
6	Trainings on board and in Companies
7	Maritime company to involve more in proceed and to spend money and time to face the new challenges
8	Digital training for all no matter the rank, position or occupation.

9	HAS TO IMPROVE THE DIGITAL KNOWLEDGE
10	N/A
11	For seafarers it's very useful because they can have a better communication home
12	The purpose of technology is to help, not to replace people. Understanding this approach is essential to overcome natural resistance to change and ensure the success of digital transformation implementation. Whether employees, customers or business partners, it is the people for whom and with whom a company can migrate to digitalization.
13	-
14	To increase the training process in IT even from high school, to create more jobs on board of the vessels that are facing serious IT problems. To implement an internet connection free and at all the times on board of the vessels.
15	Companies to make an effort and provide to seamans possibility to communicate with their family and friends.
16	Up to date antivirus program knowledge against opening/using un approved software
17	More electronic log books
18	Support level must increase the awareness of the use of Technology

3. In your opinion, what are the most in-demand skills for students, that maritime universities should consider for the new digitalized maritime market?

1	At least to manage the Office pack at a satisfactory level
2	Practice onboard. Simulators.
3	computer literate is a must/simulation
4	See above....IT training.
5	The development of decision-making skills related to multiple equipment information available
6	The compliance with maritime new requirements, practical training in line with specific activity on board
7	We need students to be open minded, hard workers, capable to learn and adapt in sort time, with skills in digital word
8	A digital course, based solely on computer skills like mail, operating system usage, but especially Office or the likes of.
9	STUDENTS HAVE TO BE FRIENDLY WITH THE COMPUTERS AT LEAST WITH THE OFFICE PROGRAMS
10	Programming skills
11	To be familiar with social media platforms
12	1. Critical thinking 2. Social Intelligence 3. Adaptive thinking 4. Cross-cultural ability 5. Mathematical thinking 6. Understanding media content 7. Transdisciplinary skills 8. Mental organization skills 9. Cognitive management skills 10. Virtual communication skill
13	On this time we need to increase the capacity of students..
14	Software knowledge, Hardware knowledge
15	I.T.
16	At least the minimum knowledge in IT and special courses for the specific equipment onboard vessels
17	Microsoft, simulator, coding
18	A I

4. What training methods do you think will be necessary for teaching such skills to our students? (You can give examples)

1	Computers and skilled personnel
2	Simulators. Also will be good to hire some sea experience people. Traffic simulation on radar. Passage plans.
3	simulation through computer system
4	Simulators.See above
5	Simulations of realistic scenarios.
6	Update knowledge of the new requirement and effective practice
7	Train in the school already the software and programs that are used on board
8	First of all the training of the faculty, and after laboratories held with leading example and practical exercises.
9	MORE PRACTICAL KNOWLEDGE GATHERED AT THE COMPANIES DURING TRAINING
10	IDK
11	I believe one hour per week of informatics in English is good for students.
12	Better use of digital technologies in teaching and learning Developing digital skills and competences Improving education through better data analysis and a forward-looking vision
13	More practice as Navigation chart plotting etc.
14	Online trainings, courses that are on an platform and you can have access even from on board of the vessels
15	The real training is when you board the vessel. Here is the reality
16	Practice is the most easy way to learn
17	A lot of video presentation and one on one coaching
18	Practical training

5. What key performance indicators (KPI) do you think will be necessary to evaluate our students' digital knowledge?

1	Computer based skills should be mandatory
2	Real situations and also to provide paper works that are used onboard. Former student can help. Also can make meetings with former students in order to give their personal opinion regarding the job related matters.
3	learning computer more
4	See above.....simulators.
6	The KPI standard must be correlated with students specific activities. For exemple we are using an ExxonMobil self assessment KPI which is specific to our activity
7	Need to be full capable to operate using digital technology
8	Existing of specific rules and the application of these rules at the level of university
9	Technical ability, people skills, etc.
10	Same as it is
11	Student Achievement Discipline Referrals Attendance Rates Graduation Rates Teacher Satisfaction
12	Yes
13	Don't know
14	Preparing documents as instructed
15	IQ and GPA together

16	Computer based skills should be mandatory
17	Real situations and also to provide paper works that are used onboard. Former student can help. Also can make meetings with former students in order to give their personal opinion regarding the job related matters.

6. Do you think is necessary to include in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandatory requirements regarding digital competencies for the safe operation of ships? Please write your reason(s).

1	The computer-based skills should be included in STCW, specially for officers
2	Yes, should be. But proper training should be made.
3	yes in line with E learning
4	Certainly, reason being self-explanatory.
5	Yes, only on management level and industry specific.
6	Yes, this is the future
7	Yes is necessary! Due to increasing of technology and the need of software in normal operations
8	Yes. Taking in consideration that almost all operations onboard are digital, a digital competency training/requirements must be mandatory.
9	YES - CONSIDERING THE TREND OF MARITIME INDUSTRY
10	Yes
11	Yes because in our days most of the equipment on board is digital
12	No
13	It's very easy to display to others...
14	To save more time on the vessel, to save the crew from stress and to help the crew for a happier environment.
15	For me is one more paper.
16	I believe they will be good. Already technology is evolved compared to what was 10 years ago. Continuous progres is and will always be required
17	Yes. Lots of people can’t even use the computer and this is an era where everything is on a screen
18	Yes and to be renewed and refreshed as well

5. Analysis of Findings

Reacting properly and duly in situations of digital and technological crisis is a key aspect during challenging advanced maritime operations. In such context, a new type of maritime leader is emerging: the *digital leader*, which is the icon person who explores the growing use of digital technologies in maritime operations, addressing risks in fast-moving digital and real environments, while adapting the role of mentorship for both non-tech and high-tech skilled followers. In the Algorithmic age, digitalization contributes to upward economic and social convergence, promoting sustainable growth of economies and encouraging the creation of high-quality maritime jobs and added value in the transport sector. Digital technology supports the process of transforming the way in which existence can be facilitated by integrating maritime stakeholders and fields of activity for the benefit of seafarers, their families and maritime businesses overall.

The Covid 19 pandemic had a profound impact on seafarers that were refused for crew exchange, lost their job or experienced significant income loss. The next generation of professionals need to upskill to keep their job in a new work environment. For young people, entry in the maritime labor market can be very challenging. Access to enhanced digital skills through MET has the multiplicative outcome to strengthen sustainable competitiveness and ensure social fairness through access to education, training and lifelong learning in the maritime sector and builds resilience to react to crises, based on the lessons learnt during the COVID-19 pandemic.

In the algorithmic era, emerging technologies such as Artificial Intelligence, the Internet of Things, datafication or the teleworking phenomena lead to new and increased digital competence requirements on the part of the citizen.

There is also an increasing need to address the green and sustainability aspects of interacting with digital technologies through the necessary knowledge skills and attitudes needed by the next generation of seafarers in the face of these developments. Seafarers need to be able to fact-check online content and its sources (information literacy), and they need competences when interacting with AI systems, to enable them to avail of new opportunities offered by technologies, while dealing with the risks occurred from algorithmic developments in social media and digital technologies.

There are several consolidated effective actions of networking for capacity development of leaders in the maritime sector. The research has analyzed the particular societal influences related to cyber and algorithm risks in global MET system. Among the research activities, the practical approach of building human capacity was related to finding effective ways of developing digital leadership and algorithm literacy culture in shipping. The main outcomes show there are critical basic digital skills required for the safe and dully operation of ships. MET programs are not effectively including such basic skills in the curriculum due to the fact is expected MET students already obtain the basic digital skills during high school.

Without having basic digital competences (as knowledge in working with PDF and Excel documents, creating and merging reports, filling port of call's online documents with various formats etc.), the effective capacity building and integration of digital leaders remains under question, as disaggregation of digital competences is observed in the maritime sector.

Digital leaders are expected to share updated perspectives, knowledge and experiences to ensure safety at sea, maritime cyber security and the protection of the environment, while assuring enough employability skills for the dynamic maritime industry, however the occurrence of training such leaders is threatened by lack of critical digital competences taught homogenously in the first year (s) of maritime studies.

In the algorithmic age, gender, racial and ethnic stereotypes in the maritime education and employment should be tackled, while supporting diversity and inclusiveness, including for young

people with disabilities that can achieve on shore employment in port and maritime. Countries and maritime universities less technological advanced should be empowered to have equal chances for development and knowledge sharing.

Next generation of seafarers professionals need to enter the international maritime labor market with at least basic digital skills, achieved through minimum short and hands-on preparatory trainings, related to specific skills needed by the maritime sector. Crash courses, open online courses or boot camps can improve, in particular, young people's digital skills and those needed for the green transition, but also entrepreneurial and career management skills. Priority operations include training sessions of short duration, reinforced mapping systems, early warning systems and tracking capabilities. Vocational education and training increasingly cater for the upskilling and reskilling needs of our adult population, it plays a key role in supporting youth employment too, in particular through apprenticeships and cadetships in the maritime.

Is needed a scientifically solid and technology-neutral basis for a common understanding of digital skills needed in the maritime sector and framing policy, while emerging technologies, such as Artificial Intelligence, Virtual and Augmented reality, robotization, the Internet of Things, datafication or new phenomena such as misinformation and disinformation, have led to new and increased digital literacy requirements on the part of the next generation of maritime professionals.

Dynamic academic leaders are best role models for the next generations of maritime leaders that we need to provide mentorship and guidance. Maritime educators are their best sustainable models and they need to be aware on the challenges of the new algorithmic age, as their students represent the generation taking further all our programs, projects, activities and efforts, while continuing the vision for an equitable sustainable seafaring profession

5.1 Opinions and Expectations of Maritime Employers regarding Digital Competences

The opinions and expectations of employers in the maritime sector address the need for good practical training of employees, supported by modern information technologies and appropriate IT equipment. These assessments were obtained from interviews with representatives of companies, professional associations and government institutions. In order to cope successfully in the new interconnected world of maritime transport and digital maritime transport, adequate education and training of navigation officers and crew, based on the new reality in transport, is needed. Maritime officers should have the knowledge and skills necessary for the operation and competent use of the computer systems with which modern ships are equipped, of the various equipment and machinery that are controlled by computers.

Modern ships contain many different equipment and machines that operate non-stop. Systems such as the engine, fuel supply, electricity, climate control, among others, require constant monitoring. Changes in temperature, fuel and oil flows and other parameters must be observed, recorded and analyzed. By using computers, the task of keeping track and analysis would be easier, which in turn improves overall performance.

At the same time, the use of modern information technologies and their application on board ships make life on board easier to manage. Thus, ships and their crews depend on different types of supplies. These include food, water, fuel, oil, spare parts and more. By using computerized inventory management systems, records of supply use can be analyzed and data can be used to make use and supply more efficient. Routine maintenance can also be facilitated by systems that monitor the daily use of the machines and record maintenance dates and times. Such systems help to remind the maintenance crew which systems need preventive maintenance and which ones need to be replaced.

Navigation systems for modern ships use GPS, radar, sonar and computer maps along with radio and satellite communications systems. These systems help navigation officers find their way and follow their routes even in the dark, bad weather or low visibility.

Cargo operations require the timely processing of cargo movements to and from ships. Systems that monitor the weight and balance of bulk and liquid cargo are vital not only for fast and efficient transfers, but also for the safety of transport and port crew.

ICT skills are also becoming increasingly important in port and related maritime industries, as technological advances involve the digitization of information exchange and the automation of port activity (through connectivity to a local network and the Internet, radio and satellite communications systems), computerized inventory management systems, systems that monitor the daily use of equipment and record maintenance dates and times, automatic door opening systems, development of container terminals, etc.).

Information technology education and training for learners should be supported by an e-learning platform, built to enable participants to improve their knowledge and gradually assess their level of achievement. The main purpose of the training is to acquire skills for using the computer as an universal means of data processing, for the use of office programs for word processing, spreadsheets, graphics processing, communications, the use of computer networks and the Internet, etc.

Preparing a theme for the integration process both in terms of the school curriculum and in terms of IT technologies, specific to navigation and shipping:

1. Microsoft Office: Word, Excel, PowerPoint, and Database Programs for Managing Documents and Workflows:

- Creating and editing Word documents, advanced use of Word text editor:
- advanced formatting of text, paragraphs, columns and tables; auto-formatting options;
- working with styles and sketches, forms and creating template documents, creating and updating contents;
- use of drawing tools;
- working with headers and footers, advanced numbering, adding references;
- inserting and working with tables, text-table conversion and vice versa, formatting and operations in tables, conversion of tabular information into diagrams, options for numbering lists on several levels;
- merging, sharing and distributing documents, advanced mail merge techniques, Object Link Editor - creating links for data integration, collaborative work;
- tools for monitoring changes, adding comments;
- document verification for private information, application of security settings;
- sectioning the document, creating a master document and adding subdocuments;
- properties for printing documents, saving in the cloud;
- functions related to the temporary memory area (Clipboard);
- working with macros and editing equations;
- document protection and authentication;
- creating electronic forms in Word;
- AutoCorrect, AutoText and AutoFormat;
- facilities for sharing and collaboration in Microsoft Word.
- Using the spreadsheet program MS Excel:
- data search, replacement and selection, cell formatting;
- MS Excel functions and formulas, formula verification, data consolidation function;
- data sorting and filtering, conditional formatting, data validation, queries;
- creation of graphs, reports and dashboards, tracking changes in the calculation register;
- grouping and structuring data;
- creation and management of Pivot Tables;

- solving complex problems - using the Solver tool;
- importing data from text files and other applications and exporting data to other applications;
- sharing the spreadsheet and creating links between spreadsheets;
2. Creating and editing documents in pdf format: advanced options for working in Adobe Acrobat - creating, editing content, combining documents in different formats, signing, creating PDF forms, converting PDF files to editable Word or Excel files, functions that ensure security of PDF files.
3. Image management and photo editing: image resizing, cropping or saving in another format, other graphic tools.
4. Reducing file size, splitting large files into small data packets:
- the size of files transmitted via satellite internet is limited, so large files are compressed and divided into smaller packages (involves the use of archiving programs). They will be assembled and decompressed to the user.
- also, photos and video files will be transmitted at the lowest intelligible resolution and their conversion will be done with dedicated programs.
5. Import, export and update documents / maps E-charts: In recent years, physical navigation maps have been increasingly abandoned in favor of electronic maps. Electronic maps are easier to keep up to date, easier to handle and access and can be integrated with other modern means of navigation.
6. Networking, Servers, Printers, Scanners, Data Backup, Memory Management (HDD, SSD, Portable):
- on-board access (crew):
- managing and monitoring users' access to network equipment (PCs, printers and scanners);
- sharing resources within the network, how certain authorized crew members can connect with cameras, portable memory devices and certain files to be transferred between devices;
- cybersecurity recommendations to avoid infecting the ship's computers or operations;
- remote access (from Office): users authorized by the Company may have access to the ship's computers remotely, via satellite Internet, through applications such as TeamViewer.
- anti-virus / anti malware protection: the antivirus is periodically updated on board, through software packages that are periodically installed on board.
- periodic back-up: also periodically, generally automatically, back-up is created on the ship's servers and on physical storage medium (usually manually).
7. ISM monthly, quarterly, half-yearly, yearly papers: preparation and transmission of ISM from the ship to the various departments of the company for their evaluation and review.
The documents are prepared and operated in MS Excel, MS Word - transmitted as such or converted to PDF format (documents are periodically audited at ships and company offices):
- periodic inspections of equipment
-event counting
-evaluation of equipment performance
-consumption of environmentally hazardous substances and materials
-treatment and disposal of environmentally hazardous waste
-record of trainings and evaluation of crew members' performance and working conditions on board
- inventory and analysis of consumption: water, fuel, supplies, spare parts, maintenance materials
- electronic inventory of personal documents of crews for authorities, charterers, charterers, inspectors
- documentation of training, learning and examination sessions of crew members on board the ship
8. Backup, import-export data from proprietary software and their transmission to third parties:
- Cargo (Bulk, Liquid, Containers, etc.) handling: Loadicator, Cargo Planner, ASTM tables, Units Converter: loading and unloading operations of the ship in order to make optimal use of the volume of cargo available and to avoid stress or abnormal floating positioning of the ship, bunkering, ballasting

of the ship and the use of different measuring systems depending on the systems of the countries / commercial entities traded.
- Ship's stress calculation: overcoming the tensions / stresses of the ship's structural elements can lead to catastrophic events. There are electronic means of calculation, including proprietary software (developed in the MS Excel environment) that evaluates the static and dynamic loads of the ship.
- Air Pollution evaluation for MARPOL Annex VI Compliance (SOx, NOx, ODSs and VOCs): water and air pollution are strictly regulated by the Annexes of the MARPOL Convention. Quantities, limits and emission zones are monitored and documented on board the ship.
- Excel spreadsheets for calculating emissions of Sulfur Oxides (SOx) and Nitrogen (NOx), which displays whether the ship emits within the permitted limits.
- various documents that monitor the loss of gases that destroy the ozone layer (ozone depleting substances), paints that harm the marine environment (zinc-based) or emissions of volatile organic compounds, especially in ports.
These records and journals are managed in Word and Excel and use advanced processing and editing features.
9. Planning: import and export of data from travel planning messages on the most efficient routes, planning the loading and unloading of the ship according to the port and the cargo plan, human resource planning, progress reporting plan of operations and other activities.
10. Inventory of resources: water, fuels, lubricants, paints, supplies, consumables, spare parts.
Data logs are maintained in spreadsheets and database applications and are transmitted and analyzed by company departments.
11. Communication of crew members' competencies and personal data to third parties: electronic transmission of crew personal documents to authorities, charterers, inspectors.
12. Communications (including satellite communications):
- The ship's communications in its immediate vicinity can be carried out quickly and efficiently by radio or signals.
Communication logs are maintained, transmitted and stored electronically as evidence in the event of subsequent disputes.
- GMDSS (Global Maritime Distress and Safety System) and AIS (Automatic Identification System).
Officers are licensed to use GMDSS, radars, AIS and other means of navigation.
Maintenance and operation logs are maintained and archived electronically for use as evidence.
- Internet Communication with Main Office (Owner or Company Management) and 3-rd Parties (Charter, Agent, Authorities, Inspectors, etc.) or Personnel / Private Communications.
All official communications of the ship are saved and archived. Modern communication is done by e-mail or telephone. There are alternative solutions, when satellite access is restricted.
Note: Private communications are via smartphone applications via the Internet, satellite or satellite telephony. However, the counting of internet or telephone traffic and access to the cards is monitored by a deck officer, appointed by the master of the ship.
13. Database applications for Planned Maintenance System (PMS): the periodic maintenance of on-board installations and equipment, of the stock of spare parts and consumables required is computerized because access is given to preventive maintenance and the limitation of unplanned repairs. Unplanned repairs can be catastrophic in an uncontrolled marine environment (severe weather, limited access to spare parts, equipment, skilled labor, etc.).
Based on the manufacturers' recommendations, the equipment is inspected and serviced periodically and the inventory of parts, materials and works is maintained through database software.

5.2. Challenges in the Use of Artificial Intelligence Digital Tools for Maritime Businesses

The context for artificial intelligence based changesets was anticipated around 1970, when Alvin Toffler, a futurist and visionary businessman, published the book "Future Shock", printed in millions of copies. After four decades, in 2016 (the year when he died), a BBC News article made an analysis of what Toffler had correctly anticipated and what he had not "guessed" until then, e.g. "demarcation of post-industrial societies, eclipsed by a knowledge-based economy" or shifted focus from manufacturing and labor to information and data" [3].

Today, at the level of 2022, is interesting to reanalyze the context of Toffler's predictions and to see what he anticipated correctly or not.

By evaluating the technological developments, social changes and political and economic context, we observe that what Toffler had anticipated in 1970 was, in fact, totally correct, and has become, in the meantime, a reality. For example, the "shift of work from both office and factory back into the home", leading to the raise of the deurbanization, is confirmed. This happens especially in the context of pandemics when maritime companies working environment is partly or totally switched from the office area to remote working from home, in order to avoid risks of contacting Corona virus which is spreading rapidly and aggressively in closed environments with lack of air circulation.

Another aspect that we notice Toffler got right is that "social isolation ignites by the wave of information". The raise of social media platforms like Facebook, Instagram, You Tube, Twitter, Pinterest, Tik Tok, We Chat, WhatsApp, Viber, Signal and other contribute to social isolation.

Toffler prediction of establishing colonies in space is in the process of becoming a reality, in 2021 first tourists being able to travel to space.

Although organizations initially understood the Internet as a new channel to increase their presence, they soon began to look for ways to maximize their various platforms and services. Currently, online marketing communications are an essential part of operational marketing in terms of becoming, in itself, a specific marketing line: digital marketing.[4]

Use of artificial intelligence is becoming more popular for communicating between the maritime company and customers through chatbots useful for natural and quick answers to customers.[5] Alibaba, a major China based technology company specializing in e-commerce, retail, Internet, and technology, with 500+ million users, combine big data analytics and artificial intelligence to customize customer experience both in physical store and in online store [6]

An AI based digital marketing plan, in addition to study the maritime organization and its environment, must analyze its online presence and position. A concrete digital strategy compares the following elements:

- Monitoring the keywords of the organization, the competition and the sector of the organization (some useful tools are Mentions, Google Alerts, Hootsuite)
- Evaluate the web positioning of the organization and its platforms (for example, Google search or Alexa top ranking)
- Evaluation of social networks. Presence, activity, influence, etc. (a number of tools such as Klout, PeerIndex and Kred become relevant here)
- Comparative analysis of the competition and the main influencers in the sector present on digitalmedia
- Specific SWOT analysis [7].

Social media is not only a market place, but is also a place where companies interact with customers to try and solve their problems. Maritime companies should be aware social media is "a major player in most people's business lives"[8].

Although the notion of social network is not new, in the period 2020-2021 it has reached new heights, due to the penetration and connectivity of Web technology and Artificial Intelligence technologies. Social networks have been developed through platforms that have different types of

functions, but common features. These features aim to create a community by connecting users, who can interact, discuss, provide information or knowledge. And in the case of these platforms, the technology must be flexible and favorable to the exchange of information. This means that free web standards and modular architectures that lead to complex but efficient applications are usually preferred [9].

5.3 Digital Skills needed by Maritime Leaders in the Algorithmic Age - Correspondence between Algorithmic Age and Information Society

Computational thinking is a relatively new concept that emerged at the beginning of this century and has quickly become popular because of its main premise: all people can use computer skills to solve problems in other domains. This concept is relevant because problem solving is one of the necessary skills of the 21st century. Currently, the idea is maintained that the development of computational thinking is directly related to learning computer programming, and for this reason, efforts to promote computational thinking have been oriented towards the inclusion of introductory programming courses in the curricula of educational systems. However, considering that learning programming is widely known to present several difficulties, it is necessary to reflect on other ways to develop computational thinking. In that sense, the purpose of this article is to present reflections that lead to a proposal based on metacognition, for the development of computational thinking during the execution of daily life activities.

While the new concept Algorithmic Age focuses on the time context where algorithms are used intensively in the production of applications and technologies and processes essential for our everyday life, the information society becomes a classic concept that refers to the changes that society has undergone, as well as the ways in which it is organized, due to the use of Information and Communication Technologies (ICTs).

The information society is the society that has implemented ICT in its way of life. That is, it uses ICT extensively to organize itself as a society and to interact with each other. The concept originated in Japan in 1960. It seeks to expose the changes that societies have experienced after implementing the use of ICTs within them. All this, in the name of a Digital Revolution, a digitization that has not ceased to expand across the planet.

Social networks, media, as well as a number of AI tools, are instruments through which these Information society enables humans' interaction.

Leading scholars of the subject regard the evolution of the information society as the heir of industrial society, evolving similarly with the industrial revolution and paving the way for disruptive innovation and transformational change (although the term „disruptive innovation" is recent).

The origin of the information society concept dates back to the 1960s in Japan, where one of the most highly regarded authors being professor and sociologist Yoneji Masuda. For this reason, Professor Masuda is credited with the authorship of this concept, in addition to the fact that he is one of the main precursors of studies based on this concept.

Among the characteristics that define an information society, the following should be highlighted:

- o The society is heavily based on the use of ICTs.
- o The society is characterized by the large volume of information flowing through these ICTs.
- o Interaction between individuals is usually carried out through these ICTs.
- o Participating in ICT is much easier.
- o Communication is immediate and effective.
- o Information is accessible to everyone.
- o There is a great diversity of opinions.

Although said information society has more advantages than disadvantages, it is worth highlighting the two sides of the coin to objectively evaluate this concept. Among the of advantages of the information society, it is worth highlighting:

- o There is greater access to information, that is immediate.
- o It facilitates interaction between individuals.
- o It facilitates globalization and the transfer of knowledge around the world.
- o It promotes debate and diversity of opinion.
- o It promotes productivity and efficiency because of its speed.

Among these drawbacks, it is worth highlighting:

- o Information is not always true.
- o Fake information can go viral, creating confusion.
- o Abuse of "fake news" can cause physical and moral harm to people.
- o The volume of information makes it difficult to choose.
- o It's a very un-personal and very digital society.

Specialists also highlight differences between information society and knowledge society These two concepts, in practice, may seem similar. However, they have differences that should be highlighted. Prominent among the advantages enlisted above is one that essentially shows the difference between the information society and the knowledge society. In this sense, their difference lies precisely in the difference that both concepts present. Thus, while knowledge may be information, not all transmitted information is knowledge. Fake information, „fake news" as well as other sets of phenomena mean that these societies do not represent the same thing.

The Internet is the tool that allows these societies to exist, so it is the best possible example. In a world where change is a constant, it is essential to create seafarers professionals with both technical and soft skills such as problem solving, sharing innovative ideas, which are essential to be able to meet new challenges.

According to [10], while in the past seafaring was considered to be a life-long occupation [11], [12], [13], [14], offering hierarchical advancement, job security and retirement certitudes, nowadays the attitude towards the longevity of the seafaring career has shifted, and it is no longer considered to be a 'job for life' [15], [16], [17], [18], most individuals finding on-shore employment opportunities at a moment of their professional path.

Although a conclusive statistical study was not yet published to analyze the percentage of seafarers' that structurally change careers from sea to shore-based employment, there is observed an increasing rate of such phenomenon in most maritime countries.

Therefore, Maritime Education and Training institutions need to educate their students to be prepared for both sea and on shore careers challenges met in the information society from the algorithmic era.

In the table below are explained seven key skills needed by maritime professionals, relevant for their off shore career or on shore activities.

Table 1. Skills for maritime professionals in the Algorithmic Era

No.	Skills	Comments
1	**Digital management skills**	Digital adapted experts in the maritime must be able to quickly conduct analysis of massive amounts of data, as well as have the talent to create clear and engaging text for platforms such as Google Ads. The right specialists will be able to increase traffic to the maritime companu website and significantly improve the webpages.
2	**SEO: technique and content skills**	Search engine optimization (SEO), is key knowledge for maritime businesses and digital (IT) departments of maritime companies. With consumer searches increasingly starting and ending online, maritime business competition for ranking keyword placements on search engines has never been more relevant. As a result, it is important to make sure the maritime company employs a team of professionals specialized in SEO digital content, treeing, link building and analytics.
3	**Digital content strategy skills**	Having the ability to reach specific audiences in a complex maritime environment means higher aims and more qualified leads. Although many areas of content can be automated, the skills required to create data-driven strategic approaches are highly coveted and represent a necessary asset to any maritime organization
4	**Social media for maritime brands**	Maritime companies need social media managers with seafaring technical background, equipped with a wealth of skills: from the ability to perform effective customer service, launching campaigns to influence the purchase of services or products, to the ability to generate digital content. Given the growth of competition in online shares, relying on a social media expert to get the most out of social channels is more important than ever.
5	**Video and animation skills**	Videos and media files are the basic instruments used in digital environments for exploring maritime business competitiveness. Creative skilled with the use of the camera, experts in editing and animation, or preferably, a resource that can handle all of these functions are highly needed. Now that the TikTok generation, coming after the YouTube generation, is entering the workforce the brightest talents in the market are highly engaged by maritime organisations.
6	**eCommerce skills**	With the boom in online commerce, the shift toward digital retail continues to accelerate. E-Commerce Manager is a complex role that requires numerous skills, ranging from a propensity to think in an omnichannel environment, to the ability to analyze big data, to become familiar with digital marketing disciplines.
7	**Programmatic advertising skills**	As awareness and adoption of this algorithmic form of digital advertising, once outsourced to external agencies, grows, maritime brands increasingly prefer to have in-house specialists to monitor and improve the return of investment of what is still a nascent discipline. For greater control and a more cost-effective approach to programmatic media, experienced professionals in this area of digital marketing are required.

Considering the respondents' opinions collected in this study and the digital competences included in the Digital Competence Wheel tool, developed by the Center for Digital Dannelse specialized in digital formation and digital competences, a synthesis of 54 most critical digital competences needed by MET students and graduates were included in the Table 2. In the Attachment of the report is included a model of the Digital Competence Wheel, which is theoretically based on a major EU research project called Digital Competence Framework for Citizens (DigComp) providing a common understanding of what digital competence is. It also provides a basis for framing digital skills policy. DIGCOMP, derived from

the European Parliament decisions, included digital competences as one of the eight core competences for lifelong learning, among the following Key competences in Fig. 2 below.

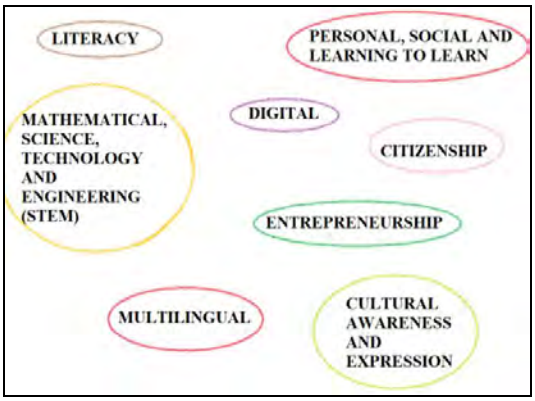

Fig.2. The core competences for lifelong learning established by the European Parliament

Selected digital competences were considered as being critical for MET students' interaction with the academic tasks, during cadetship voyages or further, during employment on board vessels or in the case of employment on shore. The enlisted competences are required not only in the MET and business environment, but also in the interaction between the user and other stakeholders involved directly or indirectly in the sector, peers, family members, during the physical or online interaction with other members of the community or outside such interactions.

Table 2. Digital competences needed for maritime studies and maritime business

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
1.	Storage Options	Knowing how to store data, photos, videos and documents in the cloud, on a hard drive or a portable device; Knowing pros and cons of storing data in the cloud, on a hard drive or a portable device consider security, availability and legality when content is stored Format and save a file or a picture in the most appropriate format Understands the guidelines for where and how material is stored. good at storing content in a way where you can easily find it again	Storing ship log book Storing vessel documents Storing MET projects Store voyage data in a file or in the cloud
2	Choice of Storage	Consideration of the security, accessibility and legality when content is stored	Choose the safest content storage media
3	File Formats	format and save a picture in the most appropriate format (for example, JPG, PNG, or raw)	Save pictures for projects of Bachelor thesis
4	Make backups and restore data on all relevant	Duplicate important data such as images, address	Duplicate vessel data (e.g. passengers/crew

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
	digital devices	book and documents on the phone, computer and tablet to a safe place.	list)
5	Evaluate information	To evaluate information critically, considering both the source and the placement; To consider the author and the website's credibility and how old the information is	Evaluate information received from the on shore office Evaluate information received from port authorities
6	Search engines	Understand how search engines operate, classify and display results Understand how search robots process and index digital resources and how these search results are returned to the user Larn how to do more complex searches on Google. For example, using date range, sentences, ignoring words, sorting of hits, etc. to search in, for example, Google advanced search. To be able to search information in English, with English keywords instead national language	Search for information on relevant cargo stakeholders, ship's agent, surveyors or authorities to make an informed decision about them. Search for port and shipping relevant data in English language; Search for the relevant multimedia or file type. For example, an image in the correct file format and resolution resulted from ECDIS
7	Networking	Mental map of how networks and the internet are built, the connection of websites, domains, servers and the different purposes of the content (e.g. personal, commercial, informative)	Understand the network of communication ship-shore-authorities
8	Search filters	make good use of search filters to limit the number of search results Knowledge of how to sort search results by date, author, multimedia or file format using filters	Know how to search and sort relevant data for the maritime sector
9	Search on the internet	proactive attitude towards finding and collecting information from the internet	For example, know how to look up means of transport cargo and providers schedules, facts, authorities opening hours, and news on the web Search, find and explore maritime information and data stored internally in the maritime shipping or crewing company.
10	Digital self-service options	Knowing most relevant digital self-	How to use

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		service options and understand how to use them	digitalization in daily professional and personal activities. For example, make delivery address changes, make plane reservations, apply for a health card, make a medical appointment, or pay a bill through online banking
11	Safety	To consider safety aspects when shopping online, using online banking or using public services that require private data Feel safe when using, for example, credit card details, home address or social security number	To know and save personal banking data, data related to professional activities or confidential company data
12	Online Self-Service Solutions	proactively look for online self-service solutions Use online self-service solution (e.g. for appointments or purchasing tickets) before you call or ask in person	Know how to use online solutions for traveling from home to ship and back
13	Quick Digital Learner	easily figure out new technologies and applications learn how to use new digital devices, online services, or software	Learn how to use maritime simulators, devices and technologies
14	Digital Curiosity	To be curious and to like to experiment with new digital devices and applications For example, curiosity about new smartphones on the market and interest in talking about new gadgets or technological achievements	Experiment the use of new digital devices in the maritime
15	Choice of communication	To have a thorough understanding of the effects of communicating through different types of media For example, understanding the various strengths and weaknesses of communication technology such as telephone, email, chat, videoconferencing, SMS	To know how to properly use means of communication between vessels, between shore and vessel or on shore only
16	Evaluation of the recipient	Evaluate the recipients and carefully tailor the communication accordingly	Avoid using inappropriate language in official mails to or

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		For example, tailor languages, slang, image types, colors or multimedia to the recipient	from the maritime company; Avoid using the company's name or brands of the company in inappropriate online public spaces
17	Democratic impact	To have an in-depth understanding of how social media enable different forms of communities and democracy Understanding the pros and cons of the internet's possibilities for political debates and sharing political messages. For example, viral media.	Use with responsibility social media and avoid posting professional aspects that can do harm to the employing company
18	Relevant Networks	To be familiar with a wide range of digital communities, networks and social media For example, familiarity with professional or social networks such as Meetup, Pinterest, Flickr, LinkedIn, Blogster, Youtube, Twitter, Reddit	Have a responsible behavior when posting on social media and avoid to affect the image of the employing company, according to the confidentiality clauses in the employment contract
19	Active Participation	To enjoy expressing thoughts and opinions through relevant social media. For example, to comment on newspaper articles, write on a blog, share posts on social media or participate actively in a professional network	Using active participation tools with responsibility
20	The effects of online behaviour	To pay close attention to how online activities can affect the life, reputation and career of individual and of others To understand, for example, how criticizing or complimenting other people or organizations in a public space can have real life consequences	To consider the multiplicative effects of online behavior, as cyberbullying, that can affect the professional climate on board vessel
21	Identity	To have a good understanding of how others can contribute (positively or negatively) to the personal digital identity Understanding of how likes, extensive feedback, or many views can help increase the visibility of your digital identity	Develop and make interaction with identities on maritime online social media, as dedicated maritime Facebook groups, LinkedIn, Instagram etc.
22	Behaviour Management	To develop good strategies for	To have responsible

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		handling the improper behavior of others To have a predetermined position on how to respond to an offensive comment or a rude email	behavior on board vessel and at the headquarters of the shipping/crewing company.
23	Tone	To consider what the most appropriate tone is when communicating with others For example, to have the ability to express an opinion or a feeling to the recipient by using a certain tone when writing a text	To consider the appropriate tone used when writing briefings, memos or company circulars
24	Legal Framework	To have an extensive knowledge of the legal framework with regards to publishing, commenting or selling online To know the law on marketing, rumors, spam, copyright, threats, discrimination, private photos or speculation on the web	To be aware on legal aspects included in the employment contract regarding the online activity of the employee.
25	Copyright	To be aware of copyright, licensing and other regulations when downloading or publishing digital material For example, checking the right to a photo before using it for anything.	Not to disclose maritime company's photos, documents or data to unauthorized persons
26	Media Choice	To choose the most suitable type of media (e.g. text, photo, video, animation etc.) to achieve the desired result	To be able to use pictures or videos for training and educational purposes
27	Applications	To be highly skilled at using applications to create relevant multimedia The ability to, for example, edit photos, videos, text, or audio in programs such as Photoshop, Final Cut, or Word	To have the ability in editing text or photos for reports requested by the maritime company's
28	Technological Support	To have a good understanding of when technology can support a process (and when it cannot) For example, understanding of when a mandatory course can be replaced with more flexible e-learning or when a weekly meeting can be replaced with a videoconference	To know when and what technology to use for on board meetings, for interviews or for communication with the maritime company, authorities or peers.
29	Databases	To make efficient use of databases to store large amounts of data	To know hot to use the maritime database with

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		The ability to use databases like Excel, MySQL, Microsoft Access or Oracle to store data when appropriate	responsibility
30	Programming language	To create content or enhance functionalities through advanced use of programming Ability to program in e.g. HTML, C, Java, PHP or Excel macros	To be able to have at least a basic knowledge in programming used in shipping
31	Hardware	To have an overall understanding of the components of a computer and how it is connected to other devices Understand the connection between elements such as CPU, RAM, motherboards, cables (e.g. HDMI) and network routers	To know how to use ship's or maritime university hardware
32	Trouble shooting	To know how to, step-by-step, locate a problem and search for a solution To try things out without knowing beforehand what exactly is going to happen (e.g. when a printer will not print)	To search for solutions related to ship's hardware or software
33	Settings	To edit advanced settings on digital devices, online services and applications Know how to, for example, change privacy settings, adjust browser font size, change a WiFi password or the color tone of a screen	To know how to edit settings for the technical equipment located on bridge or on the engine deck
34	Installation	To know how to install and update all relevant applications This includes, for example, updating antivirus, Java or the operating system, or installing a brand-new browser	To know how to install applications authorized by the maritime company
35	Ergonomics	To know the principles of an ergonomic computer station and a healthy working posture Knowledge of, for example, the healthiest posture, screen height, leg position, and the most ergonomic working tools	To use the computer station ergonomically during watch
36	New Technology	To thrive on the continuous requirement to stay up to date with new technology Feel good about having to constantly renew software and digital devices, while avoiding	To continue learning after graduating MET programs in order to get updated on the technological changesets in the

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		irritation or stress	maritime sector
37	Balanced consumption	To pay close attention to maintaining a balanced use of technology For example, paying attention to addictive aspects of technology that can cause stress and sleep deprivation	During rest hours, to use time responsibly and in a healthy manner, without making abuse on the use of technology
38	Sensitive data	To easily differentiate between personal information and sensitive data Sensitive data is, for example, credit cards, medical records and tax information, whereas personal information is, for example, name, political opinions, and profile picture	To take care of data protection for ship, vessel and maritime company's personnel
39	Identify Footprints	To do an in-depth search for information and the digital footprints Know how to search for and find personal data such as profile photo, previous comments, address, job, education etc.	To know how to search relevant maritime related information
40	Personal Information	To carefully consider what personal information to share (and not share) on the web Always consider carefully how personal information such as profile picture, marital status, political standpoint and religion can affect future careers	To act and use responsibly personal information or information of peers and company
41	Password	To have good strategies for creating and remembering (or saving) passwords For example, having a good habit of creating passwords using symbols, numbers, uppercase letters, and without using the name of family or pets	Not to disclose to unauthorized persons the passwords received from the maritime company
42	Phishing	know different methods for identifying phishing and malware (malicious programs) Methods for recognizing attempts to lure sensitive data from the user, such as username,	Identify easily phishing messages received by email from the maritime company address

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		password or credit card details.	
43	Data Security	to encrypt, password-protect or otherwise secure access to data when it is sent or stored For example, using 2-Step verification or password protection on documents, and ensuring that the connection is encrypted when the these are sent	To know who to contact if the account has been hacked, if embarrassing personal images are shared, or if something else unpleasant happens online
44	Hotkeys	I have the ability to efficiently use advanced hotkeys for relevant applications Knowledge of the most common shortcuts such as undo, search, screenshot, bold text, navigation, or zoom	To learn the most common used hotkeys necessary for accomplishment of daily professional bridge tasks
45	Digital creation	To create or edit digital content Creating a product that is exclusively digital, for example, a picture, a piece of music, or a video.	To know how to create digital content requested by the company
46	IT Patience	To have a good deal of patience when trying to solve a problem Do not get very frustrated or give up when a technical problem arises	To keep calm when problems arise when using deck IT technologies
47	Search Engines	To identify the most suitable keywords that fit with the width and depth of the topic To have the ability to quickly examine a complex topic, find facts, learning materials, or experts by using relevant search engines	To use search engines for creating documents requested by the shipping company or by the maritime trainer
48	Written language	To communicate effectively and accurately through written language For example, writing an email quickly and conveying the meaning clearly and without misunderstandings	To know how to communicate effectively with the rest of the crew, with the company's personnel, with authorities, cargo owner and other maritime stakeholders
49	Software Development	To have a good understanding of how applications and websites are developed and built Knowledge of the process that leads from a concept of programming to a finished piece of software	To understand the role and function of using maritime applications
50	Physical Symptoms	To pay close attention to physical symptoms that may be related to	To be aware of physical symptoms during watch

Digital Competences for Maritime Studies and Maritime Business			
Nr.crt.	**Competence**	**Example**	**Competence applied in the maritime sector**
		technology Including, for example, headache, blurred vision or wrist pain that may be signs of overuse	or rest time, related to the use of deck, bridge or room technologies
51	Inappropriate vs. Illegal	To easily differentiate between inappropriate and illegal behavior Know when, for example, intimidation, harassment, bullying, and the spreading of rumors and secrets go from being annoying to being illegal	To understand the risks and the consequences of using on board vessel or on shore inappropriate and/or illegal technologies or behavior.
52	Empathy	To show empathy and creating communities with others through digital communication To have the aptitude for empathizing with the emotions, thoughts and attitudes of others (even if they are never met face to face)	Using empathy in work and social relations, in board vessel or in the classroom
53	Terms and Conditions	familiarizing with the terms and conditions for using various services Always checking the rules to be accepted in order to use an online service (e.g. terms of use for e-box)	To have a good idea of what is agreeing to when in "Terms and conditions" on various online service (e.g. downloading software or accessing websites)
54	Digital Coordination	To appreciate and enjoy the benefits of technology when coordinating with others For example, sharing calendars, virtual meetings, meeting booking, knowledge sharing on intranet etc.	To use digital technologies in improving or enhancing professional or educational activities

The list above containing 54 digital competences that should be considered for inclusion and referencing in the STCW Convention is not exhaustive.

5.4. Computational Thinking and Algorithmic Age

Computational thinking is a concept that raised for the first time in 2006, and from that moment on, it has been gaining popularity due to its promising impact for all people, since its main premise is that concepts associated with the field of computing can be used for problem solving in other fields, such as maritime domain and according to [19] “many consider problem solving to be the new basis for learning in the 21st century”. For that reason, it is relevant to reflect on computational thinking.

Since computational thinking is based on solving problems by making use of fundamental concepts of computation, programming is being included in educational curricula around the world to develop

computational thinking, and can be used also in the maritime domain for the development of digital skills.

The drawback of promoting the development of computational thinking with introductory programming courses is related to the difficulties that are inherent to MET learning programming. Particularly, at the maritime university level and in the maritime domain, computational thinking is very important because it provides students with the profile currently required by the employers in the industry. One of the objectives of MET universities can be the training of professionals with inter- or transdisciplinary profiles, capable of facing real environments and providing viable and reliable answers to a society that requires them. Therefore, computational thinking is fundamental for its transdisciplinary character in problem solving, justifying the reflection on other ways for the development of computational thinking in order to facilitate its appropriation by students.

The study of concepts, characteristics and phases associated with computational thinking suggests that the MET skills that compose can be acquired in contexts other than learning computer programming. In this order of ideas, the natural relationship between computational thinking skills and daily life activities allows to consider the possibility of developing such skills during the execution of daily life activities.

Additionally, considering the satisfactory results obtained in studies that were conducted before the emergence of the concept of computational thinking, related to the application of metacognition to strengthen the problem-solving process, where [20] concludes that: “the successful solution is obtained after planning” I specifically propose the use of metacognition in MET for the development of computational thinking skills during the performance of daily life activities.

The concept of computational thinking was first raised by [21], as follows: “it represents a universally applicable attitude and skill set that everyone, not just computer scientists, would be eager to learn and use”. While it is true that this is a very general concept that conceives it as the combination of an attitude and a set of skills, it is also true that it presents the main premise of computational thinking, i.e., that all people could apply it in different domains.

Some years later, [22] specifies a little more the scope of computational thinking, referring to it as a process: “It is the thinking process involved in formulating problems, whereby their solutions can be represented as computational steps and algorithms”. This definition clarifies the scope of computational thinking because it explicitly frames it in the context of problem solving, however, it leaves implicit the fields of application.

Subsequently, [23] directly associate the concept of computational thinking with the activities of everyday life, referring to it as: “a methodology based on the implementation of the basic concepts of computer science to solve everyday problems, design domestic systems and perform routine tasks”.

There are six characteristics of computational thinking according to [24]:

1. Conceptualization;
2. Basic ability;
3. Way of thinking;
4. Complement with mathematical and engineering thinking;
5. Ideas, and;
6. Availability for anyone, anywhere;

The first two characteristics are related to its nature: conceptualization refers to thinking at multiple levels of abstraction and not just as for programming a computer; and the basic skill characteristic refers to the fact that it should not be mechanical.

The following two characteristics clarify its origin: the characteristic of way of thinking refers to the fact that people are the ones who think and not computers, that is, computational thinking is a way in which human beings solve problems with the help of the computer, therefore, it is not about humans thinking like computers; and on the other hand, the characteristic of complement with

mathematical and engineering thinking, refers to the fact that the mathematical and engineering foundations are the ones that make computational thinking possible for the construction of informatic systems.

The two remaining characteristics, related to the scope of computational thinking, are the ones that arouse the interest of this article: the characteristic of ideas highlights that computational thinking is not only related to the software that is produced, but is present daily in people's lives; and finally, the characteristic of for anyone anywhere, it shows the possibility of using this thinking generally.

In general, the six characteristics presented suggest the following aspects with respect to problem solving in everyday life:

1) Computational thinking cannot be mechanical due to the different configurations of problems that may arise in everyday life;
2) The mathematical and engineering bases are natural complements to computational thinking; however, they do not totally restrict its use;
3) Its wide scope of application makes it suitable to be considered in the resolution of any problem.

Now, with respect to the phases of computational thinking, some researchers such as [25], promote the existence of four phases:

1. Decomposition – the ability to break a task into its component steps;
2. Pattern recognition –the ability to perceive similarities, within the same problem or with other problems, to narrow the path to solving the problem;
3. Pattern generalization and abstraction – this phase requires the ability to filter and ignore all the information that is not necessary to solve a given problem, and to generalize the information that is necessary;
4. Algorithmic design – this phase requires the ability to develop a step-by-step strategy, that is, to establish a sequence of instructions to solve the problem;

The four phases presented above represent the main skills required by a person to solve problems using computational thinking. For our study the key to computational thinking is the first phase, because it is from this phase that the application of the other phases becomes possible, i.e., decomposing a problem leads to pattern recognition and generalization, which inevitably converges to the specification of the steps that solve the problem, i.e., to algorithmic design.

In order to clarify the relationship of computational thinking with everyday life, some examples of applications of computational thinking for each of its skills are presented below. The decomposition skill is often reflected when a person gives directions to another person to get somewhere, for example, walk three blocks, turn left and walk until you find the red house. Pattern recognition skills, on the other hand, can be reflected in people’s behaviors, for example, when children naturally know how to identify events that makes happy their parents.

On the other hand, examples of the application of abstraction and generalization are reflected when representations of things are made according to the attributes of interest at a given time, for example, when buying a product, the selection criteria between different brands of the same product may be price or quality, which will depend on the interests of buyers. To conclude with the examples of applications, an example of algorithmic design can be clearly appreciated when a cook details his own recipe for the preparation of his meals.

As can be seen in the examples, people already use the skills associated with computational thinking in everyday life, to a greater or lesser extent, depending on the complexity of the activities they perform, i.e., using the skills both in isolation and in combinations among them. In that sense, the main reflection of this article is oriented towards the possibility of consciously developing computational thinking during the performance of daily life activities.

5.5. Algorithmic method that can be used in maritime environments

When a solution is translated into an algorithm, a number of elements that are part of an evaluation test should be checked:

- that it is easily understood: is it completely decomposed?
- that it is effective: does it solve the problem?
- efficient: does it solve the problem, making the best possible use of available resources?

When an algorithm passes the evaluation process and meets the three criteria above, it is considered to be a correct solution; therefore, it can advance to the programming stage at some point in time. Programming without first evaluating, most of the time, makes programming more difficult, which can lead to more errors and, therefore, to greater costs in the project.

In computer science, the evaluation of programs is systematic and rigorous: it is a matter of judging the quality, efficiency and effectiveness of a program.

The evaluation is to judge the quality, effectiveness and efficiency of solutions, systems, products and processes. The evaluation verifies that the solutions do the job they are designed to do and are they are designed to do and are fit for purpose.

How do seafarer professionals evaluate a solution? There are many methods developed. In principle and as an example, one could start the task with the guidance of the following three questions:

- Is there a complete understanding of how the problem has been solved, i.e., is the constructed solution explicitly stated? That is, whether the solution constructed is fully explained. If something is not yet known, then you do not have a complete solution. In the case that you do not know clearly how to do something to solve the problem, you have to go back to the previous to verify that everything has been decomposed correctly and that each part has a solution.
- Does the solution cover all parts of the problem? Here we seek to validate that the proposed and developed solution fully satisfies the objective to be met and in addition, it does so within the constraints imposed.
- Does the solution optimize the repetition of task? If the answer is no, ask if there is any way to reduce the repetition of tasks, for this, go back to the development stage of the solution and eliminate unnecessary repetitions.

5.6 Metacognition

Due to the fact that [26] emphasizes metacognition as a competency that encompasses all phases, “we can consider a set of competencies necessary in all phases, without having to do directly and exclusively with some of them, such as metacognition”. In addition, in studies prior to the emergence of the concept of computational thinking, metacognition has been used to strengthen the process of problem solving, where Domenech [27], found that: “a high metacognition allows regulating successful resolution”; in this article we propose the use of metacognition for the development of computational thinking skills (decomposition, pattern recognition, abstraction and generalization, and algorithmic design) during the performance of activities of daily life.

Metacognition, according to [28] refers to two elements: first, the knowledge that a person has about his or her own cognitive processes or any other aspect related to them; and second, the active monitoring and consequent regulation of these processes. These two elements are the basis of metacognition, as indicated by [29] when she mentions that researchers who have subsequently worked with metacognition have maintained two dimensions: “in most cases establishing greater precision in its components, but retaining the initial distinction of two dimensions in metacognition: knowledge and regulation of cognition”.

Therefore, the proposal made in this paper consists of associating computational thinking skills to these two metacognitive elements. On the one hand, for the knowledge that a person has about his or her own processes, one should be aware that computational thinking skills are already immersed in everyday life and that they are frequently used. On the other hand, for active supervision, the possibility of using computational thinking skills during the execution of daily life activities should be considered.

Finally, in order to give to everybody interested in the maritime domain the possibility to develop computational thinking, it is suggested to cultivate the habit of answering four questions during the performance of all their daily activities. The four questions are as follows:

1. Am I decomposing the activity into several parts?
2. Am I identifying the parts that are repeated or present in other activities?
3. Am I considering only the elements of interest?
4. Am I designing a strategy to carry out the activity?

Answering to these questions will be a good exercise to achieve the desired tasks correctly and organized in the maritime environment.

Computational thinking has become more crucial for people in the 21st century and its advantages include:

- computational thinking skills enhance job competencies and are beneficial to careers in virtually every industry, also in maritime environment;
- helps a maritime company's employees take an active role in thinking through problems and creating solutions;
- through decomposition techniques and the construction of step sequences, helps solve problems using algorithmic thinking;
- helps to understand which aspects of a problem are susceptible to being solved by computation;
- helps to recognize the possibility of computational techniques in a novel way.

5.7. Case Study on using Algorithms for Problem Solving in the Maritime Crewing Sector

In the end of this study is presented an advanced case study useful for the application of algorithms in the decisional problems of maritime stakeholders, with application in many maritime working environments. In particular, is considered an example scenario in which the fuzzy version of the TOPSIS method is used to solve a heterogeneous multi-attribute decision making problem consisting in selecting the best seafaring professional candidate by a crewing recruitment committee. The case study was developed in collaboration with Lecturer Dr. Simona Dinu from Constanta Maritime University.

In the case study, the employment decision of seafarers' employment will be taken into account by the crewing department by evaluating 10 criteria in the form of:

1. previous work experience,
2. specialized studies in the maritime field
3. compliance with the risk conditions of the job
4. availability to work remotely
5. stress resistance
6. willingness to work in a multinational team
7. creativity
8. adaptability
9. knowledge of specialized English

10. digital skills.

In multi-criteria problems, the undefined nature of the criteria and the fact that they are often conflicting or contradictory, requiring multiple dimensions and multiple standards, increments the complexity of their aggregation and can create problems in the evaluation. Furthermore, experts' assessments may involve uncertainness and biased judgment in rating the importance of the selection parameters.

Using fuzzy logic, decision makers can handle these issues. Thus, instead of representing the judgments of experts with precise values, the adequacy of alternatives for various subjective criteria and the weights of the criteria are expressed in fuzzy linguistic terms, in order to be more adapted to real world applications.

To assign the relative importance of the attributes, in this study the values of the evaluation criteria used as input to the TOPSIS method, are given as fuzzy triangular numbers.

Therefore, the first step in this framework is to briefly outline some basic Fuzzy logic definitions and notations, description of fuzzy numbers and details of operations with them.

Fuzzy logic (fuzzy meaning vague), formalized by Lotfi Zadeh in 1965, is an Artificial Intelligence technique. A concept is said to be vague when its meaning is not fixed by clear boundaries. In this sense, fuzzy logic associates a degree of authenticity with each statement, or in other words a degree in verifying a condition, other than true or false, which makes it possible to take into account inaccuracies and uncertainties. It is an extension of Boolean logic (associating the two values 0 = False and 1 = True), being practically a multi-value logic, which allows the definition of intermediate values between conventional evaluations such as; true / false, black / white, yes / no, high / low.

Fuzzy logic is based on the mathematical theory of fuzzy sets, which is a generalization of classical set theory. Fuzzy set theory is an effective mathematical tool for dealing with uncertainties in decision making. If in classical theory, crisp sets are clearly defined sets of elements (numbers, objects, symbols, etc.), and the membership of an element in a set is of the binary type (yes/ no), in the case of fuzzy sets there are a number of intermediate situations, called membership degrees.

Considering that a set X (defined in a given problem) is a collection of objects generically denoted by x, then a fuzzy set $A \subseteq X$ is a set of ordered pairs:

$A = \{(x, \mu_A(x)) \mid x \in X\}$

where μ_A: $X \longrightarrow [0,1]$ is called a membership function of A, and $\mu_A(x)$ represents the degree of belonging of element $x \in X$ in the set $A \subseteq X$. The reference set X is called universe of discourse and A is called a fuzzy set of universe X.

So any element $x \in X$ has a membership degree to the set A, $\mu_A(x) \in [0,1]$. The values 0 and 1 represent the smallest and the highest membership degree of $x \in X$ in A.

The mapping of x into $\mu_A(x)$ is called fuzzification: the process of transforming a real scalar value into a fuzzy value.

Applications based on the theory of fuzzy logic in decision making use various membership functions, and the proper choice of them always depends on the application. The most common membership function used to represent fuzzy sets is the triangular one because of its simplicity and relevance in representing information in a fuzzy context.

A fuzzy number A on X is a triangular fuzzy number if its membership function μ_A: $X \longrightarrow [0,1]$ is defined as follows:

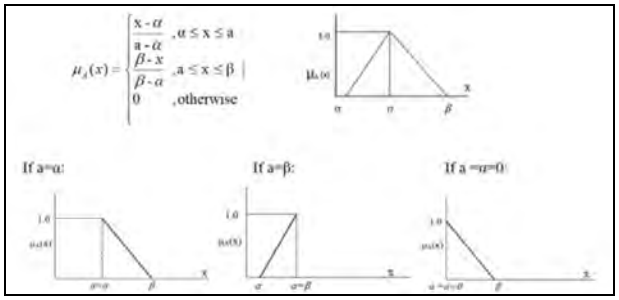

Fig. 3. Triangular membership functions

The function is defined by the inflection points (α, a, β), and the center of the set is a. A is called a triangular fuzzy number represented by three points: A = (α, a, β).

Operational rules of triangular fuzzy numbers consider A and B as being two triangular fuzzy numbers defined respectively by the triplets: A = (a1, a2, a3) and B = (b1, b2, b3). Some main operations of fuzzy numbers A and B can be expressed as follows:

$A + B = (a_1, a_2, a_3) + (b_1, b_2, b_3) = (a_1 + b_1, a_2 + b_2, a_3 + b_3)$

$A - B = (a_1, a_2, a_3) - (b_1, b_2, b_3) = (a_1 - b_1, a_2 - b_2, a_3 - b_3)$

$A \times B = (a_1, a_2, a_3) \times (b_1, b_2, b_3) = (a_1 \times b_1, a_2 \times b_2, a_3 \times b_3)$

$A / B = (a_1, a_2, a_3) / (b_1, b_2, b_3) = (a_1 / b_1, a_2 / b_2, a_3 / b_3)$

$k \times A = (k \times a_1, k \times a_2, k \times a_3)$

The distance between A and B is calculated as:

$$d(A,B) = \sqrt{\frac{(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2}{3}} \quad (1)$$

A linguistic variable is a variable whose values are not numbers (as in the case of algebraic variables), but words or sentences from a natural language. Linguistic characterizations are generally less specific than numerical ones, but closer to the way people express and use their knowledge. Because real-life situations where information is inaccurate are very common, language variables can be a powerful tool for shaping human knowledge.

In general, for a linguistic variable L, T (L) is a collection of linguistic values - a set of linguistic terms - labels or words. For example: linguistic variable L = "Performance", referring to a person's performance, with the corresponding set of linguistic values:

T (Performance) = {Very low, Low, Medium, High, Very high}.

The linguistic term is a fuzzy descriptor of a subdomain of values of the linguistic variable. The range of possible values of a linguistic variable represents the universe of definition of that variable. In this example, the universe of discourse X of the language variable "Performance" can be between 0 and 100% and can include fuzzy sets such as Very small, Small, Medium, High, Very high, which are defined by their membership functions.

For example, the performance value p = 25% belongs with the degree μVery low (p) = 0.7 to the fuzzy set “Very low” and with the degree μLow(p) = 0.3 to the fuzzy set “Low”:

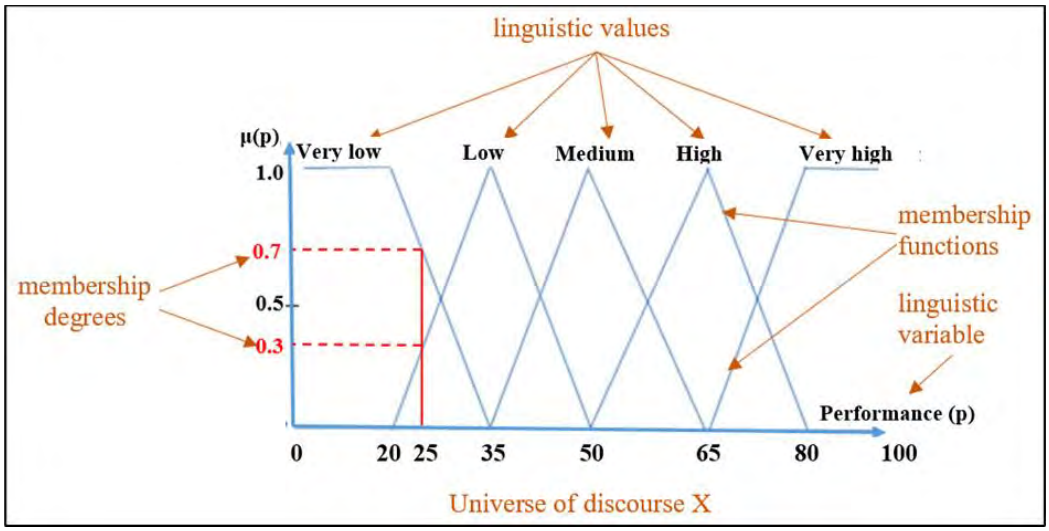

Fig. 4. Graphical representation of membership functions for a linguistic variable

So the 25% performance is characterized in fuzzy set theory by: {0.7, 0.3, 0, 0, 0}.
p = 25% ⟶ p = {0.7, 0.3, 0, 0, 0}

A multi-attribute decision method (MADM) is a procedure that involves finding the best alternative from a set of possible alternatives. Using the Fuzzy TOPSIS method, the alternatives are ranked provided that the decision-maker has identified a set of objectives, has established measurable criteria for assessing the degree of achievement of the objectives and has assigned to the decision criteria weights that establish their importance. The method orders the alternatives by means of a measure of the distance from a hypothetical ideal solution, respectively from a negative ideal solution or anti-ideal solution (the most unfavorable solution).

Because in real practice an ideal solution, which provides the maximum value of each analyzed objective, is almost impossible to achieve, it is necessary to find that decisional alternative for which the performance values are as close as possible to the ideal solution. Consequently, that decisional alternative which presents the smallest distance from the ideal solution and the longest distance from the most unfavorable solution is considered to be the multicriteria optimum.

In order to improve the shipping company recruitment performance, this paper proposes a Fuzzy TOPSIS method for personnel selection. The employee recruitment model is detailed by means of the following sets:

I) A set of evaluation criteria, $C = \{ C_1, C_2, \ldots, C_n\}$, where $w_k \in R$ is the weight of the criterion C_k, $k = 1, \ldots, n$ and $w_1 + \ldots + w_n = 1$

In this study we propose the following set of evaluation criteria $C = \{C_1, C_2, \ldots, C_{10}\}$ which will have equal weights w_i , i= 1, …, 10 in the analysis:

C_1: previous work experience
C_2: specialized studies in the maritime field
C_3: compliance with the risk conditions of the job
C_4: availability to work remotely
C_5: stress resistance
C_6: willingness to work in a multinational team
C_7: creativity
C_8: adaptability
C_9: knowledge of specialized English
C_{10}: digital skills

II) A set of decision alternatives $A = \{A_1, A_2, \ldots, A_m\}$

In this study, we assume that a number of candidates initially applied for this job position, some of them were disqualified because they could not provide the requirements and only 5 candidates met the criteria and will be further evaluated. Thus we consider 5 final candidates for the job position:
$A = \{Candidate_1, Candidate_2, Candidate_3, Candidate_4, Candidate_5\}$

III) A set of p decision makers $D = \{D_1, D2, ..., D_k, ..., D_p\}$ that must evaluate each alternative according to each criterion
In this study we consider a team of *3* decision makers involved in the evaluation of candidates
This MADM problem with *5* possible alternatives and *10* criteria can be expressed in matrix format:

$$M = \begin{bmatrix} & w_1 & w_2 & \dots & w_n \\ & C_1 & C_2 & \dots & C_{10} \\ A_1 & d_{1,1} & d_{1,2} & \dots & d_{1,10} \\ A_2 & d_{2,1} & d_{2,2} & \dots & d_{2,10} \\ . & . & . & \dots & . \\ . & . & . & \dots & . \\ . & . & . & \dots & . \\ A_5 & d_{5,1} & d_{5,2} & \dots & d_{5,10} \end{bmatrix} \quad \text{with} \quad D = \begin{bmatrix} d_{1,1} & d_{1,2} & \dots & d_{1,10} \\ d_{2,1} & d_{2,2} & \dots & d_{2,10} \\ . & . & \dots & . \\ . & . & \dots & . \\ . & . & \dots & . \\ d_{5,1} & d_{5,2} & \dots & d_{5,10} \end{bmatrix}$$

D is the performance matrix
$d_{ij} \in R$ is the performance resulting from the choice of the alternative A_i in relation to the criterion C_j, i = 1,…, 5 and j = 1,…, 10

Then, the following calculation steps are required to order alternatives using the Fuzzy TOPSIS method:

Step 1: design the decision hierarchical structure

The first step of fuzzy TOPSIS analysis consists of developing a hierarchical structure of the assessment problem detailing the objective of the problem, the criteria and alternatives. Figure 3 represents the hierarchical diagram of the personnel selection problem.

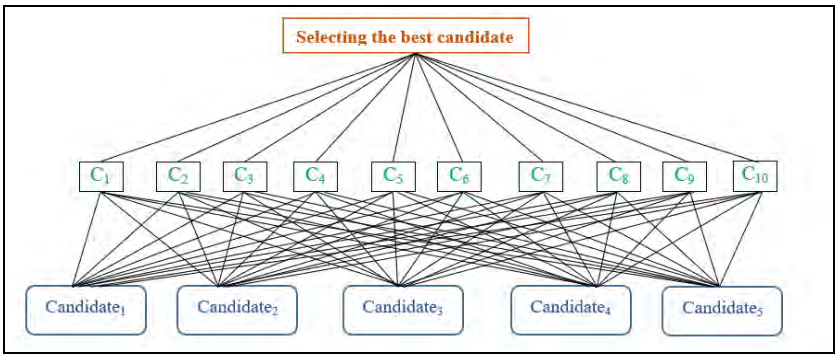

Fig. 5. The hierarchical structure of the personnel selection problem

Step 2: calculate alternative ratings and criteria weightage

The process of finding the best candidate begins with mapping the non-fuzzy input values to fuzzy linguistic terms for each criterion. Thus, in the second step, the linguistic ratings for evaluating alternatives with respect to criteria should be determined. The linguistic terms and their corresponding triangular fuzzy numbers are determined and shown in Table 1 and Figure 4 displays the graphical representation of the triangular fuzzy numbers.

Each decision maker evaluates each alternative according to each criterion using a linguistic variable with values (linguistic terms): Very weak (VW), Weak (W), Medium weak (MW), Fair (F), Medium good (MG), Good (G), Very good (VG).

Table 3. The linguistic terms and their corresponding triangular fuzzy numbers

Alternative evaluation linguistic terms	**Fuzzy triangular number linguistic values**	**Alternative evaluation linguistic terms**	**Fuzzy triangular number linguistic values**
Very weak (VW)	(0, 0, 1)	Medium good (MG)	(5, 7, 9)
Weak (W)	(0, 1, 3)	Good (G)	(7, 9, 10)
Medium weak (MW)	(1, 3, 5)	Very good (VG)	(9, 10, 10)
Fair (F)	(3, 5,7)		

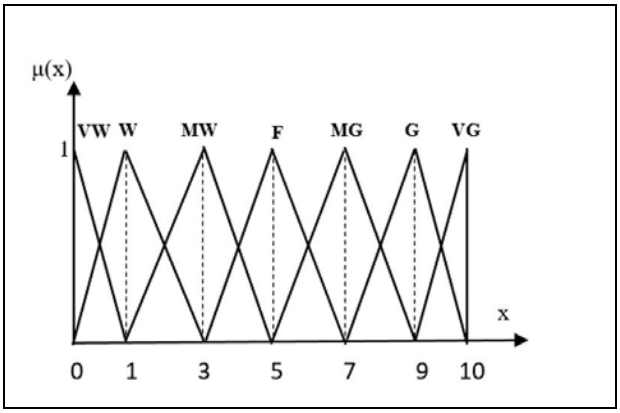

Figure 6. Graphical representation of the corresponding triangular fuzzy numbers

The following table contains the evaluation of the alternatives according to criteria by the decision makers:

Table 4. Evaluation of the alternatives according to criteria by the decision makers

Alternatives	Decision makers	Criteria C_1	C_2	C_3	C_4	C_5
Candidate$_1$	D_1	x_{111} = MG	x_{121} = G	x_{131} = F	x_{141} = VG	x_{151} = MW
	D_2	x_{112} = F	x_{122} = MG	x_{132} = G	x_{142} = G	x_{152} = F
	D_3	x_{113} = MG	x_{123} = MW	x_{133} = G	x_{143} = VG	x_{153} = F
Candidate$_2$	D_1	x_{211} = G	x_{221} = VG	x_{231} = MW	x_{241} = VG	x_{251} = VG
	D_2	x_{212} = G	x_{222} = VG	x_{232} = MW	x_{242} = VG	x_{252} = MG
	D_3	x_{213} = MG	x_{223} = VG	x_{233} = G	x_{243} = F	x_{253} = G
Candidate$_3$	D_1	x_{311} = VG	x_{321} = MG	x_{331} = G	x_{341} = G	x_{351} = G
	D_2	x_{312} = F	x_{322} = F	x_{332} = MG	x_{342} = VG	x_{352} = G
	D_3	x_{313} = F	x_{323} = VG	x_{333} = VG	x_{343} = MG	x_{353} = MG
Candidate$_4$	D_1	x_{411} = VG	x_{421} = VG	x_{431} = MG	x_{441} = MW	x_{451} = G
	D_2	x_{412} = F	x_{422} = G	x_{432} = VG	x_{442} = F	x_{452} = MG
	D_3	x_{413} = G	x_{423} = VG	x_{433} = F	x_{443} = VG	x_{453} = F
Candidate$_5$	D_1	x_{511} = VG	x_{521} = MW	x_{531} = F	x_{541} = VG	x_{551} = MG
	D_2	x_{512} = G	x_{522} = VG	x_{532} = G	x_{542} = F	x_{552} = G
	D_3	x_{513} = F	x_{523} = G	x_{533} = VG	x_{543} = MW	x_{553} = MG

Alternatives	Decision makers	Criteria C_6	C_7	C_8	C_9	C_{10}
Candidate$_1$	D_1	x_{161} = MG	x_{171} = VG	x_{181} = F	x_{191} = G	$x_{1,10,1}$ = G
	D_2	x_{162} = G	x_{172} = VG	x_{182} = MG	x_{192} = MW	$x_{1,10,2}$ = F
	D_3	x_{163} = MG	x_{173} = F	x_{183} = MW	x_{193} = VG	$x_{1,10,3}$ = G
Candidate$_2$	D_1	x_{261} = G	x_{271} = MW	x_{281} = VG	x_{291} = VG	$x_{2,10,1}$ = VG
	D_2	x_{262} = F	x_{272} = VG	x_{282} = VG	x_{292} = VG	$x_{2,10,2}$ = MG
	D_3	x_{263} = MG	x_{273} = VG	x_{283} = MW	x_{293} = VG	$x_{2,10,3}$ = G
Candidate$_3$	D_1	x_{361} = VG	x_{371} = MG	x_{381} = MW	x_{391} = G	$x_{3,10,1}$ = VG
	D_2	x_{362} = G	x_{372} = G	x_{382} = MG	x_{392} = VG	$x_{3,10,2}$ = G
	D_3	x_{363} = F	x_{373} = MW	x_{383} = VG	x_{393} = MG	$x_{3,10,3}$ = MG
Candidate$_4$	D_1	x_{461} = VG	x_{471} = VG	x_{481} = VG	x_{491} = VG	$x_{4,10,1}$ = VG
	D_2	x_{462} = G	x_{472} = G	x_{482} = G	x_{492} = G	$x_{4,10,2}$ = G
	D_3	x_{463} = F	x_{473} = VG	x_{483} = F	x_{493} = G	$x_{4,10,3}$ = F
Candidate$_5$	D_1	x_{561} = VG	x_{571} = VG	x_{581} = G	x_{591} = G	$x_{5,10,1}$ = MG
	D_2	x_{562} = G	x_{572} = MW	x_{582} = G	x_{592} = G	$x_{5,10,2}$ = VG
	D_3	x_{563} = VG	x_{573} = MG	x_{583} = F	x_{593} = B	$x_{5,10,3}$ = G

Each decision maker assesses the importance of each criterion using a linguistic variable with values (linguistic terms): Very low (VL), Low (L), Medium low (ML), Medium (M), Medium advanced (MA), Advanced (A), Very advanced (VA). The linguistic terms and their corresponding triangular fuzzy numbers are determined and shown in Table 3 and Figure 5 displays the graphical representation of the triangular fuzzy numbers.

Table 5. The linguistic terms and their corresponding triangular fuzzy numbers

The importance of the criterion linguistic terms	Fuzzy triangular number linguistic values	The importance of the criterion linguistic terms	Fuzzy triangular number linguistic values
Very low (VL)	(0, 0, 0.1)	Medium advanced (MA)	(0.5, 0.7, 0.9)
Low (L)	(0, 0.1, 0.3)	Advanced (A)	(0.7, 0.9, 1)
Medium low (ML)	(0.1, 0.3, 0.5)	Very advanced (VA)	(0.9, 1, 1)
Medium (M)	(0.3, 0.5, 0.7)		

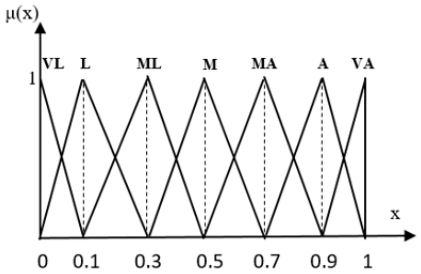

Figure 7. Graphical representation of the corresponding triangular fuzzy numbers

The following table contains the evaluation of the importance of each criterion according to decision makers:

Table 6. Evaluation of the importance of each criterion according to decision makers

	Criteria				
Decision makers	C_1	C_2	C_3	C_4	C_5
D_1	w_{11} = A	w_{21} = VA	w_{31} = VA	w_{41} = M	w_{51} = MA
D_2	w_{12} = MA	w_{22} = M	w_{32} = A	w_{42} = A	w_{52} = MA
D_3	w_{13} = MA	w_{23} = VA	w_{33} = A	w_{43} = M	w_{53} = MA
	Criteria				
Decision makers	C_6	C_7	C_8	C_9	C_{10}
D_1	w_{61} = A	w_{71} = A	w_{81} = VA	w_{91} = VA	$w_{10,1}$ = MA
D_2	w_{62} = M	w_{72} = VA	w_{82} = A	w_{92} = A	$w_{10,2}$ = A
D_3	w_{63} = MA	w_{73} = VA	w_{83} = M	w_{93} = VA	$w_{10,3}$ = MA

Step 3: calculate aggregated alternative and criteria weightage fuzzy decision matrix

Folosind evaluările alternative individuale şi ponderile criteriilor, se calculează evaluările alternative colective și ponderile criteriilor.

Step 4: calculate the normalized fuzzy decision matrix

Step 5: calculate the weighted normalized fuzzy decision matrix

It is determined by multiplying the normalized fuzzy decision matrix by the weights vector

Step 6: calculate the fuzzy positive ideal solution A+ (with maximum for all criteria) and fuzzy negative ideal solution A- (with a minimum for all criteria)

The elements of the weighted normalized fuzzy decision matrix are triangular fuzzy numbers within the close interval [0, 1].

Step 7: calculate the Euclidean distance of each alternative from the two extreme solutions: A+ and A-

Step 8: calculate the relative proximity of each alternative to the ideal positive solution

Table 7. Euclidean distance from the extreme solutions and relative proximity to the ideal solution

		S_i^+	S_i^-	C_i
Alternatives	Candidate$_1$	5.52	5.07	0.48
	Candidate $_2$	5.46	4.86	0.47
	Candidate $_3$	**5.28**	**5.37**	**0.50**
	Candidate $_4$	5.62	4.97	0.46
	Candidate $_5$	5.70	4.66	0.45

According to the Ci coefficients obtained, the candidates are ranked: Candidate3 represent the best alternative considering the ten given criteria.
The above case study had the purpose to highlight through mathematic apparatus the possibility for crewing companies or HR departments to use algorithms in decision making problems, as for example the decision to employ one seafarer out of 5 candidates, based on a scale of 10 criteria considered.

Conclusions

Next generation of seafarers professionals need to enter the international maritime labor market with at least basic digital skills, achieved through minimum short and hands-on preparatory trainings, related to specific skills needed by the maritime sector.
Maritime educators work and mission is to offer confidence and to inspire students to become leaders and to innovate, to raise questions and to strive for answers, to create solutions to stringent problems of the society.
Although the main aim of "Challenges of Maritime Digital Leaders in the Algorithmic Age" study, developed between 2021-2022, was to discover advanced digital skills and competences needed by maritime digital leaders, the results indicated serious concerns regarding the lack of critical basic digital competences at the middle age questioned seafarers, suggesting heterogeneity of the digital competences and the knowledge level for the MET students and for many of the MET graduates. Advanced digital skills, in regard to cybersecurity and safety capabilities, are expected to be learned at Master degree programs, while a major focus should be for Bachelor studies to reach a balance and homogeneity regarding the level of basic digital skills and ITC knowledge shared by students.
During the research activities of the study were inquired different maritime associations and various seafaring personnel and was concluded the necessity to update the IMO STCW for bachelor studies with relevant content related to basic digital skills necessary for effective ship operation. For the master of science programs, the curriculum should include specific aspects related to algorithm safety risks and professional skills needed by the digital leaders of the present and future.
Regarding the suggestion to include in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandatory requirements regarding digital competencies for the safe operation of ships, most of the questioned academic staff consider that specific requirements related to the *use and interpretation of electronic data*, *digitizing day-to-day operations, how to handle cyber risks for on board technologies,, regulating similar ITC and cyber training methods for ship operation* should be included in STCW due to reasons related to safe operations, increasing cyber threats nad the increase amount of digitized activities related to the maritime sector. Also, taking into account the fact that on board ship seafarers usually work with

digital and electronic equipment (radar, GMDSS, computers, AIS, loading computers, etc.) is necessary that all personnel who have responsibilities in terms of safety, should attend training courses on enhancing digital skills, as the one suggested in the study in *Table 2 - Digital competences needed for maritime studies and maritime business.* Another important aspect emphasized by one of the respondents was that in part B of the STCW convention, shore-based trainings are very limited and STCW does not currently meet the requirements of the digital age.

In conclusion, mandatory requirements regarding digital competencies should be included in the STCW for the safe operation of ships having the purpose to evaluate the competencies, standards and requirements needed for the effective use of digital equipment, media and applications on board vessel. Also, the *most in-demand skills* that MET should consider for the new digitalized maritime market, enlisted by the respondents, were: to know logistics and optimization methods; to have advanced skills in analytics and data usage in fleet optimization; to master advanced route planning; to have knowledge in operating operationally complex hybrid and zero-emission machines; to have the ability to calculate and document for sustainable operations; to have knowledge in remote control operation related to optimization services for ships and remote control of autonomous ships, including, for example, automated ship mooring systems; to have in-depth knowledge of complex systems onboard; to have the ability to interact with computer systems and respond to challenges associated with autonomous systems and to have the ability to transfer knowledge from one value chain to another, both at sea and in shore-based businesses, including using knowledge to make technological innovations. Other necessary skills include technical systems installation and maintenance, understanding and using digital systems vocabulary in the maritime context, understanding data engineering concepts, understanding maritime digital marketplace, technical resources and limitations, human interface and paper-digital transitions; knowing the regulatory landscape and outlook; process and technology efficiently improvement concepts and implementation; critical thinking; social intelligence; adaptive thinking; cross-cultural ability; mathematical thinking; understanding media content; transdisciplinary skills; mental organization skills; cognitive management skills; virtual communication skills.

Regarding the key performance indicators necessary for the assessment of MET students' digital knowledge, some technical KPIs should be based on general IT / systems understanding, networking, analytic skills, log reading, error understanding, basic troubleshooting and disaster plans. Soft KPIs are related to information fluency, communication and collaboration, critical thinking, solving and decision making, technology operation, ability to use a software based on user manual, ability to write reports based on interpreting the digital information from the software display. In essence, creating successful performance indicators is related to understanding the maritime company's aspirations using a clear and structured process. The development of meaningful performance indicators that clearly track and visualize performance requires a certain type of planning. Each KPI must address a specific business objective and provide accurate and timely information to assess progress towards the objectives. A well-constructed set of key performance indicators helps maritime organizations translate visions into strategies and track the impact of initiatives. Maritime companies thus benefit on a better perspective on their business and real-time information to make informed decisions. Other suggested KPIs are related to being able to use technology and digital media safely, responsively and effectively, being able to create new content and turn ideas into reality using digital tools, being able to create new opportunities and solve global challenges using digital media and technologies, ability to understand the value and limitations of a digital system, ability to test and criticize a digital system, appropriate level of digital security awareness and competency, knowledge of IT project management and rollout key success factors, ability to correctly evaluate a digital workload alternative as viable or unrealistic, understanding of vocabulary and compatibility criteria.

During the COVID-19 epidemic, remote working methods were applied in many sectors. As a result of Industry 4.0, artificial intelligence applications and deep learning have led to digital developments in many fields. Smart ports and smart cities have become a rising trend. Some ports have implemented artificial intelligence-based digital twin applications. Some of the *challenges* that may arise in the new digitalizing maritime industry are related to falling behind the technological applications developed in the maritime sector (especially on the ship side) which may cause the adaptation between the land and the sea to deteriorate. Also, it will not be possible for the conventional methods used in maritime to be replaced by digital applications in a short time. On the other hand, challenges include supply/demand imbalance for INMARSAT systems is pushing up cost and causing degradation of connection quality; lack of clarity for shipowners on which new digital offerings can add value to their maritime business; difficulty with extracting the full value from increased data flows; incorrect/incomplete analysis of data flows due to inexperience and/or lack of competent resources; digital security breaches; social media related reputation related risk due to lack of training, company policy or installation of employment conditions; compatibility difficulties between systems; reliability problems and lack of on board competence; digital workload not replacing but instead adding to non-digital workload due to regulatory and /or company policy lag; roll out failures and systems ignorance; the digital divide – unequal access of the population to technology; uneven development of scientific and technological knowledge in regions and states; fraudulent behavior related to IT technologies; ethical challenges in relation to technology generated by virtual organizations, virtual transactions, remote work; automated decision making/bias; lack of transparency in the use of artificial intelligence – protecting space and privacy; replacement of human control and autonomy at work by automated control.

Among the suitable solutions for most of the quoted challenges, we underline that the purpose of technology is to help, not to replace people. Understanding this approach is essential to overcome natural resistance to change and ensure the success of digital transformation implementation. Whether employees, customers or business partners, it is the people for whom and with whom a company can migrate to digitalization.

Computational thinking in the algorithmic era is a recently emerging concept, whose relevance as an object of study is supported by the interest of educational systems in incorporating it as a transversal axis of all MET disciplines through the teaching of computer programming from an early age. The review of the difficulties of learning programming makes it necessary to reflect on new ways of developing computational thinking.

The study of concepts, characteristics and phases of computational thinking suggests the possibility of developing this thinking during the performance of daily life activities, through the application of metacognition. For this, only two requirements are necessary: first, to become aware that the skills of computational thinking (decomposition, pattern recognition, abstraction and generalization, and algorithms) are already being used in everyday life; and second, to consciously consider these skills in the performance of everyday life activities.

In the first instance, the two requirements presented for developing computational thinking skills only demand a proactive initiative from individuals to cultivate the habit of answering the four questions during the performance of all their daily activities:

- Am I decomposing the activity into several parts?
- Am I identifying the parts that are repeated or present in other activities?
- Am I considering only the elements of interest?
- Am I designing a strategy to perform the activity?

Regarding the importance of computational thinking in MET education, during COVID pandemic and post-pandemic, education got highly linked to technology, for online learning or remote processes as video meetings, so it is essential that future seafarers professionals develop the ability to create and

apply technology-based solutions. In this way, citizens will stop being just consumers and become prosumers.

It is important to keep in mind that the skills developed with computational thinking go far beyond coding a program. In fact, the learning process for a maritime digital leader represents the key as it allows:

- ✓ identify and understand the problem;
- ✓ consider, reflect and define effective solutions;
- ✓ apply a methodology;
- ✓ test it;
- ✓ and, if it does not provide the expected results, to be able to modify and execute solutions again.

The proactive initiative mentioned above represents the first challenge of this proposal for those promoting the development of computational thinking in others. Finally, it is important to emphasize that the metacognitive proposal presented in this study is only a product of the reflections made, leaving as future work the realization of the respective experiments to know its effectiveness.

References

[1] https://www.downtoearth.org.in/blog/science-and-technology/developing-economies-risk-exclusion-as-age-of-ai-dawns-82831

[2] Grancharova, V., Challenges to the multimodal transport networks based on sustainable growth in the volume of containerized cargoes, *IMSC. Pedagogika-Pedagogy*. Vol.93, No.7s. pp. 53-64. ISSN-0861-3982, (2021) Available from: https://doi.org/10.53656/ped21-7s.04chal

[3] Subramanian, C. Alvin Toffler: What he got right - and wrong, *BBC News*, World. 1 July (2016). Available at: https://www.bbc.com/news/world-us-canada-36675260. [Accessed 13 April 2021]

[4] Piñeiro-Otero, T., Martínez-Rolán, X. "Understanding Digital Marketing – Basics and Actions", *Theory and Application of Business and Management*, Springer, p.38, (2016), pp.37-74

[5] Stevanovic, M., Tesic, M., Jovic, M., Digital Marketing Strategy for Healthy Food Industry. Digital Trends in Marketing and Communication - Doing Business in the Digital Age: Challenges, Approaches and Solutions (*Symorg 2018*).p.107, (2018), pp. 106-112. Available at: < http://symorg.fon.bg.ac.rs/proceedings/2018/papers/Digital%20Trends%20in%20Marketing%20and%20Strategic%20Communications.pdf . [Accessed 11 April 2021]

[6] Dudić, Ž., Analysis of the Global Electronic Retail Market. Digital Trends in Marketing and Communication - Doing Business in the Digital Age: Challenges, Approaches and Solutions (*Proc. Symorg* 2018). p.13; pp. 9-14. Available at: < http://symorg.fon.bg.ac.rs/proceedings/2018/papers/Digital%20Trends%20in%20Marketing%20and%20Strategic%20Communications.pdf . [Accessed 11 April 2021]

[7] Piñeiro-Otero, T., Martínez-Rolán, X.. "Understanding Digital Marketing – Basics and Actions", *Theory and Application of Business and Management*, Springer, (2016), pp.41-42

[8] Edosomwan, S., Prakasan, S.K., Kouame, D., Watson, J., Seymour, T.. "The history of social media and its impact on business". *Journal of Applied Management and Entrepreneurship*. Vol. 16, (2011), pp.79-91.

[9] Campos-Freire, F. „Las redes sociales trastocan los modelos de los medios de comunicación tradicionales", *Revista Latina de Comunicación Social*, vol. 63, (2008), pp. 287–293.

[10] Baum-Talmor, P. Careers at Sea: Exploring Seafarer Motivations and Aspirations. In: Gekara, V.O., Sampson, H. (eds) The World of the Seafarer. *WMU Studies in Maritime Affairs*, vol 9. Springer, Cham. (2021), p.52, https://doi.org/10.1007/978-3-030-49825-2_5

[11] Baum-Talmor, P. *Careers and Labour Market Flexibility in Global Industries: The Case of Seafarers*. PhD Thesis, SIRC, Cardiff University, (2018).

[12] Glen, D., and J. McConville, Employment Characteristics of UK Seafaring Officers in 1999. *Marine Policy* 25 (3), (2001), 215–221.

[13] Hill, J.M.M. *The Seafaring Career: A Study of the Forces Affecting Joining, Serving and Leaving the Merchant Navy*. London: Tavistock Institute of Human Relations (1972)

[14] Mack, K. When Seafaring Is (Or Was) a Calling: Norwegian Seafarers' Career Experiences. *Maritime Policy & Management* 34 (4), (2007), 347–358.

[15] Alderton, T., M. Bloor, E. Kahveci, et al., *The Global Seafarer: Living and Working Conditions in a Globalized Industry*. Geneve: International Labour Office, (2004).

[16] Baum-Talmmor, P., *Careers and Labour Market Flexibility in Global Industries: The Case of Seafarers*. PhD Thesis, SIRC, Cardiff University, (2018).

[17] Gould, E.A., Personalities, Policies, and the Training of Officer Cadets. *SIRC Symposium Proceedings*, Cardiff University, (2011).

[18] Sampson, H., *International Seafarers and Transnationalism in the Twenty-First Century*. Manchester: Manchester University Press, (2013).

[19] Trilling, B., & Fadel, C. *21st Century Skills: Learning for Life in Our Times*. Primera edición, ISBN: 978-0-470-47538-6. San Francisco, C.A.: John Wiley & Sons, p.50. (2012).

[20] Doménech, M. *El papel de la inteligencia y de la metacognición en la resolución de problemas.* Tesis Doctoral. España: Universitat Rovira i Virgili. Recuperado de: https://dialnet.unirioja.es/servlet/tesis?codigo=8216, (2004), p.322.

[21] Wing, J. *Computational Thinking.Communications of the ACM*, 49(3), 33-35, e-ISSN: 1557-7317. Recuperado de: https://doi.org/10.1145/1118178.1118215, (2006).

[22] Aho, A. (2012). Computation and computational thinking. *The Computer Journal*, 55(7), 832-835, e-ISSN: 1460-2067. Recuperado de: https://doi.org/10.1093/comjnl/bxs074

[23] Basogain, X., Olabe, M., & Olabe, J. Pensamiento Computacional a través de la Programación: Paradigma de Aprendizaje.RED. *Revista de Educación a Distancia*, (46), e-ISSN: 1578-7680. Recuperado de: https://revistas.um.es/red/article/view/240011, (2015), pp. 1-33

[24] Wing, J. *Computational Thinking.Communications of the ACM*, 49(3), e-ISSN: 1557-7317. Recuperado de: https://doi.org/10.1145/1118178.1118215, (2006), pp. 33-35

[25] Román, M., Pérez, J., Jiménez, C. Test de pensamiento computacional: diseño y psicometría general. Madrid, España: III *Congreso Internacional sobre Aprendizaje, Innovación y Competitividad (CINAIC)*. Recuperado de: https://doi.org/10.13140/Rg.2.1.3056.5521, (2015)

[26] Zapata, M. Pensamiento computacional: Una nueva alfabetización digital.RED. Revista de educación a distancia, (46), e-ISSN: 1578-7680. Recuperado de: https://revistas.um.es/red/article/view/240321, (2015), pp 1-47.

[27] Doménech, M., *El papel de la inteligencia y de la metacognición en la resolución de problemas.* Tesis Doctoral. España: Universitat Rovira i Virgili. Recuperado de: https://dialnet.unirioja.es/servlet/tesis?codigo=8216, p.384, (2004)

[28] Flavell, J., *Metacognitive aspects of problem solving.The nature of intelligence*, ISBN: 04700-13842. Hillsdale, New Jersey: Lawrence Erlbaum Associates, (1976), pp. 231-235

[29] Zulma, M. (). Aprendizaje autorregulado: el lugar de la cognición, la metacognición y la motivación. *Estudios Pedagógicos*, 32(2), e-ISSN: 0716-050X. Recuperado de: https://www.redalyc.org/articulo.oa?id=173514131006, (2006), pp. 121-132.

Appendix

Appendix

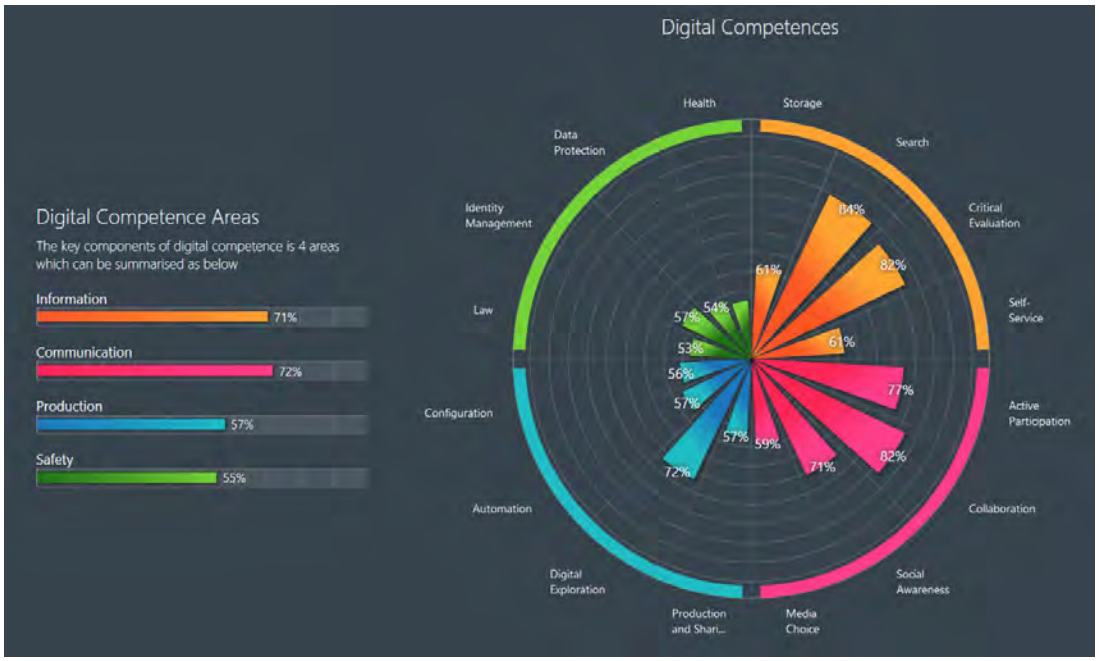

Fig.1. The Digital Competence Wheel – public tool provided by Center for Digital Dannelse

International Association of Maritime Universities

Meiwa Building 8F, 1-15-10 Toranomon, Minato-ku, Tokyo 105-0001, Japan

Tel : 81-3-6257-1812 E-mail : info@iamu-edu.org URL : http://www.iamu-edu.org

ISBN No. 978-4-907408-42-8