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(No. 20240106)

Modelling of the Use of Artificial Intelligence Platforms in Maritime Education and Training : Benchmarking of the IAMU Member Universities

By

Piri Reis University

August 2025

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International Association of Maritime Universities

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Abstract

The maritime industry is the backbone of global trade, handling approximately 85% of global transportation services with the immense value of the commercial goods leading the industry to be non-comparable to other modes of transportation regarding the impact on global economies around the world. Therefore, safety and effective operations within the entire maritime ecosystem are of interest to organizations, governments, regulatory bodies, businesses, and producers as well as the stakeholders all around the world. As the system evolves, it becomes clear that improvements can develop more opportunities for economic growth, international trades and international maritime trades. Within this scope, the maritime industry has been experiencing the digitalization and artificial intelligence (AI) utilized digital transformation at an increasing pace. Therefore, it is important that the seafarers of the merchant marine gain and sustain necessary skills and technological knowledge. In this research, an exploratory approach was adopted to develop and improve a conceptual framework on the AI utilization and implementation in Maritime Education and Training (AI-MET). Eight dimensions of AI-MET under "AI-MET Awareness" and "AI-MET Performance" headings were analyzed and evaluated by benchmarking 15 participated IAMU Member Universities and three AI-Chatbots through a survey. The expectations, limitations and prioritization ranking of several issues under the eight dimensions of AI-MET were presented quantitively through an exploratory approach. The findings from the survey were quantified and analyzed by three methodologies, namely the itemized rating scale, Analytic Hierarchy Process (AHP) and Non-metric Multi Dimensional Scale (NMDS). The findings provided a conceptual roadmap for the implementation of AI-MET for short-term and medium-term. For short-term, it is suggested that a collaboration to be established between the IAMU Member Universities and the AI researchers for the implementation of AI-MET along with advising to/convincing IMO and other regulatory bodies to find a way for the sharing of data. For the medium-term, it is suggested that the use of AI could be established for MET in classroom activities and also for scenario generation and implementation on the training simulators. The research showed that there is a necessity to apply AI-MET at a more rapid improvement and progress pace, with taking different aspects into consideration at a large scope among the IAMU Member Universities.

Keywords: *Digitalization, Artificial Intelligence, Maritime Education and Training-MET, e-Learning, Simulation Training.*

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We extend our sincere appreciation to the International Association of Maritime Universities-IAMU for their invaluable support and collaboration throughout this research. We also gratefully acknowledge the meaningful contributions of all stakeholders in Türkiye, Batumi State Maritime Academy in Georgia and Maine Maritime Academy in the USA, as well as the questionnaire respondents from IAMU Member Universities., whose input greatly enriched this research. Furthermore, we also wish to express our sincere gratitude to Piri Reis University for the institutional support, which played a pivotal role in the successful completion of this study.

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List of Abbreviations

2-D	Two dimensions
3-D	Three dimensions
AHP	Analytic Hierarchy Process
AI	Artificial Intelligence, AI-Chatbot
AI-MET	Artificial Intelligence Platforms in Maritime Education and Training
AR	Augmented reality
COLREG	Collision Avoidance Regulation
EU	Europe
FE	Far East
IAMU	International Association of Maritime Universities
IMO	International Maritime Organization
k	dimension (in NMDS)
MASS	Maritime Autonomous Surface Ships
MDS	Multidimensional scaling technique
ME	Middle East
MET	Maritime Education and Training
NA	North America
NMDS	Non-metric Multidimensional Scaling
NWT	Normalized weight
NWTc	Normalized weight of a main criteria
NWTi	Normalized weight of a subcriteria
PRU	Piri Reis University, Türkiye
TCP	Total case point
USA	United States of America
VR	Virtual reality

1 Introduction

The maritime industry is the backbone of global trade, handling over 80% of global transportation services, with a plus 2% growth expectation annually in maritime trade [1,2,3]. The immense value of the commercial goods leading the industry to be non-comparable to other modes of transportation regarding the impact on global economies around the world.

Therefore, safety and effective operations within the entire maritime ecosystem is of interest to organizations, governments, regulatory bodies, businesses, and producers as well as the stakeholders all around the world. As the system evolves, it becomes clear that improvements can develop more opportunities for international trades and further economic growth.

The maritime industry has been experiencing a digital revolution with recent concepts such as industry 4.0, blockchain, smart contracts and autonomous ships [4,5]. The high paces of digitalization and digital transformation are expected to continue with enabling new generation artificial intelligence (AI) utilization, which also calls for improved and increased adoption of automation. There is no doubt that the digital transformation with artificial intelligence (AI) supported applications are close to become an important trend in the maritime domain. Information and AI systems are expected to impact the maritime domain in the following years considering the increase in the number of vessels and complexity of operational processes [6, 7]. Therefore, it is equally important to have deck and engine officers having the technological thinking and savoir-faire in the merchant fleet [1]. The very near-future generations of seafarers, deck officers and engine officers will be expected to be able to comprehend and communicate with AI powered decision support systems [6] soon. This brings the requirement of establishing the intellectual capability of seafarers with ethical concepts and legal thinking by bringing innovative solutions while creating an education and training environment that enables balancing soft and hard skills, such as engineering and humanities [8; 9]. Stemming from this respect, the sector must show the tendency to enable new competencies for keeping up with the changes and remain relevant as the implementation of technology is imminent within the maritime industry [10]. By the fast pace of the developing technologies, Maritime industry is expected to be at medium risk to be automated completely and the implementation of technology is imminent. Many aspects of the maritime industry including law, management, education, and operations is under the influence of automation to some degree, while International Maritime Organization (IMO) encouraging the automation as well as trying to provide a framework for technical, safety and operational aspects of automation under the concept of industry 4.0 [11].

It is a fast-developing environment that the Maritime Education and Training (MET) need to be improved with a differentiating approach to be able to keep on track and align with these changes [1]. To prepare the seafarers for the digitally transformed seaborne trade environment of the near future, the Standards of Training, Certification, and Watchkeeping (STCW) regulations and competency list need to be updated and also the stakeholders of the maritime sector are required to consider upbringing skills and learning for the use of digital capability by AI implemented MET [1, 12, 13, 14, 15]. The use of AI platforms and AI applications as a tool in simulator training, theoretical classes as well as mandatory safety of life at sea and ship security training will bring a comparison to the benefits, challenges and limitations of the involvement of such technology into conventional ways of education with qualitative data analysis.

An exploratory study started at Piri Reis University on the conceptual modelling of the use of Artificial Intelligence Platforms in Maritime Education and Training (AI-MET) to prepare a guide for further research and initial findings presented in 2023 [1]. Subsequently, the exploratory approach continued with this research to develop a conceptual model for evaluating the implementation and utilization of AI as a tool in MET through the benchmarking of the use of AI and AI platforms in MET at IAMU Member Universities. Possible works on modifying the existing simulators with AI capability and also to gather information on several dimensions of awareness and performance expectations from AI-MET in continuation with the results of the previous studies were planned. Some work focusing to develop simulator training scenarios as well as the overall application in bridge and engine room simulators, in particular, with AI for determining patterns on AI answers and expert answers halted due to original

equipment manufacturers hesitancy on the interventions on simulator software. Qualitative data was received from experts, decision makers and academics by developing a questionnaire and conducting a survey. Data received via survey were quantified and examined through conceptual contexts. Furthermore, a similar survey was also applied to recently popularized three Chatbot tools of the AI platforms related companies, and a set of qualitative data were received from these three Chatbot platforms to make a comparative analysis between real human contributors and AI platforms within the analysis. Acquired responses from the IAMU Member Universities and AI-Chatbots were analyzed and compared using descriptive statistics, pairwise comparison weighting of Analytical Hierarchy Process (AHP) [16] and Non-metric Multidimensional Scaling (NMDS) methods. Along with the comparing expert opinions on the awareness on the use of AI-MET, priorities in the performance dimensions of AI-MET were ranked.

Concludingly, the challenges and limitations of using AI in MET is presented through an exploratory approach. The results indicates that in the current conjuncture of MET, AI may provide benefits and support to a certain extent on providing perspective to students in the form of research, basic knowledge, project development and career pathing. Moreover, further studies require to continue in rising awareness of AI-MET. Overall, although it is clear to emphasize that there will be benefits of using AI in MET, as in many other fields, which requires continuous improvement and progress. It is aimed to improve upon the initial vision of the AI utilization in MET, while providing reliable tools for performance evaluation as well as scenario creation for wider utilization.

This research is conducted in collaboration with three different IAMU Member Universities, Piri Reis University, Istanbul, Türkiye which is conducting the research as the Research Coordinator. As the Research Partners, Maine Maritime Academy, Maine, USA and Batumi State Maritime Academy, Batumi, Georgia are involved. In addition to the Researchers from specified IAMU Member Universities, a part-time Researcher from Batumi State Maritime Academy is a full-time academic at Tbilisi State University, Tbilisi, Georgia, which is not an IAMU Member University, and therefore, Tbilisi State University is also listed as one of the Research Partners. The fact of a collaborative study from a wide range of geographies made this research even more important, as it serves as a reference for future research experts.

1.1 Research objectives

The research aims to emphasize the role of artificial intelligence platforms in maritime education and training within an explorative approach through the development of a conceptual framework. This framework for the research explores the key concepts for the implementation of AI platforms in MET within IAMU Member Universities.

Within the scope of this project, major objectives were;

- to emphasize the use of artificial intelligence platforms in maritime education and training within an explorative approach,
- to develop a conceptual model through conceptual contexts within a framework to bring more depth to the analysis of the use of AI in MET,
- to analyze and compare the use of the AI platforms in MET through qualitative data received from human experts, academicians and AI-Chatbots,
- to analyze comparatively the conceptual awareness and performance on the use of AI platforms in MET within IAMU Member Universities,
- to benefit from the use of AI platforms to a certain extent on providing an educative perspective to students through MET,
- to develop a performance evaluation tool for AI utilization in MET,
- to establish pc-based simulator scenarios for AI integrated MET applications,
- to educate and to give students and lecturers experience on digitalized MET,
- to improve technological thinking and tendencies of students and lecturers, and
- to pave the way for innovative technological applications in MET

1.2 Methodology and Description of work

Piri Reis University-PRU, Istanbul, Türkiye, in partnership with Batumi State Maritime Academy-BSMA, Batumi, Georgia and Maine Maritime Academy-MMA, Maine, USA, conducted this research to achieve the research aims and objectives in modeling the use of AI platforms in maritime education and training within the IAMU Member Universities.

The research executed in the following 8 steps as explained below:

Step 1. Initial team meeting between Piri Reis University-PRU, Türkiye) in partnership with Batumi State Maritime Academy-BSMA, Georgia and Maine Maritime Academy-MMA, USA. The meeting developed a roadmap for execution of the research. The meeting was held online.

Step 2. A literature review period including academical and industrial publications.

Step 3. Local AI support search and decision on how to proceed for the simulator training scenarios and their implementation to the simulators' software at PRU.

Step 4. Studies on possible simulator scenarios, creation, testing, integrating and evaluating the simulator scenarios.

Step 5. Re-evaluation of pre-research and initial study interview results in way of determination and classification of the criteria for a survey among the IAMU Member Universities and AI-Chatbots to observe and analyze AI-MET Awareness and ranking of several criteria, to be followed by finalization of the survey design, where the research partners controlled and agreed on the survey questionnaire.

Step 6. An online survey via IAMU Secretariat, followed by a survey among three AI-Chatbots.

Step 7. Quantification of the received response data from survey; analyzes and evaluations by descriptive statistics, pairwise comparison of AHP method and NMDS Data analyzes, and evaluations were made by PRU.

Step 8. Site visits to Maine Maritime Academy in the USA were conducted. Site visit to Piri Reis University in Istanbul was conducted. These include visits of MMA and BSMA. Site visit to Batumi State Maritime Academy-BSMA conducted.

Step 9. The model and pre-results of this research were presented at the 24th IAMU Conference organized at Massachusetts Maritime Academy in Boston, the USA in October 2024. by the IAMU.

Step 10. Evaluation of the results, preparation of the research report, final meetings among the partners.

Step 11. Working on the collaborative journal paper to be published at a distinguished academic journal for the aim of contribution to the literature.

1.3 Expected impact

This explorative research quantitively shows the current expectations of IAMU Member Universities' in awareness in the use of AI-MET and ranking of AI-MET Performance dimensions. Stemming from research results, certain facts are clarified for MET academics and lecturers that AI tools may enable to improve AI-MET infrastructure and applications, enhance training simulator acquisition criteria, ensure interactive class environments and the tools to be used as a personal teaching assistant. The research results will affect personal developments of maritime students as the future deck officers and marine engineers, and will be reducing the level of decision-making skills, in addition to having the challenges of constantly utilizing such technologies as the main tool for learning.

1.4 Structure of the report

This report consists of five sections.

In Section 1, the background, research objectives, methodology and expected impact of the project is introduced;

In Section 2, the review on the relevant literature defining the AI applications in MET is presented.

In Section 3, the methodology in details including the interview, survey and the methods used in quantification of the survey responses are explained.

In Section 4, the results and findings from the survey, which is the status of issues on AI-MET awareness and AI-MET performance ranking by the IAMU Member Universities.

Finally, in Section 5, the evaluation of the research and the conclusions along with the recommendations for further research is presented.

2 Literature Review

An extensive literature survey was made in the open and educational access Internet sources with several keyword or phrase searches such as "*Maritime Education and Training*" "*AI in higher education*", "*AI in Maritime Sector*", "*AI in maritime Education*", etc. Eighty-four journal papers, research reports, conference papers were short listed which cover a general overview in AI use in MET, AI-Chatbot use in MET, specific use of AI in the maritime sector from the seafarers and technological trends such as Maritime Autonomous Surface Ships (MASS), beginning from the year 2011. Following the review of those previous studies, the findings were classified for further evaluation in this study. The methods and used in the development of literature leading to AI-MET are briefly presented below.

Literature review on the use of AI in MET showed that, parallel to developments in digitalization and information technology, possible improvements in MET must be taken into consideration [17]. The use of AI steadily and rapidly in utilization and implementation in various fields with beneficial functionality gains while forcing improvements in the field of education and training to surpass conventional methods [18,19,20]. Currently the utilization of AI implemented systems made available with the developments in computer technology is influencing and changing conventional education delivery [21]. As the use of AI in maritime industry enlarges in parallel, the necessity and huge tasks it bring for implementation of AI-powered algorithm technology to MET in lieu of continuing efforts to incorporate new technologies into MET, was emphasized in [22].

There are various research of AI induced education proposals in the recent literature of MET including theoretical classes [7, 23, 9, 24, 25] and practical training [26; 27, 28] including virtual reality (VR) or augmented reality (AR) applications[29]. On the development of AI-Chatbot framework for ship safety education, AI-Chatbot use in MET utilized for Collision Avoidance Regulation (COLREG) by a dedicated a custom AI-Chatbot named FLOKI and tested its applicability as a teaching aid for COLREG [20] in addition two research studies on developing two AI-Chatbot work frames on maritime communications training [30, 31]. Challenges and opportunities of using cloud-based simulators for MET was investigated in a study to observe cadets' skills and attitudes when cloud simulation on video-recorded exercises and interviews were introduced into the curriculum via navigation exercises [32]. The findings showed that frequent personal training with cloud-based simulators in MET can enhance skills for better performance in a full-mission simulator of current Technology; however, how to frame meaningful exercises in cloud-based simulators becomes a problem area [32].

International organizations currently do not formalize the education of maritime professionals and deck officers despite digitalization and AI radically change the maritime industry's job landscape [33]. However, professionals should adapt to rapidly changing technological landscapes. To meet the demands of digitalization and AI in the maritime industry, higher maritime education institutions should act urgently to overcome current knowledge gaps as sampled in the study of [33] and implement new educational modules to ensure the sustainable development of digital skills among cadets and also seafarers [33].

Identifying the most relevant AI trends and the need for respective changes in the MET curriculum, investigating the disconnect between industry demand and MET institutions were examined, resulting in more the need for more implementation of machine learning and AI related subjects [34]. An extensive research project was executed to evaluate the particularities of the digital seafarers of the future, to identify the most in-demand skills, to propose operational training methods and key performance indicators (KPI) within STCW and to assess the awareness of cadets and academicians on the challenges of digitalization and AI applications [35]. The particular influences of the information society and cyber &algorithm risks in a worldwide MET system were analyzed and results showed the lack of basic digital competences at the middle-aged seafarers, yielding a necessity for the heterogeneity of the digital competences and the knowledge level for the MET students and for many of the MET graduates; therefore, a need for IMO-STCW level approach was proposed in MET [35].

With regard to integration of AI-driven technologies in the language learning process during Maritime English courses, which deemed as inevitable, an initial short survey was made among the students of Antwerp Maritime Academy [36]. The finding that the students were eager to rely on AI-Chatbots when addressing written production in English [36]. On the other side, the translation accuracy of English Maritime documents, for a total of 10 short passages from maritime regulations and information to Japanese by an AI-Chatbot and two AI-driven software was tested [37]. Lexical errors were found resulting from the mistranslation of Maritime words and phrases, along with other mistranslation issues [37].

A several recurring was observed during the extensive literature study of [38] on the digitalization climate in the maritime industry such as;

- the integration of IoT (Internet of Things) devices for real-time monitoring,
- the application of AI and machine learning algorithms for:
  - predictive maintenance,
  - decision support, and
  - the use of blockchain technology for secure and transparent operations which also provide a guideline for further educational module needs.

AI-driven technologies, big data and augmented reality, along with the global maritime strategy of reducing greenhouse gas (GHG) emissions from ships, were defined as rapidly transforming and remolding factors in the maritime transportation [39].

In addition to improving AI-MET for cadets and seafarers for existing platforms, to incorporate AI-MET for MASS, a study was carried out at the Maritime Academy of Asia and the Pacific to understand the readiness of the cadets by assessing their knowledge, beliefs and feelings of AI technologies and its impact on their future careers [40]. Along with positive approaches, worries on the loss of job, cyber threats, and the decline of traditional maritime expertise also widely detected.

In an approach to integrate coding and AI in marine electronics in MET education at the Istanbul Technical University Maritime Faculty, effects of the socio-economic status, family support, technological literacy of the cadets along with the institutional infrastructure and financial factors were also observed in lieu of development of critical skills of cadets [41].

The increasing use of AI-Chatbots in MET, especially for several classroom applications reviewed in literature are highly appreciated. This type of studies can be extended based on the rapid improvements of AI-Chatbots, but usually remain as institution specific. However, for a globally agreed level AI-MET applications for simulator trainings, where existing seafarers are expected to attend remotely for individual trainings and qualifications, a more cloud or dedicated institutionally owned server based extended AI applications running on mission specific AI software and using global big data are deemed more appropriate to meet almost near-term needs of the maritime sector.

Based on the initial findings of this research [1], the exploratory research took the advantage of knowledge and experiences provided in the aforementioned previous literature but continued its methodology as detailed in the following sections.

3 Methodology

The methodology of the research comprised of qualitative and quantitative data collection through via a survey, followed by analyses and evaluations. The findings of the interview from the initial study phase [1] helped to design a survey for a larger extent to analyze and evaluate,

- the Awareness level on the use of Artificial Intelligence Platforms in Maritime Education and Training (AI-MET), approaches and,
- priorities of the AI-MET Performance requirements

among the IAMU Member Universities. This section discusses the methods undertaken to achieve the study objectives.

As detailed in the initial stage of the research [1], an interview only aiming at qualitative information gathering to obtain the basic approaches was executed. Then, for the survey design planned within this research phase, quantification and analyzes of the responses received was planned to be made by two methods, first by an itemized rating scale method for the AI-MET Awareness and then by pairwise comparison method for the AI-MET Performance. The itemized rating scale (Likert) survey method was used for the AI-MET Awareness levels. Pairwise comparison analyses were based on Analytic Hierarchy Process (AHP) for AI-MET Performance. The survey questions answered by IAMU Member Universities and AI-Chatbots. Analyses and evaluations made by the use of these two methods were supported by descriptive statistical analyses and Non-metric Multidimensional scaling method (NMDS) analyses.

3.1 The interview – previous exploratory phase

AI-MET had been first evaluated under four dimensions, adoption, implementation, evaluation and limitations during the previous study and interview phase. Adoption refers to the collaborations between AI experts and specialists, industry stakeholders and academy, regulatory, ethical, and legal aspects, and potential effects on seafarers. Implementation comprises of continuous learning, practical training (simulation training) and theoretical classes. Evaluation dimension represents the AI-MET utilization for evaluating trainee performance and AI-MET application performance. Limitations refer to data availability, expectations on cost reduction and personal limits of AI-MET implementation [1]. Then, to establish a framework on AI-MET, a set of qualitative questions (see Appendix 1), as grouped shown in Fig. 1 was prepared on;

- Adoption (three questions, questions 1-3),
- Implementation (four questions, questions 4-7) and,
- Evaluation (three questions, 8-10) and were asked to experts comprise of seafarers and academics, to understand potential opportunities, challenges, and limitations at an initial level [1].

The questions on Adoption aimed to understand the collaborations between AI experts and specialists, industry stakeholders and academy, regulatory, ethical, and legal aspects, and potential effects on seafarers. The questions on Implementation aimed to understand the comprise of continuous learning, practical training (simulation training) and theoretical classes. The questions on Evaluation aimed at understanding the AI utilization for evaluating trainee performance and AI application performance.

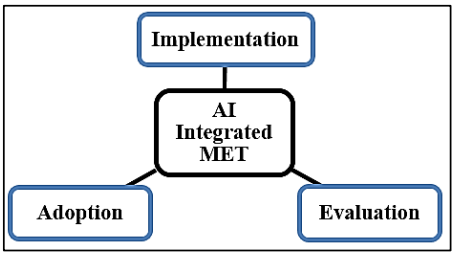


Fig. 1. Dimensions of AI integrated MET [1]

The same set of questions were asked to the Chatbot of the AI company OpenAI's ChatGPT to make a

comparison of the answers. Four separate replications have been carried out for ChatGPT, where two of them with 3.5 Legacy version and two with GPT4 March 2023 version.

Seven experts, with seafarer and academic positions experiences, as detailed in Table 1 were participated voluntarily to the interview at the previous study phase [1].

Table 1. Interview participants' demographics

LATEST RANK	CURRENT POSITION	EXPERIENCE IN MARITIME FIELD
Master	Maritime Lecturer	>15 years
Chief Engineer	Academic	>15 years
Marine Engineer	Academic	5-10 years
Officer of the Watch	Academic	5-10 years
Officer of the Watch	Academic	5-10 years
Officer of the Watch	MET Specialist	5-10 years
Officer of the Watch	Maritime IT Engineer	5-10 years

The interview results were summarized as follows [1]:

3.1.1 Adoption:

- Fast information access and transfer may allow an intensive education model. Development and integration of AI-powered simulators will help seafarers to maintain their employability.
- Common statements from both experts and AI-Chatbot showed the necessity of the collaboration between MET and AI specialists to develop and optimize the learning algorithm for AI for each task. This approach help to set minimum standards in the quality of the trainers.
- Regarding practical training, generating simulated environments is costly. However, procedural generation of onboard VR environments with the AI is possible with current technology. A sustainable scientific infrastructure can be enabled by academy and industry collaborations by AI-MET. This also will help to reduce costs and time and open new opportunities for experiments and measurements.
- Regulations and ethics are important criterion for AI adoption. Also, data privacy and protection is necessary with accountability. Before generalization of AI-MET, independent audit and service approval processes with clear definition of legal limits and liabilities and compliance with these laws and regulations must also be considered.

3.1.2 Implementation:

- AI-prepared training aids, supervised AI training tools and learning tracking may provide cost effective MET with increased efficiency by personalized continuous learning and distance learning.
- For simulation training, AI-driven scenario generation has been emphasized by the majority of the participants and the AI-Chatbot.
- Simulation training can be adjusted according to the requirement of the trainee. AI-MET assist in MET experts and AI experts work in collaboration to optimize the training, including difficulty levels, realism as well as scalability, interoperability, and user-friendliness. Collaborating with shipping companies may enhance this where actual data can be feed such as near-miss, accidents, type specific applications and rare events, which may provide a valuable experience for each seafarer.

3.1.3 Evaluation:

- AI-MET may provide an environment for better education by determining the measurement and evaluation criteria more precisely. Optimum performance evaluation can be achieved to observe weaknesses and strengths of the trainee, uncovering performance trends and skill deficiencies.
- AI-MET can enhance the effectiveness of lecturers that can be linked back to the re-planning of

training parameters in the loop of planning-monitoring-execution-analysis.

3.1.4 Limitations:

Limitations may apply for three proposed AI-MET dimension above. Data availability affect AI-MET, which trains AI continuously. Data sharing is necessary between all stakeholders of the maritime sector for sustainability of AI-MET. The stakeholders, initially IMO and other regulatory bodies, must be convinced on data sharing.

3.2 The survey design

To fulfil the major objectives of this research;

- to emphasize the use of artificial intelligence platforms in maritime education and training within an explorative approach,
- to develop a conceptual model through conceptual contexts within a framework to bring more depth to the analysis of the use of AI in MET,
- to analyze and compare the use of the AI platforms in MET through qualitative data received from human experts, academicians and AI-Chatbots,
- to analyze comparatively the conceptual awareness and performance on the use of AI platforms in MET within IAMU Member Universities,

a survey was designed to be held among IAMU Member Universities and AI-Chatbots on the basis of the outcome of literature review and previous interview summarized above. Therefore, the method to applied and questions in the survey questionnaire were aimed to be chosen and designed so that they fulfil the survey objectives and provide an exploratory overview. However, based on experiences from previous research, one of the main concern is not to bore the respondents during a survey. Therefore, the survey questions were prepared in an extensive content at the beginning of the research but for the sake of respondents possible patience, then the survey questionnaire arranged and finalized based on the results of the interview and survey design with a limited number of questions under eight dimensions in two main headings and classified to reconceptualize the conceptual framework of AI-MET than that of the [1] as illustrated in Fig. 2.:

For evaluating “AI-MET Awareness”,

- Adoption,
- Opportunities and,
- Limitations;

for evaluating “AI-MET Performance”,

- Implementation of AI-MET,
- Accessibility to AI-MET,
- Customization and enhancement capabilities,
- Performance of AI-MET in general and,
- Performance of AI-MET in simulation.

The responses was planned to be made in two different methods

- first by an itemized rating scale method for the AI-MET Awareness and,
- then by pairwise comparison method for the AI-MET Performance.

The itemized rating scale (Likert) survey method was used for the AI-MET Awareness levels. Pairwise comparison analyses were based on Analytic Hierarchy Process (AHP) for AI-MET Performance.

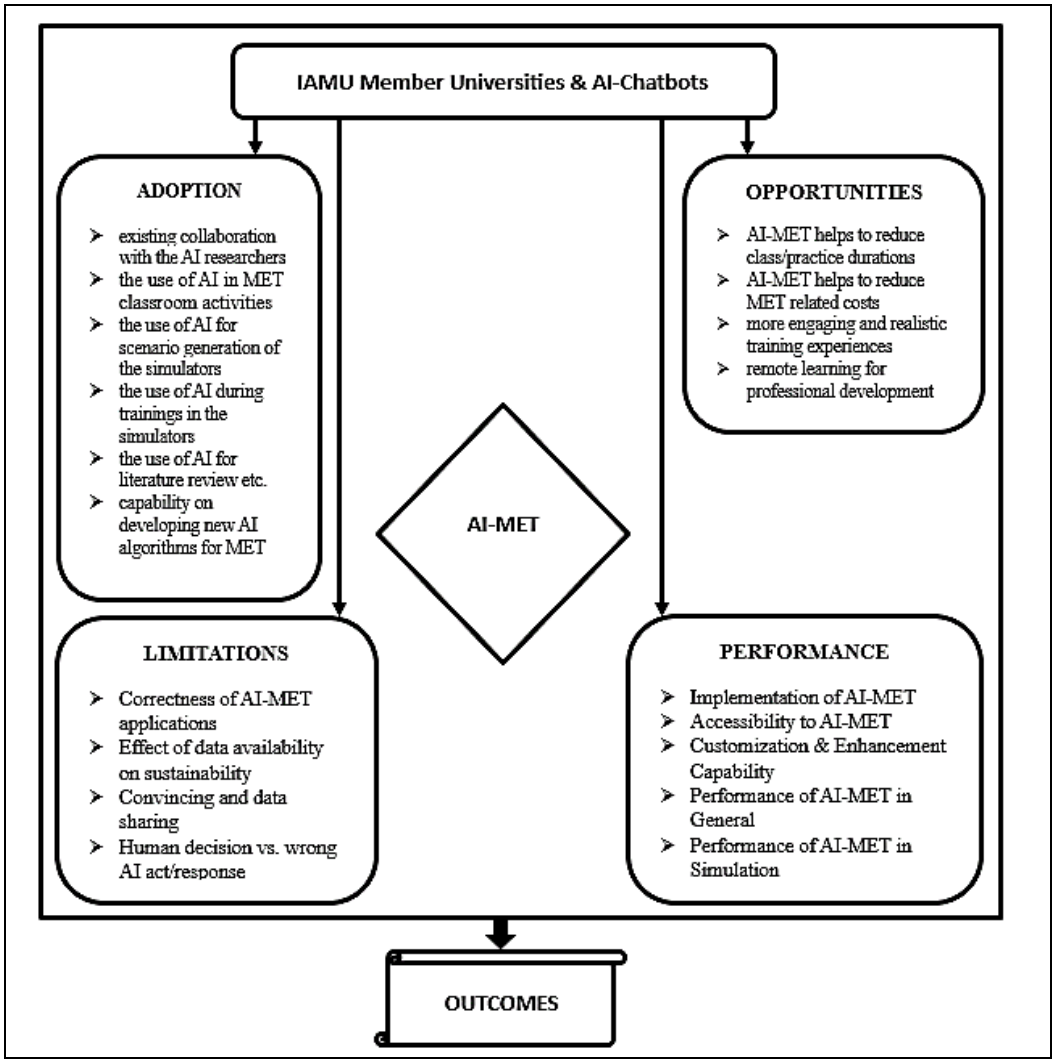


Fig. 2. Conceptual framework of AI-MET (updated) (Source: the authors)

For the evaluation of "AI-MET Awareness", for its Adoption dimension, the issues to be examined were as follows:

- existing collaboration with the AI researchers: if any collaboration already exists between IAMU Member University and AI researchers for implementation AI in maritime education training;
- the use of AI in MET classroom activities: if any AI use in MET classroom activities (theory, analyses, assignments, etc.) exists at the IAMU Member University;
- the use of AI for scenario generation of the simulators: if any scenario generation for the simulators (bridge, machinery, etc.) by the AI exists at the IAMU Member University;
- use of AI during trainings in the simulators: if any use of AI during watchkeeping, communications trainings at the simulators exists at the IAMU Member University;
- the use of AI for literature review etc.: if any use of AI for activities like literature review, language translations, grammar checking, etc. exists at the IAMU Member University;
- capability on developing new AI algorithms for MET: if the IAMU member University is capable of developing new AI algorithms for MET.

For Opportunities dimension, the issues to be examined were as follows:

- AI-MET helps to reduce class/practice durations: if there is an agreement that AI-MET helps to reduce class/practice durations;
- AI-MET helps to reduce MET related costs: if there is an agreement that AI helps to reduce MET related costs;
- more engaging and realistic training experiences: if there is an agreement that AI-driven scenario generation in survival at sea, cargo handling and navigational training might lead to more engaging and realistic training experiences;
- remote learning for professional development: if there is an agreement that AI-MET facilitates remote and distance learning opportunities for continuous professional development and lifelong learning (i.e., online courses, etc.) for seafarers.

For Limitations dimension, the concerns to be examined were as follows:

- Correctness of AI-MET applications: if there is an agreement that the correctness of AI-MET applications is based on correct data and algorithm inputs;
- Effect of data availability on sustainability: if there is an agreement that data availability affects the sustainability of AI-MET;
- Convincing and data sharing: if there is an agreement that the stakeholders must be convinced that AI will reduce the cost of MET and will be beneficial in the long-term; then, IMO or other regulatory bodies can find a way for data sharing;
- Human decision vs. wrong AI act/response: if there is an agreement that human decision is final when AI act/response is deemed wrong

For evaluation of the priority ranking in the "AI-MET Performance", the dimensions were selected as;

- Implementation of AI-MET,
- Accessibility to AI-MET,
- Customization and enhancement capabilities,
- Performance of AI-MET in general and,
- Performance of AI-MET in simulation.

The issues to be examined for each of them were as follows:

- Implementation of AI-MET,
  - The choice of correct tools: the choice of correct tools for the use of AI;
  - Reduction in class/ practice durations: AI-MET's help to reduce MET class/practice durations
  - Reduction in scenario generation: Reduction in the amount of work needed for procedural scenario generation for simulation trainings;
  - Improvement in personal qualification: AI-MET's help to improve Maritime cadets' & seafarers qualification.

- Accessibility to AI-MET,
  - 7/24 connectibility: A sustainable AI connection infrastructure and 7/24 availability;
  - Motivation of all stakeholders: Motivation of the all stakeholders to use AI-MET;
  - User-friendliness: User-friendliness of AI-MET.

- Customization and enhancement capabilities,
  - Customizability: Customizability of AI-MET;
  - Enhanced simulation training;
  - Skills development: Students' skills development;
  - VR / AR cases: VR / AR capability of AI;
  - Automated repetitive tasks: Automated repetitive tasks capability of AI-MET.

- Performance of AI-MET in general and,
  - Innovative response(s); Receiving innovative responses from AI;
  - Correctness of the AI-MET generated information;
  - Fast access to information: Fast access to information in AI-MET.

- Performance of AI-MET in simulation
  - Scalability: AI-MET runs fast, efficiently and can truly simulate the real world for simulator training;
  - Tracking and supervising the learning: Tracking and supervising the learning capability of the AI-MET
  - Re-planning of training parameters: Capability of re-planning of training parameters of the AI-MET;
  - Reliability (repetitions): Reliability of the AI-MET results

Analyses and evaluations made by the use of itemized rating scale and AHP methods were supported by descriptive statistical analyses and Non-metric Multidimensional scaling method (NMDS) analyses. In this respect, a close ended survey questionnaire was developed using the online tool Google Forms and distributed to IAMU Member Universities online through emails. The questionnaire covered four parts;

Part 1 : Information on the survey;
Part 2 : Respondents' information for survey participant demographics,
- Institution identification,
- Specialty, title and position
- Experience in the institution,
- Experience in the Maritime field,
- Communication information (voluntary);

Part 3a : Fourteen five-point itemized rating scale (Likert) questions on AI-MET Awareness dimensions,
- Adoption (six questions),
- Opportunities (four questions) and,
- Limitations of AI in the institution (four questions);

Part 3b : Eighteen pairwise comparison Questions on determining AI-MET Performance evaluation criteria;
- Five main criteria prioritization (four questions),
- Implementation of AI-MET (three questions),
- Accessibility to AI-MET (two questions),
- Customization and enhancement capabilities (four questions),
- Performance of AI-MET in general (two questions) and ,
- Performance of AI-MET in simulation (three questions).

The survey questionnaire is attached as Appendix 2. The same questions in Parts 3a and 3b were also asked online to three randomly selected AI-Chatbots. The questions are given in Appendix 3.

In the Section 3a of the Questionnaire, a five-point itemized rating scale where one (1) corresponds to "strongly disagree" and five (5) corresponds to "strongly agree" were assigned to each of the questions. The five-point itemized rating scale (Likert) question style and its evaluation is rather easy both for the respondent and researchers respectively. The scale of measurements with the corresponding expressions are presented in Table 2.

Table 2. Applied scale for Part 3a (Source: authors)

Scale	Definition
1	Strongly disagree
2	Disagree
3	Neither agree nor disagree
4	Agree
5	Strongly agree

For the analyses of five-point itemized rating scale type 14 questions, internal consistency checks by the Cronbach's Alpha method, descriptive statistics analysis to obtain cleaned data (if needed) were foreseen.

At the beginning of the project, a complex multivariate analysis environment was expected. It was decided the NMDS method would be good approach to analyze the complex survey results at simulators level. Multidimensional scaling techniques (MDS) are rarely used in maritime educational studies; however, they help to identify and visualize positioning of competing or variating opinions [42]. In the progress of this research, due to the external reasons, the obtained data remained relatively low but an evaluation by the use of NMDS method still deemed helpful. NMDS is one of the multivariate methods which especially allows visualization of complex relationships in small dimensions. This method attempts to find a low dimensional representation of the data where the inter-point distances are preserved as much as possible and tries to represent the pairwise dissimilarity between objects in such low-dimensional space. Due to the exploratory approach of the research, an NMDS analysis was decided by the researchers to observe relations on AI-MET Awareness dimensions of the respondents by their geographical location survey groups against AI-Chatbot survey results. NMDS was decided to be applied also for the AHP application (on main criteria and subcriteria basis) of the AI-MET performance issues. NMDS works on rank order and tries to choose coordinates so that sample units that are similar are close together in the ordination space and sample units that are dissimilar are far away from one another in the ordination space. The distance matrix summarizes the differences among each pair of sample units in terms of any number of response variables. Due to iterative characteristic of NMDS, there is no single solution but an optimum, and it can proceed even if some distances are missing from the dissimilarity matrix.

To evaluate and determine the rank of several performance issues for AI-MET, the pairwise comparison technique of the Analytic Hierarchy Process (AHP) [16]is used. AHP is a very common decision-making method. It is used to select the best one among a number of alternatives with respect to several main and sub-criteria. Based on the conceptual frame work as defined during initial studies [1], interview results and design of the questions on Awareness dimensions, AI-MET Performance evaluation criteria and subcriteria was structured and agreed upon among the research team & partners as follows (Table 3):

Main criteria (Cx):

- Implementation of AI-MET (C1),
- Accessibility to AI-MET (C2),
- Customization & Enhancement Capability (C3),
- Performance of AI-MET in General (C4),
- Performance of AI-MET in Simulation(C5);

Subcriteria (Cxi):

- The choice of correct tools (C11),
- Reduction in class/ practice durations (C12),
- Reduction in scenario generation (C13) and,
- Improvement (C14) in personal qualification in Implementation of AI-MET;
- 7/24 connectibility (C21),
- Motivation of all stakeholders (C22) and,
- User-friendliness (C23) in Accessibility to AI-MET;
- Customizability (C31),
- Enhanced simulation training (C32),
- Skills development (C33),
- VR / AR cases (C34) and,
- Automated repetitive tasks (C35) in Customization & Enhancement Capability of AI-MET;
- Innovative response(s) (C41),
- Correctness (C42) and,
- Fast access (C43) to information in Performance of AI-MET in General;
- Scalability (C51),
- Tracking and supervising the learning (C52),
- Re-planning of training parameters (C53) and,
- Reliability (repetitions) (C54) in Performance of AI-MET in Simulation.

Table 3. The structure of the AHP model for analyses (Source: authors)

MAIN CRITERIA (C_x)				
C1 **IMPLEMENTATION of AI-MET**	**C2** **ACCESSIBILITY to AI-MET**	**C3** **CUSTOMIZATION and ENHANCEMENT CAPABILITY**	**C4** **PERFORMANCE of AI-MET in GENERAL**	**C5** **PERFORMANCE of AI-MET in SIMULATION**
SUBCRITERIA (C_{xi})				
C11: The choice of correct tools	C21: 7/24 Connectibility	C31: Customizability	C41: Innovative response(s)	C51: Scalability
C12: Reduction in class/practice durations	C22: Motivation of all stakeholders	C32: Enhanced simulation training	C42: Correctness	C52: Tracking and supervising the learning
C13: Reduction in scenario generation work	C23: User-friendliness	C33: Skills development	C43: Fast access to information	C53: Re-planning of training parameters
C14: Improvement in personal qualification		C34: VR/AR case		C54: Reliability (repetitions)
		C35: Automated repetitive tasks		

In Section 3b of the Survey Questionnaire, the questions were ordered in order to quantify the survey participants' opinion on pairwise comparisons (Appendix 2). The pairwise comparisons are arranged among the main criteria and, among the subcriteria of each Criteria, as to be evaluated under a fundamental scale [43,44]. This scale is usually called as the conventional nine-point rating scale in the AHP application, as given in Table 4. As the intensity of importance increases, the scale changes from one to nine while as the intensity of importance decreases, the scale changes from 1/3 to 1/9.

Table 4: Applied pairwise comparison scale for Section 3b (Source[45])

Definition	Intensity of Importance
Equally important	1
Moderately important	3
Strongly important	5
Very strongly important	7
Extremely important	9
Slightly less important	1/3
Less important	1/5
Much less important	1/7
Extremely less important	1/9

As explained in [43,44], a Consistency Ratio (*CR*) is calculated for consistency checks of the pairwise comparisons. An exception is the "perfect consistency" approach where all comparison items (main criteria or subcriteria) are only compared to the first criteria, an anchor criteria, and then the consistency checks are not applied accepting some inconsistencies [43]. During the design of the questionnaire for the survey, the "perfect consistency" approach is decided not to overwhelm the respondents. Minor inaccuracies in this respect became possible but ignored.

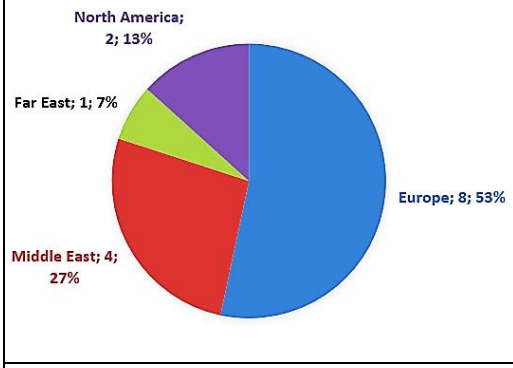
3.3 The survey

IAMU Member Universities were applied to respond to the survey by e-mails. The survey questionnaire (Appendix 2) was distributed in Google Forms. Academicians/experts from a total of 69 IAMU Member Universities were expected to participate in the survey but only 25 participants from 15 IAMU Member Universities responded. The 25 participants responded to all questions in the questionnaire which was found suitable to be used in the analysis. The online survey was conducted from 09 August to 16 September 2024.

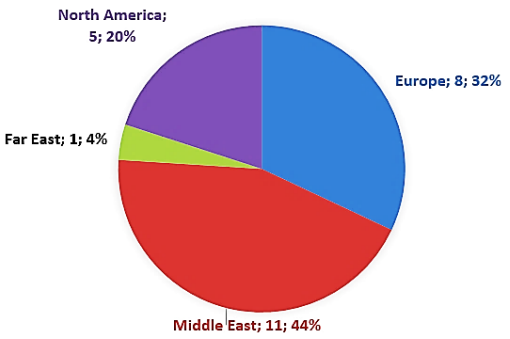
As presented in Table 5 and in Fig. 3, from the IAMU Member Universities in Europe, eight universities participated with eight respondents; from the IAMU Member Universities in Middle East, four universities participated with 11 respondents; from the IAMU Member Universities in Far East, one university participated with one respondent; and from the IAMU Member Universities in North America, two universities participated with five respondents; making a total of 15 IAMU Member Universities worldwide and 25 respondents.

Table 5. Survey participants

Region Code	Region	Number of Participating Universities	Number of Respondents from Universities
EU	Europe	8	8
ME	Middle East	4	11
FE	Far East	1	1
NA	North America	2	5
	Total	15	25



a. Geographical distribution of 15 universities



b. Geographical distribution of 25 respondents

Fig. 3. The distribution charts of survey participants

Then the same questions (Appendix 3) were asked online to three randomly selected AI-Chatbots;

- ChatGPT4o mini of the company OpenAI,
- MS Copilot of the Microsoft company and
- PHIND-70B of the Michael Royzen- Y Combinator

between 19 September to 21 September 2024. The AI-Chatbots responded to all questions which was found suitable to be used in the analysis.

4 Results and Discussion

This section presents the results and the findings from the survey executed during this research. Its results are presented in accordance with the sections of the questionnaire, starting with the demographics on the Respondents.

4.1 Respondents' demographics

The survey respondents' demographic data depicts the participants holding a mix of specialty, title, position and experiences. As given in Table 6, the highest number of respondents is comprised of maritime related fields, which is 60%, excluding a possible increase from "not specified" group. Therefore, the results from this survey indicate the background of most of the respondents in sufficient evaluation of any AI involvement in their specialty areas. The respondents are distributed at all levels of academicians and seafarers by their titles as shown in Table 7.

Table 6. Specialties of the respondents

Specialty	Number of Respondents
Maritime	6
Marine Engineering	1
Marine Transportation	1
Master on Oil & Chemical Tankers	1
Navigation	1
Mechanical Engineer	1
GMDSS instructor	1
Electronics	1
Computer Science	1
Engineering Psychology and Human Factors/Ergonomics, Human-Automation Interaction Design in Autonomous Shipping Systems	1
Science, Education, Geography	1
Social and Humanitarian Disciplines and Innovative Pedagogy	1
Not specified	8

Table 7. Titles of the respondents

Title	Number of Respondents
Director	1
Professor	3
Captain and Assistant Professor/Professor	2
Associate Professor	4
Ph.D.	1
Instructor at Training Centre	1
Captain	1
Second Officer	2
Master on Oil & Chemical Tankers, Instructor	1
Engineer	1
Specialist	1
Not specified	7

Regarding to academic positions of the respondents, as given in Fig. 4., there exists a slight increase of 40% which is due to the positions of the seafarer origin respondents in the academic institutions. Respondents with over 15 years of past are slightly overridden by the respondents having 1 to 5 years past in their current institution, 32% to 36% respectively as shown in Fig. 5, However, 60% of the respondents stated that they have experience in the maritime field over 15 years as given in Fig. 6. The respondents demographics presented an unbiased environment in the survey, representing responses from different experience levels and points of view.

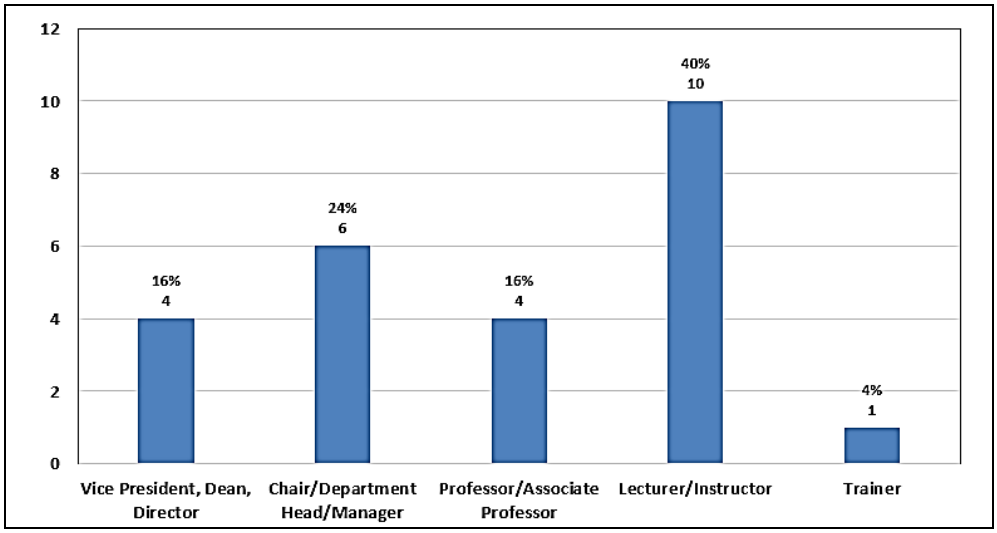


Fig. 4. Positions of the respondents

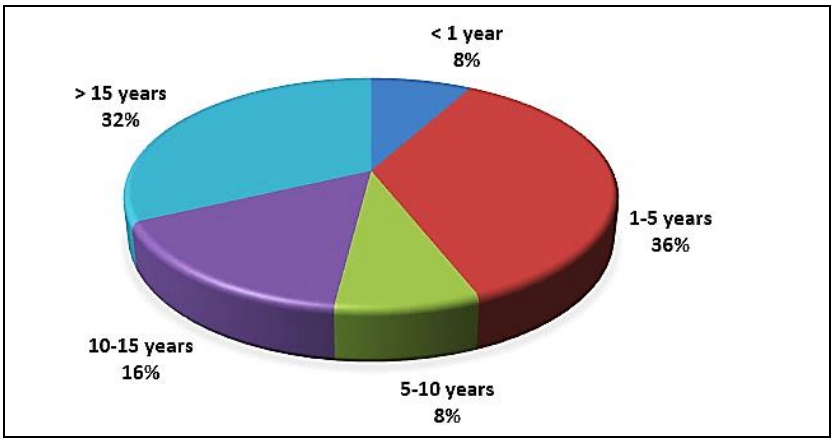


Fig. 5. The distribution of the respondents' time in their institution

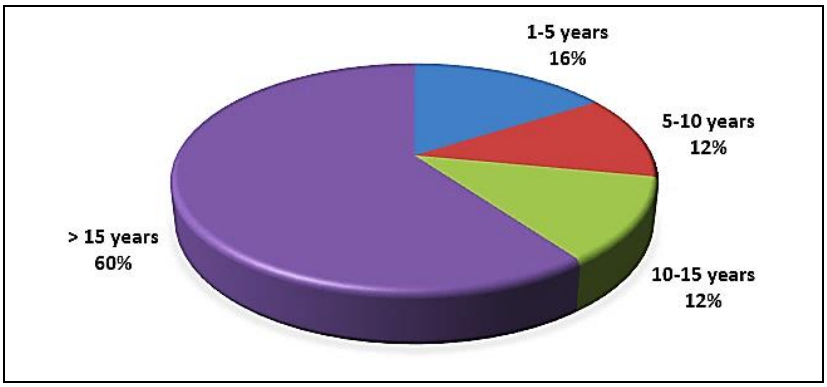


Fig. 6. The distribution of the respondents' experience in the maritime field

4.2 Awareness dimensions on AI-MET

Survey results on AI-MET Awareness dimensions, based on the Section 3a of the Survey Questionnaire, covering, Adoption, Opportunities and Limitations were first quantified by the numerical analysis of the five-point itemized rating scale (Likert) method. Since the number of respondents remained below an acceptable sample rate of at least 30, the survey result was non-parametric, therefore interferential statistics couldn't be applied. In this respect, for the responses on 14 five-point itemized rating scale type questions from the Section 3a of the Questionnaire, descriptive statistics were calculated on MSExcel software (MS360, 2024) by the embedded functions and data analysis add-in file. For the 14 x 25 (i.e., 25 respondents from universities) size response matrix, data cleaning by Measure of Skewness was applied and 26 responses out of 350 were eliminated. Survey response data from IAMU Member Universities are checked for consistency by Cronbach's Alpha method and found internally consistent, all being above 0.70, as given in Table 8.

Table 8. Internal consistency measurement results

CRONBACH's ALPHA			
All Sections in 3a	**Adoption**	**Opportunities**	**Limitations**
0.905	0.917	0.864	0.788

During the analyses, the geometrical mean was preferred to the arithmetical mean for being more conservative and its openness to the future addition of more survey data, for the survey response data from IAMU Member Universities and AI-Chatbots. The use of geometrical mean also complied with the outputs received from and evaluations during the NMDS analyses.

For each of the 14 questions on Awareness dimensions (Section 3a of the questionnaire), the distribution of responses (cleaned data) from IAMU Member Universities' respondents are presented below, from Fig. 7 to Fig. 20. In the figures;

- the columns show responses of the IAMU Member Universities' respondents,
- black vertical lines show geometrical means (cleaned data) of responses from IAMU Member Universities and,
- red dashed vertical lines, with stars below, show geometrical means of responses from AI-Chatbots.

========== *(intentionally left blank for the integrity of the following Figures)* ==========

As shown in Fig. 7, 36% of the respondents strongly disagree, 16% of the respondents disagree, 16% of the respondents are neutral, 20% of the respondents agree and 12% of the respondents strongly agree on **an already existing collaboration with the AI researchers for the implementation of AI-MET**, from the Adoption aspect. Mean of the cleaned data of the respondents is 2.13 which indicates a tendency between disagreement and neutrality, close to a disagreement. Mean of the responses of AI-Chatbots is 3.91 which indicates a tendency between neutrality and an agreement, close to an agreement.

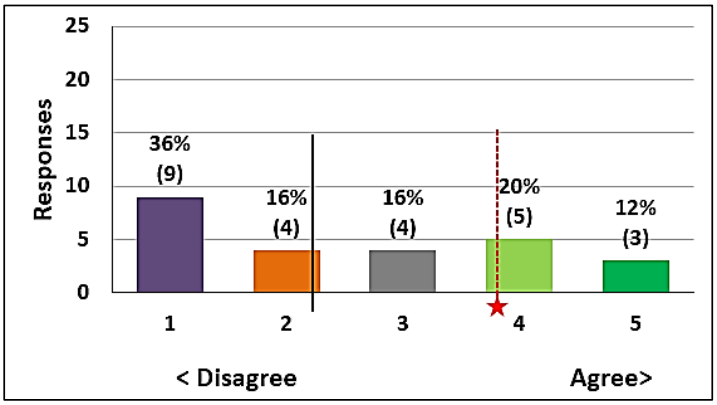


Fig. 7. Survey responses on Adoption: "existing collaboration with the AI researchers"

As shown in Fig. 8, 32% of the respondents strongly disagree, 20% of the respondents disagree, 20% of the respondents are neutral, 12% of the respondents agree and 16% of the respondents strongly agree on **the use of AI in MET classroom activities (theory, analyses, assignments, etc.)**, from the Adoption aspect. Mean of the cleaned data of the respondents is 2.19 which indicates a tendency between disagreement and neutrality, close to a disagreement. Mean of the responses of AI-Chatbots is 4.00 which indicates that they have a full agreement.

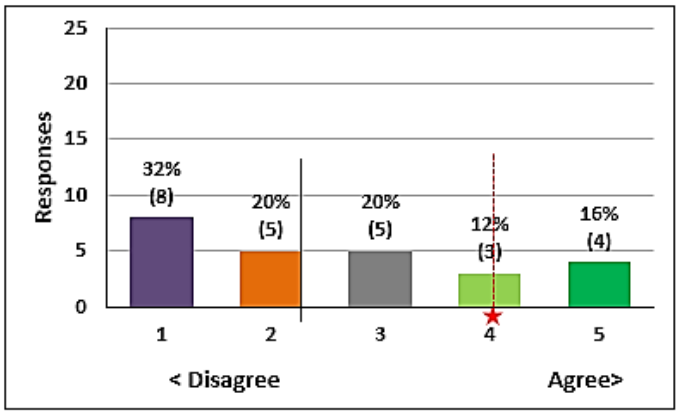


Fig. 8. Survey responses on Adoption: "the use of AI in MET classroom activities"

As shown in Fig. 9, 52% of the respondents strongly disagree, 12% of the respondents disagree, 12% of the respondents are neutral, 8% of the respondents agree and 16% of the respondents strongly agree on **the use of AI for scenario generation of the simulators (bridge, machinery, etc.)**, from the Adoption aspect. Mean of the cleaned data of the respondents is 1.79 which indicates a tendency between strong disagreement and disagreement, close to disagreement. Mean of the responses of AI-Chatbots is 3.63 which indicates a tendency between neutrality and agreement, close to an agreement.

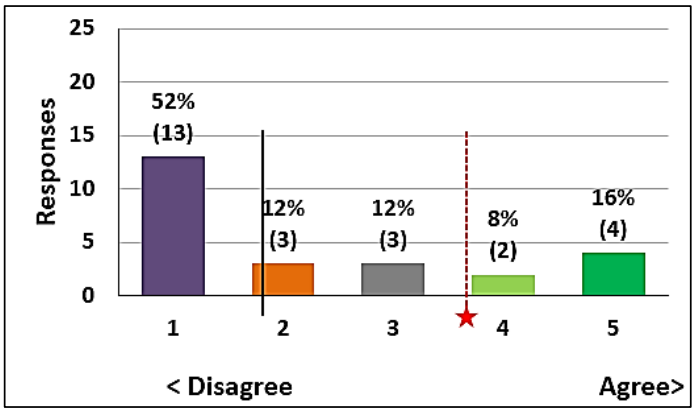


Fig. 9. Survey responses on Adoption: "the use of AI for scenario generation of the simulators"

As shown in Fig. 10, 41%, almost half of the respondents strongly disagree, 27% of the respondents disagree, 9% of the respondents remain neutral, 5% of the respondents agree and 18% of the respondents strongly agree on **the use of AI during watchkeeping, communications trainings in the simulators**, from the Adoption aspect. Mean of the cleaned data of the respondents is 1.91 which indicates a disagreement. Mean of the responses of AI-Chatbots is 3.63 which indicates a tendency between neutrality and agreement, close to an agreement.

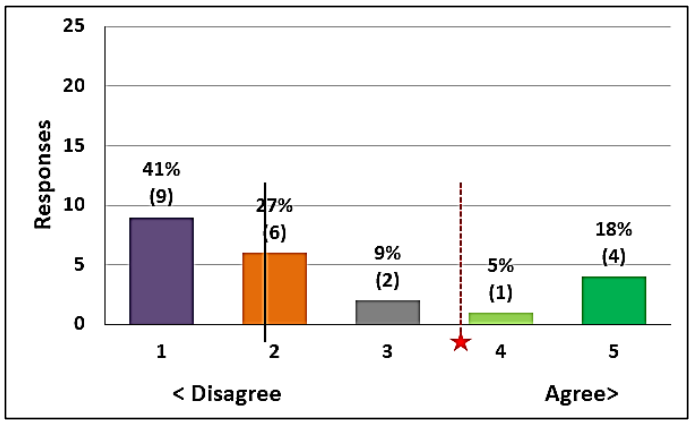


Fig. 10. Survey responses on Adoption: "the use of AI during trainings in the simulators"

As shown in Fig. 11, 24% of the respondents strongly disagree, 8% of the respondents disagree, 16% of the respondents are neutral, 28% of the respondents agree and 24% of the respondents strongly agree on **the use of AI for literature review, language translations, grammar checking, etc.**, from the Adoption aspect. Mean of the cleaned data of the respondents is 2.73 which indicates a tendency between disagreement and neutrality, close to a neutrality. Mean of the responses of AI-Chatbots is 4.31 which indicates a tendency between an agreement and strong agreement, close to an agreement.

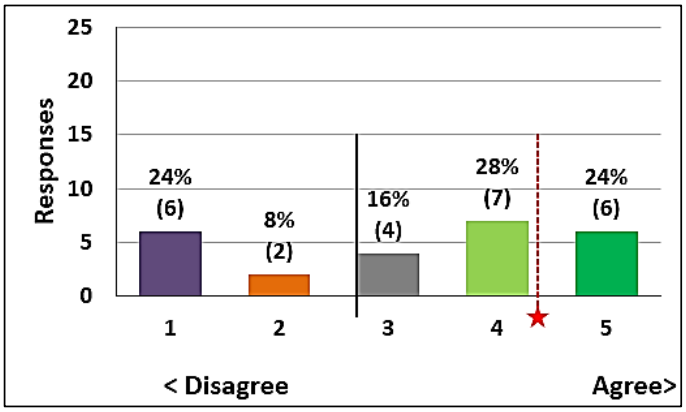


Fig. 11. Survey responses on Adoption: "the use of AI for literature review etc."

As shown in Fig. 12, 32% of the respondents strongly disagree, 20% of the respondents disagree, 20% of the respondents are neutral, 16% of the respondents agree and 12% of the respondents strongly agree that **they have capability on developing new AI algorithms for MET**, from the Adoption aspect. Mean of the cleaned data of the respondents is 2.17 which indicates a tendency between disagreement and neutrality, close to a disagreement. Mean of the responses of AI-Chatbots is 3.91 which indicates a tendency between neutrality and agreement, close to an agreement.

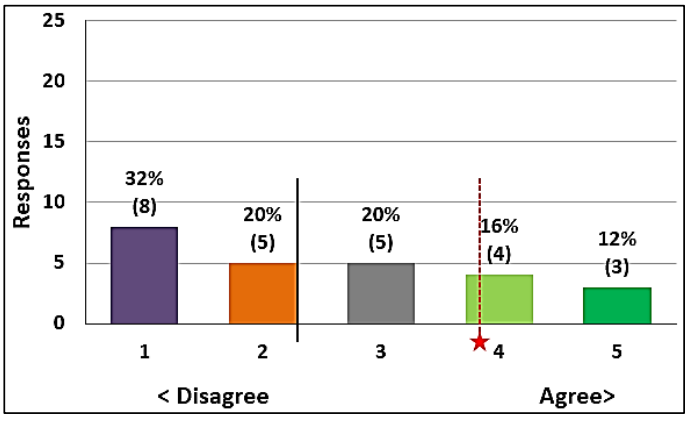


Fig. 12. Survey responses on Adoption: "capability on developing new AI algorithms for MET"

As shown in Fig. 13, 28% of the respondents strongly disagree, 12% of the respondents disagree, 36% of the respondents are neutral, 8% of the respondents agree and 16% of the respondents strongly agree on that **AI-MET helps to reduce class/practice durations**, from the Opportunities aspect. Mean of the cleaned data of the respondents is 2.33 which indicates a tendency between disagreement and neutrality, close to a disagreement. Mean of the responses of AI-Chatbots is 3.91 which indicates a tendency between neutrality and agreement, close to an agreement.

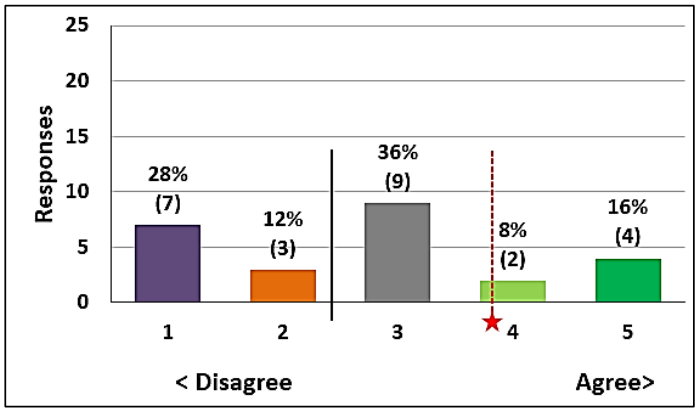


Fig. 13. Survey responses on Opportunities: "AI-MET helps to reduce class/practice durations"

As shown in Fig. 14, 28% of the respondents strongly disagree, 4% of the respondents disagree, 32% of the respondents are neutral, 16% of the respondents agree and 20% of the respondents strongly agree that **AI-MET helps to reduce MET related costs**, from the Opportunities aspect. Mean of the cleaned data of the respondents is 2.52 which indicates a tendency between disagreement and neutrality. Mean of the responses of AI-Chatbots is 4.64 which indicates a tendency between agreement and strong agreement, close to a strong agreement.

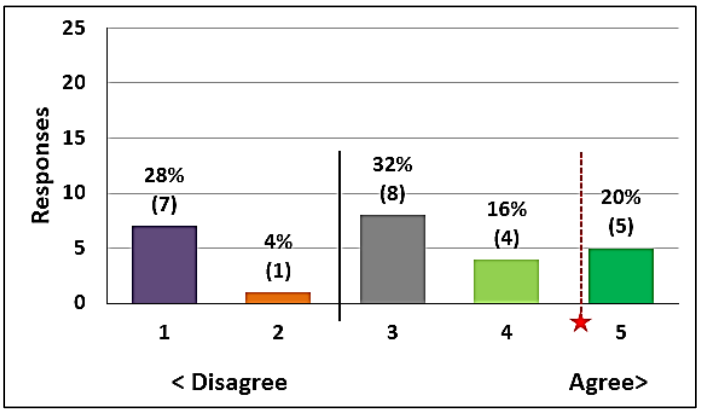


Fig. 14. Survey responses on Opportunities: "AI-MET helps to reduce MET related costs"

As shown in Fig. 15, 8% of the respondents strongly disagree, 8% of the respondents disagree, 24% of the respondents are neutral, 28% of the respondents agree and 32% of the respondents strongly agree that **AI-driven scenario generation in survival at sea, cargo handling and navigational training might lead to more engaging and realistic training experiences**, from the Opportunities aspect. Mean of the cleaned data of the respondents is 3.39 which indicates a tendency between neutrality and an agreement, close to the neutrality. Mean of the responses of AI-Chatbots is 5 which indicates a full strong agreement.

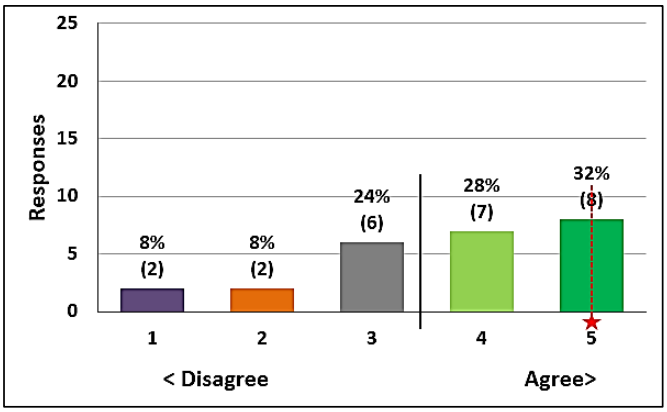


Fig. 15. Survey responses on Opportunities: "more engaging and realistic training experiences"

As shown in Fig. 16, 12% of the respondents strongly disagree, 12% of the respondents disagree, 16% of the respondents are neutral, 20% of the respondents agree and 40% of the respondents strongly agree that **AI-MET facilitates remote and distance learning opportunities for continuous professional development and lifelong learning (i.e., online courses, etc.) for seafarers**, from the Opportunities aspect. Mean of the cleaned data of the respondents is 3.25 which indicates a tendency between neutrality and an agreement, close to the neutrality. Mean of the responses of AI-Chatbots is 5 which indicates a full strong agreement.

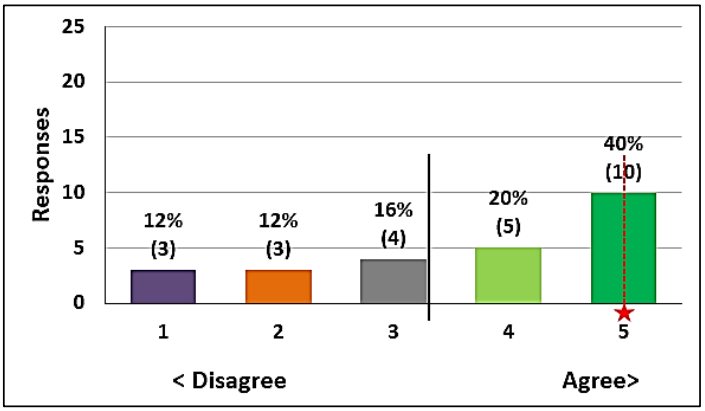


Fig. 16. Survey responses on Opportunities: "remote learning for professional development"

As shown in Fig. 17, 10% of the respondents strongly disagree, 10% of the respondents disagree, 14% of the respondents are neutral, 19% of the respondents agree and 48% of the respondents strongly agree that **correctness of AI-MET applications is based on correct data and algorithm inputs,** from the Limitations aspect. Mean of the cleaned data of the respondents is 3.50 which indicates a tendency between neutrality and an agreement. Mean of the responses of AI-Chatbots is 5 which indicates a full strong agreement.

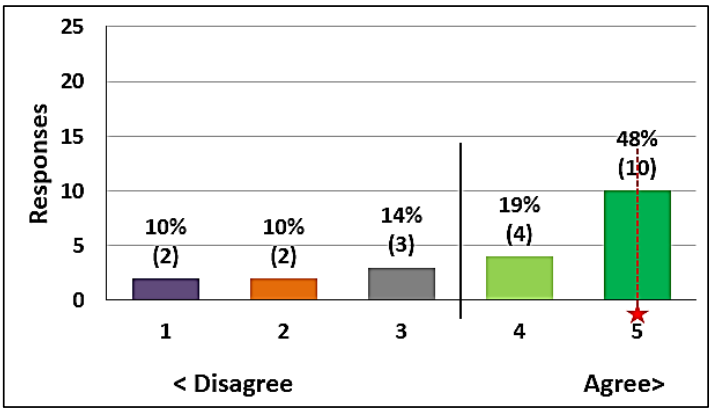


Fig. 17. Survey responses on Limitations: "Correctness of AI-MET applications"

As shown in Fig. 18, 10% of the respondents strongly disagree, 29% of the respondents are neutral, 24% of the respondents agree and 38% of the respondents strongly agree that the **data availability affects the sustainability of AI-MET**, from the Limitations aspect. Mean of the cleaned data of the respondents is 3.52 which indicates a tendency between neutrality and an agreement. Mean of the responses of AI-Chatbots is 5 which indicates a full strong agreement.

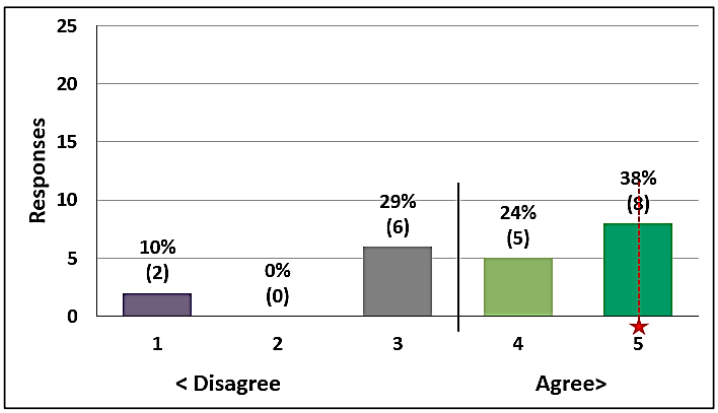


Fig. 18. Survey responses on Limitations: "Effect of data availability on sustainability"

As shown in Fig. 19, 5% of the respondents strongly disagree, 30% of the respondents are neutral, 25% of the respondents agree and 40% of the respondents strongly agree on **the stakeholders must be convinced that AI will reduce the cost of MET and will be beneficial in the long-term; then, IMO or other regulatory bodies can find a way for data sharing**, from the Limitations aspect. Mean of the cleaned data of the respondents is 3.74 which indicates a tendency between neutrality and an agreement, close to an agreement. Mean of the responses of AI-Chatbots is 4.64 which indicates a tendency between agreement and strongly agreement, close to a strong agreement.

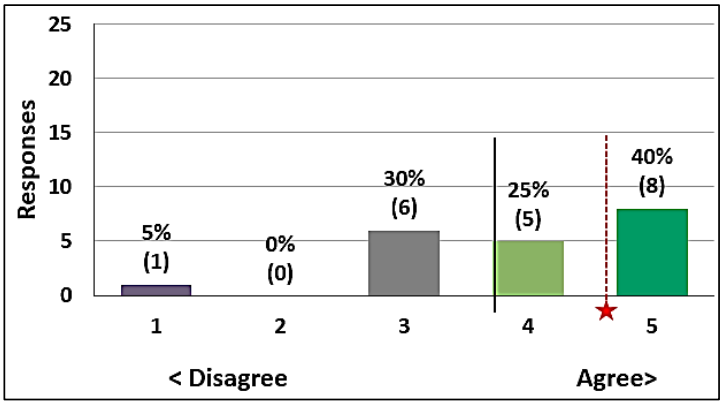


Fig. 19. Survey responses on Limitations: "Convincing and data sharing"

As shown in Fig. 20, 13% of the respondents strongly disagree, 20% of the respondents are neutral, 33% of the respondents agree and 33% of the respondents strongly agree that **human decision is final when AI act/response is deemed wrong,** from the Limitations aspect. Mean of the cleaned data of the respondents is 3.38 which indicates a tendency between neutrality and an agreement, close to neutrality. Mean of the responses of AI-Chatbots is 5 which indicates a full strong agreement.

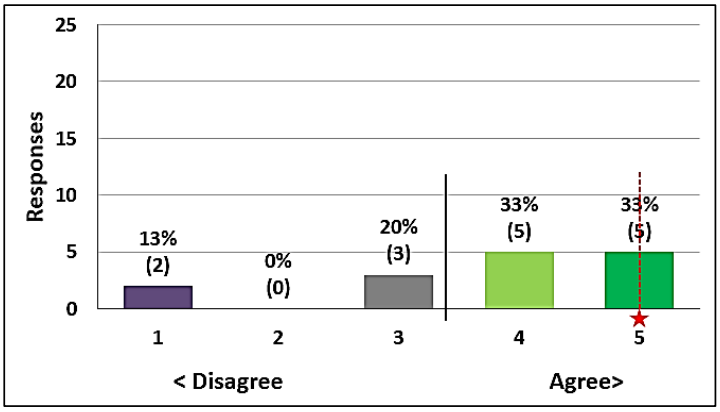


Fig. 20. Survey responses on Limitations: "Human decision vs. wrong AI act/response"

The responses of IAMU member Universities and AI-Chatbots on the Awareness of AI-MET were also evaluated by the NMDS method. For NMDS analyses, PAST 4.06b software [46] was used. In PAST software, the Bray-Curtis distance metrics technique [47] was used which fits to the current limited data best. NMDS analyses for Awareness on AI-MET were held both for raw and cleaned data from the surveys. In the PAST software, points with missing values (i.e., for the cleaned data) are disregarded and missing data is supported by pairwise deletion.

The simplest indicator for the goodness of fit of the regression in NMDS is by a stress value (coefficient), which comes from the "Kruskal's stress formula 1". Stress value is between zero and one, calculated from residuals around monotone regression line and expresses a proportion between the distance in the original dissimilarity matrix and the fitted distance in ordination space. In NMDS analysis, stress value analyses are first to be made for a decision on the best dimension (k) preference. The target is to seek an acceptable, low stress value and appropriate number of dimensions, usually in 2-D or 3-D. Stress value always decreases with an increase in dimension. Shephard diagrams help to visualization of stress after iterations at selected dimensions k. Then, Scatter Plots, Convex Hull diagrams and 3-D Plots help as the visualization tools for evaluations. A generally accepted table, as shown in Table 9 [48] is used to decide on the dimension based on the achieved stress values.

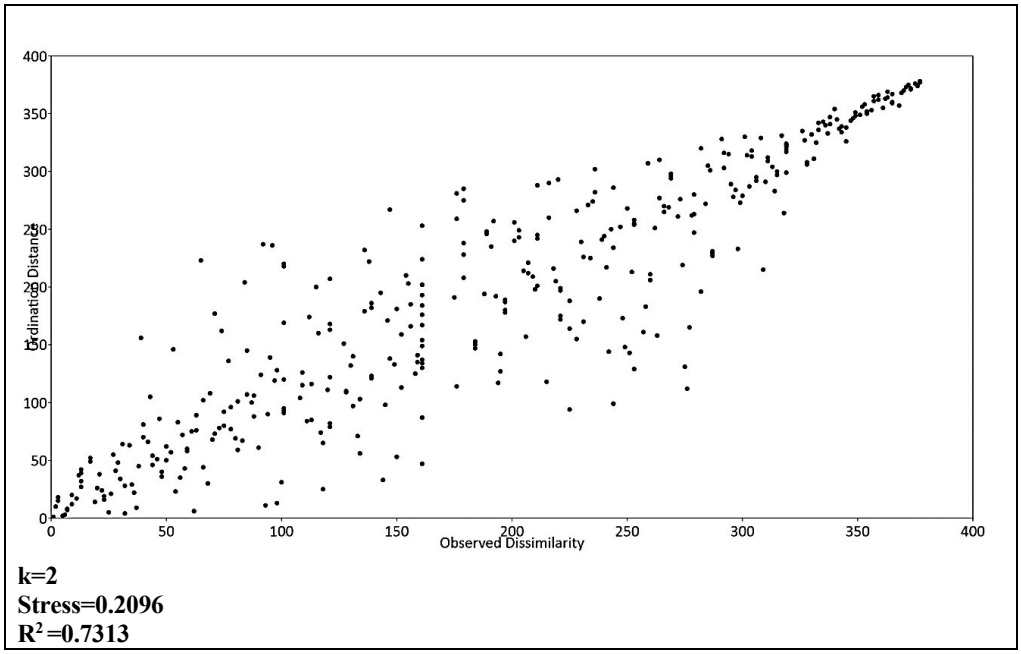
Table 9. NMDS Stress value interpretation (Source: [48])

Stress value (0-1 scale)	Interpretation
< 0.05	Excellent representation, no prospect of misinterpretation
< 0.10	Good ordination, no real risk for false inferences
< 0.20	Useful but has potential to mislead. Shouldn't place too much reliance
> 0.20	Could be wrong to interpret

In the PAST software, 11 iterations are made by default to obtain the lowest stress value for any selected dimension. In this research, for 2-D and 3-D dimensions, in search of lowest stress values, three runs were made. The reached lowest stress values at 2-D and 3-D analyses are presented in Table 10. The R^2 values are the coefficients of determination between distances along each ordination axis and the original distances. The stress values, R^2 results after the iterations are visualized on a Shepard diagram, as shown in the Fig. 21 for 2-D and in Fig. 22 for 3-D runs.

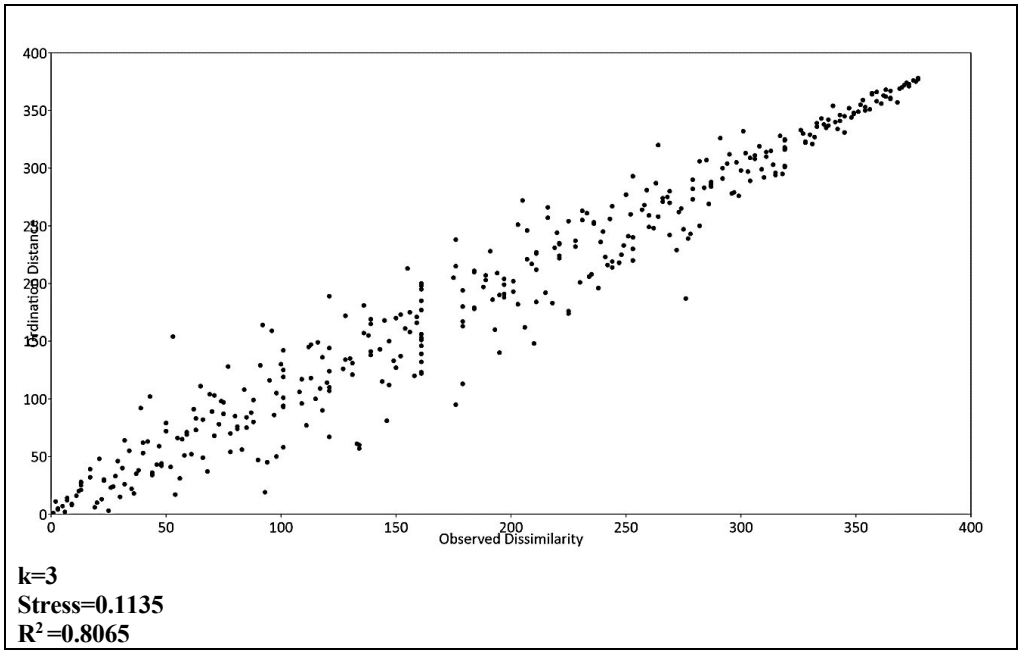
Table 10. NMDS Stress values for AI-MET Awareness

Data type and matrix size	Dimension (k)	Stress Value	R^2	Decision
Raw (14 x 28)	2-D (k=2)	0.2096	0.7313	Could be wrong to interpret
Raw (14 x 28)	3-D (k=3)	0.1135	0.8065	Lowest stress, good ordination, no real risk for false inferences
Cleaned (14 x 28) less 16 data	2-D (k=2)	0.2410	0.6952	Could be wrong to interpret
Cleaned (14 x 28) less 16 data	3-D (k=3)	0.1770	0.6976	Useful but has potential to mislead. Shouldn't place too much reliance



k=2
Stress=0.2096
R^2 =0.7313

Fig. 21. NMDS stress (Shepard) diagram, raw data, 2-D



k=3
Stress=0.1135
R^2 =0.8065

Fig.22. NMDS stress (Shepard) diagram, raw data, 3-D

Since solutions with higher stress values (usually above 0.20) should be interpreted with caution, as given in Table 9 above, for further NMDS analysis on the AI-MET Awareness, 3-D analyses with stress values of 0.1135 (raw data) and 0.177 (cleaned data) was decided. For the total received raw data from the IAMU Member University and AI-Chabot surveys on AI-MET Awareness, initial scatter plot at the XY-plane (NMDS 1 , NMDS 2) of 3-D analysis showed a distributed response environment except rather close distances between the AI-Chatbot responses from the universities, as shown in Fig. 23, despite two responses lie within expected extremity, showing an anomaly but were kept in the analyses due to their non-outlier positions.

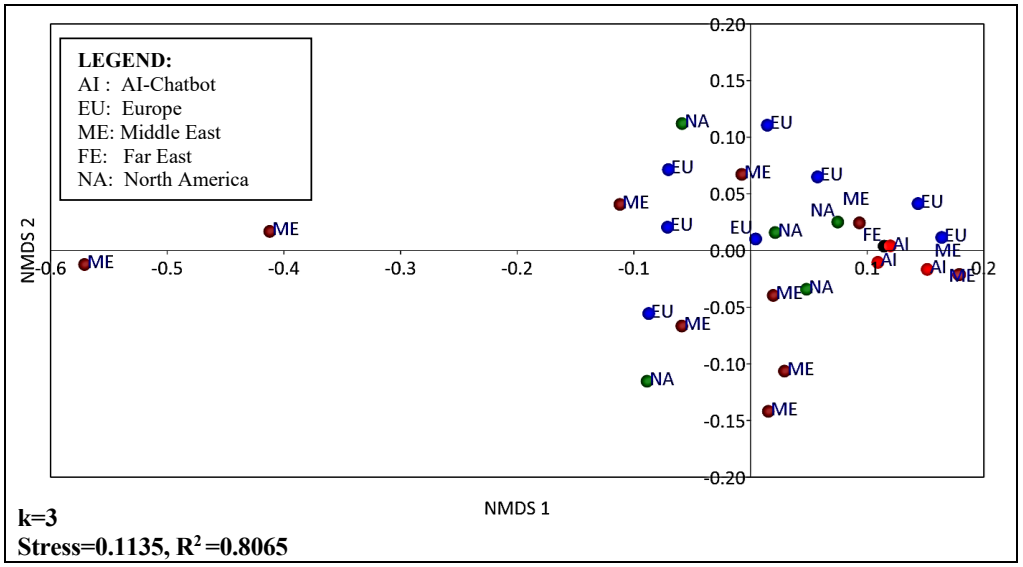


Fig. 23. NMDS scatter plot, raw data, xy-plane of 3-D

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Therefore, the Convex Hull in Fig. 24 which are the smallest convex polygon containing all points of the scatter plot, also drawn in in order to show the areas occupied by points of different groups. At the Convex Hull diagram in Fig. 24, the responses from IAMU Member Universities in the European region are the closest ones to AI-Chatbot responses, followed by Far East and then North American regions for the AI-MET Awareness dimension. IAMU Member Universities in the Middle East region shows a more largely distributed structure.

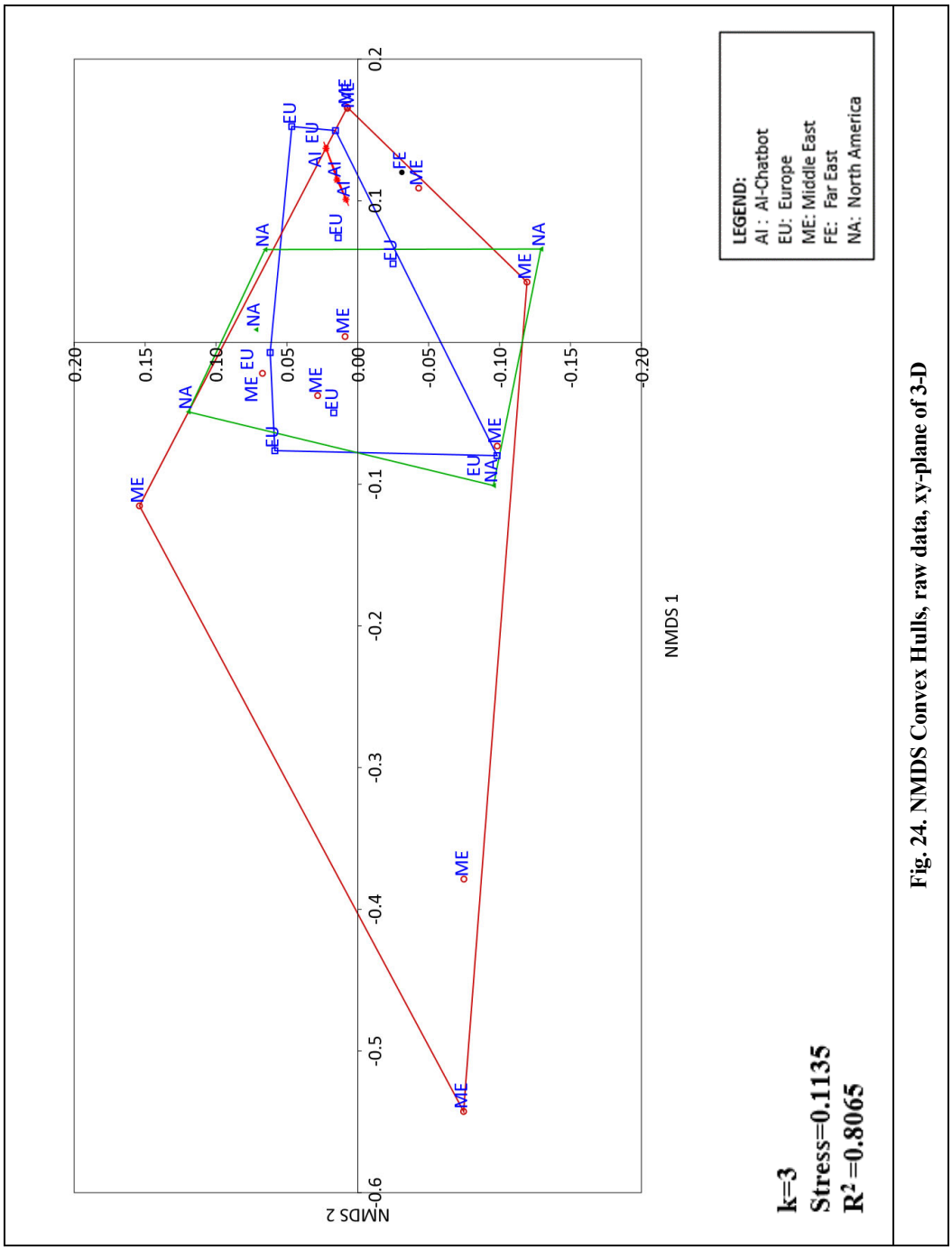

Fig. 24. NMDS Convex Hulls, raw data, xy-plane of 3-D

The positions of the responses on the AI-MET Awareness in a 3-D plot, viewing the NMDS data cloud from another angle can be seen in Fig. 25.

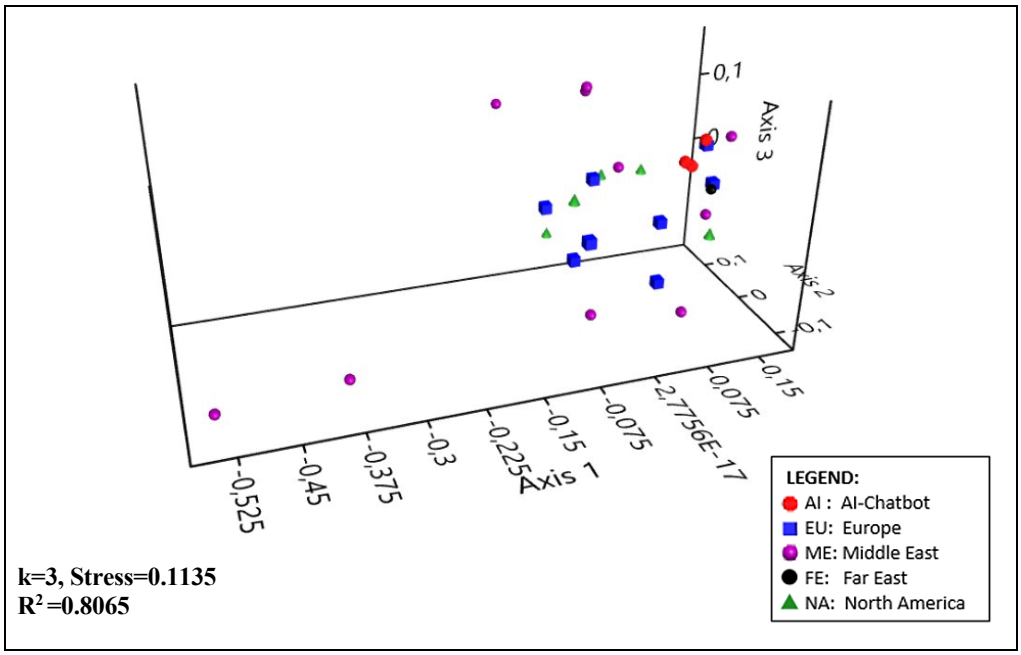

Fig. 25. NMDS 3-D plot, raw data, 3-D

The cleaned data for AI-MET Awareness responses overall showed a slightly higher stress values compared to raw data. There exists a potential to mislead but for a comparison between the two, parts from the 3-D analyses, with better stress value of 0.177 compared to 0.241 of 2-D analyses are presented below, beginning with the Shepard diagram in Fig. 26.

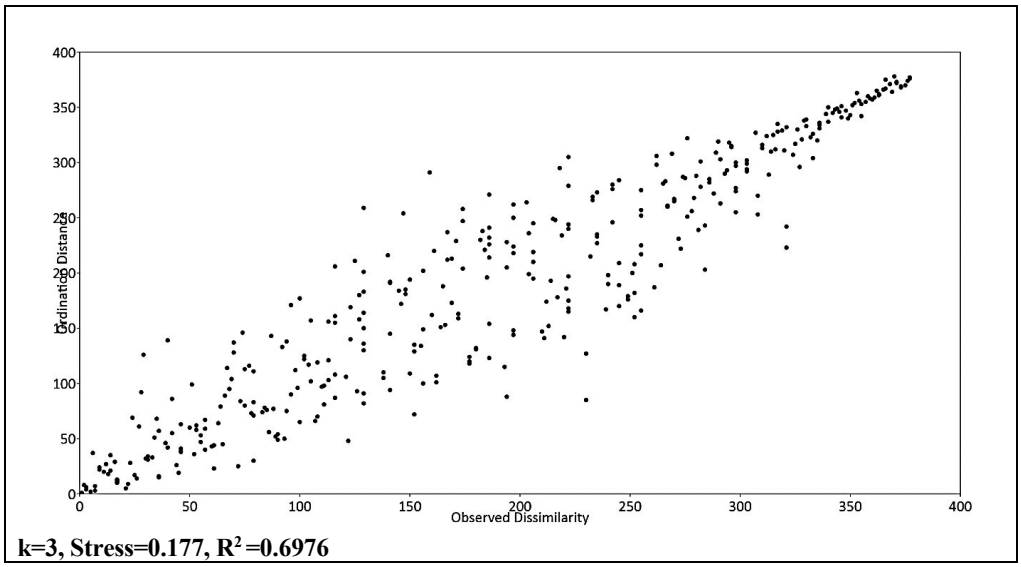

Fig. 26. NMDS stress (Shepard) diagram, cleaned data, 3-D

Again, in the Convex Hull in Fig. 27, the responses from IAMU Member Universities in the European region are the closest ones to AI-Chatbot responses, followed by Far East and then North American regions for the AI-MET Awareness dimension. IAMU Member Universities in the Middle East region still shows a more largely distributed structure. However, the positions of the responses on the AI-MET Awareness in a 3-D plot in Fig. 28. showed a more concentration around the AI-Chabot responses almost all responses, except two extremities from the Middle East region.

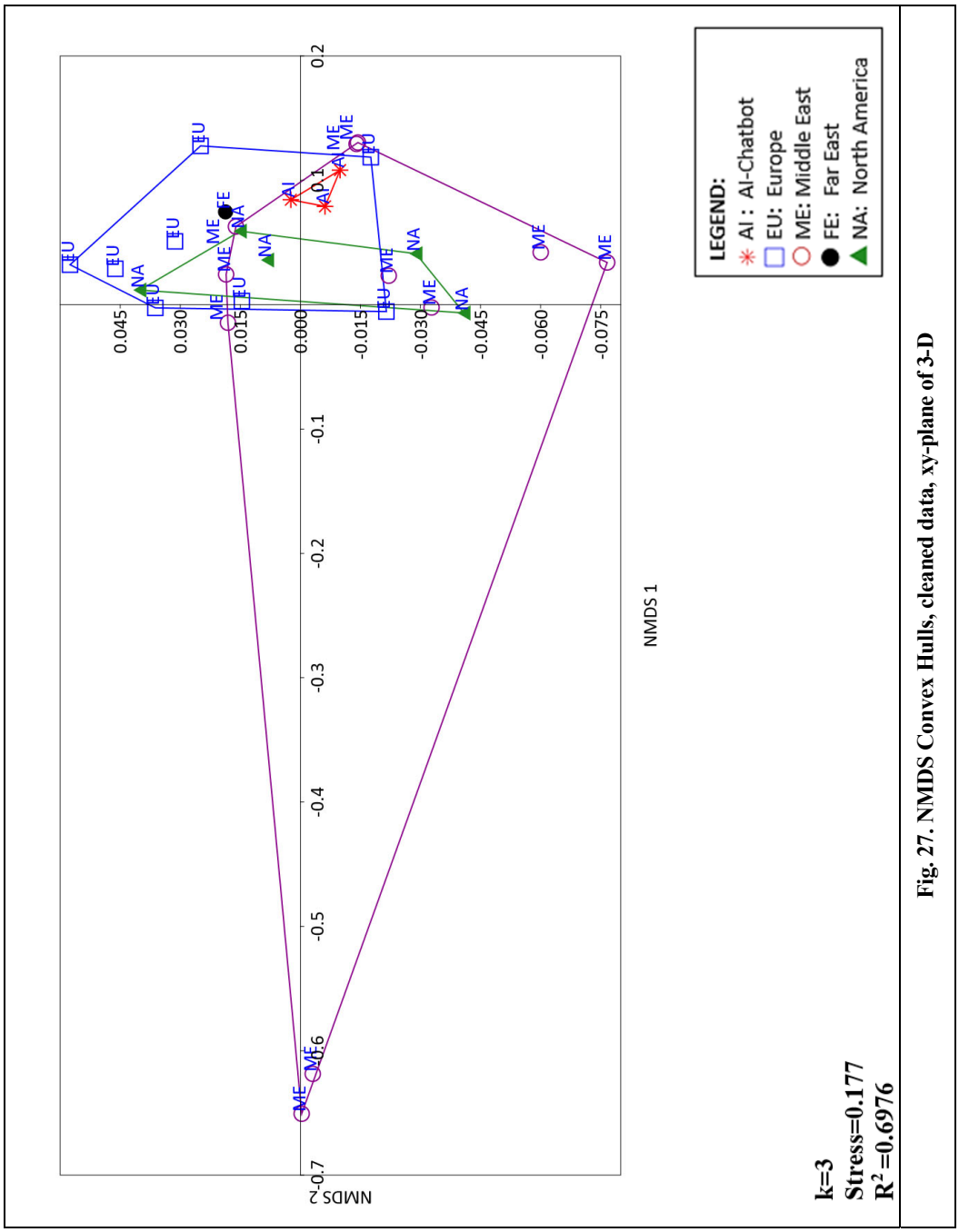

Fig. 27. NMDS Convex Hulls, cleaned data, xy-plane of 3-D

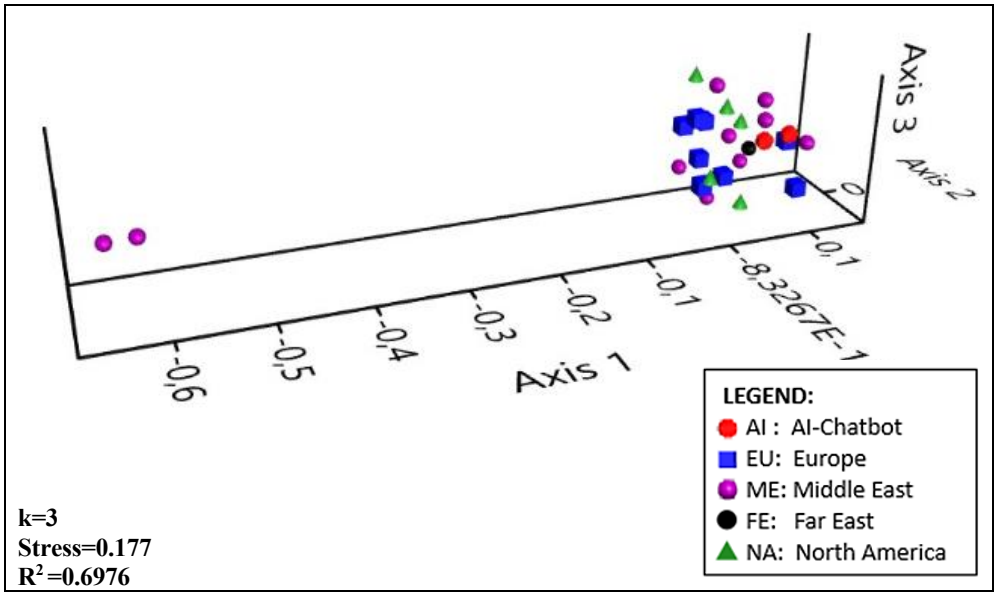

Fig. 28. NMDS 3-D plot, cleaned data, 3-D

Despite the two extremities from the Middle East region stay in the regular analyses due to their acceptable deviation, alternative illustrations disregarding those two responses are provided in Fig. 29. and Fig. 30 for the NMDS 3-D analyses where the stress value did not change much.

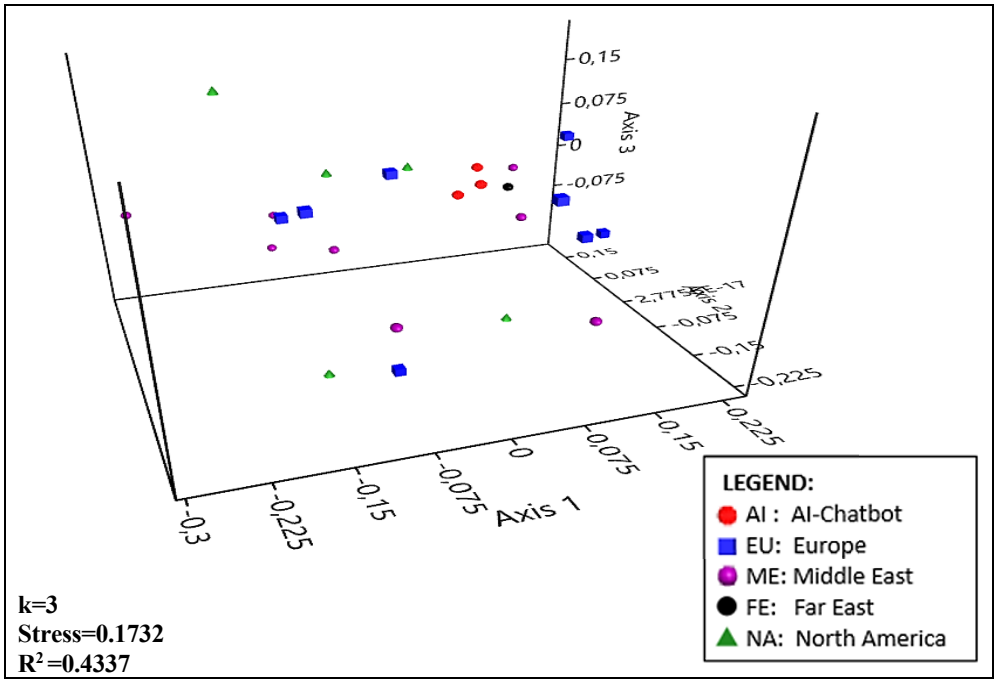

Fig. 29. NMDS 3-D plot, cleaned data also with two extremities deleted, 3-D

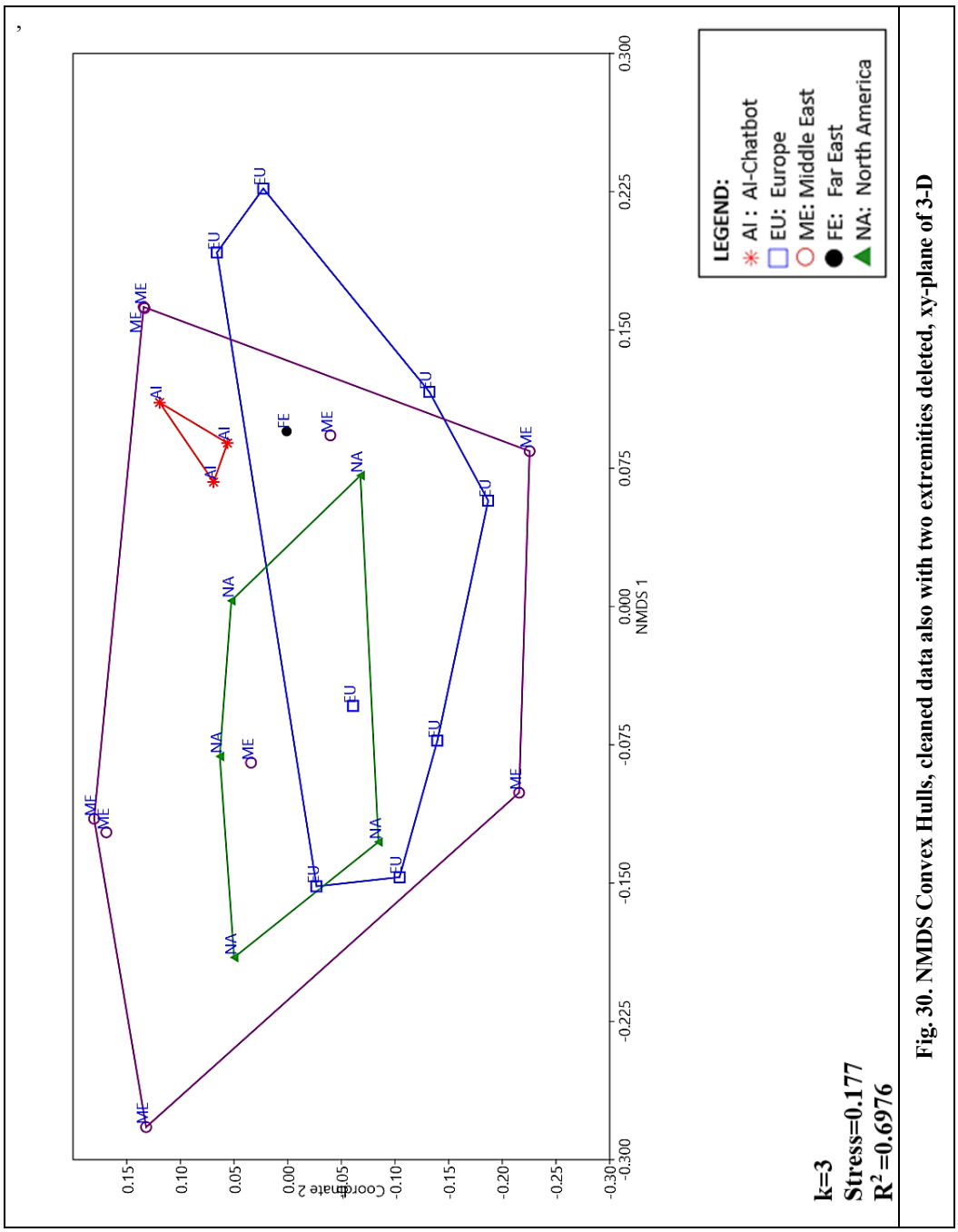

Fig. 30. NMDS Convex Hulls, cleaned data also with two extremities deleted, xy-plane of 3-D

The convex Hull diagram in Fig. 30 above provided a better evaluation visibility for the evaluation by NMDS analysis. The result from Far East was the closest to AI-Chatbot results, followed by the results of North America which is a group also with closest distances to each other. Despite the longest distances between responses of the Middle East group, results of the Middle East managed to enclose the other groups (Europe partly) and AI-Chatbot results.

During the analyses on each of AI-MET Awareness dimensions, for

- Adoption and,
- Opportunities,

3-D NMDS analyses were held with the cleaned data since their stress values showed no real risk for false inferences as presented in Table 11. However, 3-D stress value for the Limitations found high and 2-D analyses were held. For the responses on Adoption, as shown in Fig. 31 as a sample, AI-Chatbots are close to the geometric means of the responses along with some European, Far East and Middle East region responses. Despite the close distances between AI-Chabot responses, responses from the IAMU Member Universities are dispersed.

Table 11. NMDS Stress values for AI-MET Awareness, cleaned data, 3-D (k=3)

	ADOPTION 3-D	OPPORTUN. 3-D	LIMITATIONS 3-D	LIMITATIONS 2-D
Stress Value	0.09	0.06	0.030	0.07
R^2	0.89	0.86	0.07	0.90

For the same analysis on Opportunities, some European, Far East and Middle East region responses were close to the AI-Chatbot responses while North America region responses were concentrated around the geometric means of the responses. However, for the Limitations of AI-MET, all data including AI-Chatbots were dispersed largely, which is possibly due to the lesser number of data and deleted data during the cleaning process.

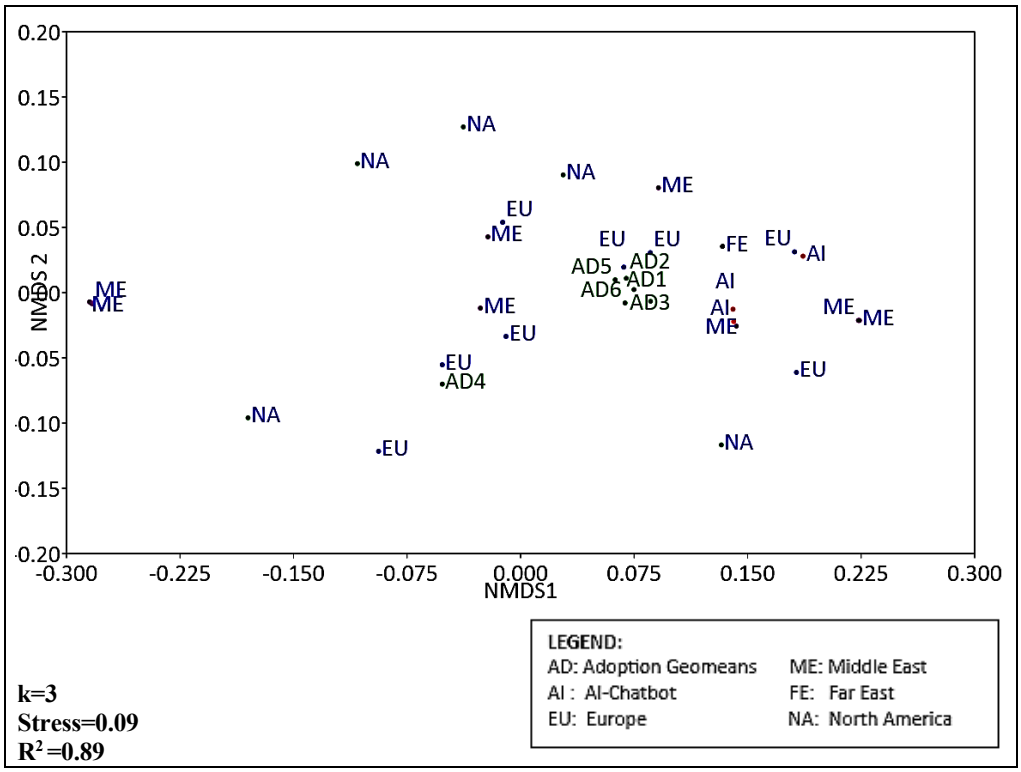

Fig. 31. Adoption NMDS scatter plot, cleaned data, xy-plane of 3-D

4.2.1 Findings on AI-MET Awareness

Based on the above analyses, also summarized in Table 12, the results of the survey held among IAMU Member Universities and AI-Chatbots on the Awareness of the use of AI-MET showed the following:

(1) All respondents "Agree" that,
   a. MET stakeholders must be convinced on cost-reducing effect of AI implementation in MET and its benefits in the long-term. To meet the required data in utilizing AI means, IMO and other regulatory bodies should develop a way for data sharing and,
   b. human decision is final when AI act/response is deemed wrong.

(2) On the following issues, the opinions are between "Neutral and Agree";
   a. correctness of AI-MET applications is based on correct data and algorithm inputs and,
   b. data availability affects the sustainability of AI-MET.

(3) The opinions are at "Neutral" level on;
   a. the use AI for literature review, language translations, grammar checking, etc.,
   b. current help of the AI-MET to reduce MET related costs,
   c. lead of the AI-driven scenario generation for more engaging and realistic training experiences in survival at sea, cargo handling and navigational training,
   d. facilitation of AI-MET remote and distance learning opportunities for continuous professional development and lifelong learning (i.e., online courses, etc.) for seafarers and,

(4) There is a general "Disagreement" on;
   a.existence of a collaboration between the universities and the AI researchers for the implementation of AI-MET currently,
   b. the use of AI in MET classroom activities (theory, analyses, assignments, etc.),
   c. the use of AI for scenario generation of the simulators (bridge, machinery, etc.),
   d. the use of AI during watchkeeping, communications trainings in the simulators,
   e. existence of capabilities in developing new AI algorithms for MET in the universities and,
   f. AI-MET helps to reduce class/practice durations.

AI-Chatbots responded in a more optimistic approach than the conservative approach of the IAMU Member Universities' respondents. This is possibly due to wider scanning capability of the AI-Chatbots from the earlier and previous academic research results, papers and the media.

Table 12. AI-MET Awareness summary

DISAGREE	NEUTRAL	AGREE
A collaboration exists	in use for Literature review, translations etc.	Beneficial in the long-term. Data sharing is necessary
in use for classroom activities	Reduces MET costs	Human decision is final
in use for simulation scenario generation	More realistic training	
in use during simulation	Distance learning opportunities	
Capability to develop exists	Correctness is based on correct data, input	
Reduces class/practice durations	Data availability affects the AI-MET sustainability	

From the NMDS analyses, it was also seen that, when there exists enough data, AI-Chatbot results are close to each others; responses from European, Far East and North American regions are relatively close to those of the AI-Chatbots while the responses from Middle East institutions are more scattered.

During the course of this research, researchers of the Piri Reis University also observed three additional cases;

(1) Despite, allowing and motivating the MET Senior students to use, receive assistance from AI-Chatbots during home studies a low-level interest was observed;

(2) Despite, freedom of using mobile phones, tablets and computers during two mid-term exams of the MET Senior students on ship stability and ship production, no use of the AI-Chatbots by the students was observed. These two events show that not only the academicians but also the MET students need to be made more aware of the use of AI-MET.

(3) A simple navigation question (ship speed over ground during sailing into the current and wind at Dardanelles Strait) was asked to ChatGPT4o mini by one of the Piri Reis University researchers. The AI-Chatbot was not correct in its answer on the effect of wind, for which it did not include the projected hull and superstructure area of the ship in the calculation. This showed that AI-Chatbots may not be ready for AI-MET for some time and currently it may be better to use institutional or organizational level dedicated AI systems for AI-MET, which is costly.

4.3 Performance of AI-MET

For the analyses on the pairwise comparison type questions in the Section 3b of the Survey Questionnaire, which covers the AI-MET Performance on the five main criteria of;

- Implementation of AI-MET,
- Accessibility to AI-MET,
- Customization and enhancement capabilities,
- Performance of AI-MET in general,
- Performance of AI-MET in simulation

and their own subcriteria, the weight calculations are made on the basis of Analytic Hierarchy Process (AHP) method as defined in Section 3.2.NMDS analyses were also held for the visualization of main criteria and subcriteria evaluations.

It was mentioned that since the number of respondents remained below an acceptable sample rate of at least 30, the survey result was considered non-parametric and interferential statistics couldn't be applied. In survey responses, one IAMU Member University respondent also declined to answer in this Section 3b due to having less information on the subject. Therefore, the performance on AI-MET survey results are analyzed for the responses from 24 IAMU Member Universities and three AI-Chatbots. For the responses on 18 pairwise comparison type questions from the Section 3b of the survey questionnaire, weight calculations and descriptive statistics are calculated on MSExcel software (MS360, 2024) by the use of researchers' AHP templates, embedded MSExcel functions and data analysis add-in file. For the 24 x 24 (24 respondents from universities) size response matrix, data cleaning by Measure of Skewness was applied and 19 responses out of 576 were eliminated. A 24 x 3 size response matrix, as per responses of the AI-Chatbots for the Section 3b of the Survey Questionnaire were analyzed separately.

During the analyses, for the survey response data from IAMU Member Universities and AI-Chatbots, the geometrical mean was preferred to the arithmetical mean for being more conservative and its openness to the future addition of more survey data. So, for each result of pairwise comparison from the responses, geometrical mean represents the average weight calculated for subject question. For the main criteria and for the subcriteria of each main criteria, the calculated geometrical means of the weights were normalized (NWT) and presented in Table 13. The use of geometrical mean also complied with the outputs received from and evaluations during the NMDS analyses.

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Table 13. Survey responses – Normalized Weights (NWT)

MAIN CRITERIA	SUBCRITERIA	NWT (University responses)	NWT (AI-Chatbots)
C1-The implementation of AI-MET		**0.285**	**0.548**
	C11-The choice of correct tools for the use of AI	0.464	0.713
	C12-AI-MET's help to reduce MET class/practice durations	0.195	0.086
	C13-Reduction in the amount of work needed for procedural scenario generation for simulation trainings	0.178	0.096
	C14-AI-MET's help to improve Maritime cadets' & seafarers qualification	0.163	0.105
C2-Accessibility to AI-MET		**0.164**	**0.138**
	C21-A sustainable AI connection infrastructure and 7/24 availability	0.525	0.751
	C22-Motivation of the all stakeholders to use AI-MET	0.252	0.107
	C23-User-friendliness of AI-MET	0.223	0.142
C3-Customization and Enhancement capabilities of AI-MET		**0.159**	**0.154**
	C31-Customizability of AI-MET	0.342	0.558
	C32-Enhanced simulation training	0.146	0.106
	C33-Students' skills development	0.203	0.106
	C34-VR/AR capability of AI	0.156	0.112
	C35-Automated repetitive tasks capability of AI-MET	0.152	0.118
C4-Performance of AI-MET in general		**0.218**	**0.072**
	C41-Receiving innovative responses from AI	0.419	0.619
	C42-Correctness of the AI-MET generated information	0.296	0.108
	C43-Fast access to information in AI-MET	0.285	0.273
C5-Performance of AI in specific MET applications (simulation etc.)		**0.175**	**0.088**
	C51-Scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training	0.345	0.558
	C52-Tracking and supervising the learning capability of the AI-MET	0.167	0.153
	C53-Capability of re-planning of training parameters of the AI-MET	0.206	0.118
	C54-Reliability of the AI-MET results	0.283	0.171

Main criteria and subcriteria results on the AI-MET Performance were also evaluated by the use of NMDS method. For NMDS analyses, again PAST 4.06b software [46] was used with Bray-Curtis distance metrics technique [47]. NMDS analyses for Performance of the AI-MET were held for cleaned data from the surveys. The reached lowest stress values at 3-D analyses are presented in Table 14.

Table 14. NMDS Stress values for AI-MET Performance, cleaned data, 3-D (k=3)

	Main Criteria (Cx)	Subcriteria C1x	Subcriteria C2x	Subcriteria C3x	Subcriteria C4x	Subcriteria C5x
Stress Value	0.057	0.044	0.055	0.040	0.034	0.074
R^2	0.47	0.59	0.83	0.33	0.70	0.48

All stress values show good ordination, no real risk for false inferences. For the following 3-D analyses, evaluations by NMDS, geometrical means of the NWT from cleaned data were used.

4.3.1 Findings on the Performance of AI-MET

Based on the resulted NWTs on the Table 13 above, priorities for the main criteria on AI-MET performance are ranked from highest to lowest as follows and shown in Table 15:

- **The implementation of AI-MET** receives the highest priority (0.285/1.000) by the IAMU Member Universities. This criteria is also identified as the highest priority by the AI-Chatbots.
- **Performance of AI-MET** in General" receives the second priority (0.218/1.000) by the IAMU Member Universities. However, AI-Chatbots identify this issue as the lowest priority.
- The third priority is the **Performance of AI-MET in Simulation** for the IAMU Member Universities. (0.175/1.000). According to AI-Chatbots, this issue is the one before the lowest.
- IAMU Member Universities identifies the forth, one before lowest, priority as the **Accessibility to AI-MET** (0.164/1.000). AI-Chatbots identifies this issue as the third priority.
- **Customization and Enhancement Capabilities** is given the lowest priority (0.159/1.000) by the IAMU Member Universities. However, AI-Chatbots identifies this issue as the second priority.

Table 15. Survey responses – Priorities of main criteria

Priority ranking		Main criteria	NWT (University responses)	NWT (AI-Chatbots)
by University responses	by AI-Chatbots			
1	**1**	The implementation of AI-MET	0.285	0.548
2	**5**	Performance of AI-MET in general	0.218	0.072
3	**4**	Performance of AI-MET in simulation	0.175	0.088
4	**3**	Accessibility to AI-MET	0.164	0.138
5	**2**	Customization and enhancement capabilities	0.159	0.154

In Fig. 32, priority rankings of the main criteria based on the responses from IAMU Member Universities and AI-Chatbots are shown.

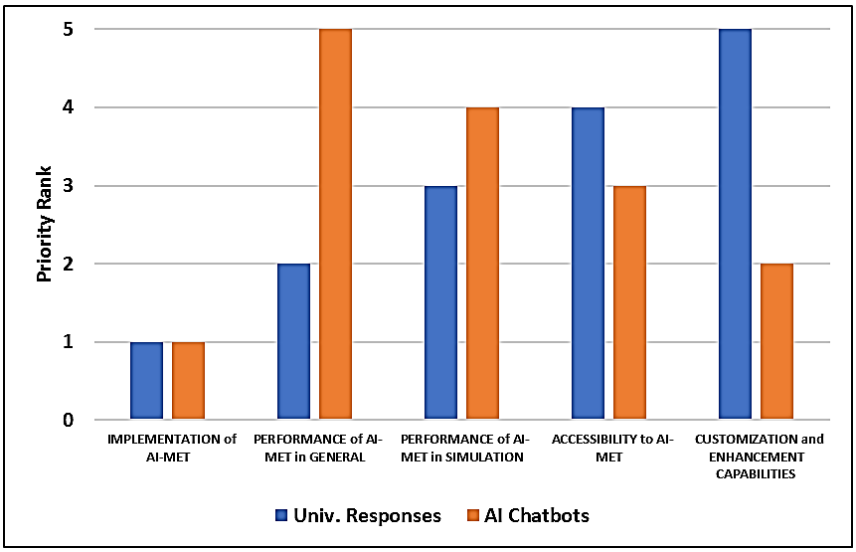

Fig. 32. Priority ranking differentiation for main criteria

As illustrated in Fig. 32 above, the equivalent agreement of IAMU Member Universities and AI-Chatbots are seen for the implementation of AI-MET and close agreement in performance of AI-MET in simulation and also in accessibility to AI-MET. Disagreements are seen for performance of AI-MET in general with much more importance given by AI-Chatbots and, customization and enhancement capabilities with much more importance given by the responses from IAMU Member Universities.

When NWTs are shown graphically in Fig. 33, on the priority rankings of the main criteria based on the responses from IAMU Member Universities and AI-Chatbots, importance given to implementation of AI-MET by the AI-Chatbots is much higher than the other main criteria.

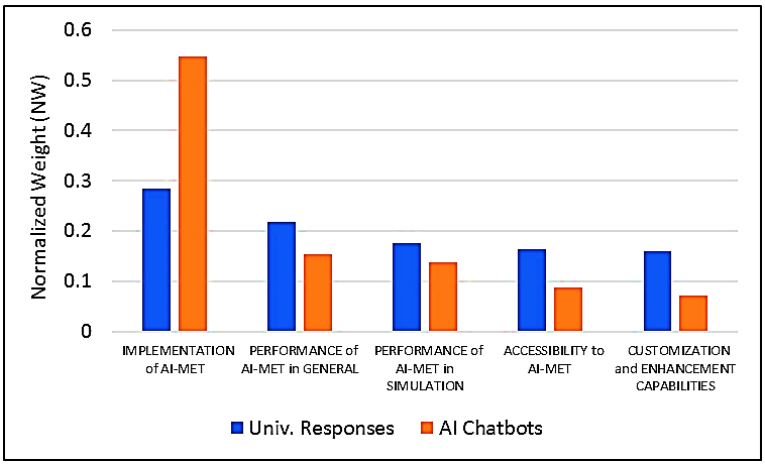

Fig. 33. NWT comparisons of the main criteria

The NMDS scatter plot of the main criteria at the xy-plane (NMDS 1, NMDS 2) of the 3-D analysis showed a distributed response environment. A rather close distance between the AI-Chatbot responses and main criteria C1 (the implementation of AI-MET), as shown in Fig. 34, is an exception to this. The dispersion of the main criteria NWT can also be seen in the 3-D plot in Fig. 35.

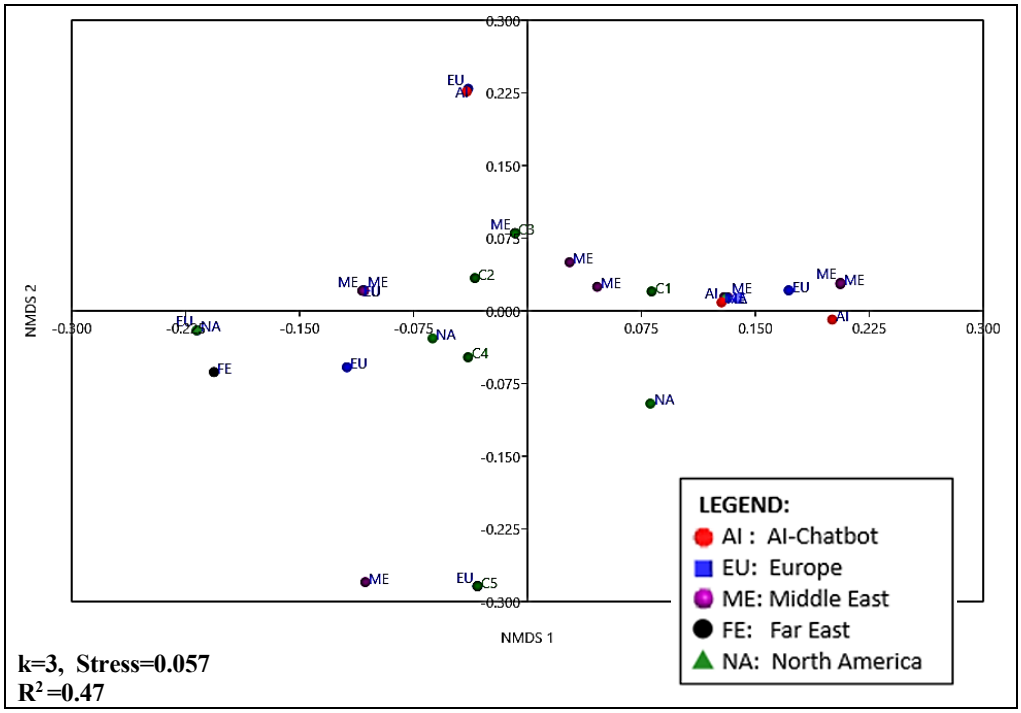

Fig. 34. NMDS scatter plot for main criteria Cx, clean data, xy-plane of 3-D

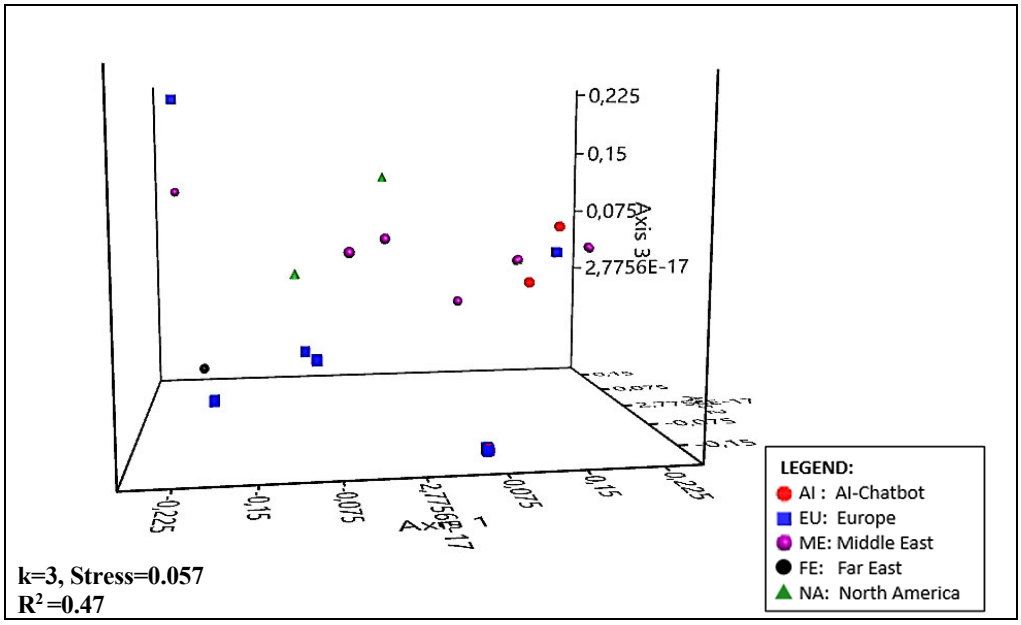

Fig. 35. NMDS 3-D plot for main criteria, clean data, 3-D

Prioritization of subcriteria within their own criteria can be seen from the NWTs in Table 13 above. However, for a more meaningful evaluation and to see the priority ranking of subcriteria for overall analysis, the normalized weight of each subcriteria (NWTi) is multiplied by the normalized weight of its own main criteria (NWTc) to obtain a total case point "TCPi" (Eq. 1), an AHP application.

$$TCP_i = NWT_i \, x \, NWT_C \quad (1)$$

Accordingly, for the 19 subcriteria, their priority rankings and calculated total case points (i.e., TCP) are listed below and given in Table 16, from highest priority to the lowest as assigned by the IAMU Member Universities.

- The choice of correct tools for the use of AI,
- Receiving innovative responses from AI,
- A sustainable AI connection infrastructure and 7/24 availability,
- Correctness of the AI-MET generated information,
- Fast access to information in AI-MET,
- Scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training,
- AI-MET's help to reduce MET class/practice durations,
- Customizability of AI-MET,
- AI-MET's help to improve Maritime cadets' & seafarers qualification,
- Reliability of the AI-MET results,
- Reduction in the amount of work needed for procedural scenario generation for simulation trainings,
- Motivation of the all stakeholders to use AI-MET,
- User-friendliness of AI-MET,
- Capability of re-planning of training parameters of the AI-MET,
- Students' skills development,
- Tracking and supervising the learning capability of the AI-MET,
- VR/AR capability of AI,
- Automated repetitive tasks capability of AI-MET,
- Enhanced simulation training.

As seen in Table 16, IAMU Member Universities and AI-Chatbots all assign the highest priority to the "choice of correct tools for the use of AI".

========== *(intentionally left blank for the integrity of the following Table)* ==========

Table 16. Subcriteria priorities overall by Universities' response total case points (TCP)

Priority ranking		Subcriteria	TCP (University responses)	TCP (AI-Chatbots)
by University responses	by AI-Chatbots			
1	**1**	The choice of correct tools for the use of AI	0.132	0.391
2	**8**	Receiving innovative responses from AI	0.091	0.045
3	**2**	A sustainable AI connection infrastructure and 7/24 availability	0.086	0.103
4	**19**	Correctness of the AI-MET generated information	0.064	0.008
5	**9**	Fast access to information in AI-MET	0.062	0.020
6	**6**	Scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training	0.061	0.049
7	**7**	AI-MET's help to reduce MET class/practice durations	0.055	0.047
8	**3**	Customizability of AI-MET	0.054	0.086
9	**4**	AI-MET's help to improve Maritime cadets' & seafarers qualification	0.051	0.057
10	**15**	Reliability of the AI-MET results	0.050	0.015
11	**5**	Reduction in the amount of work needed for procedural scenario generation for simulation trainings	0.046	0.053
12	**16**	Motivation of the all stakeholders to use AI-MET	0.041	0.015
13	**10**	User-friendliness of AI-MET	0.036	0.020
14	**18**	Capability of re-planning of training parameters of the AI-MET	0.036	0.010
15	**14**	Students' skills development	0.032	0.016
16	**17**	Tracking and supervising the learning capability of the AI-MET	0.029	0.013
17	**12**	VR/AR capability of AI	0.025	0.017
18	**11**	Automated repetitive tasks capability of AI-MET	0.024	0.018
19	**13**	Enhanced simulation training	0.023	0.016

Referencing to IAMU Member Universities' priority ranking of subcriteria, TCPs of Universities' responses and AI-Chatbots' responses are shown in Fig. 36. Again, for "the choice of correct tools for the use of AI" subcriteria, it is seen that AI-Chatbots assign a very high importance.

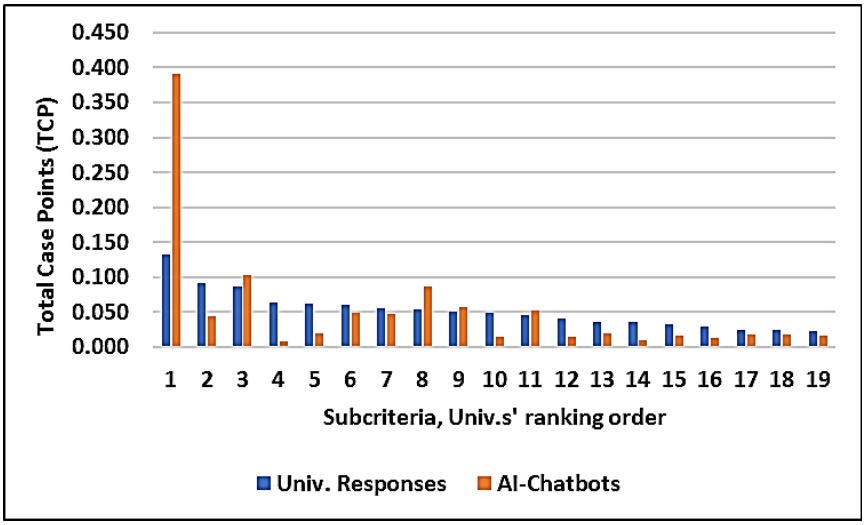

Fig. 36. Subcriteria priorities overall on IAMU Member Universities' ranking basis

========== *(intentionally left blank for the integrity of the following Table)* ==========

From AI-Chatbots' response perspective, subcriteria priority rankings from highest priority to the lowest and calculated TCPs are given in Table 17.

Table 17. Subcriteria priorities overall by total case points (TCP), AI-Chatbot ranking

Priority ranking		Subcriteria	TCP (AI-Chatbots)	TCP (University responses)
by AI-Chatbots	by AI-University responses			
1	**1**	The choice of correct tools for the use of AI	0.391	0.132
2	**3**	A sustainable AI connection infrastructure and 7/24 availability	0.103	0.086
3	**8**	Customizability of AI-MET	0.086	0.054
4	**9**	AI-MET's help to improve Maritime cadets' & seafarers qualification	0.057	0.051
5	**11**	Reduction in the amount of work needed for procedural scenario generation for simulation trainings	0.053	0.046
6	**6**	Scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training	0.049	0.061
7	**7**	AI-MET's help to reduce MET class/practice durations	0.047	0.055
8	**2**	Receiving innovative responses from AI	0.045	0.091
9	**5**	Fast access to information in AI-MET	0.020	0.062
10	**13**	User-friendliness of AI-MET	0.020	0.036
11	**18**	Automated repetitive tasks capability of AI-MET	0.018	0.024
12	**17**	VR/AR capability of AI	0.017	0.025
13	**15**	Enhanced simulation training	0.016	0.032
14	**19**	Students' skills development	0.016	0.023
15	**10**	Reliability of the AI-MET results	0.015	0.050
16	**12**	Motivation of the all stakeholders to use AI-MET	0.015	0.041
17	**16**	Tracking and supervising the learning capability of the AI-MET	0.013	0.029
18	**14**	Capability of re-planning of training parameters of the AI-MET	0.010	0.036
19	**4**	Correctness of the AI-MET generated information	0.008	0.064

For a better comparison, AI-Chatbots priority ranking is illustrated in Fig. 37, referencing to the priority ranking order of the IAMU Member Universities' for subcriteria.

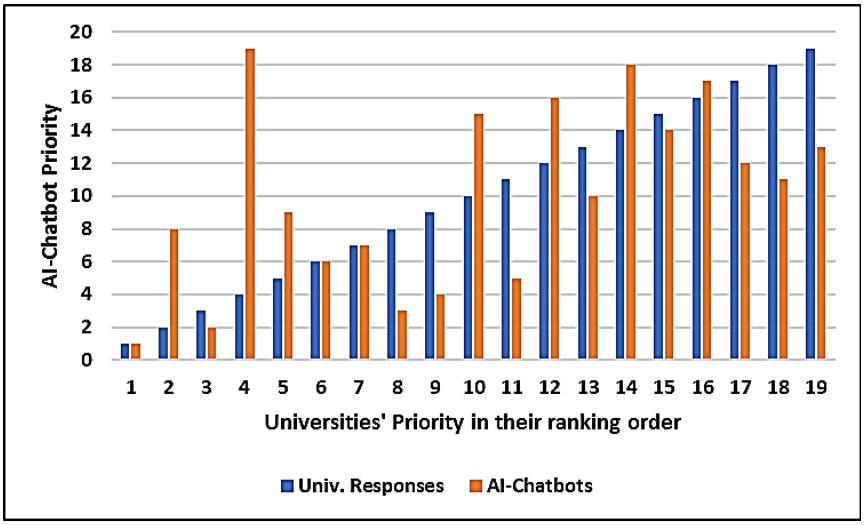

Fig. 37. Priority ranking differentiation for subcriteria overall

For the "choice of correct tools for the use of AI" subcriteria, it is seen that IAMU Member Universities' respondents and AI-Chatbots assign the highest importance. IAMU Member Universities' respondents and AI-Chatbots agree on the same importance level of "scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training" and "AI-MET's help to reduce MET class/practice durations", having sixth and seventh priorities consecutively. A sustainable AI connection infrastructure and 7/24 availability subcriteria shows a close agreement at third priority area while, "Students' skills development" and "Tracking and supervising the learning capability of the AI-MET", are again close to an agreement between IAMU Member Universities' respondents and AI-Chatbots around 15th and 16th priorities. A full or a very high agreement exists between the IAMU Member Universities' responses and AI-Chatbots' responses for the assigned priority ranking on following subcriteria:

- choice of correct tools for the use of AI,
- scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training,
- AI-MET's help to reduce MET class/practice durations,
- a sustainable AI connection infrastructure and 7/24 availability,
- students' skills development and,
- tracking and supervising the learning capability of the AI-MET.

On the other hand, major difference exists between the IAMU Member Universities' responses and AI-Chatbots' responses for the assigned priority ranking on following subcriteria:

- correctness of the AI-MET generated information,
- automated repetitive tasks capability of AI-MET,
- receiving innovative responses from AI,
- reduction in the amount of work needed for procedural scenario generation for simulation trainings and,
- enhanced simulation training.

During the NMDS analyses on the subcriteria of each main criteria of the AI-MET Performance, NWT based on cleaned data are used since 3-D stress value stated no real risk for false inferences as mentioned earlier. In Fig. 38, scattered plot of the subcriteria C1x NWT, of the main criteria C1, is presented as a sample. In Fig. 38, for each subcriteria C1x, there exists a grouping of different regions around, while AI-Chatbot and a large group of university responses gather around C11 (the choice of correct tools for the use of AI).

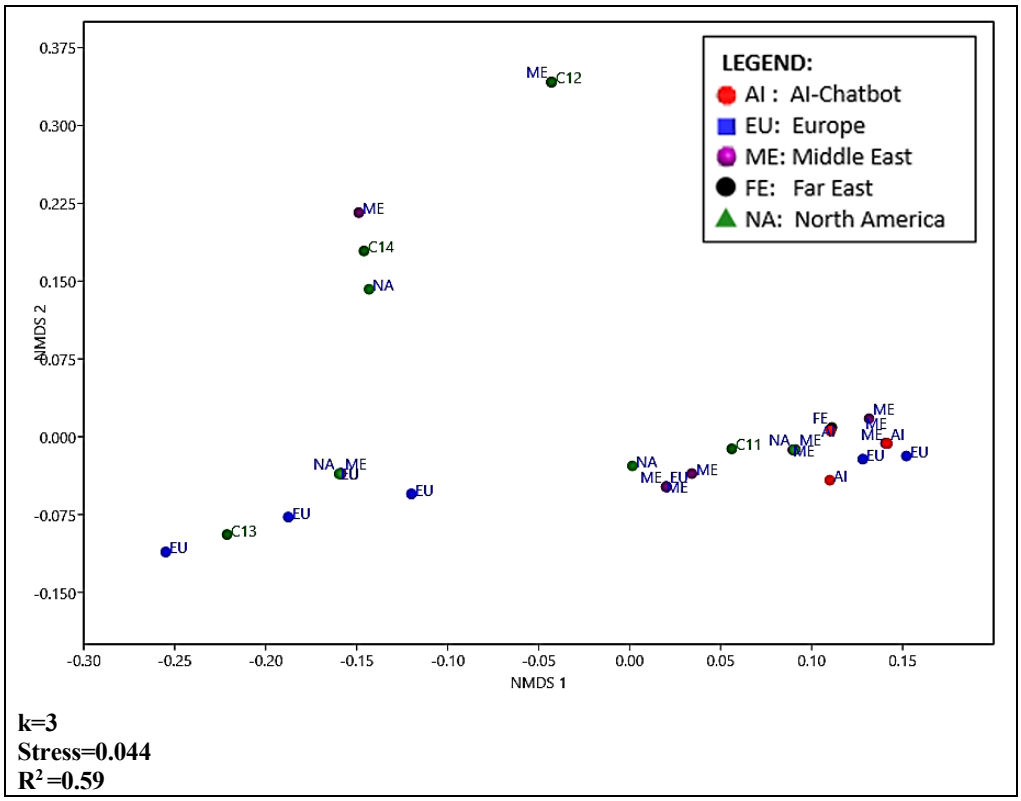

Fig. 38. NMDS scatter plot for subcriteria C1x, clean data, xy-plane of 3-D

For subcriteria C2x, C3x, C4x and C5x, again a group of AI-Chatbots and universities' responses gather around subcriteria C21 (a sustainable AI connection infrastructure and 7/24 availability), C31 (customizability of AI-MET), C41 (receiving innovative responses from AI) and C51 (scalability). This shows a consistency between applied AHP methodology and NMDS analyses.

4.4 Final Discussions: "the Outcome"

From an operational and strategic planning approach, based on the findings from the survey as detailed above, gaining an increase in the awareness and expectations from AI-MET can be classified under two time-scales namely short-term, medium-term as sampled in Table 18. Due to the rapid development pace in the use of AI globally, a long-term planning better not be considered. It would be appropriate starting from the AI-MET Awareness issues listed under "Agree" and "Neutral" columns in Table 12 above which can be classified as short-term tasks. The issues listed under "Disagree" column in Table 12 can be classified as medium-term tasks.

Table 18. AI-MET Awareness issues classified as per proposed time-scales

SHORT-TERM	MEDIUM-TERM
Convince stakeholders that AI will reduce the cost of MET and will be beneficial in the long-term; IMO and other regulatory bodies should be convinced to find a way for the sharing of correct data	Establish collaboration between the IAMU Member Universities and the AI researchers for the implementation of AI-MET; use existing internal capability
Use AI-MET for classroom activities such as literature review, translations etc. to reduce MET costs	Use AI-MET for classroom activities, simulation scenario generation and simulator trainings to reduce class/practice durations

However, with applied classification, two points rise a question on;

- initiating AI-MET without expert knowledge of AI researchers at the beginning,
- concentrating on cost reduction at an initial stage for classroom use of AI-MET,

as seen in Table 18 above.

In addition, the priorities as ranked for AI-MET performance must be embedded in those time-scales. Having two different rankings for priorities from IAMU Member Universities' respondents and AI-Chatbots, a solution must be found. Since there exists a mutual agreement between the IAMU Member Universities' respondents and AI-Chatbots that human decision is final when AI act/response is deemed wrong, the ranking from IAMU Member Universities' respondents takes a priority. But one cannot state that AI-Chatbots' responses were fully wrong here and for a balanced solution, combining a list of priorities may be deemed as helpful by taking first five subcriteria of the IAMU Member Universities' respondents and first five of the AI-Chatbots responses for further actions, as given in Table 19. This comply with the consolidated priority ranking illustrated in Table 20 and also with the NMDS analyses.

Table 19. First five subcriteria priorities overall by total case points (TCP)

Priority ranking		Subcriteria	TCP (University responses)	TCP (AI-Chatbots)
by University responses	by AI-Chatbots			
1	**1**	The choice of correct tools for the use of AI	0.132	0.391
2	**8**	Receiving innovative responses from AI	0.091	0.045
3	**2**	A sustainable AI connection infrastructure and 7/24 availability	0.086	0.103
4	**19**	Correctness of the AI-MET generated information	0.064	0.008
5	**9**	Fast access to information in AI-MET	0.062	0.020
8	**3**	Customizability of AI-MET	0.054	0.086
9	**4**	AI-MET's help to improve Maritime cadets' & seafarers qualification	0.051	0.057
11	**5**	Reduction in the amount of work needed for procedural scenario generation for simulation trainings	0.046	0.053

Table 20. Subcriteria priorities overall by total case points (TCP)

Priority ranking	Subcriteria	Respondents	TCP
1	The choice of correct tools for the use of AI	IAMU Memb.Univ. and AI-Chatbots	0.391
2	A sustainable AI connection infrastructure and 7/24 availability	AI-Chatbots	0.103
3	Receiving innovative responses from AI	IAMU Memb.Univ.	0.091
4	Customizability of AI-MET	AI-Chatbots	0.086
5	Correctness of the AI-MET generated information	IAMU Memb.Univ.	0.064
6	Fast access to information in AI-MET	IAMU Memb.Univ.	0.062
7	Scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training	IAMU Memb.Univ.	0.061
8	AI-MET's help to improve Maritime cadets' & seafarers qualification	AI-Chatbots	0.057
9	AI-MET's help to reduce MET class/practice durations	IAMU Memb.Univ.	0.055
10	Reduction in the amount of work needed for procedural scenario generation for simulation trainings	AI-Chatbots	0.053
11	Reliability of the AI-MET results	IAMU Memb.Univ.	0.050
12	Motivation of the all stakeholders to use AI-MET	IAMU Memb.Univ.	0.041
13	User-friendliness of AI-MET	IAMU Memb.Univ.	0.036
14	Capability of re-planning of training parameters of the AI-MET	IAMU Memb.Univ.	0.036
15	Students' skills development	IAMU Memb.Univ.	0.032
16	Tracking and supervising the learning capability of the AI-MET	IAMU Memb.Univ.	0.029
17	VR/AR capability of AI	IAMU Memb.Univ.	0.025
18	Automated repetitive tasks capability of AI-MET	IAMU Memb.Univ.	0.024
19	Enhanced simulation training	IAMU Memb.Univ.	0.023

Since the number of respondents remained below an acceptable sample rate, keeping in mind that an inference may be wrong but from the available data and findings a general guideline may be set as follows:

For short-term, it may be suggested that;

- A collaboration should be established between the IAMU Member Universities and the AI researchers for the implementation of AI-MET using correct tools, a sustainable AI connection infrastructure, 7/24 availability, fast access to information, customizability and scalability.
- Since data availability affects the AI-MET sustainability the stakeholders must be convinced that AI will reduce the cost of MET and will be beneficial in the long-term; IMO and other regulatory bodies should be convinced to find a way for the sharing of correct data.

For medium-term, it may be suggested that;

- The use of AI must be established for MET classroom activities on theoretical, analytical areas, assignments, literature review, language translations, grammar checking, etc.,
- the use of AI for scenario generation of the simulators and during the trainings in the simulators (bridge, machinery, watchkeeping, communications, survival at sea, cargo handling and navigational training etc.). Checking correctness of the AI-MET generated information and also means to receive innovative responses from AI must be considered in implementation.

5 Conclusions

In this exploratory research, different dimensions of the use of artificial intelligence platforms in maritime education and training (AI-MET) were analyzed and evaluated by benchmarking of the IAMU Member Universities using data received from 25 human experts of the 15 IAMU Member Universities and also from three AI-Chatbots. Eight dimensions were analyzed, three under AI-MET awareness heading (Adoption, Opportunities and Limitations) and five in "AI-MET Performance" heading (implementation of AI-MET, accessibility to AI-MET, customization and enhancement capabilities, performance of AI-MET in general and performance of AI-MET in simulation.). Works to develop simulator training scenarios as well as the overall application in bridge and engine room simulators with AI for determining patterns on AI answers and expert answers halted due to original simulator equipment manufacturers' hesitancy on the interventions on simulator software, which had a little impact on this research. On the contrary, based on the findings from the survey, concerns of the IAMU Member Universities' academics and experts were quantified by several methods. The itemized rating scale (Likert scale) survey method was used for the AI-MET Awareness levels; pairwise comparison analyses were based on Analytic Hierarchy Process (AHP) for AI-MET Performance. The survey questions answered by IAMU Member Universities and AI-Chatbots. Analyses and evaluations made by the use of these two methods were supported by descriptive statistical analyses and Non-metric Multidimensional scaling method (NMDS) analyses. The findings provide a conceptual roadmap for implementation of AI-MET from different aspects. Along with the keeping the expectations and requirements of implementing AI-MET one side, AI tools will enable to develop scenarios for simulator training, analyze big data packs and ensure interactive class environments and the tools can also be used as a personal teaching assistant. During the research, AI-Chatbots were found to be more optimistic for the future use of AI-MET.

The findings helped to develop a conceptual roadmap such that;

For short-term, it may be suggested that;

- a collaboration should be established between the IAMU Member Universities and the AI researchers for the implementation of AI-MET using correct tools, a sustainable AI connection infrastructure, 7/24 availability, fast access to information, customizability and scalability,
- since data availability affects the AI-MET sustainability the stakeholders must be convinced that AI will reduce the cost of MET and will be beneficial in the long-term; IMO and other regulatory bodies should be convinced to find a way for the sharing of correct data, and

for the medium-term, it may be suggested that;

- the use of AI must be established for MET classroom activities on theoretical, analytical areas, assignments, literature review, language translations, grammar checking, etc.,
- the use of AI for scenario generation of the simulators and during the trainings in the simulators (bridge, machinery, watchkeeping, communications, survival at sea, cargo handling and navigational training etc.). Checking correctness of the AI-MET generated information and also means to receive innovative responses from AI must be considered in implementation.

The research concluded that there is a necessity to apply AI-MET at a more rapid improvement and progress pace, with taking different aspects into consideration at a large scope among the IAMU Member Universities. The increasing use of AI-Chatbots in Maritime Education and Training-MET, classroom applications, in particular, were reviewed in literature and it was found out that they are highly appreciated. This type of studies can be extended by focusing on the rapid improvements of AI-Chatbots, however, it appears that they usually remain within the institutions specifically. Moreover, for a globally agreed level of AI-MET applications for simulator trainings, where existing seafarers are expected to attend remotely for individual trainings and qualifications, a more cloud-based or dedicated institutionally owned server-based extended AI applications running on mission specific AI software and using global big data are deemed more appropriate to meet almost near-term needs of the maritime industry.

Academic studies are currently conducted to finalize a paper on this research to be published in an international peer-reviewed distinguished journal.

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Appendix

Appendix 1

The Interview Questions [1]

1. What collaboration opportunities exist between AI researchers, maritime experts, and educational institutions to advance the integration of AI in maritime education training?

2. What are the potential long-term implications of adopting AI technologies in maritime education and training, both for the industry and individual seafarers?

3. What ethical and legal considerations should be taken into account when implementing AI technologies in maritime education and training, and how can stakeholders work together to address these challenges.

4. How can AI be used to facilitate remote and distance learning opportunities for supporting continuous professional development and lifelong learning (i.e., online courses, virtual reality simulations) for seafarers ensuring they remain up to date with the latest industry standards and best practices and what challenges must be addressed to ensure successful implementation?

5. What are the key factors to consider when designing and implementing AI-driven simulation training in order to ensure maximum effectiveness and accessibility for trainees?

6. How can AI-driven adaptive learning systems be used to tailor maritime education and training (including theoretical classes, practical classes, and simulator training) for individual trainees' needs, and what impact might this have on knowledge retention and skill development?

7. What are the potential applications of AI-driven scenario generation in survival at sea, cargo handling and navigational training, and how might this lead to more engaging and realistic training experiences?

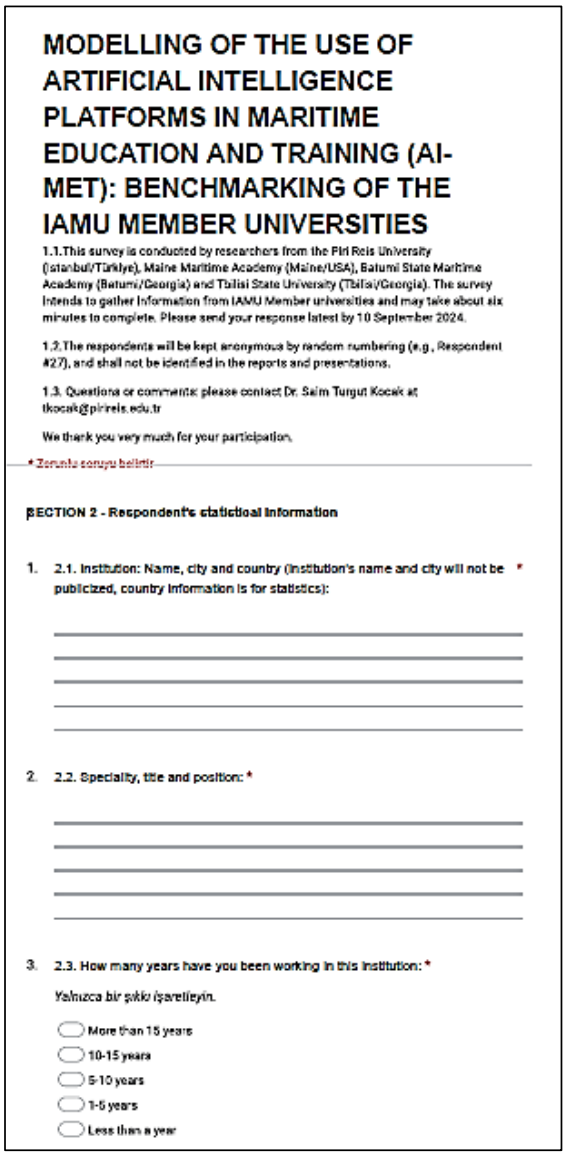
8. How can AI be employed to analyze historical accident and incident data in order to develop more effective survival at sea, cargo handling and navigational training scenarios.

9. How can AI be used to help identify and address common challenges in practice (i.e., during emergency situations, cargo handling, watchkeeping) such as improving communication, coordination, situational awareness, and decision-making?

10. How can AI-powered data analysis be used to identify trends in trainee performance (i.e., areas of weakness, skill gaps) and develop targeted interventions to enhance the effectiveness of practical training (simulation training) outcomes?

Appendix 2

The Survey Questionnaire for IAMU Member Universities



MODELLING OF THE USE OF ARTIFICIAL INTELLIGENCE PLATFORMS IN MARITIME EDUCATION AND TRAINING (AI-MET): BENCHMARKING OF THE IAMU MEMBER UNIVERSITIES

1.1.This survey is conducted by researchers from the Piri Reis University (Istanbul/Türkiye), Maine Maritime Academy (Maine/USA), Batumi State Maritime Academy (Batumi/Georgia) and Tbilisi State University (Tbilisi/Georgia). The survey intends to gather information from IAMU Member universities and may take about six minutes to complete. Please send your response latest by 10 September 2024.

1.2.The respondents will be kept anonymous by random numbering (e.g., Respondent #27), and shall not be identified in the reports and presentations.

1.3. Questions or comments: please contact Dr. Salim Turgut Kocak at tkocak@pirireis.edu.tr

We thank you very much for your participation.

* Zorunlu soruyu belirtir

SECTION 2 - Respondent's statistical information

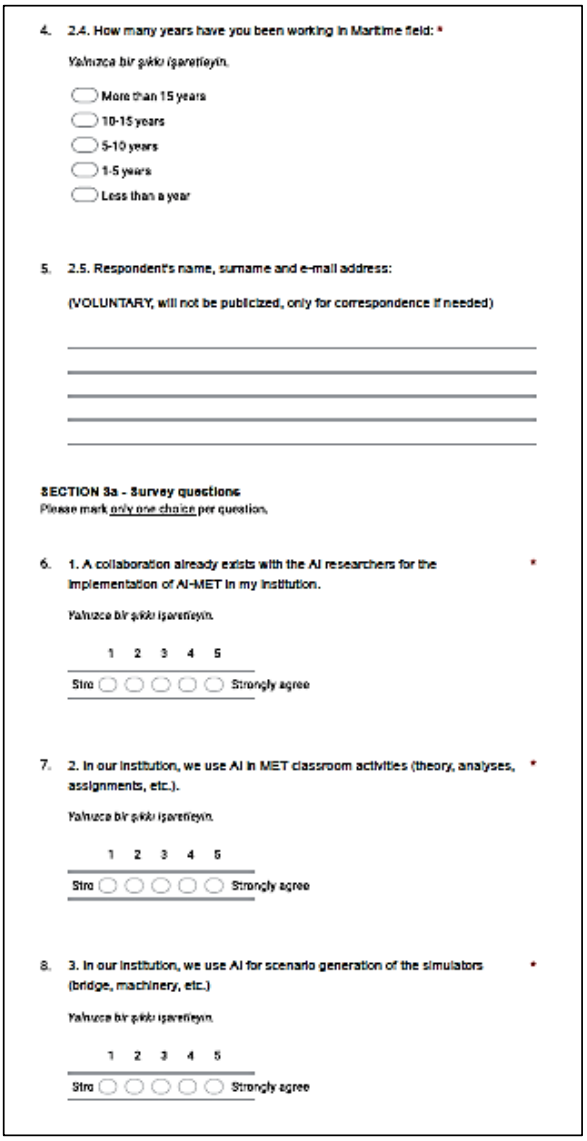
1. 2.1. Institution: Name, city and country (institution's name and city will not be publicized, country information is for statistics): *

2. 2.2. Speciality, title and position: *

3. 2.3. How many years have you been working in this institution: *

Yalnızca bir şıkkı işaretleyin.

- More than 15 years
- 10-15 years
- 5-10 years
- 1-5 years
- Less than a year



4. 2.4. How many years have you been working in Maritime field: *

Yalnızca bir şıkkı işaretleyin.

- More than 15 years
- 10-15 years
- 5-10 years
- 1-5 years
- Less than a year

5. 2.5. Respondent's name, surname and e-mail address:

(VOLUNTARY, will not be publicized, only for correspondence if needed)

SECTION 3a - Survey questions

Please mark only one choice per question.

6. 1. A collaboration already exists with the AI researchers for the implementation of AI-MET in my institution. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

7. 2. In our institution, we use AI in MET classroom activities (theory, analyses, assignments, etc.). *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

8. 3. In our institution, we use AI for scenario generation of the simulators (bridge, machinery, etc.) *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

9. 4. In our institution, we use AI during watchkeeping, communications trainings in the simulators. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

10. 5. In our institution, we use AI for literature review, language translations, grammar checking, etc. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

11. 6. In our institution, we are capable of developing new AI algorithms for MET. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

12. 7. AI-MET helps to reduce class/practice durations. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

13. 8. AI-MET helps to reduce MET related costs. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

14. 9. AI-driven scenario generation in survival at sea, cargo handling and navigational training might lead to more engaging and realistic training experiences. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

15. 10. AI-MET facilitates remote and distance learning opportunities for continuous professional development and lifelong learning (i.e., online courses, etc.) for seafarers. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

16. 11. Correctness of AI-MET applications is based on correct data and algorithm inputs. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

17. 12. Data availability affects the sustainability of AI-MET. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

18. 13. The stakeholders must be convinced that AI will reduce the cost of MET and will be beneficial in the long-term. Then, IMO or other regulatory bodies can find a way for data sharing. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

19. 14. Human decision is final when AI act/response is deemed wrong. *

Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Strc	◯	◯	◯	◯	◯	Strongly agree

SECTION 3b - Survey questions (pairwise comparisons)

Please mark only one choice per question.

20. **15.1. The implementation of AI-MET, when compared to the Accessibility to AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

21. **15.2. The implementation of AI-MET, when compared to the Customization and Enhancement capabilities of AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

22. **15.3. The implementation of AI-MET, when compared to the Performance of AI in MET in general, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

23. **15.4. The implementation of AI-MET, when compared to the Performance of AI in specific MET applications (simulation, etc.), is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

24. **16.1. The choice of correct tools for the use of AI, when compared to the AI-MET's help to reduce MET class/practice durations, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

25. **16.2. The choice of correct tools for the use of AI, when compared to the Reduction in the amount of work needed for procedural scenario generation for simulation trainings, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

26. **18.3. The choice of correct tools for the use of AI, when compared to the AI-MET's help to improve Maritime cadets' & seafarers qualification, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

27. **17.1. A sustainable AI connection infrastructure and 7/24 availability, when compared to the Motivation of the all stakeholders to use AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

28. **17.2. A sustainable AI connection infrastructure and 7/24 availability, when compared to the User-friendliness of AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

29. **18.1. Receiving innovative responses from AI, when compared to the Correctness of the AI-MET generated information, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

30. **18.2. Receiving innovative responses from AI, when compared to the Fast access to information in AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

31. **18.1. Customizability of AI-MET, when compared to the Enhanced simulation training, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

32. **18.2. Customizability of AI-MET, when compared to the Students' skills development, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

33. **18.3. Customizability of AI-MET, when compared to the Virtual Reality/Augmented Reality capability of AI, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

34. **18.4. Customizability of AI-MET, when compared to the Automated repetitive tasks capability of AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

35. **20.1. Scalability, that is AI-MET runs fast, efficiently and can truly simulate the real world for simulator training, when compared to the Tracking and supervising the learning capability of the AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

36. **20.2. Scalability for simulator training, when compared to the Capability of re-planning of training parameters of the AI-MET, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

37. **20.3. Scalability for simulator training, when compared to the Reliability of the AI-MET results, is** *

Yalnızca bir şıkkı işaretleyin.

- Extremely less important
- Much less important
- Less important
- Slightly less important
- Equally important
- Moderately important
- Strongly important
- Very strongly important
- Extremely important

38. 21. Additional comments if any:

Bu içerik Google tarafından oluşturulmamış veya onaylanmamıştır.

Google Formlar

Appendix 3

The Survey Questions asked to AI-Chatbots

1. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that a collaboration already exist with the AI researchers for the implementation of the use of artificial intelligence platforms in maritime education and training among IAMU Member Universities?

2. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that IAMU Member Universities use AI in maritime education and training classroom activities (theory, analyses, assignments, etc.)?

3. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that IAMU Member Universities use AI for scenario generation of the simulators (bridge, machinery, etc.)?

4. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that IAMU Member Universities use AI during watchkeeping, communications trainings in the simulators?

5. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that IAMU Member Universities use AI for literature review, language translations, grammar checking, etc.?

6. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that IAMU Member Universities are capable of developing new AI algorithms for maritime education and training?

7. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that the use of artificial intelligence platforms in maritime education and training helps to reduce class/practice durations?

8. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that the use of artificial intelligence platforms helps to reduce related costs in maritime education and training?

9. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that AI-driven scenario generation in survival at sea, cargo handling and navigational training might lead to more engaging and realistic training experiences?

10. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that the use of artificial intelligence platforms facilitates remote and distance learning opportunities for continuous professional development and lifelong learning (i.e., online courses, etc.) for seafarers?

11. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that the correctness of artificial intelligence platforms in maritime education and training applications is based on correct data and algorithm inputs?

12. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that data availability affects the sustainability of artificial intelligence platforms in maritime education and training?

13. Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that the stakeholders must be convinced that AI will reduce the cost of maritime education and training and will be beneficial in the long-term. Then, International Maritime Organization or other regulatory bodies can find a way for data sharing?

14.Do you strongly agree or agree or neither agree nor disagree or disagree or strongly disagree that human decision is final when AI act/response is deemed wrong?

15.1. Does the Implementation of artificial intelligence platforms in maritime education and training, when compared to the Accessibility to artificial intelligence platforms in maritime education and training, is Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

15.2. Does the Implementation of artificial intelligence platforms in maritime education and training, when compared to the Customization and Enhancement Capabilities of Artificial Intelligence Platforms in Maritime Education and Training, is Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

15.3. Is the Implementation of artificial intelligence platforms in maritime education and training, when compared to the Performance of artificial intelligence platforms in maritime education and training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

15.4. Is the Implementation of artificial intelligence platforms in maritime education and training, when compared to the Performance of artificial intelligence in specific maritime education and training applications (simulation, etc.), Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

16.1. Is the choice of correct tools for the use of AI, when compared to the artificial intelligence platforms in maritime education and training's help to reduce maritime education and training class/practice durations, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

16.2. Is the choice of correct tools for the use of AI, when compared to the Reduction in the amount of work needed for procedural scenario generation for simulation trainings, is Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

16.3. Is the choice of correct tools for the use of AI, when compared to the artificial intelligence platforms in maritime education and training's help to improve Maritime cadets' & seafarers qualification, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

17.1. Is a sustainable AI connection infrastructure and 7/24 availability, when compared to the Motivation of all stakeholders to use artificial intelligence platforms in maritime education and training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

17.2. Is a sustainable AI connection infrastructure and 7/24 availability, when compared to the User-friendliness of, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

18.1. Is receiving innovative responses from AI, when compared to the Correctness of the artificial intelligence platforms in maritime education and training generated information, is Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly

less important or Less important or Much less important or Extremely less important?

18.2. Is receiving innovative responses from AI, when compared to the Fast access to information in artificial intelligence platforms in maritime education and training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

19.1. Is customizability of artificial intelligence platforms in maritime education and training, when compared to the Enhanced simulation training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

19.2. Is customizability of artificial intelligence platforms in maritime education and training, when compared to the Students' skills development, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

19.3. Is customizability of artificial intelligence platforms in maritime education and training, when compared to the Virtual Reality/Augmented Reality capability of AI, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

19.4. Is customizability of artificial intelligence platforms in maritime education and training, when compared to the Automated repetitive tasks capability of artificial intelligence platforms in maritime education and training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

20.1. Is Scalability, that is the artificial intelligence platforms in maritime education and training runs fast, efficiently and can truly simulate the real world for simulator training, when compared to the Tracking and supervising the learning capability of the artificial intelligence platforms in maritime education and training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

20.2. Is scalability for simulator training, when compared to the Capability of re-planning of training parameters of the artificial intelligence platforms in maritime education and training, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

20.3. Is scalability for simulator training, when compared to the Reliability of the artificial intelligence platforms in maritime education and training results, Extremely important or Very strongly important or Strongly important or Moderately important or Equally important or Slightly less important or Less important or Much less important or Extremely less important?

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