On-line ERS

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The shipping industry has been significantly affected by the COVID-19 pandemic, and whilst the biggest challenge has been visible in change of crew changes, the impacts of the COVID-19 pandemic on maritime education and training and the supply of qualified and certificated seafarers is a growing area of concern for the industry. The MERSol – project (Maritime Engine Room Simulator on-line) was created due to the Covid-19 pandemic, that made face-to-face simulator lessons mostly impossible and focuses mainly on the horizontal priorities of supporting individuals in the maritime sector to acquire and develop key competences.

The main issues with implementation of simulation technologies virtual reality in combination with e-learning in professional training of future seafarers have been revealed. The e-learning system based on Moodle, which helps to provide information, technology and professional training support for future seafarers has been created during MERSol - project. WÄRTSILÄ, which is one of the biggest simulator manufacturers in the world, has recently begun to offer online engine room training, though the training is only available to students by purchasing pr. hour training.

Keywords: engine room simulator, online, Moodle platform, SWOT-analysis, Guidebook

1. Introduction

The European Education and Culture Executive Agency, EACEA, opened an additional call for proposals as part of the measures supporting recovery from the coronavirus crisis. The funding in the additional call was granted to Erasmus+ KA2 strategic partnerships. The application period was limited, as it took only two months to complete. The MERSol consortium was initiated by Satakunta University of Applied Sciences (SAMK) from Finland, as they have an excellent network due to a long history and 20+ years of experience with maritime projects. SAMK invited maritime training partners from Spain, Universitat Politecnica de Catalunya (Nautical Studies of Barcelona) Lithuania, Lietuvos aukstoji jureivystes mokykla (Lithuanian Maritime Academy, Klaipeda), Turkey, T. C. Piri Reis Universitesi (Maritime University of Piri Reis, Istanbul) and Ukraine (Kherson State Maritime Academy, Kherson) to join the MERSol Consortium [3]. Finnish simulator manufacturer Image soft Ltd was invited as a simulator manufacturer and Spinaker from Slovenia as an awarded online teaching specialist.

The outcomes were achieved approximately in accordance with the project plan. As the war of aggression on Ukraine began on February 24th, 2022, it halted the project for a considerable amount of time, as the Ukrainian partner's work was heavily challenged by the circumstances, despite this the project progressed forward with determination.

Through the project eight study and assessment modules were developed by the maritime engineer partners and the platform Moodle was chosen as the platform on which the modules were to be stored. Whilst the Finnish simulator manufacturer Image soft Ltd, had already developed an early stand-alone engine room simulator model of the research vessel M/S MIRABILIS, which had been delivered to the Namibian Ministry of Fisheries and Marine Resources in 2012, the vessel was constructed at the shipyard in Rauma, Finland. This ERS version was modified to work online and the SAMK server was chosen as the home base of the simulator, to which all the partners could connect. This paper will present all the abovementioned research which has been collected and presented in the ERS guidebook. This guidebook serves as the last output of the project [4] introducing difficulties met and problems solved.

2. Submission

The MERSol-project has developed new ship related, high class and up-to-date study modules followed with assessment study modules which are set in the Moodle-platform [5].

Modules are as follows (table 1).

Table 1. List of study modules (Maritime Engine Room Simulator on-line application).

Study module	Topics	Develop	Check
Electricity	Electric motors (electric propulsion), electric power plant, diesel generator, emergency generator, shaft generator, shore connection, batteries, and fuel cells	KSMA	LMA
Steam, thermal oil, ventilation of machinery systems, air conditioning	Steam, thermal oil, ventilation of machinery spaces	PRU	LMA
Auxiliary systems 1	Fuel- and lubrication oil (bunkering, storage, transfer, purifying, feeding), exhaust gas scrubbers- cooling (sea water, LT & HT), starting air, air pressure systems	LMA	KSMA
Auxiliary systems 2	Bilge (main bilge, oily bilge), ballast water treatment, fire protection systems (water fire extinguishing, CO2)	LMA	PRU
Operations of engine	Monitoring, controlling, automation	PRU	SAMK
Water systems	Fresh water, technical water, water production	KSMA	PRU
Connection to deck systems and bridge connection	M/S MERSol connections to deck and bridge through classification notations. M/S AURORA BOTNIA as an example of a new building ship from 2021.	SAMK	SPIN
Vocabulary (with explanation)	Vocabulary from modules 1-7	ALL	

Designing and developing the study modules and assessment modules on a specific e-learning delivery platform allows cadets and seafarers to access the training programme and learning materials over the Internet at any time and any place. This is particularly relevant in the Maritime sector where seafarers are highly mobile and have less opportunity to take long face-to-face training courses whilst they are working.

During the application phase the topics of the modules were set and at the beginning of the project only minor adjustments were accomplished and all the main topics remained unchanged. In the beginning of the project study and assessment roles were agreed among the project partners taking the best expertise into consideration and the first commenting partner set.

A total of 35 online partner meetings were convened to address the modules in question, with each module's respective partners conducting multiple online meetings of their own. The ultimate approval authority for each module rested with the UPC.

Due to the Russian attack on Ukraine on 24th of February 2022 project on-line meetings became very sensitive and other partners could only show their full support to the brave Ukrainian partners. One multiplier event was planned in Kherson but due to the situation in Ukraine it was firstly planned to arrange in Odessa but soon found out that also impossible so agreed with the financer, Finnish National Agency of Education (OPH), that this multiplier event will be shared amongst the capable partners.

The large earthquake that struck Türkiye in the early spring of 2023 impacted the final conference of the project, as it was scheduled to be held in Istanbul, Türkiye. By approval of the OPH, the event was moved to Helsinki, the capital of Finland.

The development of the online engine room simulator followed a structured process flow, which can be broken down into the following key stages [4]: Conceptualization and planning, collaborative design, technical development, testing and refinement, implementation, and integration, evaluation, and continuous improvement.

The development of the online engine room simulator can be further divided into the following stages: requirements gathering, content development, software and infrastructure development, quality assurance and testing, deployment and integration, monitoring, evaluation, and improvement.

The development of the online engine room simulator involved the use of a variety of technologies, software, and tools, including:

1. Cloud-based infrastructure. To support the scalable, accessible, and reliable delivery of the simulator, a cloud-based infrastructure was utilized. The cloud-based infrastructure supports simulation software, user identification and communication.

2. Simulation software. Specialized software was used to create high-fidelity, physics-based simulations of engine room operations, ensuring a realistic model of the simulated ship. The simulation software also handles the training scenarios.

3. User identification software. Software for identifying the simulator users was created. Each trainee is assigned with a unique identifier and simulator station on connecting the cloud-based simulation server. The responses from the cloud-based server are arranged using the above-mentioned credentials.

5. User interface. User interfaces were created for both trainees and instructors. Instructor interfaces contain the modules for controlling the simulation. Instructor interfaces display the online trainees and offer functions for controlling the simulator usage. Trainee interfaces contain the essential controls for operating the simulated ship systems.

6. Communication. Communication between simulator users and cloud-based server was established. Cloud-based simulation software sends simulation status changes to online users. User interfaces that visualize the simulated ship constantly listen to and display the attributes evaluated by the physic-based model of the simulated ship.

7. Low-latency data transmission protocols. To ensure real-time interaction and responsiveness in the simulator, low-latency protocols were implemented for data transmission between the user's device and the cloud-based server.

To comprehensively analyze the work of the Engine Room Simulator and to clarify how the changes in physical lectures, workshops, simulators, and other practical classes that arose amidst COVID-19 pandemic would affect the evolution in the long term, a strengths, weaknesses, opportunities, and threats (SWOT) analysis was performed in this project discussions as well as related research results.

Strengths, weaknesses, opportunities, and threats of the MERSol project are listed in table 2.

Table 2. SWOT-analysis of the MERSol project [4].

Strengths	**Weaknesses**
Flexibility and accessibility	Limited Tactile Experience
Cost-effectiveness	Dependence on Stable Internet Connectivity
Scalability	Technological Learning Curve
Customizable Learning Experiences	Integration with Existing Curricula
Realistic Simulation Environment	
Opportunities	**Threats**
Expansion into New Markets	Traditional Training Heritage
Technological Advancements	Regulatory Challenges
Collaborations and Partnerships	Technological Obsolescence
Increasing Adoption of Online Learning	Cybersecurity Risks
Innovative and Attractive Training Solution	Economic Uncertainties

By conducting a SWOT analysis, we have identified the key strengths, weaknesses, opportunities, and threats associated with our online engine room simulator. This analysis provides valuable insights into the areas where we excel, areas that need improvement, and potential avenues for growth and development.

The MERSol project is designed to provide realistic training for marine engineering students and professionals. Some recognized challenges that this project may face include [4], technical challenges ensuring stable and reliable connectivity for all users. Latency, the migration to the cloud introduced additional latency due to the increased distance between users and the server hosting the simulation.

Ensuring consistent server reliability, frequent server downtime or performance issues could have severe consequences for training schedules and user satisfaction. To address this issue, we suggest adopting a multi-server architecture with automatic failover mechanisms, which would ensure that if one server encountered issues, the system would automatically switch to another server, maintaining the simulator's availability. Geographic issues arose due to the diverse locations of users and institutions participating in the online engine room simulator training.

Although the online simulator provides an interactive environment for learning engine room operations, it is essential to ensure that trainees also gain a strong theoretical foundation. To address this challenge, we worked closely with maritime school partners to integrate the simulator into a comprehensive curriculum that combined theoretical lessons with practical exercises in the simulated environment. This allowed trainees to apply their theoretical knowledge in real time, enhancing their understanding of the subject matter and developing their practical skills simultaneously.

Maintaining trainee engagement and promoting active learning was another challenge we faced. The online nature of the simulator could potentially lead to trainees becoming passive observers rather than active participants. To overcome this, we collaborated with our maritime school partners to design engaging learning activities and scenarios within the simulator.

To address accounting for the diverse learning needs and preferences of trainees, we worked with our maritime school partners to develop a flexible and customizable learning environment that could cater to individual trainee needs. By incorporating a range of learning resources, the trainees can focus on the areas where they needed the most improvement.

Another challenge was the ability to assess trainee progress and provide meaningful feedback as traditional assessment methods may not be easily applicable in an online simulation environment.

Ensuring that the online simulation provided an accurate and realistic representation of actual engine room operations required close collaboration of the maritime school experts and engineers to develop a simulator that captured the nuances and intricacies of real-world engine room operations. In the end we succeeded at refining the simulations based on the feedback to ensure that the experience closely mimicked the behavior of actual equipment.

Although the online simulator offered an immersive environment, it could not fully replicate the tactile sensations associated with physically manipulating machinery. This would need to be mitigated in the future by having the online training supplemented by the hands-on training on the actual equipment.

The challenge of the integration of our online simulation with existing maritime training curricula was met having close collaboration with maritime schools to identify possibilities in their current programs, as well as different opportunities to enhance learning outcomes using our online engine room simulator.

Conclusions

MERSol – project brought together experienced engine room simulator lecturers, engine room simulator manufacturer and on-line teaching specialist.

Introduction of the latest technologies, such as virtual simulation technologies reality, distance, and electronic learning, will improve quality educational process, make it modern and accessible to everyone and, most importantly, ensure verification of acquired professional competences.

The strengths of the online Engine Room Simulator are flexibility and accessibility, cost-effectiveness, scalability, customizable learning experiences and realistic simulation environment.

Along with the strengths, weaknesses were also identified, such as limited tactile experience and stable internet connectivity. The simulator requires trainees to be proficient in using digital technology, which may present a learning curve for some individuals, particularly those with limited experience in using online learning platforms. According to the project partners the positive thing is that weaknesses were fewer than the strengths. Same findings were done in opportunities versa threats.

Developed study and assessment modules in the moodle-environment can effortlessly be updated when new versions of equipment are installed onboard. New mooring methods like suction pads, mooring without ropes, are already presented but as digitalization is progressing rabidly new semi-autonomous shipping modules may soon need to be added.

The online Engine Room Simulator does have limitations on the number of users participating simultaneously, as the exercises are stored on a single server. By being aware of these limitations, it is still an exceptional package for METs to utilize in their training of cadets.

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References

[1] Image Soft Ltd: Engine room simulation of a research vessel. Available at https://imagesoft.fi/product/is-engine-room-simulator/.

[2] IMO model course 2.07 Engine room simulator, 2017 edition.

[3] Maritime Engine Room Simulator On-Line application: 2020-1-FI01-KA226-HE-092597. Available at https://erasmus-plus.ec.europa.eu/projects/search/details/ 2020-1-FI01-KA226-HE-092597.

[4] Maritime Engine Room Simulator on-line. Guidebook to the related industry. Available at https://drive.google.com/file/d/1hJp59naYf0_HnpvGqh4IdCgvTEFT3IIn/view?usp=share_link .

[5] MERSol moodle platform. Available at https://samkmoodle.samk.fi/enrol/index.php?id=420.