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Comparative analysis of cloud-based server and conventional server of simulators for marine engineering

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COMPARATIVE ANALYSIS OF CLOUD-BASED SERVER AND CONVENTIONAL SERVER OF SIMULATORS FOR MARINE ENGINEERING

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Declaration

I certify that all the material in this dissertation that is not my work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my personal views and are not necessarily endorsed by the University.

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Supervisor's affiliation**: World Maritime University**

Acknowledgments

Abstract

Title of Dissertation:
Comparative Analysis of Cloud-based server and Conventional server for Marine Engineering

Degree: **Master of Science in Maritime Education and Training**

The dissertation is a comparative analysis of the cloud-based server with conventional server for marine engineering simulator competency-based assessment, comparing the results obtained from participants during the simulator training assessment for both types of servers. Current techniques for determining competency in the field of marine engineering are briefly examined, together with the historical trends that led to them. a description of competency-based evaluation. Special attention is paid to the STCW competence table.

At the Watchkeeper level, the ship simulator can be used to train and evaluate seafarers in a variety of skills. Performance assessment techniques and limitations are also devised. A program of assessment exercises involving two sets of simulations and the recording of the results was conducted on two groups of aspiring seafarers. Performances were recorded and assessed based on the procedure programmed and aligned with the competence table requirement of the STCW

Every cadet took part in the debriefing that followed the simulator training exercises, and all of their responses were recorded for comparison. In connection to the degree of simulator training and seagoing experience, the results were compiled and evaluated for performance. For the Power Plant Diesel simulator exercise, the results indicate that there is little to no difference between how well students utilize a conventional server and a cloud-based server simulator. Consequently, either a traditional simulator or a cloud-based simulator may be utilized interchangeably to achieve the course outcome of the simulator training activity or assessment.

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Abbreviations

STCW –   Standard Training Certification and Watchkeeping
IMO –   International Maritime Organization
METI-   Maritime Education and Training Institution
ISS –   Interactive Simulator Service
IBM SPSS 23 -   Statistical Package for the Social Sciences
CHED –   Commission on Higher Education
KSIM-   Kongsberg simulator
KSIM connect –   Kongsberg simulator cloud-based
CBA –   Competency Based Assessment
IT –   Information Technology
GMDSS -   Global Maritime Distress and Safety System
MIITD –   Management Information and Instructional Technology
                          Department
KUP   Knowledge, Understanding, Proficiency
PPD –   Power Plant Diesel
GPA-   Grade Point Average

Chapter 1 – Background of the research

1.1 - World Economy

The world economy relies largely on international shipping and it plays a vital role in world trade. Seaborne trade continuously grows each year in gross tonnage and ship fleets worldwide Michaelowa & Krause as cited by (Hmam et al., 2015). The shipping industry's prospects for continued growth remain bright due to the increasing efficiency and practical cost of shipping as a mode of transporting goods. The seafarer plays a vital role in making this shipping industry as efficient as it is, without the seafarers transporting goods would not be possible. When we discussed efficiency in shipping and the role of seafarers in the industry, we could not disregard the significant role of the International Maritime Organization {IMO}. IMO is the global standard-setting authority for the safety, security, and environmental protection of international shipping which includes the education and training of seafarers (Hwang, 2020).

1.2 – Seafarers

Seafarers guarantee the security of a variety of things, including cars, industrial and agricultural products, health products, home appliances, and factory equipment (MANSOURIAN, 2011). According to Ziarati et. al., (2010), Seafarers leave behind their families, comforts, and daily routines to essentially stay on board ships at sea, where they are exposed to many risks. However, shorter voyages, continuing work, and opportunities enabling partners and families to sail can all help to reduce the negative effects of sailing (Thomas et al., 2003). Even while these actions could incur expenses, they can be balanced out by better retention of seafarers and efficiency at work. As the need for shipping skyrockets, the importance of providing competent seafarers with a solid education and training is greater than ever. The demand for competent seafarers creates an opportunity for Maritime education and training institutions to increase their admission of aspiring seafarers. On the other hand, this is also a challenge for the

maritime administration to put in place precautionary measures to ensure quality graduates produces by Maritime education and training institutions worldwide.

1.3 - Maritime education and training institutions

Maritime Education and Training Institutions (METI) worldwide are crucial to maritime safety (Basak, 2017). They influence the security and sustainability of shipping operations by educating, training, and preparing both new and experienced seafarers for effective and safe job performance (Manuel, 2017). METI bears an immense obligation to ensure that the standards for generating qualified seafarers are met in any way possible and having a good quality simulator for conducting competence-based training exercises and assessments will help in easing that vast responsibility. Therefore, the researcher would like to examine simulator cloud-based and conventional servers to ensure that the requirement for simulator training competency-based assessment is met without compromise.

1.4 - Cloud-based simulator

The cloud-based simulator is a significant development in the field of maritime education and training since it paves the way for students to gain access to training courses whenever and wherever they may be. Using cloud-based simulators may save time and resources, they are long-lasting, and can be easily updated as needed. On the other hand, cloud computing can only be accessed through an internet connection (Duke et al., 2013). If the local network or the connection to the cloud provider goes down, one will be automatically separated from the virtual computer in the cloud. In places like third-world nations and rural areas where internet connectivity is limited, this is by far the biggest problem. Moreover, the fact that all users use the same server makes it more vulnerable to attacks and reduces its performance is a major drawback of the public cloud. The researcher is interested in learning more about cloud-based simulator because the technology is novel and their utility is not research.

1.5 – Research Objectives

The researcher objective is to examine how engineering students' cloud-based simulator training activities compare to those on a traditional server, as well as addressing the challenges encountered during simulation training, which may contribute to the enhancement of the simulation for maritime education and training.

1.6 - Research questions

The study intends to investigate simulation on cloud-based and traditional servers to answer the following questions:

1) Is there a significant difference in the performance of the students during the simulation runs?
2) How was the connectivity on both simulator server types during the exercise?
3) How was the monitoring functionality on both simulator server types?
4) How about the software compatibility for assessment result accessibility?
5) Have errors been observed during simulation training?

1.7 - Limitation

This study is limited by the fact that (1) only Power plant diesel course specific simulator exercises and assessments are assessed, (2) only Kongsberg simulators are used, and (3) only at a specific METI.

1.8 - Research methodology plan

For this research, a mixed-method approach was chosen as the preferred method. To meet the research aims and solve the questions posed, a combination of qualitative and, quantitative. The researcher will conduct a quasi-experiment to compare the performance of students utilizing a conventional server with a cloud server simulator. Due to the non-random assignment of participants to each group, a quasi-experiment will be conducted. In two (2) iterations, both groups will be exposed to traditional and cloud-based servers, and their outcomes will be compared. If the result is identical in

both iterations, the result is more precise. To supplement the experiment's findings, a debriefing focus group will be conducted to address all of the issues encountered by the students during the simulation, followed by interviews with the facilitators, instructors, assessors, and service engineers to obtain their perspective on simulation training.

1.9 – Chapter Summary

The context for the facts addressed throughout the study article is provided in this chapter. Background data contains both significant and pertinent studies as well as the study's goals and limitations. This chapter tackles the importance of seafarers in world trade and how maritime education and training institutions influences the safety of shipping worldwide quality education and training for seafarers which includes a vast requirement on contact hours on competency-based training that involves the use of simulation for both training exercises and assessments.

In this section, the researcher also reviewed the study's objectives and aims, and how they relate to the study's research questions. In laying out the study's restrictions, the researcher established a firm boundary for how far we can go in this inquiry.

Chapter 2 - Related Literature

This chapter's objective is to review relevant literature from a variety of perspectives on the factors that influence the efficient delivery of simulator exercises and training, with an emphasis on simulator technology as a tool for delivering the intended learning outcomes for a particular course and how E-learning is utilized in maritime education and training, with a focus on the use of simulators, based on the requirements of the STCW competence table, with an emphasis on simulator technology as a tool for delivering the intended learning outcomes for a particular course. To gain a comprehensive understanding of the simulation process, the researcher decided to go through the process of simulation beginning with the conceptualization of the simulation, qualification of facilitators, selection of the infrastructure to be used, administration of the learning method, and evaluation to be performed.

2.1 - E-learning

E-learning is a means of enhancing and improving learning via the use of computers and communication technology. In online education, E-learning is frequently employed. According to McConell (2005), as cited by (Mohseni, 2014), E-learning is now an integral part of the curriculum and pedagogy in all settings. Most governmental institutions are making strides in e-learning and technological innovation in the classroom. Traxler (2018), argues that this is significant and useful in many ways, but that the challenges and emerging trends in distance learning provide an opportunity to consider distance learning's place in a world where cultures and ideologies clash, employment and education are no longer secure, universities and colleges face unexpected stresses, and innovative educational technologies and developments depict a chaotic and disorganized spa. Njenga (2010) adds that those with a vested interest in the success of E-learning in higher education are constantly creating, disseminating, and channeling this content without giving faculty members the resources necessary to assess the potential drawbacks and advantages of E-learning for student learning. Conversely, Guri-Rosenblit (2005) says that schools need to pause and ask themselves

crucial questions about the role of technology in the classroom. Both Robertson(2003) and Guri-Rosenblit (2009) emphasize the importance of the instructor in E-learning, while Robertson's article focuses on a broader range of topics. As the global lifelong learning market continues to grow, many universities are still figuring out how to deal with the increased competition for online students (Payne & Askeland, 2016).

2.2 – E-learning in Maritime education

E-learning has become a common method of education since it provides users with very simple access to the required knowledge. E-learning has also been utilized in maritime education and training, Shipping is one of the most strictly regulated sectors, with several intricate regulations and requirements. These requirements mandate ongoing education for maintaining valid certifications of competence. Moreover, the expansion of maritime commerce continues to provide benefits for global consumers by providing cheap freight charges. Nonetheless, the provision of maritime education via online distance learning will maintain the status of quo the maritime industry's skills and competencies in the fourth industrial revolution. However, according to Bhandar, (2017)an instructor should be present to facilitate an E-learning process. This shifts the instructor's position from the focus of the learning process to that of a guide.

2.3 - Nature of MET and STCW

The International Maritime Organization (IMO) is the regulating body for the maritime industry which coordinates the international convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), 1978, as amended, that regulates the use of simulators and enables their use as a substitute for shipboard training (Hwang, 2020). The International Maritime Organization (IMO) adopted the International Maritime Organization Convention. Convention on Standards for Maritime Training, Certification, and Watchkeeping (STCW 95) to ensure maritime safety and environmental protection (Wei, 2013). Enhancing human element

performance and establishing global minimum standards wherein administrations are tasked with enforcing standards for seafarer competence and conformity with its requirements (Saha, 2021). Maritime Education and Training Institutions (METI) are tasked with implementing the international convention for maritime Standard Training, Certification, and Watchkeeping in the delivery of their designed curriculum. Consequently, IMO establishes the regulatory framework, and maritime administrations, along with METI, implement and monitor it.

2.4 – Use of Simulator in MET

According to Mallam (2019a) technological advances, cost-effectiveness, and a strong emphasis on safety and sustainability are advancing the availability and potential of high-fidelity simulator solutions. This is supported by Saastamoinen (2019), noting that simulator-based training and instruction are utilized as a supplement to help seafarers gain some of the prerequisite skills for their board duties. According to Lera (2010), the significance of monitoring students' and groups' performance is that instructors can use these reports to classify students and groups based on their activities and learning objectives, track their development, and identify students who may need immediate attention. A simulator is a machine meant to produce a realistic simulation of the controls and operations of a complicated system, in this case, a ship engine room, for educational and training reasons. Simulations allow trainees to purposefully engage in high-risk activities or procedural tasks in a safe environment, allowing them to enhance their skills and learn from their mistakes at a lower cost and with fewer risks (Chybowski et al., 2015a). Simulation can be tailored to the level of realism required to improve their skills. Trainees can receive fast feedback that will help them understand exactly what went wrong and how they can improve and are not need to wait for a real-life setting to learn (Sellberg, 2018). Simulators, on the other hand, can be quite costly and necessitate frequent upgrades and upkeep. Furthermore, Simulator training is not only about the simulator equipment, but it is also more about the socio-technical interaction of the trainees towards the equipment the equipment is just a tool, and the instructor's expertise in both technical and in teaching using the equipment is

as valuable (Shen et al., 2019). Simulators provide the potential opportunities we hoped for, as well as an alternate and strong method of teaching and learning, based on improved presentation, sensory engagement, and experiential learning. However, In the early stages, the simulator can entice students with a multi-sensory approach of text, visual, and audio impacts, but it is the instructor's presence that provides the crucial link between the real world and the virtual representation of that environment. Learning can take place on a much more profound and relevant level thanks to the simulation experience. In addition to encouraging students to take an active role in their education through the experience approach, the trainer also gives them the chance to practice an inquiry-based approach by asking them questions and engaging in group discussions about difficult ideas (Mangga et al., 2021). During the exercise's pre-exercise briefing, during the exercise itself, and again during the exercise's post-exercise debriefing, the instructor has a significant opportunity to draw and sustain the much-discussed but sometimes-ignored component of learning and training known as "motivation of students." The trainer's expectations of students are an unappreciated factor in the student's overall success on simulators, but it is nonetheless crucial. Since a new method of training was introduced, a trainer's role has become increasingly crucial. The role of the trainer has evolved from that of a sole authority figure to that of a facilitator and manager due to the growing trend of "learner-centered" rather than "teacher-centered" education (Ohta et al., 2017). Simulators are versatile instruments for building individual and team competence not only in skill-based tasks but also in task management, such as emergency and crisis management. Simulators have been incorporated into maritime training and certification by STCW regulations. The use of simulators is both beneficial and time-consuming. With this in mind, simulator makers have created tools that may be used in a variety of roles, from assistance to operation and administration (Felsenstein et al., 2013). Additionally, a variety of simulators are accessible for training in everything from a single activity to a large number of complex tasks, and simulators can be integrated according to role or division. That's why it's so important for getting the most out of simulations. It is possible to optimize with the right approach to simulator training and a well-designed progressive

simulation program. The training program for the simulator will be created in two stages: first, the goals for using the simulator will be determined, and then, second, the simulator itself will be designed in detail.

Simulators allow students to learn needed information and skills faster than they might in a typical classroom setting. According to Saastamoinen et al.(2019a), Simulators have the advantages of cost-effectiveness, repeatability, and security. Moreover, navigation bridge and engine simulation operations can be integrated with advanced ship simulators (Sandaruwan,2010). Increasing technological readiness and advancements in these systems have made possible a new generation and category of simulators and simulation-based experiences for professional education, training, and operations. These systems are essential to the development of seafarer skills in maritime education and training. This is supported by Mallam (2019a), stating that, although using virtual reality, augmented reality, and mixed reality head-mounted displays for professional training and operations is not a novel idea, recent improvements and widespread adoption now make this possible. Moreover, new opportunities and paradigms for operators and operations on land and at sea are made possible by the use and integration of these technologies into maritime sector education, training, and operations, in particular (Cao & Zhang, 2020). This is supported by Ficco et.al.,(2018) in their study on cloud-based hybrid simulation platforms to test complex systems the so-called vessel traffic control. In addition to familiarity with numerous cutting-edge design techniques, there is a current need for efficient modeling tools and skilled simulation engineers. In addition to being an integral part of a company's simulation toolkit, best practices for fostering the efficient and exhaustive use of models are also essential. However, according to Shen et.al., (2022), the evaluation process in marine engineering simulator training could be challenging due to randomness in the evaluation process.

2.5 - Engine room simulations

To prepare marine officer engineers for potentially dangerous scenarios that may arise during actual marine diesel operations, Engine room simulations are helpful, as stated by Chybowski et al.,(2015b). By reducing the potential for human error in the upkeep and operation of marine equipment, and improving students' ability to respond quickly and effectively in the event of an emergency, computer simulation-interactive programs are becoming increasingly popular in the maritime education sector (Cwilewicz & Tomczak, 2004). In addition, Lakowski (2015) argues that using a simulator in the engine room might lead to more eco-friendly practices including careful and conscientious use of equipment. Marine education software has developed from a single instance, just as practice and training programs have been utilized in simulations and programming environments. To a large extent, pedagogical theories have not been taken into account as various types of educational software have developed (Kandemir et al., 2018a). In addition, the future iteration of the STCW Convention ought to include worldwide recognition and incorporation of realistic simulator categorization recommendations should include how to choose which simulator type is best for achieving specific educational goals (Mindykowski, 2017).

2.6 - Maritime cloud-based simulation

Maritime cloud-based simulation is a new technological advancement that enables a new environment for decentralized interaction, with content and functionality that closely resembles traditional on-site simulator software (Hjellvik & Mallam, 2021a). Moreover, cloud technologies are also suggested for creating a user-friendly online interface and a distributed infrastructure. By using cloud-based simulator, students are not limited by their location when it comes to gaining access to instructional materials. Cloud computing, as described by Siddiqui (2019), is an emerging and rapidly changing technology that has opened up exciting new avenues for research and innovation in the realms of education and IT. Because of this, e-learning places a premium on the use of technology to adapt and deliver instruction and education. If an

e-learning system uses a cloud computing platform, students can learn more quickly and effectively.

Technological development has steadily enhanced the efficacy of simulators and introduced a vast array of benefits for aspiring seafarers. According to Siddiqui (2019), cloud computing is an emerging and quickly evolving technology that has opened up exciting new options for study and innovation in the fields of education and information technology. This is supported by Hjellik & Mallam (2021), according to Hjellik & Mallam, Maritime cloud-based simulation is a new technology innovation that offers a new environment for decentralized engagement, with similar content and capability to traditional on-site simulator software. However, to guarantee that this cutting-edge technology for simulation training serves its intended purpose, it must be properly evaluated to see whether or not it satisfies the requirements outlined in the STCW.

2.7 - Developing simulator program

The many tasks and skill set that students will master are outlined in detail, as are the corresponding learning outcomes. To narrow down the practical performance to be demonstrated by the candidate, the task performance must be determined from the intended learning outcomes (Shen et al., 2019). To do this, we can look at the results for verbs like "show," "plan," "apply," "identify," "compute," and others that have to do with performance. In this way, the desired results for each level and function can be used to infer the task at hand. This is supported by Tsoukalas et. at., (2008), stating that the tasks so specified will be used to determine the performance goals that are specific to the simulated activity. After settling on a set of goals for teaching a particular skill via simulation, it is necessary to properly craft the simulator program. Moreover, according to Felsenstein et. al., (2013), the process of creating a simulator-based training program entails analyzing the situation, deciding on performance goals, choosing simulators and simulated exercises, organizing and writing up the program content, and establishing an evaluation method.

2.8 - Qualifications of Instructors

To create and execute the training program, there will need to be a minimum of two experienced trainers on hand who have an in-depth understanding of the simulator and a solid foundation. It is necessary to have prior experience in the development of instructional materials for instructors as well as training programs for simulation environments (Mangga et al., 2021). On the other hand, it is possible that without prior skill in seafaring, it will be impossible to manage all of the common items that are associated with the profession. According to Ali (2006), who is referenced by (Sellberg, 2017a), a prevalent fallacy is that the efficiency of an instructor is exclusively dependent on their knowledge of the subject area being taught by them. When a trainer has a "Certificate of Competency" approved by a marine service, it is simple to assume that the trainer's ideas, comments, or recommendations should be accepted and implemented. Therefore, to provide their students with the best possible simulation experience, teachers should have prior expertise both working onboard vessels and with maritime simulators (Ohta et al., 2017). Even if it is not expected of a teacher to know the answers to all of the questions, if they can't answer even one of the questions, their credibility will be called into doubt. It is essential to keep abreast of the latest advances and shifts in the real-world field upon which the simulation is based to have superior knowledge to that of the students. This topic covers everything to do with a person's professional life, from psychological to purely legal.

2.9 - Infrastructure and equipment

It will be necessary to have the classroom infrastructure. According to Mallam et. al., (2019), it is recommended that the atmosphere created for the entire course encourage interactive sessions rather than the routine setting of a traditional classroom that includes a simulator room, a briefing and debriefing room will assist in the simulator exercises delivery. Moreover, the competency-based training makes use of hands-on

activities carried out in a simulator to familiarize the potential instructor with the various shipboard functions. As a result, the trainees must have access to a variety of simulator technologies, which will be a crucial component of the course's infrastructure and equipment (Sellberg, 2018).

2.10 - Competency-Based Assessment

Kandemir (2018b) states that the practical training concept in engine room simulators includes the following steps: competency selection, scenario definition, task identification, observation method, data gathering, initial condition preparation, briefing, conducting exercises, assessment, and debriefing. This realization highlights the importance of assessment systems that are in sync with knowledge, comprehension, and competency to reliably demonstrate whether or not skills have been gained, which in turn has a profound impact on learning outcomes. Additionally, the term "competency-based assessment" is used to describe the process of gauging a student's knowledge and skills about a set of expected outcomes (CBA). It's a way to gather data about a student's development and accomplishments. The goal of using CBA in higher education is to improve courses and curricula in light of student feedback and employer needs (Idrissi et al., 2020). However, Noureldin (2018) claims that the use of simulation for grading purposes is much more divisive than its use in the classroom. Lacking reliable simulation-based assessment tools, objectively assessing technical skill competencies in a competency-based education framework will remain challenging. This is corroborated by Kobayashi (2005) as cited (Sellberg, 2017b), who writes that using appropriate evaluation methodology enables continuous and statistical measurement of the mariner's proficiency in safe navigation throughout the simulator training period. Djoub (2020) adds that these methods can be used by teachers or facilitators to spark students' interest in feedback, make them more aware of its significance, and encourage them to actively participate in analyzing, reflecting on, and responding to it. Having access to debriefing sessions can help students learn how to effectively incorporate feedback into their growth and development.

2.11 - Simulation related theories

To "replace or magnify real experience with guided experiences" is the stated objective of simulation-based education. This is according to recent research (Aebersold, 2018). It's not a piece of equipment, but rather a method of teaching grounded in scientific studies of how people learn. which Jeffries (2020) agrees with, according to him, the point of the simulation is to allow students to fully immerse themselves in a realistic setting through various forms of interaction. In addition, Aebersold (2016) states that simulators have been used for some time in aviation and the military to train personnel in both technical skills and safety-related attitudes (such as teamwork and communication), both of which are crucial to ensuring the safety of the operation onboard the vessel. The researcher also recognizes that simulation training, whether it be exercises or assessments, is not just about the simulator equipment but rather the entire process that involves qualified personnel, simulation guidelines, infrastructure, designed learning outcomes, and the learning method that the facilitator or instructor chooses to administer on a particular scenario.

2.11.1 - Cognitivism

Cognitivism often applies a paradigm of computational information processing. Learning is seen as an input-management process with a built-in memory storage mechanism. A schema is a unit of knowledge, cognition, and skill, as Clark (2018) explains. Individuals store separate schemas in their long-term memory. An adult's memory has hundreds of thousands of interrelated schemas. when new information is taken in by any medium, new schemas are produced and current ones are updated.

2.11.2 – Constructivism

The idea is that, rather than only receiving information, students should take an active role in constructing their knowledge. As they experience and reflect upon the world,

people construct mental representations of it, refining and expanding their prior understanding in the process. In essence, constructivism is a theory about the nature and process of education. The "most promising model of learning" label was given to it by Yager (1991) as cited by (Stern et al., 2014). Furthermore, Glynn et. al., (2012) mentioned a Kuhnian paradigm shift and hypothesized that constructivism may promote the merging of existing ideas and the development of brand-new ones. This is not an exaggeration; indeed, we would go so far as to suggest that the potential extends well beyond the field of science instruction (Matthews, 2014).

2.11.3 – Behaviourism

All behaviors are conditioned by experience with the environment, as proposed by the behaviorist theory of learning (McKenzie, 2017). Sir Karl Popper, as cited by Harlow et al. (2007), argues, however, that it is not true because repetition leads to conditioning. Popper argues that practice does not make perfect, hence there is no such thing as memorization. One of the most straightforward and distinctive attacks in the scant literature on behaviorism among scientific philosophers, argues that conditioning, the theory's basic tenet, is untrue rather than debating the relative merits of mentalism or cognitivism.

2.12 – Chapter Summary

This chapter aids the researcher in comprehending the discussions and studies that have already been conducted on cloud-based simulation and other related studies. This cutting-edge technology for simulation training must be properly evaluated to see whether or not it complies with the requirements outlined in the STCW. This information is needed to have a basis for the study being undertaken in comparing two

types of simulator servers that are widely used for maritime education and training and to discuss the data in the study's later stages.

Moreover, the importance of the instructors or facilitators who will handle this technology and the teaching methodology used to deliver the courses the students need will be explained in this chapter and how E-learning enhances knowledge transfer in education and training; the development of the simulation training program is crucial in ensuring that the knowledge being transferred is aligned to the requirement stipulated in the competence table of the STCW.

The nature of MET and STCW in the maritime sector is that the IMO creates the regulatory framework for STCW based on the conventions, while the maritime administration ensures the implementation of METI requirements. METI must ensure that they adhere to these requirements and produce seafarers of the highest caliber.

Infrastructure is also important when it comes to the E-learning topic, as is having the right people and the right tools; the final piece of the puzzle is the methodology, which is determined by which theory could be applicable based on the results of the situational analysis.

The three learning theories that are most frequently used in the creation of learning environments are behaviorism, cognitivism, and constructivism. The facilitator's handling of the simulation process and application of the proper learning strategy will determine whether or not the simulation training will be successful.

Chapter 3 - Research methodology and methods

To compare the cloud-based server with the conventional server the researcher decided to use a mixed method, by blending qualitative and quantitative approaches.

The researcher will run a quasi-experiment to evaluate if there is a substantial difference in the performance of students using a conventional server vs a cloud-based server simulator. In two runs, the two groups will be exposed to both traditional and cloud-based servers, and their results will be compared. In the study, participants were divided into two groups, A and B, and given training on a simulator using either sort of server simultaneously while doing two distinct types of simulator training exercises. The reason that the researcher chose to use two different simulator exercises for the two different groups (A and B) specimens and eventually switch them was to let both of them experience both types of simulator servers on two different simulator exercises for this experiment to ensure the reliability of the results of the experiments that have been conducted.

Having two different sets of simulator exercises for the specimen provided the researcher with the possibility to test different scenarios in a controlled environment. This enabled us to observe the change in behavior of the specimen and eliminated the possibility of merely memorizing the procedure rather than having a profound understanding of the knowledge and skills that need to be acquired. As a result, the researcher will be able to obtain more accurate results by using this method.

If the results are the same on both runs that will give the researcher an initial analysis, but to supplement the findings of the experiment making it more accurate, the researcher has will conduct a debriefing focus group to address all the issues encountered by the students during the simulation and then interview the facilitators,

instructors, assessors, and the service engineers to get their perspective on this simulation training.

This chapter details the methodological framework, theories, and procedures to address the research question posed in the first chapter. This chapter will include a detailed overview of the research methodology as well as a full discussion of how the approach and the dissertation's goals are aligned. Based on the results of the simulator training assessment, a quantitative strategy will be used, and during the debriefing, a focus group and semi-structured interview will be used to apply a qualitative strategy.

3.1 - Method selection and approach

Because of its systematic approach and apparent objectivity, quantitative research plays an essential role in the dissemination of research methods (Johnson & Christensen, 2019a). However, as a result of its systematic nature, it risks overlooking issues that could be better explored using the qualitative approach. Quantitative research methods, on the other hand, are broad and can be used on any topic, whereas qualitative research methods are narrow and need an in-depth look at a single issue (Creswell & Poth, 2016). The analysis provides insight that helps the researcher better grasp the study's topic. New research avenues could be identified using the same data. Croswell and Poth (2016) argue that overemphasizing either qualitative or quantitative research is limiting and that it is important to recognize the philosophical tension between the two before settling on a suitable strategy.

The research design and process flow are depicted in the following figure 1.
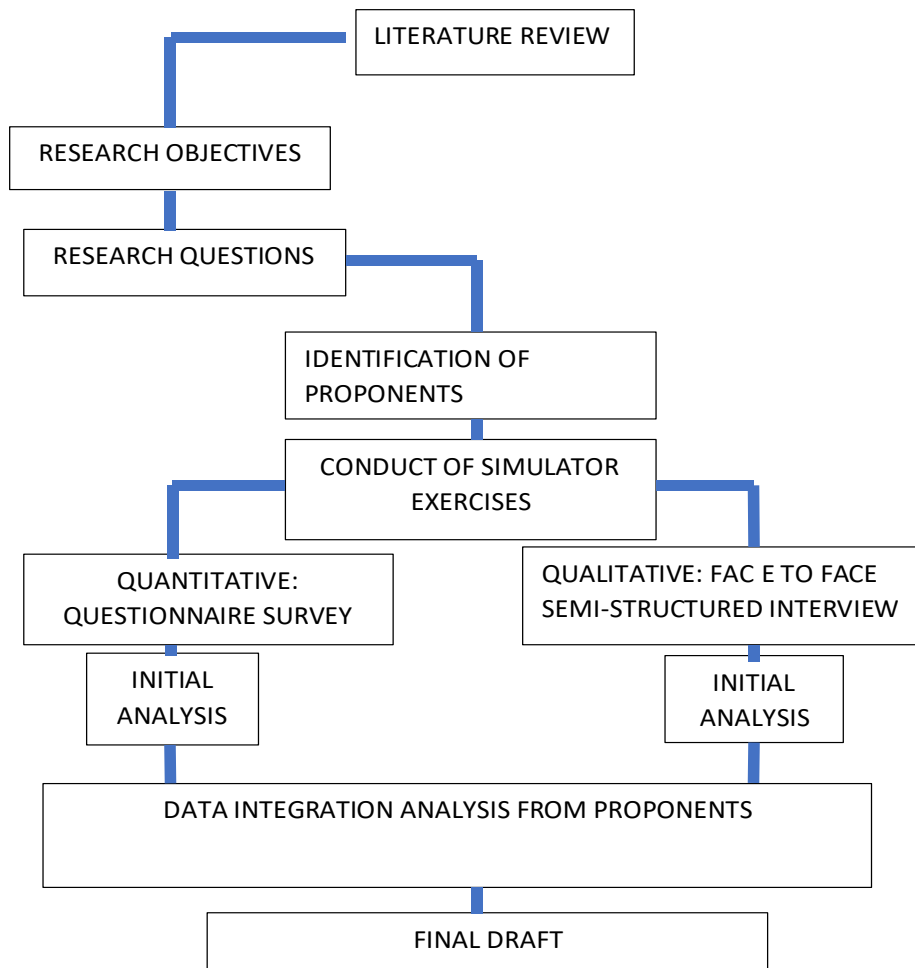
Figure 1: Research Methodology Process Flow

3.2 – Participants' selection

The selection of participants for the conduct of simulator exercises and assessment was based on the academic performance of the students. The researcher wanted to ensure that both groups of 28 participants had the same level of academic performance.

3.3 - Conduct simulator exercise and assessment

 The Selected 28 participants were divided into two groups or a section. One group performed the simulator exercise using the conventional server and the other group performed the simulator exercise on the cloud-based server and then swapped them to be able to perform two different sets of exercises one on each platform of the simulator server. This will give the researcher four sets of assessment results that will analyze in the later part of the study.

3.4 - Data processing and analysis

3.4.1 - Quantitative

Descriptive and inferential statistics were utilized as a part of a quantitative methodology to obtain analysis and provide answers to study question 1 on whether or not a cloud-based server could address the targeted learning outcomes for a simulator exercise for maritime engineering. Research question 5 was also analyzed and answered using the same methodology, which included focus groups and a series of simulation exercises in which participants used either a traditional server or a cloud server, and then switched platforms to complete the same simulation exercise using inferential statistics. The challenges and issues that arise during the use of cloud-based server simulator training (questions 2,3,4 and 5) were investigated.

3.4.2 - Qualitative

All of the interviews were transcribed and translated by the researcher. One of the most difficult aspects of qualitative data is that its interpretation might be skewed. This shortcoming was acknowledged by the researcher, who attempted to triangulate the methods for interpreting the data. The author requested that the participants double-check the data that had been transcribed. In addition, the author took notes on the ideas of students, facilitators, instructors, assessors, and service engineers during the interviews and asked them to ensure that the researcher had interpreted them correctly. To guarantee consistency and accuracy, these notes were compared to the transcribed data. Personal judgments and biases will be minimized during the interpretation of qualitative data using these approaches.

3.5 Trustworthiness and triangulation

Keeping in mind the bounds of both qualitative and quantitative approaches, the author of this study employs a triangulation strategy. To begin, the students were split into two groups and each one performed the same activity on both server types. Next, the qualitative approach will be put into action through the use of a semi-structured interview. Finally, the researcher will go through the groundwork that was laid for processing and analyzing the data. Fourth, a quantitative strategy will be implemented based on the outcomes of the assessment, and the initial interview data will be coupled with the focus group data for the final data processing and analysis. The chapter will conclude with a discussion of the ethical implications and limitations of the study methodology. to a greater extent in the qualitative approach. It was conducted using multiple sources of evidence rather than a single one. Any result that has been collected from various sources is more highly probable to be compelling and accurate, as Schoch (2020) explains that doing so enables the establishment of interrelated lines of investigation. Evidence-based analyses that drew from a variety of sources were judged to be more credible than those that depended on a single data point (Yin, 2018). The study analyzed data from a wide range of sources, such as semi-interviews,

documents, and focus groups, using a consistent qualitative methodology. Methodological triangulation, as described by Flick (2018), is a useful tool for bolstering one research approach with another to get more reliable findings. Therefore, this investigation employed a triangulation of qualitative and quantitative methods, a technique deemed useful by Johnson and Christensen (2019b).

3.6 – Chapter Summary

In this chapter, the researcher outlined the overall strategy the researcher will use to conduct the investigation. Priority was also given to the researcher's methodology for selecting study participants and carrying out the experiment as a whole. All of the collected information will next be analyzed and synthesized.

Quasi-experiment assessment results were analyzed and synthesized using the same qualitative analytic methods used in this study. These methods included focus groups and quasi-interviews. Methodological triangulation is a methodology that uses multiple methods to reinforce a single one, leading to more reliable findings which is the method of choice for this study.

Chapter 4: Cloud-based and Conventional Simulator Experiments

This chapter will provide a detailed description of the simulation experiments. These experiments will begin with the introduction of "KSIM connect" also known as the cloud-based simulator, and the conventional simulator. After a brief introduction of the host institution, the participants, and the chosen course for these experiments, the results will be presented. In the conclusion, the findings of the experiments will be compared, examined, and synthesized in light of the student's performance during the experiment.

The "KSIM connect" or cloud-based server simulator training was conducted in a computer lab, as seen in the following figure 2, and for the conventional server as shown in figure 3 the researcher opts to use the desktop units. In this study, twenty-eight (28) individuals were assigned to one of two groups (A and B), and each group completed two exercises on each server type.

Figure 2: KSIM connects computer laboratory/GMDSS west campus

Figure 3: Conventional server desktop east campus

Two different simulator activities were performed, one on a traditional server and the other on a cloud-based server. One of the simulator exercises involved setting up and running a diesel generator, and the other involved stopping and safeguarding its operation. Both participant groups A and B underwent two runs on two separate simulator activities to experience both types of servers.

The research took place on both east and west campuses of the Maritime Academy of Asia and the Pacific (MAAP). MAAP is a non-profit maritime education and training institution located in barangay alas-asin Mariveles, Bataan Philippines. MAAP is the leading maritime education and training institution in the Philippines which offers both Bachelor of Science in Marine Engineering and Bachelor of Science in Marine Transportation and currently has a total of 1,787 currently enrolled cadets and a total no. of 4,770 graduates since the year 2003. The institution utilizes Kongsberg simulators for its competency-based assessment.

Fifty-six (56) cadets, two (2) facilitators, two (2) instructors, two (2) assessors, and two (2) MAAP simulator service engineers participated in the research activity wherein cadets were split into two groups. The cadets were incoming 2nd class midshipmen or 3rd-year students in regular university settings. The selection of the cadets was based on their 5-point scale grade from their previous year level. One of the facilitators was a seafarer and has been teaching for more than 9 years while the other is still an active seafarer and has been teaching for more than 5 years. The MIITD

service engineers have been working in MAAP for more than 7 years and the other one is 5 years. While the assessor has been working in MAAP for more than 5 years and the other one is more than 7 years.

Before experimenting, the researcher wanted to ensure that the groups of students involved in the study are comparable based on their academic performances, particularly on Power Plant Diesel. Hence, the two groups were compared as shown in Table 1.

Table 1: Comparison of Students' Performance in PPD

Area	Group 1		Group 2		t (26)	p	Cohen's d
	Mean	SD	Mean	SD			
PPD Grade	1.679	0.158	1.729	0.082	-1.051	.306	0.397

Note: A grade of 1 is the top-grade indicating excellence and 5 is the failing grade.

The first group's mean Power p performance (M=1.679. SD=0.158) is not significantly different from that of the second group (M=1.729, SD=0.082), t(26)=1.05, p=.306. However, Cohen's d measure of 0.397 indicates a small effect size. This result indicates that the two groups have relatively similar performance levels and are therefore comparable.

The assessment's outcome is connected to both classroom instruction and student learning (Ahmad et al., 2020). All of the results in table 1 above are derived from the 5-Point Scale grade of the students who volunteered to participate in the study. Examinations taken for both admissions to higher education and on an annual basis serve the same purpose. The host institution follows a 5-Point Scale grading system of 1 to 5, wherein lower numbers reflect more academic achievement.

Before the actual simulator training exercises, the researcher gathered all the cadet participants to give them an overview of the activity that will take place in a few days using the simulator facility of the host institution. In line with that, the researcher also took the opportunity to distribute the consent form to the participants and discussed it further, and entertain all possible questions that the participants may ask regarding the consent form and the research.

4.1 - Chosen Exercise

The researcher has identified the subject of Power Plant Diesel as our primary concern for this study. The subject was selected because it requires a lot of competency-based assessments based on the Knowledge, Understanding, and Proficiency (KUP) of the STCW competence table which recommends the use of a simulator facility. Another significant factor is that the instructors in charge of this course want to guarantee that a cloud-based server satisfies the prerequisites for using the simulator.

There is a direct correlation between the outcomes of the Power Plant Diesel (PPD) course and the STCW competency table, as outlined in figure 4 below, which also includes the criteria for the simulator training exercise. The course outcome was consistent with the specific training activity detailed in the KUP of the STCW

competence   table.

Figure 4:   *Preparation and starting operation of diesel generator simulator training exercise documentation for both types of servers*

The simulator training document shown in the figure above is the identical one that is used for both traditional and cloud-based servers. The process is to program the aforementioned simulator exercises on a conventional server, then use it for both types of servers. The facilitator will only need to upload the aforementioned simulator training exercise program to the cloud-based server, after which it will be made accessible to the students for use. Two simulator exercises—one for setting up and running a diesel generator and another for shutting it down and securing it—were

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utilized to experiment. Figure 5 below shows the document for simulator exercises for stopping and securing the operation of diesel generators for both types of simulators.

F-038a Issue 0 Rev 5 24 January 2022	**MARITIME ACADEMY OF ASIA AND THE PACIFIC-KAMAYA POINT** **MAAP SIMULATOR CENTER** Associated Marine Officers' and Seamen's Union of the Philippines – PTGWO-ITF Kamaya Pt., Brgy. Alas-asin, Mariveles, Bataan

SIMULATOR TRAINING EXERCISE (INSTRUCTOR'S COPY)

COURSE TITLE	Power Plant Diesel
EXERCISE NO.	PPD-001C-22
EXERCISE TITLE	Stopping and securing operation of Diesel Generator Engine
DURATION	**30 Minutes Total** 10 minutes Briefing 5 minutes Planning and Familiarization 10 minutes Exercise Execution 5 minutes Debriefing
TYPE OF EXERCISE	☐ Individual ☑ By Group Ratio Example 1:3 _____
PROGRAM	BS Marine Engineering
STCW CODE FUNCTION	Function 1: Marine Engineering at the Operational Level
COMPETENCE	STCW Code, 2010 Manila amendments **Chapter III, Part A- Table A-III/1** A-III/1.F1.C4: Operate main and auxiliary machinery and associated control system A-III/2.F1.C1: Manage the operation of propulsion plant machinery A-III/2.F1.C2: Plant and schedule operations A-III/2.F1.C3: Operation surveillance, performance, assessment and maintaining safety of propulsion plant and auxiliary machinery
KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	A-III/1.F1.C4.KUP3: Preparation, operation, fault detection and necessary measures to prevent damage of (.1) main diesel engine and associated auxiliaries and (.3) auxiliary prime movers and associated systems A-III/2.F1.C1.KUP1.1: Design features and operative mechanism of marine diesel engines and associated auxiliaries A-III/2.F1.C2 and C3.KUP2.1: Practical knowledge on start – up and shut down main propulsion and auxiliary machinery including associated system A-III/2.F1.C2 and C3.KUP2.2: Practical knowledge on operating limits of diesel propulsion plant
CRITERIA FOR EVALUATING COMPETENCE	Operations are planned and carried out in accordance with operating manuals, established rules and procedures to ensure safety of operations and avoid pollution of the marine environment.
CO (COURSE OUTCOME)	CO2: Prepare and operate the main engine and associated auxiliaries for ship departure from port in accordance with the established rules and procedures to ensure safety of operations and avoid pollution of marine environment
TO (TRAINING OUTCOME)	Stop and secure Diesel Generator Engine using Engine Room Simulator. LO 2.4 Carry out Start up and Shut Down of auxiliary prime mover and associated machinery system in accordance to prescribed safety procedures. LO 2.6 Perform the monitoring procedures carried out for the associated auxiliary systems and the Dual Fuel Diesel Engine during their operation.

Figure 5: Stopping and securing the operation of diesel generator simulator training exercise documentation for both types of servers

The method for the briefing before the simulation begins and the student's expected behavior during the briefing are shown in detail in figure 6 below.

INSTRUCTOR'S ACTION	1. Trainees are adequately *briefed* beforehand on the exercise objectives and tasks and are given sufficient *planning time* before the exercise starts; 2. Trainees have adequate *familiarization time* on the simulator and with its equipment before any training or assessment exercise commences; 3. Guidance given and exercise stimuli are appropriate to the selected exercise objectives and tasks and to the level of trainee experience; 4. Load the Exercise Scenario in the designated Engine Room Simulator. In case of any technical difficulty in loading the exercise, call the designated technician for assistance; 5. Exercises are effectively monitored, supported as appropriate by audio and visual observation of trainee activity 6. Trainees are effectively debriefed to ensure that training objectives have been met and that operational skills demonstrated are of an acceptable standard; 7. Refer to Simulator Use Checklist during community quarantine Form F-072
EXERCISE PROCEDURE	
EXERCISE BRIEFING	1. State the name of the exercise 2. State the basis of the exercise as per STCW (Regulation, Table, etc). 3. State the course outcome and training outcome of the exercise. 4. State that the exercise should be treated as realistic as possible as if they were on board the ship. 5. Give additional House Rules in the use of the simulator complex that includes safety tool box meeting which when violated may result to exercise stoppage. 6. Explain the exercise scenario. 7. Hand the ship's particulars. 8. Explain the initial condition. 9. State the duration of the exercise. 10. Explain the performance criteria of the exercise. 11. Explain the performance standards of the exercise. 12. Explain that all *performance standards* and *criteria* should be completed to accomplish the objective 13. Explain the conditions when the exercise will be stopped. 14. Assign student's roles if necessary. 15. Explain the failure state of the exercise. 16. Ask students if they have any other clarification or questions. 17. See form F-041 for Briefing Checklist.
STUDENT'S ACTION	1. The student at first should understand the necessity of this simulator exercises 2. The students are assigned on particular ERS station. 3. They will be briefed about the scenario and their task to accomplish. 4. The students should complete the task, given on the performance criteria. 5. If they are unable to comply the task the student should repeat the said exercise.

Figure 6: Part of the documentation of the simulator exercise wherein the exercise procedure is stipulated

The instructor also goes through the performance criteria and standards during the briefing to make sure that the students are fully aware of what they must accomplish by the end of the session. The automated assessment was programmed before this experiment by the facilitator in conjunction with the course instructor and assessor using the performance standards as a guide. In the later stages of developing a simulator training exercise or assessment, pilot testing is performed to ensure the quality of the final product. If after the evaluation process the simulator was found not suitable enough to address the STCW competence table the said simulator training exercise will be reprogrammed to address the issue observed by the approving body

including the feedback of the specimen used during the pilot testing.

MONITORING CHECKLIST					
Performance Criteria	**Performance Standard**	**Done**	**Not Done**	**Observations/ Comments**
1. Prepare fresh water system	1.1 Filled up FW exp tank	☐	☐	
	1.2 Set pre-heater to auto X03310	☐	☐	
	1.3 Set FW Temperature controller to 85°C	☐	☐	
2. Prepare Sea Water cooling system	2.1 Opened DG2 FW cooler SW shut off valve V00678	☐	☐	
	2.2 Established SW Flow to DG Cooler 40 ton/Hr minimum flow	☐	☐	
3. Prepare Lubrication oil system	3.1 Closed LO discharge valve to Sludge Tank	☐	☐	
	3.2 Filled up LO sump tank to minimum 40% level	☐	☐	
	3.3 Lined up lubrication system. Opened 1 LO filter V03344 or V03345	☐	☐	
	3.4 Started Priming pump R03354	☐	☐	
	3.5 Established DG 2 LO Pressure minimum of 1.30 Bars	☐	☐	
	3.6 Set LO priming pump to AUTO X03355	☐	☐	
	3.7 Established DG 2 LO Temperature of 30~55°C	☐	☐	
4. Prepare Fuel oil system	4.1 Opened DG2 FO shut off valve V03350	☐	☐	
	4.2 Opened One FO filter V03351 or V03352	☐	☐	
	4.3 Established FO flow and pressure minimum 100kg/hr and 1 bar	☐	☐	
	4.1 Opened DG2 FO shut off valve V03350	☐	☐	
5. Prepare starting air system	5.1 Drained moisture content of Starting Air Reservoir	☐	☐	
	5.2 Opened starting air supply valve to DG No. 2	☐	☐	
	5.3 Established DG 2 Starting air pressure of 15 Bars minimum	☐	☐	
6. Start Diesel Generator engine at Local control panel	6.1 Pressed START button at Local side Engine control panel	☐	☐	
	6.2 Established Generator Engine Idle Speed 905.4 ~ 905.6 rpm	☐	☐	

Figure 7: Performance criteria and Standard of the simulator exercise
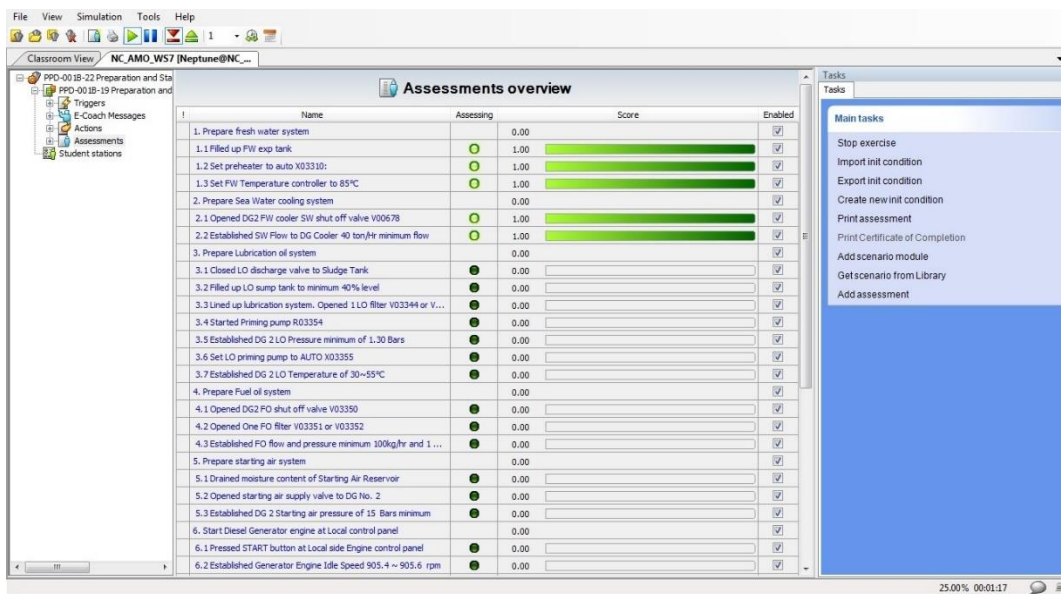
Figure 8: Automated assessment programmed directly aligned with the performance standards

After discussing the performance criteria and standard of the exercise the instructor explains to the student that aside from accomplishing the objectives, he or she can stop the exercise at any point of time during the exercise if it is deemed necessary for instance horse playing, etc. as what the figure 9 below shows.

EXERCISE STOPPAGE	1. When objective have been accomplished.
	2. When any of the following situations arises during the exercise:
	a. Deviation from the objective.
	3. When any of the following is committed during the exercise:
	a. Horse Playing
	b. Unsafe action by the student
	4. Exceeded simulation time limit
	5. When it is apparent that the objective can no longer be achieved

Figure 9: Exercise stoppage procedure stipulated in the simulator training specifications

Each group had to perform on both cloud-based and conventional-based servers undergoing the same exercises and assessments. To make this simulation training a complete learning experience for the students, the expertise of the following personnel as needed;

The simulator facilitators were in-charge of programming the exercise through logic gates algorithm programming taking into full consideration the requirement stipulated in the course syllabus which is aligned with the competence table of the STCW. Moreover, preparation of the facility and test run before the said research exercise was also done by the facilitator in coordination with the instructor, assessor, and the simulator service engineer.

The course instructors were in charge of conducting the exercise briefing before administering the exercise, monitoring during the exercise, and debriefing right after the exercise has been concluded. Selection of the instructor in charge was based on the procedural selection of the institution for their instructors which includes experience working onboard vessel, completion of IMO model courses 6.09 and 6.10, and other maritime administration and Commission on Higher Education (CHED) requirements.

The assessors ensure the alignment of the program assessment with the competence requirement stipulated in the STCW competence table. During the conduct of simulator training exercises or assessments of a particular course, the assessors evaluate the program assessment to ensure continuous improvement.

The simulator service engineer is in charge of the installation and maintenance of the whole simulator system well of course in coordination with the maker's technical service engineers. They also communicate all observed glitches and

recommendations for improvement in the system directly to the maker's customer care.

Simulation training whether exercises or assessments require more than the simulator itself it involves a socio-technical process requiring the expertise of multiple people working together to enhance the programmed simulation environment for the students to meet the requirement of the competence table of the STCW and at the same time making in a full learning experience to the student.

4.2 – Findings

Table 2: Comparison of Student Performances in Conventional and Cloud-based Server Simulators

Run	Group 1		Group 2		t (26)	P	Cohen's d
	Mean	SD	Mean	SD			
Run 1	(Conventional)		(Cloud-based)				
	18.86	.663	19.07	.267	1.122	.272	0.416
Run 2	(Cloud-based)		(Conventional)				
	9.93	.267	9.86	.363	.593	.558	0.220

As reflected in Table 2, the performance (M=18.86, SD=.663) of students under the conventional server during the first run does not differ significantly from that of those under the cloud-based server simulator (M=19.07, SD=.267), t(26)=1.112, p=.272). The Cohen's d of 0.416 supports the statistical test result as it indicates low effect or low practical significance.

When the groups were reversed in the second run, the same 'no statistical difference' result was noted (t (26) =.593, p=.558, d=0.220). The performance of students under the cloud-based server (M=9.93, SD=.267) is not statistically higher than that of those under the conventional server (M=9.86, SD=.363). Cohen's d of .220 suggests a low effect size, indicating the weak practical significance of the difference between the two (2) groups.

The replication of the functioning of an actual onboard operation or system over time is the essence of a simulation (Noureldin et al., 2018). The use of models is necessary for simulations; a model is a representation of the essential qualities or behaviors of the system or process that is being simulated, while a simulation is a representation of how the model changes over time. The type of server for the simulation can greatly affect the quality of imitation of the said environment or the system operation. The experiment conducted tried to determine the difference that may or may not affect the performance of the student.

Figure 10 below shows the result of the simulator training exercise experiment conducted on both types of simulator servers that shows a practical weak significant difference.
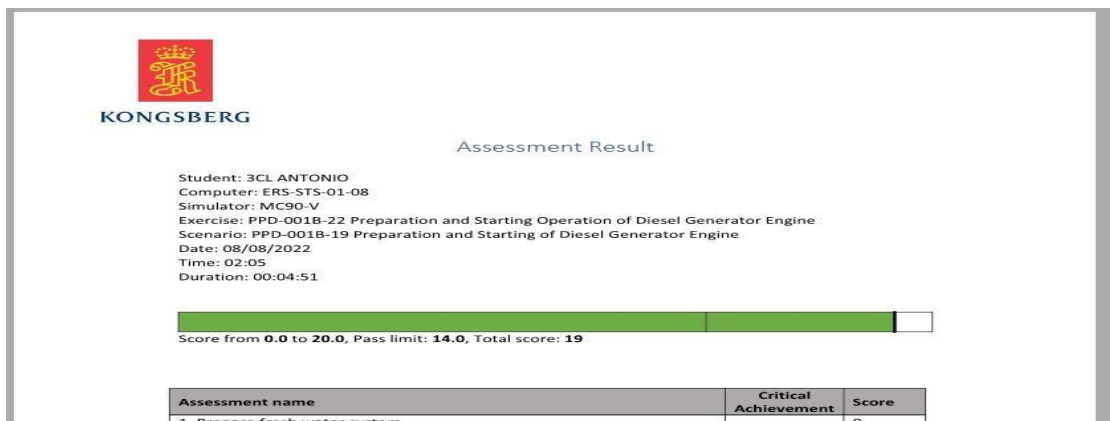
Figure 10: Assessment result sample from a conventional server
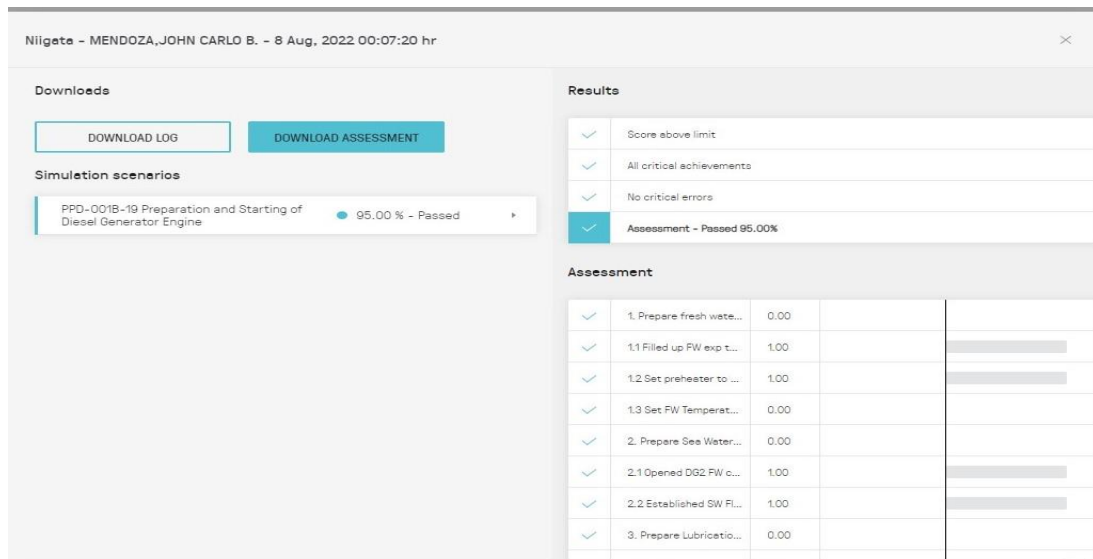
Figure 11: Assessment result sample from the cloud-based server or also known as "KSIM connect"

RAW SPSS OUTPUTS

Table 3: RAW SPSS OUTPUTS

Group Statistics

	INTERVENTION	N	Mean	Std. Deviation	Std. Error Mean
PPD Grade	Conventional	14	1.6786	.15777	.04216
	Cloud-base	14	1.7286	.08254	.02206

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PPD Grade	Equal variances assumed	4.141	.052	-1.051	26	.303	-.05000	.04759	-.14782	.04782
	Equal variances not assumed			-1.051	19.621	.306	-.05000	.04759	-.14939	.04939

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A statistical test, the t-test compares the averages of two sets of data. It is utilized frequently in the testing of hypotheses to determine whether a process or treatment affects the population of focus or whether two groups are distinguishable from one another (Ruxton, 2006). The table above shows the t-test resulting in a 95% confidence interval of the difference with equal variances assumed and not assumed upper and lower which shows that there is no significant difference in the performance of the students on both types of simulator servers.

The results show that there is little to no difference between how well students do use a conventional server versus a cloud-based server simulator for the Power Plant exercise. Consequently, either a conventional simulator or one hosted in the cloud can be used interchangeably to achieve the course outcome of the simulator training exercise or assessment.

RUN 1

Table 4: Experiment first run result

Group Statistics

	INTERVENTION	N	Mean	Std. Deviation	Std. Error Mean
SCORE1	Conventional	14	18.86	.663	.177
	Cloud-base	14	19.07	.267	.071

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SCORE1	Equal variances assumed	2.760	.109	-1.122	26	.272	-.214	.191	-.607	.178
	Equal variances not assumed			-1.122	17.116	.278	-.214	.191	-.617	.189

The table above shows the result of the first run of the experiment wherein group A underwent the simulator training exercises on the cloud-based server and group B on a conventional server.

RUN2

Table 5: Experiment second run result

Group Statistics

	INTERVENTION2	N	Mean	Std. Deviation	Std. Error Mean
SCORE2	Conventional	14	9.93	.267	.071
	Cloud-base	14	9.86	.363	.097

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
						Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.	t	df				Lower	Upper
SCORE2	Equal variances assumed	1.473	.236	.593	26	.558	.071	.121	-.176	.319
	Equal variances not assumed			.593	23.889	.559	.071	.121	-.177	.320

The results of the second run of the experiment are presented in the table that can be found above. In this run, group B completed the simulator training exercises on a cloud-based server, whereas group A completed them on a conventional server.

4.3 - Chapter Summary

The researcher's attempt at conducting a quasi-experiment was successful in determining the difference in performance between the two kinds of servers. The researcher was able to achieve a result that pointed in the direction of a weak significant difference by using the IBM SPSS 23 data analyzer. This result was based

on the performance of the student who had gone through sets of exercises on both platforms. It is quite clear that the performances of students using traditional server simulators and cloud-based server simulators are not considerably different from one another. As a result, conventional servers and cloud-based servers can be used interchangeably depending on the type of simulation.

Chapter 5 – Further Investigation to Supplement the Experiment

A follow-up interview was conducted to further investigate the difficulties encountered by the students during the simulator training exercise by first conducting the debriefing of the students and then obtaining the opinions of the following experts (instructor, facilitator, assessor, and service engineer) as well as the researchers' direct observations to have the data gathered to analyze and develop a potential solution to the problem presented in the first chapter.

This chapter gives the full detail of the data gathered during the interviews and then analyze the data to form a summary of all the things that transpired and synthesize all the ideas and issues observed that will help the researcher develop a solution to solve the issues.

Figure 12 below depicts the standard configuration of a KSIM conventional server instructor station, which consists of a few pieces of hardware used to run and keep tabs on the simulation. A server computer set, an instructor station computer set for controlling the simulation, an auxiliary screen for watching student activities throughout the simulation, and a printer to document the exercise or assessment are all

part   of   the   equipment.

Figure 12: Conventional server instructor station

Image 13 below depicts what an exercise using a "KSIM connect" or cloud-based simulator looks like from the perspective of an instructor station. If an account holder has a computer that meets the system's minimal requirement (windows 10 and above), he or she can access the account whenever and wherever he or she chooses with a program called "KSIM connect." However, the account holder can't access the account through an Android or iOS smart device. The inability to track individual student's progress during the simulation limits the instructor's ability to make notes about difficulties that arose in the course of the exercise, which is essential for addressing them in the post-exercise debriefing.
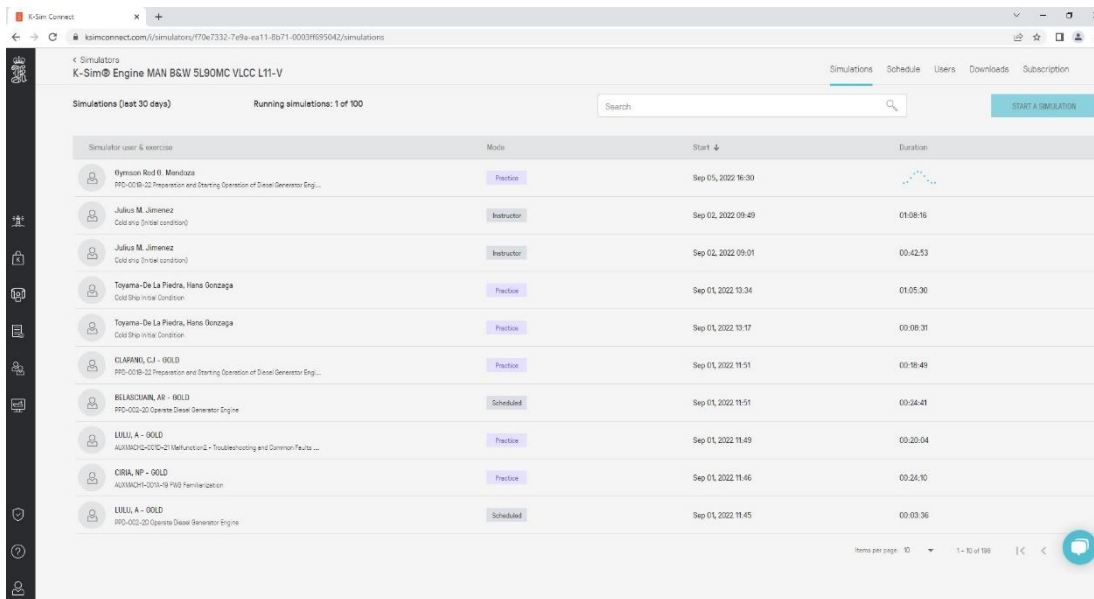
Figure 13: KSIM connect or cloud-based instructor's view during simulation training

Figures 14 and 15 below depict how an instructor using a conventional server could track each student's progress in a simulation-based training or assessment which the cloud-based server doesn't have. An instructor or facilitator can access a student's workstation to keep tabs on their progress, make notes on any problems they encounter, or even record their entire simulation experience to use as a discussion point during a debriefing session.
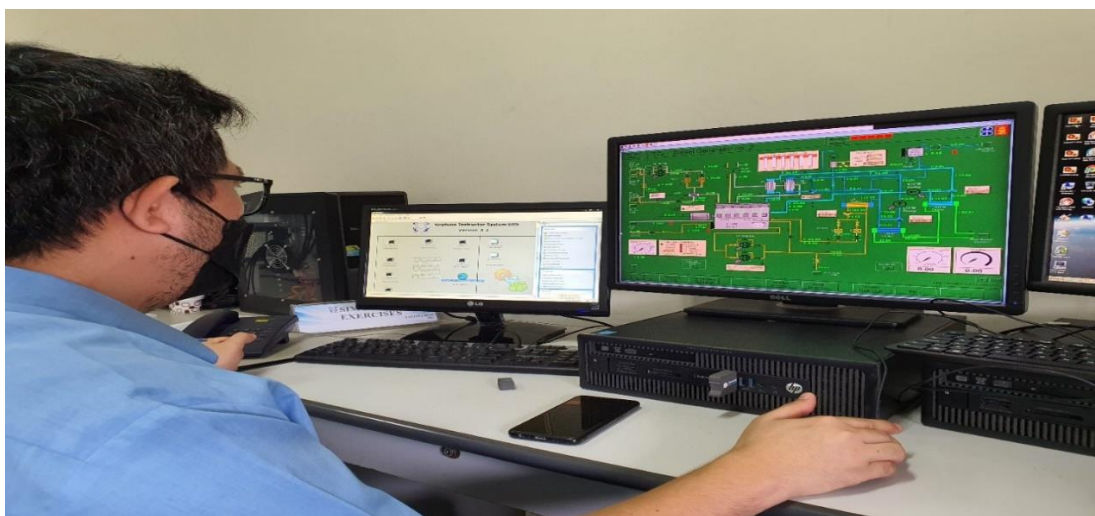
Figure 14: Real-time monitoring of student activity on instructor's station (conventional server)

Figure 15 below demonstrates how an instructor can track a student's progress in real time as the students take exercises or assessments using a simulator.

Figure 15: Auxiliary screen shows the real-time assessment progress of a student

5.1 - Challenge 1 – Server accessibility

The first problem that the researcher ran into while beginning the simulation exercise was establishing a connection to the distant server. There was a problem since the client-server required an update every time a user logged in; users had no choice but to update their accounts and wait a few minutes for the process to finish. And the internet connection to the server is to blame for the few cadets who experienced system crashes while using the application.

Figure 16 below shows what the client-server update looks like before the start of the simulator exercise.
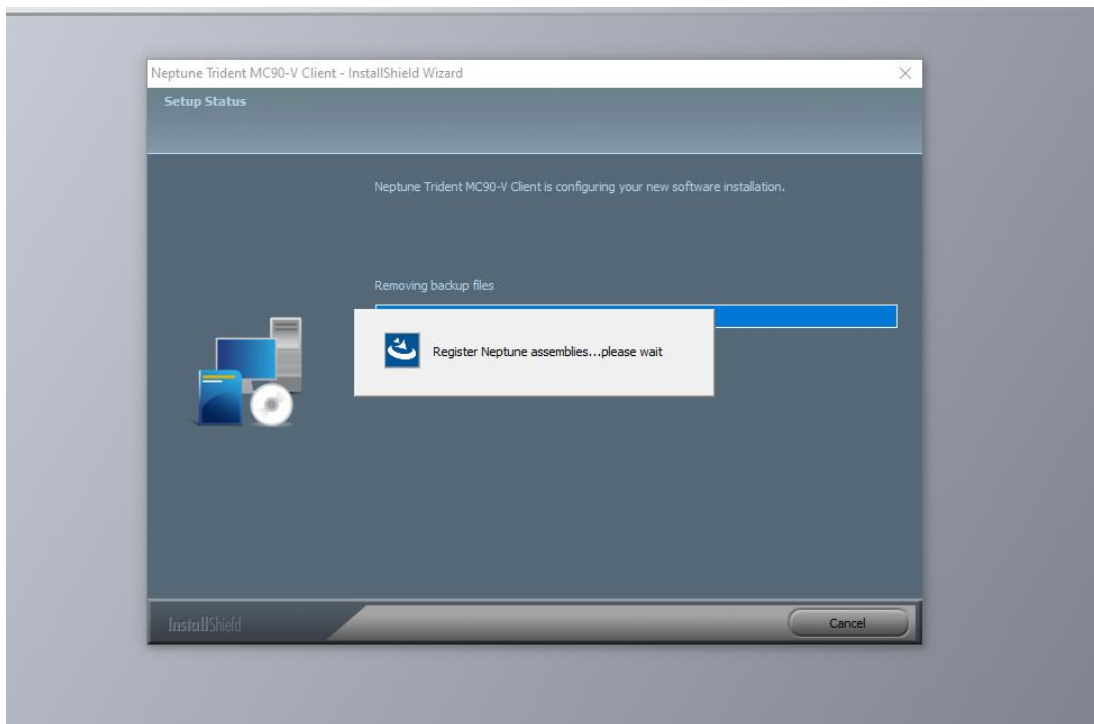
Figure 16: typical software update on KSIM connect launcher

Instructor; - "this issue usually happens when several sections are using "KSIM connect" at the same time and when an update to the software takes place just like what we are experiencing right now but updates like this only take about 5 to 10 mins only to complete after that they can log-in already and start working with their simulation exercises or assessment."

Assessor; - "updates for the launcher for all "KSIM connect" account sometimes becomes the main cause of delay in conducting simulation training for the cadets and I suppose it should be done in advance by the service technicians."

Students; - "Sir we cannot proceed to the simulation exercise because my account asks for a client-server update.

"If our account is not updated yet then we need to update first before proceeding to the simulator training exercise"

"During the simulator exercise, I encounter loss of server connection and lagging in the client-server"

The figure below shows an example of a system crash that resulted in a disconnection from the simulation training.
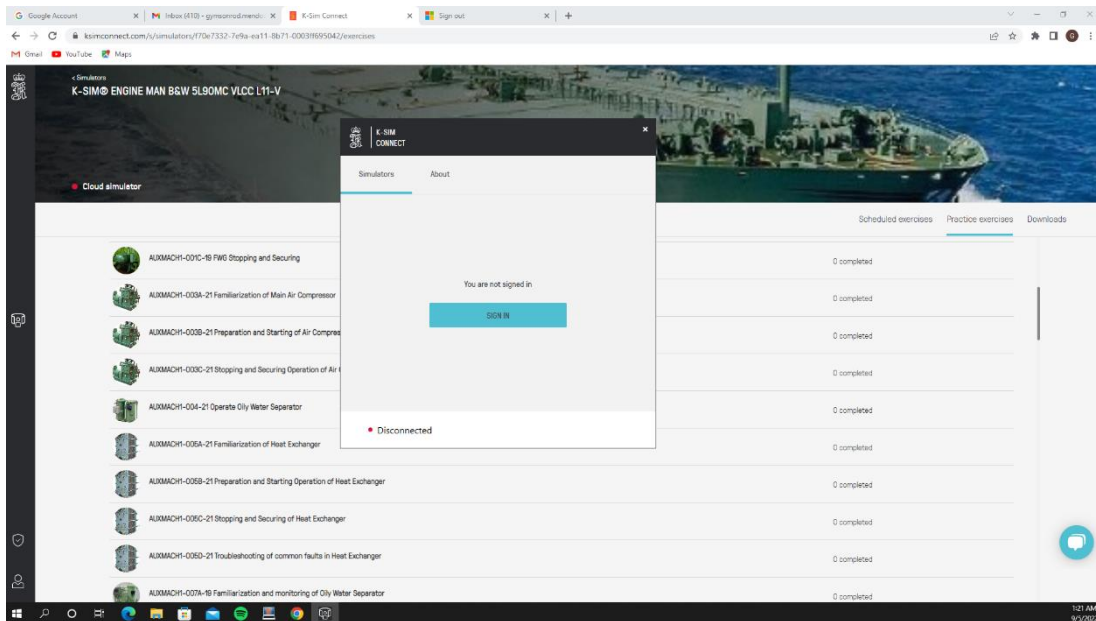
Figure 17: Student disconnected from the remote server

"Conventional simulator is much more preferred than the cloud-based because there is no issue on the connection and the simulation is smooth"

"Slow process when starting the exercise sir, we need to log in to the launcher every time and make sure to log out it after used"

"There was no issue encountered during the exercise everything went smooth"

"No problem was encountered; however, I just find it unnecessary to log in redundantly with the launcher and on the site (shouldn't be enough to log just once?). If I may add, some of our classmates last semester had a problem logging into their

account, and then the MIITD service engineer find out that their account was still logged in on another computer at the other campus. In turn. Their assessment was delayed because of that issue our instructor had to reschedule their assessment"

"I encountered delay when opening the application because the launcher demands an update or the client-server"

"Cloud-based is quite good but not convenient for some reason"

"In my opinion, the conventional server is more convenient to use than the cloud-based server because the conventional server does not require an internet connection"

"Improve server connection to prevent delays of the exercises being conducted"

MIITD service engineer; - "we cannot update this thing in advance because these are individual accounts only the account holder can open it and have the capacity to update their account when they log in."

"Students not logging out of their account from their device. If the student logs in to another device without logging out from his/her previous device it causes it to not connect."

"If a student still can't connect after the update, Student's account should be reported to Kongsberg for checking"

Facilitator; - "We can prepare the computer laboratory for them before their session and make sure that the equipment is running well aside from making sure that the

simulation program on the conventional server was a pilot test and approved but other than that it is beyond our control such as those requirements for their accounts that only they have the access."

5.1.1 - Researcher's Observation;

Due to client-server changes, which can only be accessed by account holders, the simulation training exercise could not begin right away since students were unable to connect to the server and begin the exercise. In addition, connection drops were also observed on some cadets because of the server's remote location and poor internet service.

5.1.2 - The solution to challenge #1

The challenge of connecting to the cloud remote server could be addressed by the registered account holder since they can log in to their "KSIM connect" account anytime and anywhere the service engineer advises the students to allocate time for these updates to take place outside the laboratory instructions preferably during their study call in the evening.

Based on the data shown above the students experience difficulty connecting to the server for variable reasons but more often than not the problems are found by the end-user or the account holder itself just like for instance the issue of not being able to log in or being disconnected after login as what the statement shows below;

Student: "During the simulator exercise, I encounter loss of server connection and lagging in the client-server"

This statement is supported by what the service engineer said during his interview the service engineer said that the student who failed to log out from their last workstation

will not be able to log in on the next workstation and this was the statement by the service engineer;

MIITD service engineer: "Students not logging out of their account from their device. If the student logs in to another device without logging out from his/her previous device it causes it to not connect."

And according to the service engineer they cannot do anything about it because the full control of the account is in the account owner itself and the statement below was mentioned during the interview;

MIITD service engineer: "we cannot update this thing in advance because these are individual accounts only the account holder can open it and have the capacity to update their account when they log in."

This statement was also supported by the facilitator according to the facilitator: "We can prepare the computer laboratory for them before their session and make sure that the equipment is running well aside from making sure that the simulation program on the conventional server was a pilot test and approved but other than that it is beyond our control such as those requirements for their accounts that only they have the access."

This data indicates that account holders are more frequently than not responsible for connectivity disruptions. On the other hand, removing the use of the launcher, which, according to the data, is the primary source of a connection issue with the server or simulation delays, could be of great assistance in addressing the launcher-related issue.

The information above demonstrates that connectivity is as crucial to this generation's learning as any technology or strategy. According to the constructivism theory, students learn more effectively if they are given the technical skills necessary to use

and develop for learning. However, if the connection to the source of knowledge is obstructed in any way the flow of learning is also impeded.

5.2 - Challenge 2 – Monitoring Functionality

The conventional server instructor's station can monitor in real-time each student's activity as they progress through the exercise on the instructor's monitor, while the cloud-based server does not have that monitoring capability, hindering the instructor's access to taking notes of all the possible observable issues during the exercise or assessment. This is a significant feature that the cloud-based server does not have at present. Moreover, opening another tab during the assessment to take undue advantage or cheat cannot be done on a conventional server because the server does not have an internet connection, unlike the "KSIM connect" cloud-based that requires an internet connection to work, but it comes with a risk: the ability to open other tabs while using "KSIM connect" and take advantage of that, especially during assessments.

Instructor; - "We cannot monitor the ongoing simulation exercises or assessments of our students using KSIM connect because it does not have that option and we just rely on the results of the simulation after completion of the training exercises or assessments"

Figure 18 below shows the assessment result after completion of the simulation training on a "KSIM connect" cloud-based server.
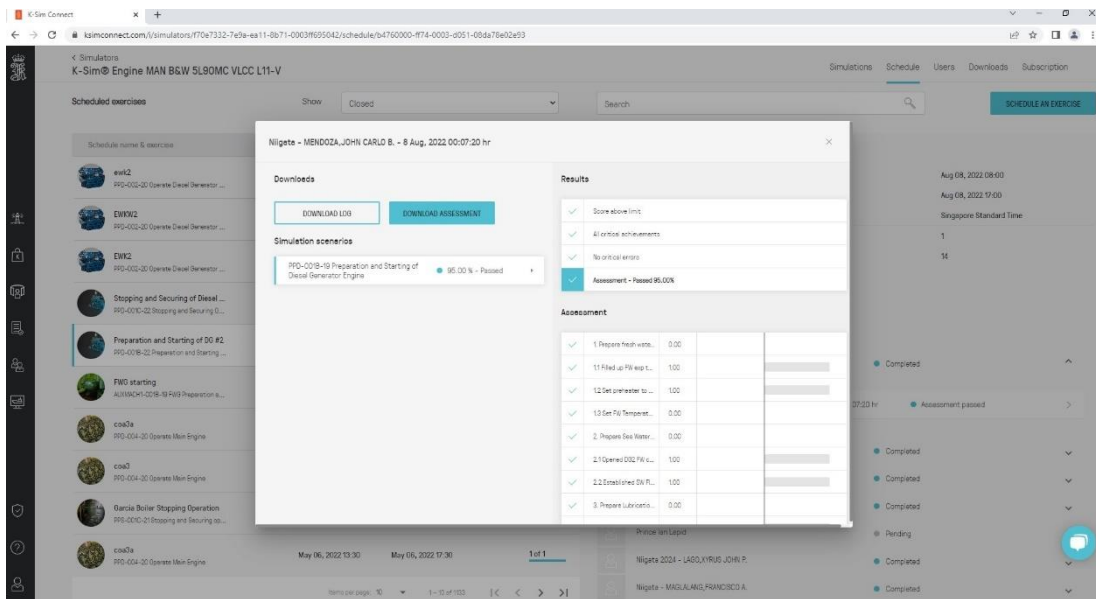
Figure 18: Result of the assessment of a student on a KSIM connect simulator after a simulator training

Figure 19 below depicts what "KSIM connect" looks like for trainers using a simulator for either practice or evaluation purposes. It is unclear what is happening throughout the exercise or evaluation; the instructor can only observe how many students have completed the simulator training and how many are still working.
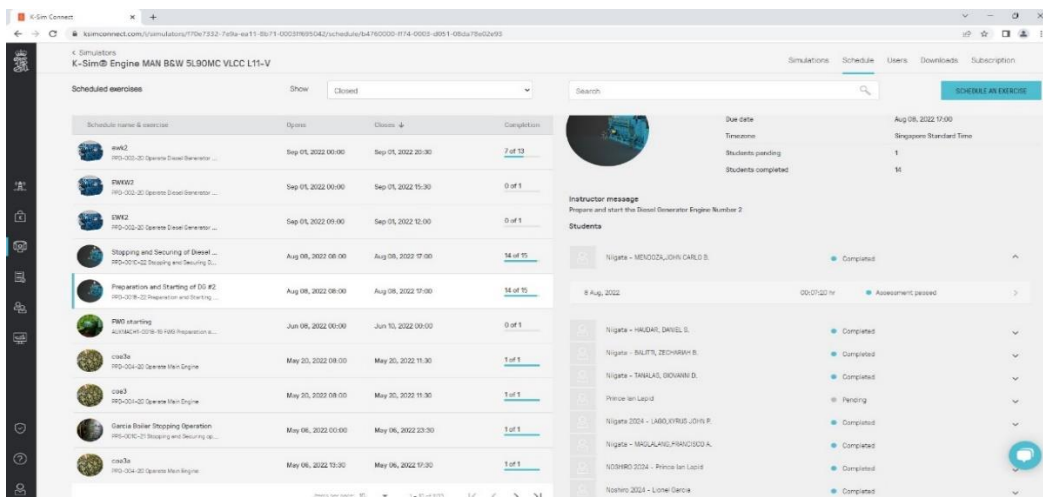
Figure 19: The instructor's station view on a KSIM connect simulator during the simulator training

Assessor; - "programming of the automated assessment of the training exercise can only be done in the conventional server then upload it to cloud but it is limited to displaying the results after completion of the simulator training. During the simulation, no assessment of real-time progress is displayed for the instructor station"

Figure 20 below shows the real-time monitoring of assessment progress or even exercise progress during simulator training on a conventional server.
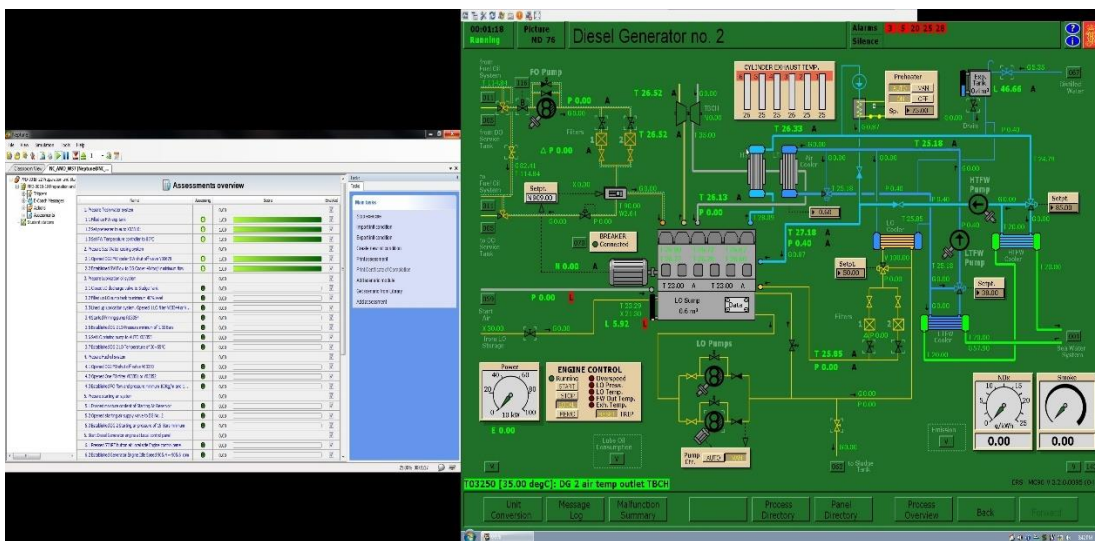
Figure 20: The assessment of real-time progress of a student (left), the right side of the photo shows the actual activity of a selected workstation viewed in the instructors' station on a conventional server

Figure 21 below shows the "KSIM connect" or cloud-based server simulation platform showing that the assessment of the simulation can only view after completion. Furthermore, notice the tabs that were open on the upper part of the photo which means that even during the assessment, they can open other tabs and browse the internet in search of an answer any time they want and without the instructors' knowing.
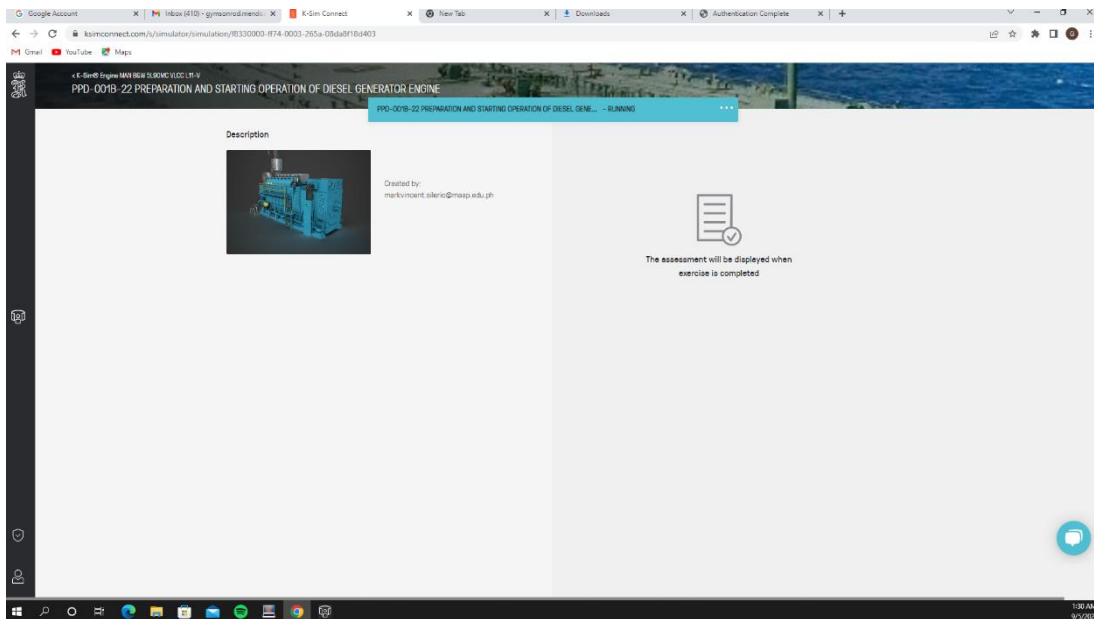
Figure 21: KSIM connect ongoing exercises cannot be monitored and can only be checked after completion

"Assessment results from "KSIM connect" do not give us the full detail of the assessment itself it's just the summary of the whole thing it does not help us evaluate the assessment and the process of printing the results is quite tedious because the instructor had to manually input the names of the students on each result before printing"

Students; - "after completion of the simulation exercise sir, we have to press "F3" to freeze the simulation then advised our facilitator or instructor that we completed the exercise already then, they will confirm that to us before securing our station or wait for further instructions"

"We just do the simulator training exercises or assessments after our instructor gave us the briefing on what to do and what we are expected to achieve during the exercise sir then during the debriefing the instructor ask us what happen during the simulation and helps us understand clearly what happens and what should be our course of action in such cases"

"Make the simulator automatically exit when done with the exercise then lets you show the overall statistics of the progress or result. Also, let the system show what are the specific mistakes done during the exercise"

"I'd also recommend a virtual reality exercise just like what we do on our integrated simulator training program making it a lot understandable and know how to perform it on board ship"

"Cloud-based server to be used for exercises but not for assessments"

MIITD service engineer; - "KSIM was introduced during the pandemic in our view it is a new technological advancement that still needs a lot of research and development and on our side, as a client, we are just waiting for their software updates and hopefully, next update will include this monitoring issue"

Facilitator; - "We do not have the option to monitor the activities of the students during the simulation exercise. KSIM does not have that feature yet, the instructor has to walk around to observe and take note of whatever transpired during the simulation and discuss it during the debriefing"

5.2.1 - Researcher's Observation;

The simulator is merely a tool to help the learning process be as realistic as possible in addressing the competence each student needs to acquire. It will also help the instructor's job be more manageable in delivering the lessons he or she needs to deliver, but the instructor's knowledge of how to use the simulator and his onboard experience will still greatly contribute to ensuring the achievement of the learning outcomes. The student's whole learning experience is hampered by their inability to have their activity during simulation exercises monitored in real time and have all those observed issues

addressed during the debriefing. "KSIM connect" could be used for simulator training exercises but not for assessments for the reason that the application is not that secure, unlike the conventional server that does not need to connect to the internet making it secure and tamper-proof.

5.2.2 - The solution to challenge #2

The challenge of monitoring the student activities during simulator training and the assessment progress could be possibly addressed by the host institution by installing a recording app that is available online and that can be installed on the desktop computers that will be used for simulator training exercises using cloud-based storage to monitor the performance of the students while they are using the simulator. This will allow the instructors to record the simulation that the students complete and then make it available for the instructor to evaluate at a later time. Even though it does not provide real-time monitoring as a conventional server does, at least it provides a recording that the instructor may go back and watch after the simulation has been completed.

Figure 18 depicts the outcome of a student's evaluation on a KSIM connect simulator following simulator training. The aforementioned assessment result in the KSIM connect simulator is only available upon completion of the simulation training, which means the instructor cannot observe real-time progress during the simulation training. Figure 19 depicts the instructor's station view during the simulation training, which is extremely limiting for an instructor who wishes to observe and record the observed issues of the students. Figure 20 depicts the assessment real-time progress of a student (left) and the actual activity of a selected workstation viewed from the instructor's station on a conventional server (right), allowing the instructor to observe the real-time progress of the student assessment and take note of the observed issues that will be addressed during the debriefing, thereby creating a full-simulator learning experience.

This is supported by the data coming from the students and the statement below serves as an example of their comment;

Students; - "after completion of the simulation exercise sir, we have to press "F3" to freeze the simulation then advised our facilitator or instructor that we completed the exercise already then, they will confirm that to us before securing our station or wait for further instructions"

Second the motion by the instructor's or facilitator's statement below;

Facilitator; - "We do not have the option to monitor the activities of the students during the simulation exercise. KSIM does not have that feature yet, the instructor has to walk around to observe and take note of whatever transpired during the simulation and discuss it during the debriefing.

The monitoring of the activities that are carried out by the students provides the instructors with the points to discuss during the debriefing that comes after the simulated training exercise. The debriefing is the most important part of the learning process that occurs during a simulation training activity. According to Lera (2010), the significance of keeping an eye on students' and groups' performance is that these reports can be used by instructors to categorize groups of students and individuals based on their activities and learning objectives, follow their development, and pinpoint students who may require immediate support. This functionality is provided by conventional servers, which are used widely in simulator training. As a result, cloud-based simulators are inferior, creating an opportunity for their creators to further develop cloud-based server capability in simulator training.

5.3 - Challenge 3 – Software Compatibility

After completion of the simulator training assessment on "KSIM connect" the facilitator had to save the file to a flash drive and bring it to the instructor's station of a conventional server simulator to have the results printed. The underlying reason why they have to go through that long process is that the files can only be open to the same software and are not compatible with any other application like Microsoft office.

Instructor; - "I have to ask the facilitator to have the results of the assessment saved to a flash drive and then have it printed from their full-mission simulator downstairs because we cannot print it using Microsoft office software"

See what an assessment looks like on the "KSIM connect" cloud server in figure 22 below. The facilitator addresses the issue temporarily by typing each student's name just above the label "container administration" before printing or saving the evaluation so that it can be used as evidence.

Assessment Result

Student: ContainerAdministrator
Computer: SIMPOD-E00A0000
Simulator:
Exercise: Exercise
Scenario: PPD-001B-19 Preparation and Starting of Diesel Generator Engine
Date: 08/08/2022
Time: 03:08
Duration: 00:05:21

Score from 0.0 to 20.0, Pass limit: 14.0, Total score: 19

Assessment name	Critical Achievement	Score
1. Prepare fresh water system		0
1.1 Filled up FW exp tank		1
1.2 Set preheater to auto X03310:		1
1.3 Set FW Temperature controller to 85°C		0
2. Prepare Sea Water cooling system		0
2.1 Opened DG2 FW cooler SW shut off valve V00678		1
2.2 Established SW Flow to DG Cooler 40 ton/Hr minimum flow		1
3. Prepare Lubrication oil system		0
3.1 Closed LO discharge valve to Sludge Tank		1
3.2 Filled up LO sump tank to minimum 40% level		1

Figure 22: KSIM connect assessment result just before editing the label

Figure 23 below shows the sample of an assessment result that label has been changed to name it after the trainee who undergone the simulator training.
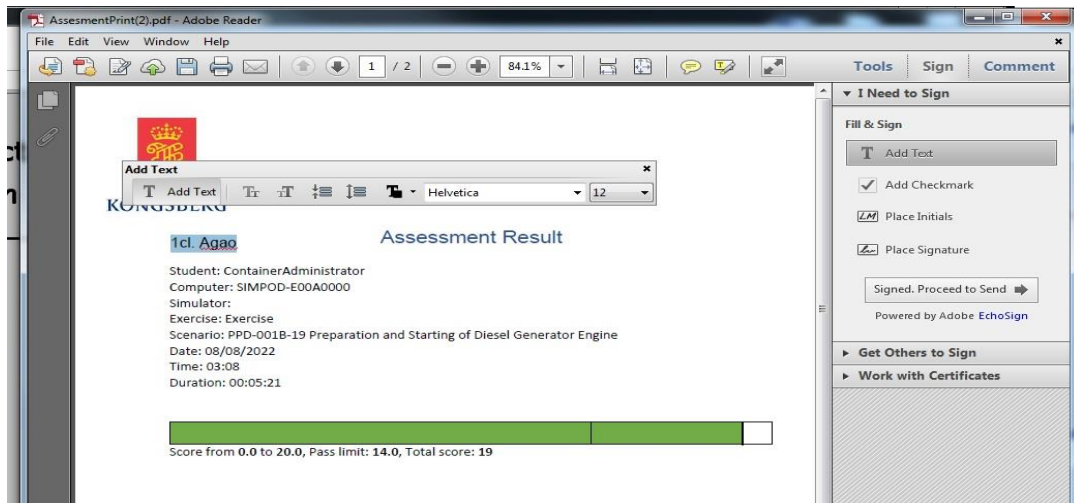
Figure 23: KSIM connect after editing the name of the assessment result

Figure 24 below shows an example of an assessment result from a simulator training done on a conventional server.
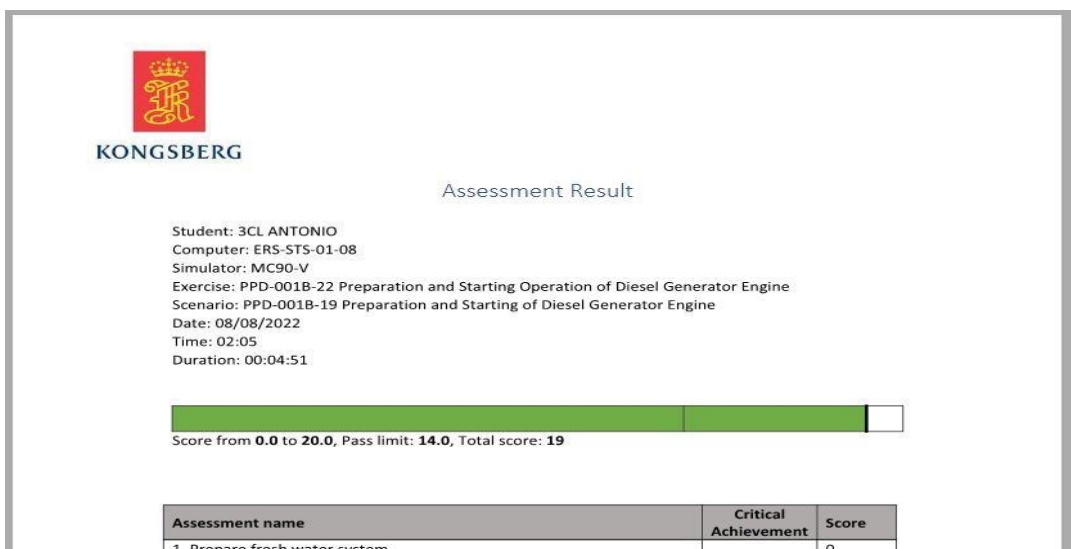
Figure 24: Conventional server automatically shows the "student name" of the assessment result and it is ready for printing or saving for documentation purposes

Students; - "we ask our instructor if there is a possibility to use our gadget like apple iPad or android tablet in logging in to our KSIM account and perform our

familiarization during our open time or free time and they told us that the app can only run on a windows 10"

"I see cloud-based server solution helpful in cases wherein midshipmen would use their laptops when they are away from the academy grounds and would want to run simulation exercises to practice or familiarise. however, when inside the academy the conventional server has been proven effective in terms of smooth operation and reliability. Moreover, for the cloud-based server it could have been better if aside from laptops that run windows 10 and above, I suppose it would be a great update if the simulation can also run using our android tablets and smartphones"

MIITD service engineer; "We ask the maker regarding this particular issue and if they could include it on their updates but their response is quite vague they are not sure about it"

Facilitator; "When an instructor uses KSIM we expect that after the simulator training exercise or assessment they will ask for a copy of the assessment result that we have printed from the conventional server manually inputting the names of each student"

5.3.1 - Researcher's Observation;

Printing the assessment result could have been better if the end-user can just conveniently print it right away without doing the long process of having it saved on a flash drive then opening it on a conventional server and manually inputting the name of each student before printing the assessment results.

Imagine the potential gains if the compatibility concerns with other devices are resolved; KSIM was developed to facilitate students' easy access to simulator activities. Currently, KSIM is only compatible with the newest version of Windows on a laptop and not with Android or iOS.

5.3.2 - The solution to challenge #3

Figure 22 depicts the KSIM connect evaluation result without the trainee's official label or name. Figure 24 depicts the "student name" of a typical server's assessment result, which is available for printing or saving for documentation purposes. This may seem like a minor issue, but for an instructor with five sections to manage and each section having a total of 20 students, this may be a significant problem, and this inconvenience may take its toll on the instructor. This is supported by the statement of the facilitator during the interview;

Facilitator; "When an instructor uses KSIM connect we expect that after the simulator training exercise or assessment they will ask for a copy of the assessment result that we have printed from the conventional server manually inputting the names of each student"

Second the motion by student's statement;

Students; - "we ask our instructor if there is a possibility to use our gadget like apple iPad or android tablet in logging in to our KSIM account and perform our familiarization during our open time or free time and they told us that the app can only run on a windows 10"

The data reveals a compatibility issue that is beyond the control of the end-users and causes problems for them. Currently, the only option is to wait for the platform's developer to improve it and, hopefully, resolve this issue. This is supported by the statement of the MIITD service engineer;

MIITD service engineer; "We ask the maker regarding this particular issue and if they could include it on their updates but their response is quite vague they are not sure about it"

While the creator continues to work on the program, end users can utilize a flash drive to move files from the cloud server to a conventional server and stick with the time-consuming approach of manually encoding the names of each student to their evaluation result.

5.4 - Challenge 4 – Common error made by the students during the simulator training exercise experiment

For the first exercise (Run1), direct inspection of the student scores indicates that most of the students failed assessment no. 1.3 – set FW temperature controller to 86°C. For the second exercise, some students made errors on assessment nos. 1.3 – Cooled down engine, 1.4 – Stopped engine, and 2.1 – Closed starting air valve.

Figure 25 below shows the common errors mentioned made by the students on instructors' station view.
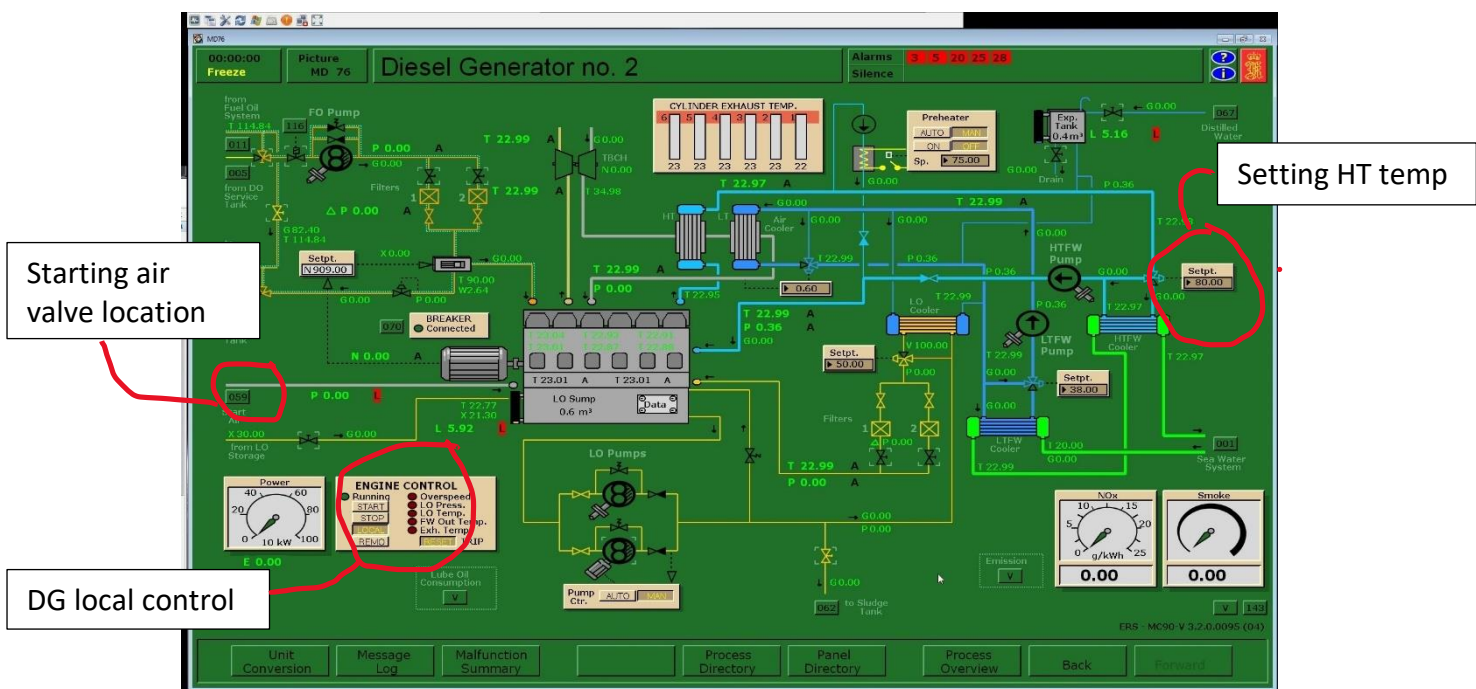
Figure 25: Instructors' station real-time monitoring view

5.4.1 – Researcher's Observations;

The collected data reveals that simulator training exercises require a comprehensive understanding of the procedures that must be executed in compliance with the STCW's competency criteria. To effectively integrate the technique while remembering its fundamentals takes extensive practice, and a simulator was built for this purpose. This is supported by Sardaruwan (2010), according to him, simulators have the benefits of being cost-effective, repeatable, and secure.

5.4.2 - The solution to challenge #4

The debriefing was used to discuss the problem and brainstorm potential solutions. To become more comfortable with the system and, ideally, perform better during the assessment, the facilitator recommended devoting more time to the simulator training exercise. The conventional server gives the instructor the capability of observing things in real-time and the opportunity to take note of all the observable issues encountered by the student during the simulator training exercise which will be addressed and discussed during the debriefing which is a crucial thing when it comes to simulator training. On the other hand, the cloud-based server lacks that special feature that the conventional server has that makes the cloud-based somewhat inferior to the capability of reaching a higher level or learning experience that the student should be able to reach on a simulator-based training.

5.5 - Chapter Summary

The researcher was able to undertake a successful inquiry to augment the conducted experiment and address the issues given by the usage of a cloud-based simulator for maritime education and training. Based on the collected data, cutting-edge cloud-based simulation is undoubtedly a step ahead in maritime education, although the technology is still in development.

Chapter 6 – Discussion and Conclusion

In this chapter, the researcher ensures that the research questions posed in the introduction have been properly addressed before presenting the study's conclusion, limits, and key findings. The scientific contribution and recommendations of this study are elaborate.

6.1 - Discussion

6.1.1 - Research question #1: Is there a significant difference in the performance of the students during the simulation runs?

A result obtained by the researcher indicated a slightly significant difference. This conclusion was decided by the performance of the student after completing problem sets on both platforms. Traditional server simulators and cloud-based server simulators produce identical results for students. The results of the investigation are restricted to the simulation training activities and evaluations conducted as part of the Power Plant Diesel course. However, the technique for programming the simulator exercise applicable to both types of servers and the operation of the system during the delivery of the simulator exercise are comparable to all other competency-based simulator training in marine engineering programs. Moreover, cloud-based servers and conventional servers can be deployed interchangeably depending on the situation. This is backed up by Hjellik and Mallam (2021b). According to Hjellik and Mallam, maritime cloud-based simulation is a novel technology innovation that offers a decentralized engagement environment with the same content and capabilities as traditional on-site simulator software. This study concludes that cloud-based simulators can be utilized for competency-based training activities, but not for assessment owing to a lack of security. Additional development is also required to provide students with a comprehensive simulator training experience. In addition, simulation training exercises or assessments are produced through the collaboration and cooperation of a group of experts to ensure the simulation is as near as possible to a real-life scenario, hence making the simulator training effective. As a result, simulator training is about more than simply the equipment; it's a process that is

constantly evolving to meet the demand for qualified seafarers. However, the results were biased towards a particular marine engineering course simulator instruction. Depending on the subject chosen in other maritime courses, such as marine transportation, the outcome may vary.

6.1.2 - Research Question #2: How was the connectivity on both simulator server types during the exercise?

This data indicates that account holders are more frequently than not liable for connectivity loss. On the other hand, uninstalling the launcher, which, according to the data, is the primary source of server connection issues and simulation delays, could be of great assistance in resolving the launcher-related issue if that would be feasible.

The previous information demonstrates that connectedness is equally crucial to the education of this generation as any technology or approach. According to the constructivist theory of Glynn and Duit (2012), children will learn more effectively if they are given the technical skills they need to use and develop for learning. Nonetheless, if the connection to the knowledge source is broken in any way, the flow of learning is also inhibited. Consequently, based on the collected data, the researcher may recommend that students receive a separate briefing on the core operation and technical features of KSIM connect to ensure seamless operation throughout simulation training exercises and assessments. In addition, the manufacturer may be able to modify the system such that a launcher is no longer required to activate it. Infrastructure is just as important as simulator facilities and technical knowledge for completing the simulation process for aspiring seafarers, according to the results of the study. However, the online platform used in this research was KSIM connect of Kongsberg the result may vary in some other platforms of the cloud-based simulator. Moreover, In places with inadequate internet connectivity, such as third-world countries and rural areas, this is by far the biggest issue. In addition, the fact that all users utilize the same server makes it more susceptible to attacks and diminishes its performance, which is a significant disadvantage of the public cloud.

6.1.3 - Research question #3: How was the monitoring functionality on both simulator server types?

The data indicates that the monitoring functionality is only available on the traditional simulator and not yet on the cloud-based simulator, which hinders the students' simulation-based educational experience. The significance of monitoring the performance of students and groups, according to Lera (2010), is that instructors can use these reports to categorize students and groups based on their activities and learning objectives, track their development, and identify students who may require immediate attention. Consequently, based on the collected data, cloud-based simulators can be utilized for competency-based training activities, but they require significant enhancements to provide students with a comprehensive simulator training experience. This will significantly contribute to the implementation of competency-based evaluation in marine engineering courses. The interaction during the debriefing creates an environment conducive to an open forum, which contributes significantly to the learning process during simulator training exercises; consequently, the need for monitoring functionality is justifiable for noting observable problems during simulator training. As a solution to the problem of monitoring the functionality of the cloud-based server, the hosting institution accepts the use of application software that records the student's actions while using the simulator as soon as the student registers.

6.1.4 - Research question #4: How about software compatibility for assessment result accessibility?

The data reveals a compatibility issue that is beyond the control of end users and causes them difficulty. Currently, the only option available to end customers is to wait for the platform's creator to improve it and, hopefully, resolve this issue. According to the MIITD service engineer, they have already asked the manufacturer about this issue, but the manufacturer has not yet provided a clear response. With all hopes high, the next software update will address this issue. To solve this issue the facilitator in charge

will be taking care of the printing of the assessment results from the KSIM connect simulator while waiting for the upgrade.

6.1.5 - Research Question #5: Have errors been observed during simulation training?

A direct examination of the student scores for the first exercise (Run1) reveals that the majority of students failed evaluation no. 1.3 – set FW temperature controller to 86°C. During the second activity, some students made mistakes with their assessment numbers. 1.3 - Engine cooled down, 1.4 - Engine stopped, and 2.1 - Starting air valve closed.

The objective of the debriefing was to discuss the issue and offer workable solutions. The facilitator suggested devoting more time to the simulator training exercise to familiarize oneself with the technology and, ideally, do better on the assessment. The conventional server enables the instructor to view events in real-time and record all observable issues raised by the student during the simulator training exercise. These concerns will be addressed and discussed during the debriefing, which is an essential component of simulator training. On the other hand, the cloud-based server lacks a certain feature that the traditional server possesses, which makes the cloud-based server somewhat inferior in terms of the student's ability to achieve a higher level of learning experience during simulator-based training. According to Chybowski et al. (2015c), engine room simulations effectively prepare marine officer engineers for potentially hazardous circumstances that may arise during actual marine diesel operations. In this situation, the utilization of a simulator is justifiable. The researcher has determined, based on the results of the experiment and the information acquired during the debriefing, that additional training activities are necessary to ensure that students are adequately prepared for subsequent simulator training assessments. Thus, ensuring the competence of our future maritime personnel.

6.2 - Conclusion

This research study conducted a comparative examination of engineering students' training exercises using cloud-based simulators and conventional servers. The study set out to determine if the intended learning outcomes were accomplished through the use of the cloud-based server, and to further investigate the challenges and issues encountered during the simulation exercises, while taking the opinions of the stakeholders into account (student, instructor, facilitator, assessor, and the service engineer). The primary objective was to establish whether a cloud-based simulator can meet the requirements for competency-based assessment in marine engineering, and then find a solution to the challenges and issues encountered throughout the simulation.

Based on the data gathered during the experiment it is found that the capabilities of students on traditional server simulators and cloud-based server simulators are comparable. As a direct consequence of this, it is feasible to utilize either conventional servers or those that are hosted in the cloud. Both servers are capable of handling the demand that comes with conducting simulator training activities for assessment and training alike.

The researcher ran a quasi-experiment. In two runs on two different simulator exercises, the two groups were exposed to both traditional and cloud-based servers, and their results were compared. If the result is the same in both simulations, it is accurate since it eliminates the possibility of pupils merely remembering the technique rather than putting their knowledge to genuine simulator practice.

Moreover, the semi-structured interviews and focus group debriefing with the stakeholders showed that cloud-based computing is quite effective for the purpose for which it was designed. There is a significant amount of room for improvement as observed by the end users, which the maker needs to address. The difficulties and problems that were seen during the simulator training were noted and discussed during the debriefing as well as the individual interviews. Challenges like monitoring

functionality, connectivity, software compatibility, and errors observed during the simulator exercise. Even though some of the problems can be solved temporarily by the end users, it would preferable if the maker could resolve those problems permanently with their next software update.

This shows that cloud-based simulation is indeed state-of-the-art technology but still under development and a regulatory framework should also be established to have a minimum requirement for simulator capacity for competency-based assessments.

6.3 - Key takeaways

During the evaluation of the simulator training, the researcher made the observation that both cloud-based and conventional servers are state-of-the-art technology that enhances the delivery of education and training for the seafarers, these are still just tools. The expertise of the instructor, facilitator, assessor, and the simulator service engineer and their teamwork on the simulator system operation, onboard ship experience application, and teaching methodology preparation is what makes the difference.

Socio-technical system

The research shows that when simulators are used in training and education, people collaborate and work together and become a network of sources of knowledge to give students the best possible simulation experience. Learning environments where technology plays a significant role feature sociotechnical interactions. Each person has a unique sociotechnical network, consisting of both other people and technological tools.

The term "sociotechnical" describes the interplay between an organization's social and technological structures. In essence, the sociotechnical theory rests on two pillars: the

idea that the interplay between human factors and technological factors determines the contexts in which organizations thrive or flounder.

Improving either the social or technological aspects separately tends to increase not only the number of unpredictable, "undesigned," and performance-detrimental linkages but also the number of people who are affected by them.

Figure 26 below illustrates the outcome of the empirical research conducted by the researcher that shows how simulation training development's connections to numerous factors affect the weight of a student's or aspiring seafarer's complete learning experience.
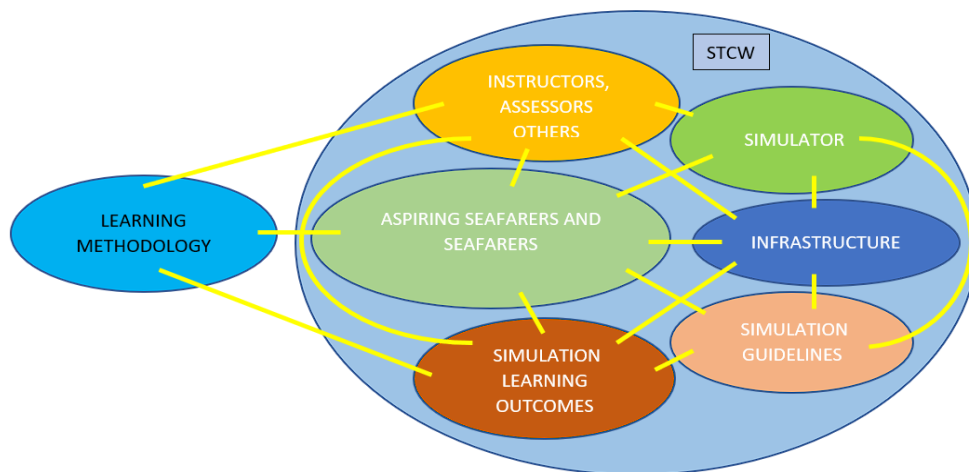
Figure 26: Socio-fish model

Figure 26 above shows the socio-fish model depicting how each aspect influences the quality of simulation training that is developed for both aspiring seafarers and seafarers.

The STCW addresses the majority of aspects for the development of simulation training exercises or assessments, such as the qualifications of the instructors, the type of simulators, the infrastructures, the guidelines for the use of simulators, and the

alignment of learning outcomes with the STCW's competence table. On the other hand, the teacher or facilitator is free to select whether or not to apply a particular learning approach during simulation training activities; the STCW does not specify which method an instructor or facilitator must employ giving them control over the whole simulation training in which the socio-fish model clearly shows that learning methodology is the "rudder" of the whole simulation training process that dictates the direction of the learning process of the student while actively participating. In line with the result of the experiment done by the researcher, it is evident that the performance of students utilizing traditional server simulators and cloud-based server simulators is not significantly different. Consequently, conventional servers and cloud-based servers can be utilized interchangeably depending on the type of simulation. Hence, supporting the socio-fish model that a simulator is just a tool and a part of a learning process and should be treated that way always. This is supported by Stern et.al., (2014), stating that instead of passively collecting information, the notion is that students should actively develop their knowledge. People develop mental representations of the world as they experience and reflect upon it, enhancing and expanding their existing understanding in the process. In cognitivism, Learning is viewed as an input-management process with an integrated mechanism for memory storage. Clark (2018) defines a schema as a unit of knowledge, cognition, and skill. Hence, Simulators are novel technology innovation for maritime education and training and a vital component of simulation training process that should be utilized with guidance.

6.4 - Limitation of the study

Simulator training requirements for the Marine Engineering Power Plant Diesel course were examined in this study using both types of Kongsberg simulator servers; however, it is reasonable to assume that the findings of this study could apply to all of the courses in the Marine Engineering program that require competency-based evaluations that can be performed using the Kongsberg marine engine simulator. Because simulation exercises or assessment programming for both types of servers

follow the same procedure and operation. However, pilot testing is still needed to prove the reliability of the system for other exercises or assessments. This assumption is based on the fact that the simulator training requirements for the Marine Engineering PPD course were the only ones that were examined in this study using both types of Kongsberg simulator servers and were fully accomplished.

6.5 - Recommendation

The study's author recommends replicating the same study with Bachelor of Science in Marine Transportation programs, in addition to looking into the relationship between technological progress and students' capacities to learn well in an ever-evolving environment.

6.6 - Research contribution

The study's findings indicate that, although cloud-based and conventional servers can be used interchangeably and cloud-based is an engineering state-of-the-art technology service that is available for simulator training, the inability to monitor the student's activity in real-time during simulator exercises or monitor the student's progress during assessment demonstrates that the technology can address the course outcomes set for the simulation exercises but still need further development.

This is for METI, which is currently researching whether or not to purchase a simulator. Based on the findings of the research conducted to effectively utilize the capacity of a Kongsberg simulator. It is advised to purchase the simulator that uses a conventional server, though if the maker has already fully developed one, an institution might also take into consideration purchasing a cloud-based simulator should the need arise.

For the simulator maker, the research revealed the cloud-based server's weakness, which is a fantastic opportunity to further develop it and possibly surpass the capability

of a conventional server, making it more appealing in the market because it is efficient and effective.

For the IMO, Despite the option to use simulators for competency-based assessment, the research revealed that clear regulations or minimum requirements that a simulator should be able to meet in order to be certified for use in competency-based assessment for Maritime education and training have not yet been clearly established. Giving the end users a less-than-clear direction in ensuring high-quality education and training to produce well-rounded, highly competent seafarers. Therefore, the researcher humbly recommends that a regulatory framework should be established specifically for the use of simulators in maritime education and training.

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Appendices

Appendix A: Interview Instrument

The topic of the Dissertation is a comparative analysis of cloud-based servers with conventional server simulators for marine engineering

The information provided by you in this interview will be used for research purposes and the results will form part of a dissertation, which will be published online and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted.

Anonymized research data will be archived on a secure virtual drive linked to a World Maritime University email address. All the data will be deleted as soon as the degree is awarded.

Your participation in the interview is highly appreciated.

Student's name	JOSE MARIA RAZON NALUS
Specialization	MARITIME EDUCATION AND TRAINING
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* * *

I consent to my personal data, as outlined above, is used for this study. I understand that all personal data relating to participants is

held and processed in the strictest confidence, and will be deleted at the end of the researcher's enrolment.

Name: …………………………………………………………………

Signature: …………………………………………………………………

Date: …………………………………………………………………