JOURNAL OF MARITIME RESEARCH

Vol XIX. No. III (2022) pp 68–76

ISSN: 1697-4040, www.jmr.unican.es

Implementing Digitalization and Authentication of Seafarer's Identification and Certification in the Sultanate of Oman

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ARTICLE INFO

Article history:
Received 7 Nov 2022;
in revised from 7 Nov 2022;
accepted 11 Nov 2022.

Keywords:
Seafarers, Certificates, Digitalization, Administration, Maritime sustainability.

ABSTRACT

When seafarers join a ship, they must carry a bunch of certificates comprising competency certificates, short course certificates, and endorsements. The onus is on the ship's captain to check the certificates' authenticity. Various industries incorporated digitalization systems into their daily activities. However, the maritime field has not taken advantage of digitalization yet. For this research, a questionnaire with thirteen questions about the advantages and disadvantages of certification digitalization was prepared and distributed to professionals in maritime and port operations. Sixty-four professionals from the maritime industry answered. In this study, the authors propose innovation to digitalize the certificates and make them available for identification either to the Master of the ship, the shipping companies, or the port state controls of any other country worldwide. This study aims to create a reliable and approved system that certificates issued by the training centers, colleges, and private institutes would cease to be on paper.

1. Introduction.

1.1. Seafarers? certificates.

A seafarer means any person who is employed or is engaged or works in a capacity on board a vessel, except warships, who are involved in maritime navigation (ILO, 2016).

The Standards of Training, Certification, and Watchkeeping for seafarers (STCW) Code, first introduced in 1978 with subsequent amendments in 1995 and 2010, maps out the guidelines for the certification of seafarers. Seafarers must be appropriately certified for every rank they will serve onboard. Their certificate states the capacity to act based on their qualification, the areas they may sail, and the vessel's gross tonnage or propulsion limitations of the ships they are competent to operate (Library, 2020).

A mariner joining a vessel is always carrying many certificates and documents.

As stated in STCW 2010 convention, regulation I/2 section 2, the administration shall only issue the certificates to masters and officers (IMO, 2011).

According to Regulation I/4 (IMO, 2011), a duly authorized control officer shall verify and make sure that all seafarers serving on board, who must be certified according to the convention, hold an appropriate certificate or certificates.

These certificates are proof of a seafarer's qualification and past training. When joining, these certificates are to be handed over to the captain and ready for the authorities' inspection.

The following are some of the certificates that mariners shall always carry but are not limited to:

- Certificate of Competency (COC)
- Basic safety training
- Crisis management and human behavior
- Medical fitness certificate
- Radio Detection and Ranging (RADAR) at operational level

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- RADAR at management level
- Electronic Chart Display and Information System (ECDIS)
- Advanced firefighting training
- Yellow fever
- Survival craft and rescue boat
- Tanker familiarization course
- Advanced tanker course
- Crowd management course
- Global Maritime Distress and Safety System (GMDSS)
- Passenger Safety
- Cargo Safety and Hull Integrity
- Proficiency in Fast Rescue Boats
- Proficiency in Survival Craft and Rescue Boats, other than Fast Rescue Boats
- Bridge Resource Management (BRM),
- Engine Resource Management (ERM)
- Medical Care course
- Designated Security Duties (DSD)
- Medical First Aid
- High Voltage
- Basic training for liquified gas tanker
- Advanced training for liquified gas tanker cargo operations
- Ship Security Officer (SSO)
- Security Awareness
- Rating forming part of a navigational watch
- Rating as Able Seafarer Deck.

Failure of seafarers to hold a certificate or have an appropriate certificate may pose a danger to persons, property, or the environment (IMO, 2011).

As a result, A merchant officer requires a small suitcase to carry all the above certificates. They may leave them at home after fleeing to the port or leave them onboard after signing off from a vessel.

A seafarer travel frequently. Therefore, losing their documents on the way to embark on a vessel can be an absolute nightmare and have a natural knock-on effect not only for them but also for the ship and the rest of her crew (Jones, 2021).

When joining a vessel, the seafarers shall leave many certificates and documents in the custody of the Captain. All these documents, such as the yellow fever vaccination certificate, STCW certificates, etc., must be checked for and taken back by mariners before signing off from a ship (Marineinsight, 2021).

There are cases where seafarers lose their certificates during the emergencies such as fire or sinking. Most shipping companies' emergency preparedness plans (EPP) checklists mention the following responsibility while abandoning ship:

- Collect ship certificates, documents, and logbooks.

To get the certificates, the seafarer shall apply on the country's website to get a new certificate, which requires time and expense. When any Omani seafarer loses their certificate, in that case, they must fill out a form (Application for Replacement of Lost, Stolen, Damaged or Destroyed Certificate, Endorsement or Seafarer's Passport) which is three pages. (Photo No.1/ Appendix)

With the digitalization of the maritime industry, the authors believe that digital certificates can replace paper certificates and documents, undoubtedly reducing costs.

1.2. Cross Track Error (XTE or off course).

There is a professional word in the navigation. It indicates the distance that vessel is off the system to port or starboard. It is the environmental factor that usually causes drifts. Those in the maritime industry will understand how important it is to be aware of XTE, as it is at the core of corrective action. Technological developments, particularly the new digital technologies and 'Industry 4.0', also known as the fourth industrial revolution, rapidly reshaped the maritime industry (Singh et al., 2022).

Seafarers shall always make sure that a ship is following its intended course. If there is any error, it shall be taken care of by adjusting a set for it. The administration or maritime college can quickly correct the practice of issuing the certificates by adopting digitalization into the certification of mariners.

The use of digitalization enables the involved parties to stay up-to-date and agree on corrective and mitigating actions (Lind and Lehmacher, 2021).

Digitalizing the maritime industry also requires innovative solutions to ensure the maritime sector is sustainable in conducting its operations (Newsroom, 2021a).

The digitalization of the maritime industry supports the global economy as it is the backbone of the worldwide economy (Newsroom, 2021b).

As stated by (Fiorini and Gupta, 2021), the advantages of the digitalization are:

- Increasing transparency
- Reducing the operational expenses
- Increasing the accuracy of the reports
- Reduce working hours
- Increases the confidentiality
- Protecting the environment by stopping the printing of the certificates.

2. Literature Review.

2.1. Spotting a fake.

Untrained and incompetent officers put the lives of fellow crew members at risk and pose a severe safety risk to their subordinates, who rely upon them to determine safe working practices and undertake a realistic risk assessment.

When seafarers take up the new job position, apply to enter examination or enter the books of crewing agency or present a certificate for endorsement. The certifications demonstrate the proof of their qualification in their custody. A competency certificate defines the qualification level under STCW 2010 and outlines any additional skills or restrictions. A medical certificate underlines their fitness to work on board. During the whole career of the seafarer, he collects plenty of certificates attesting to genuine qualifications and experience.

Regulation five of the STCW 2010 (Verification of certificates of competency and endorsements) requires the administrations to take the following steps (IMO, 2011):

1. To establish electronic databases to verify the authenticity and validity of COCs and endorsements.
2. To respond promptly to requests from other administrations for verification, truth, and authenticity of COCs.

After the Manila conference in 2010, STCW introduced improved measures to prevent fraudulent practices associated with certificates of competency and strengthen the evaluation process.

Although appropriate measures are in force to avoid fake certificates, the digitalization of the certificates improves them more. Even if someone issues a fraudulent certificate, they cannot upload it to the appropriate folder where the administration created it.

According to (DNV, 2021), the road toward digitalization and automation is boosting the maritime industry. Digital technologies and solutions are increasing competitiveness and enhancing operational efficiency. However, ensuring optimum vessel performance, sustainable operation, and providing remote support, the shipping requires the availability of the following services:

- IT and system integration,
- Robust and fast satellite communication,
- Automation, remote monitoring, and control,
- Data management and cyber security,
- Increased network and connectivity,
- Data collection, sharing, and -analysis,
- Data standardization (protocol).

Digitalization enables mariners, fleet personnel departments, and administrations to stay up-to-date and take corrective actions when required.

Digitization is the gateway to faster data retrieval, reduced errors, and less overhead costs. In that way, digital documents are the backbone of a successful organization and an opportunity to ensure the confidentiality of countless office records (Kane, 2021).

Presently most of the certificates issued by training centers or the colleges in Oman are in the form in the written form. To avoid fake or mistaken certificates, they should preferably be issued by the administration, not by colleges or training institutes.

This research proposes how certificates can be created digitally and issued by the administration. Thus, the authorities can quickly check their source and integrity.

The issuing center or college sends the folder's link of such digital certificates to the student. Therefore, adopting a data-sharing platform is essential after issuing a certificate. In Oman, the issuing party can also send the certificates folder's link to the Ministry of Transport, Communications, and Information Technology (MTCIT) in case of Oman. Once the certificates are issued digitally, the seafarer submits the digital certification by sharing the link instead of the paper certificate to the concerned parties enabling them to check the file's authenticity.

In the authors' opinion, the digitalization of the certificate will also end up in the smoother remote surveys and inspections.

2.2. Structural System.

Regulation I/14 of STCW 2010 (responsibilities of companies), section four, requires the documentation and data relevant to all seafarers employed on its ships to be maintained and readily accessible and include, without being limited to, documentation and data on their experience, training, medical fitness, and competency in assigned duties (IMO, 2011).

Digitalization will be a considerable part of the progress we see in Oman over the coming years (Thomas, 2020).

As stated, (CMS, 2020), Omani law permits E-signatures and digital signatures according to the Electronic Transactions Law (Royal Decree 69/2008 (as amended)) (the "ETL"). The ETL defines 'Electronic Signatures' to include digital signatures as follows:

"The signature on an electronic message or transaction in the form of letters, numbers, symbols, signs or others of a unique feature that allows others to identify the signatory."

According to article fifty of ETL, the government may carry out the following task using electronic records and signatures (Injaaz, 2020):

- Accept filing, submitting, creating, or retaining documents.

The Danish Maritime Authority (DMA) launched a range of digital certificates for seafarers, alongside many other digital self-service systems for shipping companies and educational institutions (O'Dwyer, 2021). It will allow seafarers to manage access to digital certificates, applications, qualifications, and seagoing services. Shipping companies and manning agencies can access the digital certificates shared by seafarers online and apply for recognition certificates through the self-service system. The digitalization of certificates enables Online verification of all STCW, medical and ship certificates. Maritime ed-

ucational institutions can also log in to the platform to report exams, courses, and certificates of proficiency for seafarers.

In the authors' opinion, the same practice can get started in Oman, allowing the seafarers to use all the benefits stated earlier.

3. Methodology.

This study employed quantitative and qualitative research methods by conducting online surveys and interviews.

3.1. Requirements.

- Certificate issuing party:

It can be the administrations who issue the certificates themselves based on the evidence from maritime colleges and institutes. Sometimes, the administration authorizes the maritime colleges or institutes to issue the certificates themselves. The certificate must be compatible with the machine language and shared with the other authorized parties via the cloud.

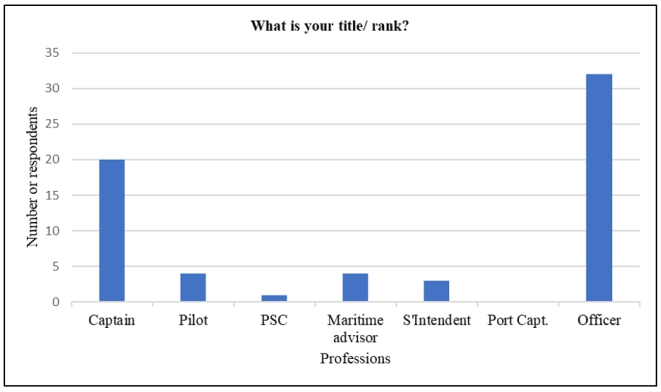
- The Seafarers: The seafarer with digital certificates can easily send the link to the shipping companies for jobs.

3.2. Survey Results.

For this research, in April 2022, a questionnaire about the advantages and disadvantages of seafarers' certificates digitalization, with thirteen close-ended questions, was prepared in the Microsoft Forms and then distributed the link over the internet (LinkedIn, WhatsApp, Emails) to those who work in the maritime industry and port operations.

A total of sixty-four persons responded to the questionnaire.

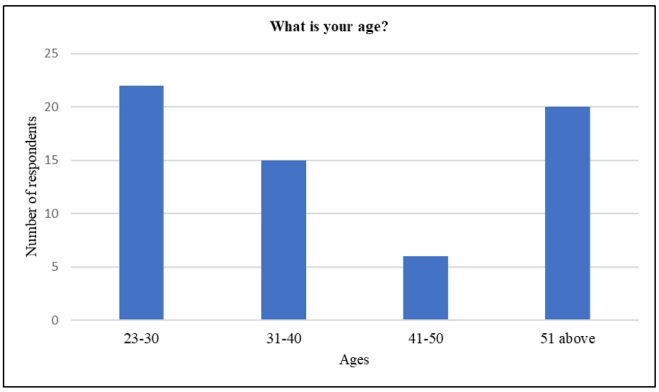
Figure 1: Professions.



Source: Authors.

Figure one indicates that most of the respondents were deck and engine officers, followed by the Captains. This fact will add value to our questionnaire reviewed mainly through those involved with the seafarers' certificates.

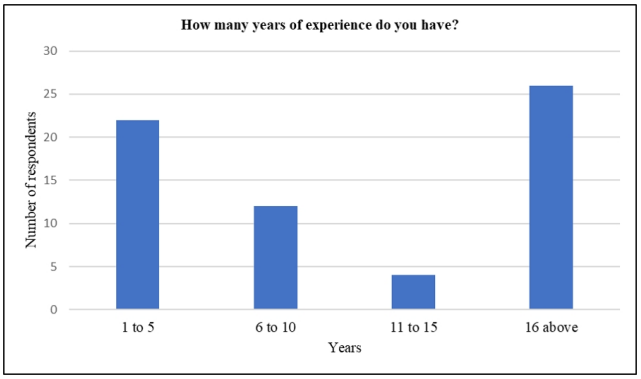
Figure 2: Age of respondents.



Source: Authors.

As figure two indicates, the authors aimed to submit the questionnaire to those already working or related to the maritime industry. For this purpose, the authors did not offer the questions to cadets.

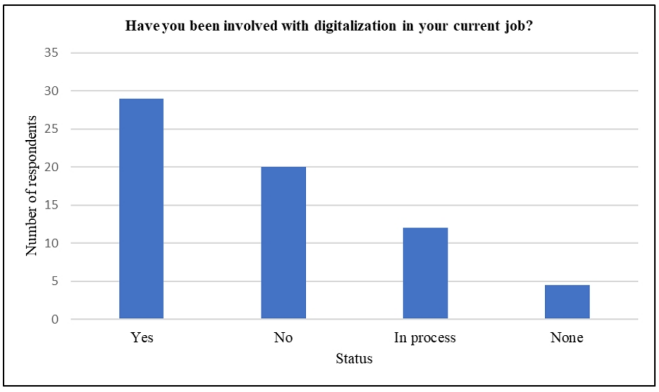
Figure 3: Practical experience.



Source: Authors.

As shown in figure three, most of those who answered the questions have enough experience in their field. It will improve their ability to understand the questions well and choose the best answer.

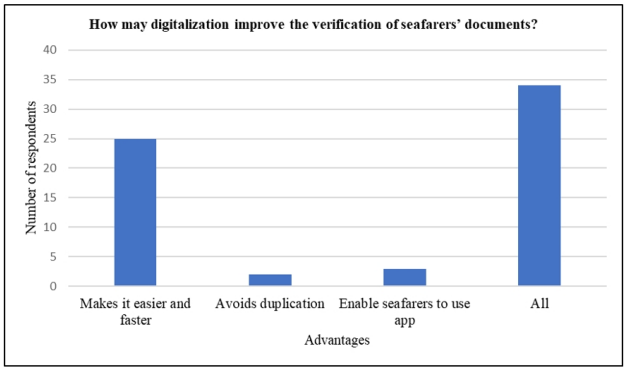
Figure 4: Digitalization integration.



Source: Authors.

As shown in figure four, many respondents use digitalization in their work activities. About twenty percent of them are in the process of the implication of digitalization in their job. However, around thirty percent of those who responded are not using digitalization in their workplaces. We must implicate our new opinion sooner to ensure the maritime industry is progressing as fast as the other industries.

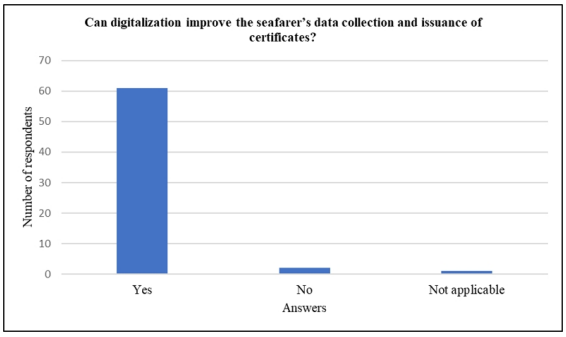
Figure 5: Documents' digitalization.



Source: Authors.

According to figure five, more than half of the respondents believe in numerous advantages of using digitalization to issue and verify the seafarers' certificates. A number of those who replied to the questionnaire believe that digitalization can stop the duplication of the certificates. In addition, they would like to use an application instead of carrying many paper certificates in their bags.

Figure 6: Ease of date collection.

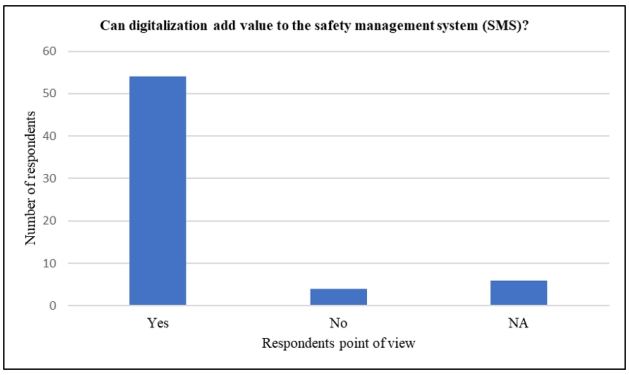


Source: Authors.

Nearly ninety-three percent of the respondents agree that digitalization plays a critical role in collecting the seafarers' data and issuing their certificates (figure six).

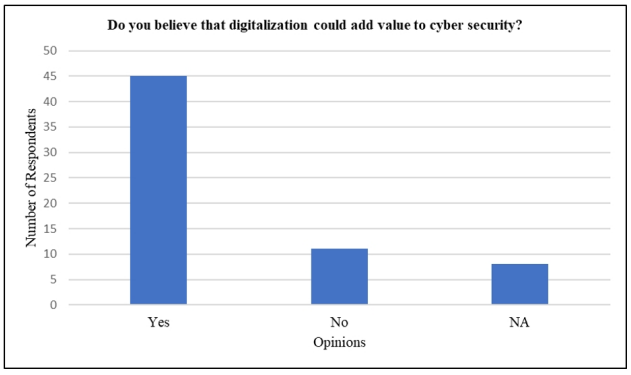
As shown in figure seven, most participants in our questionnaire agree that digitalization can add an excellent value to SMS. According to the STCW requirements, the companies shall ensure that all vessels run with qualified and certified crew members. It has a significant role in improving SMS by providing safety at sea and developing a safety culture.

Figure 7: Digitalization and SMS.



Source: Authors.

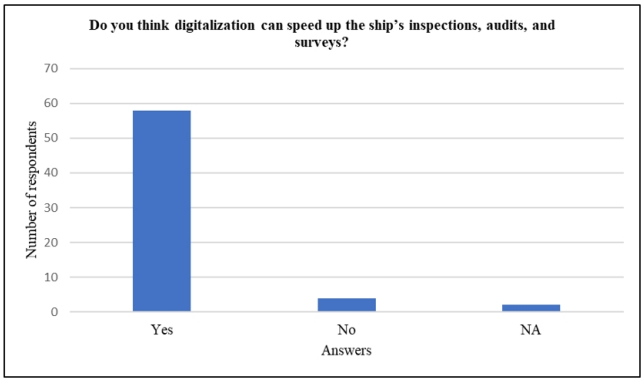
Figure 8: Improving cyber security.



Source: Authors.

According to figure eight, nearly eighty percent of participants in the survey believe that digitalizing issuing the seafarers' certificate improves the knowledge and implication of cyber security. In addition, to avoid hacking and misuse of the data, the websites or applications must be safe and secure to cope with cyber security threats.

Figure 9: Remote inspections.

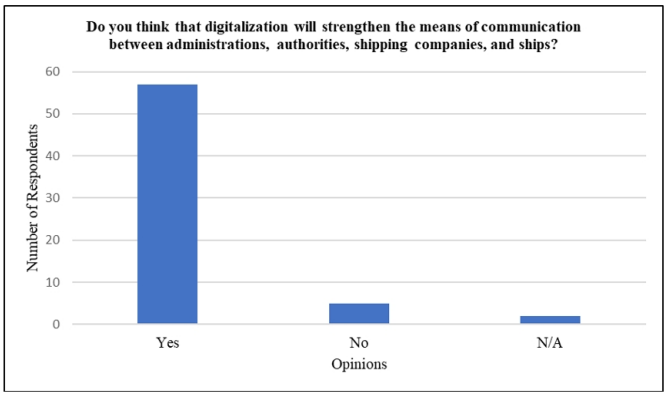


Source: Authors.

Most participants agree that digitalization improves the progress of the inspections, audits, and remote surveys (figure 9). The

surveyors or auditors can quickly check and verify the seafarers' documents from a website or application. Therefore, the audits or surveys will be shorter, faster, or even remotely.

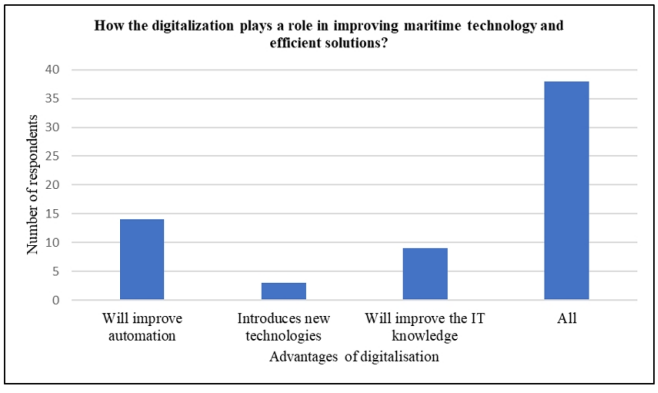
Figure 10: Ease of communication.



Source: Authors.

As indicated in figure ten, most respondents agree that all professional bodies involved in the maritime industry can communicate faster and more quickly after the implication of digitalization. The responsible organization uploads all seafarers' data to the website or application; consequently, all other professional bodies can access them easily.

Figure 11: Technology growth.

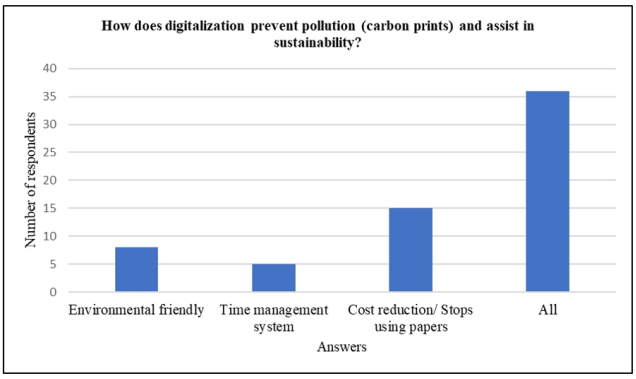


Source: Authors.

Seventy percent of the participants believe that digitalization improves technologies involved in the maritime industry (figure 11). An effective digitalization requires advanced knowledge and the use of automation and Information Technology (IT).

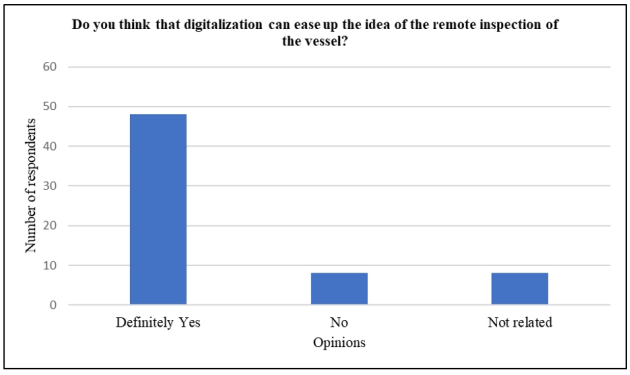
According to the vote of participants shown in figure twelve, nearly all agree on the positive effect of digitalization on sustainability. Mariners are no longer required to print all those certificates on the website or application. Besides, checking and verifying the data also take less time.

Figure 12: Sustainability.



Source: Authors.

Figure 13: Distant inspection.



Source: Authors.

Figure thirteen shows that the participants mostly believe responsible parties can conduct remote inspections easier.

3.3. Interviews with maritime professional.

The authors conducted online interviews with professionals to gain their opinion about the new idea. Two Master mariners, a manager in MTCIT in Oman directly dealing with seafarers and their documents, and an IT manager. The following questions were prepared and asked from them:

- How can digitalization, in general, reduce corruption and illicit activities in the maritime sector?
- Do you believe it is time to facilitate a global digital revolution in the maritime sector?
- How can the digitalization of certificates assist a Captain/ PSC officer/administration in checking the authentication of the certificates?
- Can digitalization improve the process of issuing seafarers' certificates?
- What are the disadvantages of digitalizing seafarers' certificates? (e.g., the confidentiality of the information)

Initially, the authors briefed participants on the innovative idea.

Interviewee 1:

He is a maritime professional and works as a manager in MTCIT Oman.

Question 1: Digital certificates will provide a higher level of security and validity, while instant and automatic verification will be essential.

Question 2: Yes, but first, the International Maritime Organization safety committee must change some of the regulations in the STCW convention. For example, Regulation 1/2, section 11 states that the original STCW certificates must be available while serving on a ship.

Question 3: Digital certificates will provide a higher level of security and validity, while instant and automatic verification will be critical.

Question 4: Lessen the administrative burdens of all stakeholders within the maritime sector.

Digital Certificates are Delivered Instantly.

Digital Certificates Can replace Paper Certificates.

Question 5: Hackers often target certificate authorities to manipulate certificate information. As a result, when a certificate authority is compromised, hackers can create websites or send emails that look genuine and pass fraudulent certification tests.

Digital certificates have become a prime target for hackers and other cybercriminals, given that the information they protect is valuable. The software requires constant vigilance to protect users from cybercrime.

Interviewee 2:

He is a professional Master mariner with more than fifteen years of command.

Question 1: It will enable the central bank to control all the documents, improving information security and avoiding fraudulent activities. It will also assist in reducing the number of employees in the offices

Question 2: Other industries have started incorporating digitalization and replacing paperwork with intelligent solutions.

Question 3: It will affect the time taken to authenticate the documents. It will also reduce unwanted mistakes and errors when issuing the documents.

Question 4: Indeed, it will improve the process of issuing certificates, but on the other hand, it requires appropriate planning and procedures, which need time and expense.

Question 5: Pirates may easily hack the information and data or even change their content, requiring a very reliable antipiracy software. In addition, seafarers and those responsible for issuing and working with the system must undergo the necessary training and familiarization sessions.

Interviewee 3:

He is an IT expert responsible for maintaining a navigation bridge simulator.

Question 1: Digitalization allows only specific authorized persons have access to the system. Therefore, corruption will reduce. In addition, they will keep all the data in a secure place like a cloud, and only authorized persons can reach those dates.

Question 2: Yes. I am not a mariner, but I am sure most other industries have already started digitalization. Oman's government's digital transformation project is one of the main objectives of Oman's vision 2040. Hence, the maritime sector shall commence going towards digitalization.

Question 3: With digitalization, all processes will be simpler, easier, and faster. The Captain and other authorities will undoubtedly enjoy the benefits of digitalization as the online availability of information.

Question 4: It will make the issuing of certificates faster and more reliable. It will also allow the standardization of procedures.

Question 5: The only disadvantage is if some unauthorized persons access the password of the system to take or change the data. A complex password is necessary to avoid accessing unauthorized parties to the certificate folder. In addition, the passports are to be changed frequently. Furthermore, the organization can integrate Multi-Factor Authentication (MFA) into the system as a wise option.

Interviewee 4:

He is a professional Master mariner with years of experience dealing with STCW regulations and seafarers training. He was also dean of a nautical college.

Question 1: Digitalization generally facilitates the smooth flow of up-to-date and authentic information from one side and enhances information accessibility from the other side. Therefore, it would improve transparency and reduce corruption and illicit activities in the maritime sector.

Question 2: The move towards digitalization in the maritime sector started years ago, considering the subsector's readiness and willingness. However, standard implementation in the maritime industry is moving conservatively. The reason is that naval activities are global with different stakeholders, especially states/ countries, who have other backgrounds/facilities and are eager for digitalization.

However, international agreement for the issuance of ships and seafarers' electronic certificates by amending the relevant international instruments (maritime Conventions and Codes) could have been seen as an essential step toward digitalization in the maritime sector. Bearing in mind that the restrictions imposed due to the COVID 19 pandemic have facilitated the mentioned step.

Question 3: In general, digitalization should facilitate monitoring processes/ procedures and verifying the presented documents; however, its effectiveness largely depends on the efficiency of the entity (such as the Administrations and Recognized Organizations) which is hosting the database to maintain its security and availability/ accessibility. Otherwise, it could be a burden for the end users.

Question 4: Yes, and in this respect, many states have implemented software for approval and monitoring of maritime training and issuance of certificates, of course, to various levels depending on the digital/ software culture of the state/ entity.

Question 5: The disadvantage of digitalizing seafarers' certificates arises mainly when the involved entities (e.g., administrations, shipping companies) do not use and enjoy the same digital culture and facilities. Or when the hosting entity cannot keep the security and availability of the used platform and database to an acceptable level.

4. Findings.

The results of our study are as follow:

a. The Seafarer must have access to the originally issued certificate to apply for a job in any of the shipping company.
b. Digital certificates shall be made available to the seafarers. It allows them to get the certificate online and quicker.
c. The application can also have a built-in messaging function that enables seafarers to reach employers and manning agents.
d. A digital certificate issued to a seafarer should not be usable by any other seafarer (protection of data).
e. In this system, even if someone issues a fake certificate, they cannot upload it to the folder in the cloud.
f. The International Maritime Organization safety committee must amend some of the regulations in the STCW convention. For example, Regulation 1/2, section 11 states that the original STCW certificates must be available while serving on a ship.
g. The new idea has the advantage over previous and current studies as verification and maintaining the data relevant to the seafarers will be easier in digital format.
h. The responsible administration, MTCIT in Oman, shall recognize and authorize those colleges and universities that can issue the certificates on their behalf.
i. The proposed method does not require high-speed internet as it is like browsing.
j. We shall develop digital services using the fourth industrial revolution technologies, enabling data sharing between administrations, colleges, shipping companies, ships, ports, and classification societies.
k. There must be a genuine link between the administrations to recognize a certificate issued by the Sultanate of Oman by other parties.
l. Expertise must carefully and continuously monitor the service, including scanning against cyber threats and vulnerabilities. A complex password is necessary to avoid accessing unauthorized parties to the certificate folder. In addition, the passwords are to be changed frequently. Carrying out security audits and drills to ensure the system is not vulnerable to threats.
m. Expertise shall consider a backup system to avoid losing data in emergencies or unwanted situations.
n. The administration or a maritime college can create an application enabling the mariners to save their certificates in case of having difficulty with internet access or remain offline for a long time.
o. The administration or a maritime college shall have procedures to protect backup data.
p. The administration can integrate MFA into the system to ensure more security of data.

Conclusions.

The results of this study assist us in following up on our objective. There are hundreds of seafarers and cadets in Oman that will enjoy the benefits of the digitalization of the certificates. In the authors' opinion, we can start issuing the digitalized certificates even at the International Maritime College of Oman (IMCO) under the authority of MTCIT. This paper's findings and recommendations rely on the authors' research on a survey study with sixty-four professional seafarers in the maritime and port industries and virtual interviews with three maritime experts and one IT expert. Further investigations, research, and actual trials are to be done by other researchers, investors, marine industries, and shipping companies.

Acknowledgements.

The authors gratefully acknowledge the support from the International Maritime College Oman for this research. We also thank Mr. Waleed Al Mamari for his helpful comments on the manuscript.

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Appendix.

Figure .14: Application form.

إستمارة

APPLICATION FOR REPLACEMENT OF LOST, STOLEN, DAMAGED OR DESTROYED CERTIFICATE, ENDORSEMENT OR SEAFARER'S PASSPORT

Part A : to be completed by the applicant

1- Personal details

Name:			الاسم:
Surname:			اللقب:
Date of birth:	Place of birth:	مكان الميلاد:	تاريخ الميلاد:
Father's name:			اسم الأب:
Country of birth:	Nationality:	الجنسية:	بلد المولد:
Nationality identity No:			رقم بطاقته الهوية:
Home address:			عنوان المنزل:
Telephone No.	Mobile No.	Email:	

2- Replacement(s) applied for

1	Type of document:*	2	Document number:
3	Date of issue:	4	Date of expiry:

* Please specify the document type such as certificate of competency (CoC), certificate of proficiency (CoP) or Seamen's passport as applicable.

Source: MTCIT website.