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Implementation of Smart Pilotage to Safeguard Pilots from Pilot Ladder Accidents

Abstract

This study aims to identify and use digital technology to ensure the pilots' lives' safety and to avoid unnecessary delays due to vessels staying at quarantine anchorage during pandemics. The primary means for a pilot to board or disembark a ship is by a pilot ladder. Many pilots suffered severe injuries or even lost their life due to accidents involving the failure of pilot ladders. For this research, a questionnaire with five questions about the dangers and its reasons which threaten pilots' lives, was prepared, and distributed to professionals both in the maritime industry and port operations. Eighty-nine professionals from the maritime industry answered it. The most common causes affecting pilots' safety were unsafe rigging and not securing the ladder correctly or the breaking of a defective pilot ladder. In addition, interviews made with three maritime experts about the distance pilotage. This study aims to utilize and implement the digital technology enabling pilots to sit in the port control office or Vessel Traffic Services (VTS) office instead of going onboard a vessel. For assessing our innovation, a berthing and one unberthing scenario were designed and tested in our full mission bridge simulator by an experienced pilot. The results discovered during the debriefing sessions and the feedback from other experienced pilots and captains were satisfying, making us confident and comfortable with the innovation idea.

Keywords: Pilots, Pilot ladder accidents, Risks, Safety, pandemic, smart pilotage.

1. Introduction

Many incidents worldwide related to maritime pilots' transfer end up with some fatalities. The average number of fatal accidents globally are two to three annually (Sawhney, 2020a). The principal means of transferring a pilot between a vessel and a pilot boat is by the pilot ladder. A pilot ladder must comply with the international rules and regulations to ensure that they are in good working order and that they are safe for the pilots to climb up and board a vessel.

According to Capt. Sawhney (2020b), pilot transfer is a vital operation because if Master, crew, and pilots are not well prepared, the transfer may end in an accident such as drowning. According to the Safety of Life At Sea (SOLAS) convention, ships engaged on voyages in which pilots may be employed shall be provided with pilot transfer arrangements (IMO, 2014). The pilot ladder must have a certificate which complies with the appropriate requirements.

As Broers (2020) said, The International Safety Management (ISM) requires all the following regulations, resolutions, and standards to be complied with to ensure the safe transfer of a pilot:

◊ SOLAS convention CH V Regulation 23: regulations regarding Pilot Transfer Arrangements.
◊ Resolution 1045(27) of the International Maritime Organization (IMO),
◊ International Organization for Standardization (ISO) 799-1 industry standard.

Apart from IMO, various associations and authorities focus on issuing new regulations and notices about pilots' safety. Some of them are:

◊ Maritime Pilot's Association (IMPA)
◊ American Pilot Association (APA)

IMPA has designed a useful poster which is called Required Boarding Arrangements for Pilots (see bibliography). It shows the standard specifications of a pilot ladder and rigging and arrangements. A notice was issued by APA in February 2020 indicating the unsafe pilot transfer arrangement consisting of an accommodation ladder/pilot ladder combination with a trapdoor that does not meet IMO standards.

All the parties involved in the pilot transfer, including owners, Master and crew, pilot, pilot boat, and pilotage providers, are responsible for its safe operation (AMSA, 2019). However, accidents are still happening. Accidents are often significant and even fatal. Many pilots have lost their lives during boarding or disembarking vessels.

Pilots should climb a pilot ladder that is supposed to be in a proper safe condition, and they must rely mostly on the ship crew. Accidents mostly happen in the following circumstances:

◊ Slipping when jumping from the pilot boat to the pilot ladder and then falling into the sea. In many cases, they drown, get smashed between the pilot boat and the vessel hulls, or get sucked up by the pilot boat's propeller.
◊ Falling from the pilot ladder when embarking or disembarking. The reasons are pilot ladder steps and ropes which break or incorrect rigging of the ladder.
◊ In this case, the pilots either fall directly onto the pilot boat (if she is still alongside) or fall into the sea.
◊ Falling into the sea when trying to jump from the pilot ladder to the pilot boat, especially during bad weather.

◊ The pilot boat is pushed upwards by high waves or swells and smashes into the pilot's body or legs.

The reasons for the above accidents are:

◊ The pilot ladder is not maintained accordingly.
◊ The pilot ladder is not rigged properly.
◊ Poor boat maneuvers.
◊ Rough sea and swells.
◊ Lack of implementing risk management.

2. Background

On a night in July 2019, the pilot boat had to carry out a search and rescue operation and pick up a pilot from the sea because the ladder had broken which caused the pilot who was stepping down the ladder to fall into the sea (Habib, 2019).

In another accident reported by Voytenko (2020), a pilot boat that was pushed up by the high waves hit the pilot's leg when he was climbing up the ladder. The pilot suffered severe injuries.

In a fatal accident reported by Schuler (2016), a pilot was killed in an accident when trying to board a vessel on the river Thames.

The occurrence of all these serious and life-threatening accidents made the author to find a solution to protect a pilot's life.

In another incident in April 2020, a pilot fell into the sea. A defective securing rope on a ladder broke while he was disembarking from the tanker departing from the Port of Durban. The Pilot vessel managed to come to his rescue, and he was recovered and transported to hospital (Voytenko, 2020).

The pilot's life is mostly in the hands of others (ship crew, pilot boat skipper) who do not use the pilot ladder. In December 2019, a pilot sustained a severe injury and subsequently died after falling from an improperly rigged accommodation ladder when he was boarding an inbound container vessel at the Port of New York and New Jersey (Schuler, 2019).

Most of the Maritime organizations, pilot companies, and associations are concerned about the risks involved when using a dangerous ladder and the subsequent effects on the pilots' safety.

After the New York pilot's death in December 2019, the American Pilots' association prepared a letter concerning pilots' safety and submitted it to the US state pilotage authorities (mfame, 2020a).

In specific ports worldwide, a helicopter is engaged in marine pilot transfers incurring fewer risks for the pilots but require using safety precautions and risk management.

The current Covid pandemic is causing a significant challenge to the shipping industry. The Standard Club is aware that social distancing is essential for protecting both pilots and crew members during port calls. Remote pilotage could be a solution for high infection risks (Standard club, 2020).

This industry, including Maritime, is moving towards getting autonomous.

The Maritime Safety Committee (MSC) has issued guidelines in MSC 1- Circ 1604 for the Maritime Autonomous Surface Ships (MASS) related trials (IMO, 2019). Some of the main objectives are as following:

◊ The trial shall consider the risks to safety, security, and the environment.
◊ Use of effective emergency plans based on the outcomes from risk assessment.
◊ To evaluate the trial's safety constantly.
◊ Ship personnel and remote operators shall be qualified to conduct the trial.
◊ Measures to be taken to provide appropriate cyber risk management of the data exchanged.

As Captain Dolan (2020) said, remote pilotage shall be from the pilot station to the area closest to the jetty or berth. The rest of the operation is to be under the supervision of an experienced pilot. They need to rely on their tracking device data or receive the vessel's bridge team's information over the VHF or other communication means.

One idea is using remote pilotage inside an intelligent fairway when Master and crew, pilot, Vessel Traffic Service (VTS) operators are in continuous contact with each other and have access to all bridge equipment and many other sensors and cameras (Lahtinen *et al* 2019, p. 55).

In Finland, pilots sitting in the office or a pilot boat, are practicing remote pilotage. But still, there is a lack of communication between the Master and the pilot. Besides, the pilots are unable to feel the exact movement of the vessel and the surrounding conditions.

The author attended a webinar about remote pilotage hosted by the Nautical Institute (NI) on June 3, 2021. One of the key speakers, Dmitry Rostopshin (2021), talked about a remote pilotage simulation trial for an inbound vessel on the port of Rauma in Finland. They used one set of rotational cameras in the bridge plus four cameras in selected fairway positions and other navigational equipment, including a portable pilot unit (PPU).

In the author's opinion, remote pilotage is a beautiful idea. However, has below disadvantages:

◊ The Master of the vessel is receiving advice from VTS operators and not from experienced pilots.
◊ Even with pilots sitting behind the monitors instead of VTS officers, the pilots do not have reliable data access from the ship's navigational equipment.
◊ The lack of proper and continuous communication between the pilot and Master is too risky as they depend only on very high frequency (VHF) equipment.
◊ The pilot's visual monitoring is limited to only one camera in the bridge and four others from selected fairway positions.

◊ Remote pilotage requires incorporating an intelligent fairway system. It can be costly and requires permanent maintenance as the system is subject to different weather conditions.

Author's new idea is to upgrade the remote pilotage to smart pilotage. It enables pilots to visually monitor the vessel's movement, watch the bridge team activity, and feel the vessel's motion.

3. Methodology

This study employed quantitative, qualitative, and simulated research methods by conducting online surveys and interviews. In addition, the author tested his new idea in a full mission bridge simulator.

3.1 Survey results

For this research, in July 2020, a questionnaire about the dangers and reasons threatening pilots' lives, with five close-ended questions, was prepared in SurveyMonkey application and the link distributed over the internet (LinkedIn, WhatsApp, Emails) to those who work in the maritime industry and port operations. Eighty-nine professionals responded to it. The structured questions are as following:

◊ What is your profession?
◊ How many years of experience do you have?
◊ Were you involved in an accident relating to a pilot's embarkation/ disembarkation?
◊ What was the cause of the accident?
◊ What is the main reason that causes the breaking apart of a pilot ladder?

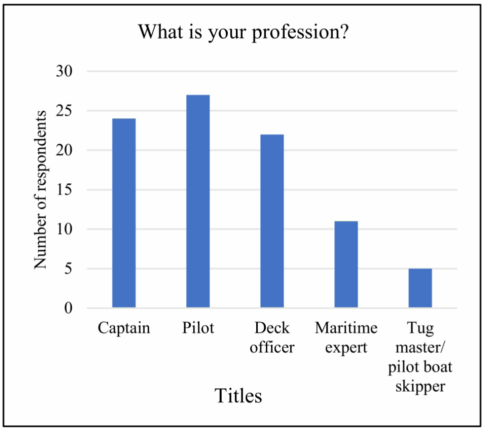

Figure 1: Positions/ Titles of respondents

Figure 2: Work experience of respondents

Figure 1 shows the rank and titles of the respondents. The stack bars depict twenty-seven respondents being pilots, followed by twenty-four Master mariners, twenty-two deck officers, eleven maritime experts, and five tug masters. The author intended to acquire different impressions from the persons involved in the pilots' transfer to and from the ships.

As shown in figure 2, thirty-three persons have two to ten years of experience, thirty-four of them are in the industry for eleven to twenty-five years, and twenty-two of them have work experience of more than twenty-six years. Thus, it is evident that the respondents are experienced and familiar with the dangers which threaten pilots when boarding or leaving a vessel.

Figure 3 makes the author quite comfortable to see that seventy-three percent of the participants were not involved in an accident relating to the transfer of pilots. It means that all parties are complying well with the relevant safety regulations and notices. However, the stacked bar depicts twenty-three percent of them involved with accidents. The result is very critical and indicates the high risks pilots are facing during embarking or disembarking.

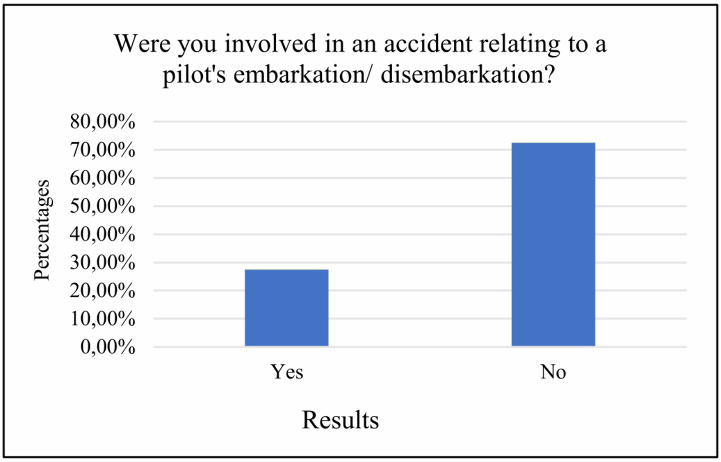

Figure 3: Involvement in an accident

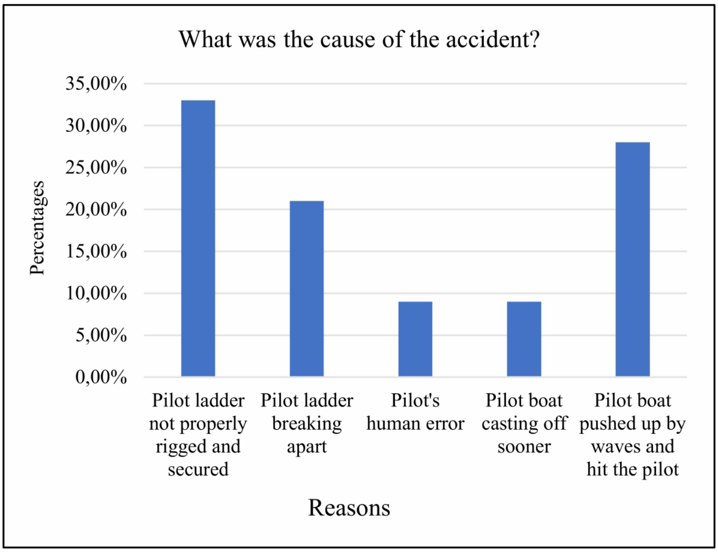

Figure 4: How accidents happened

Figure 4 indicates that some of the accidents that happened are due to improper maintenance of the pilot ladder (%21) and lack of vigilance in rigging the ladder (%33). It also shows that most of the accidents that happen are beyond the pilot's control (%37). The stacked bar in the middle of the above figure depicts nine percent of the casualties are because of the pilot's human error.

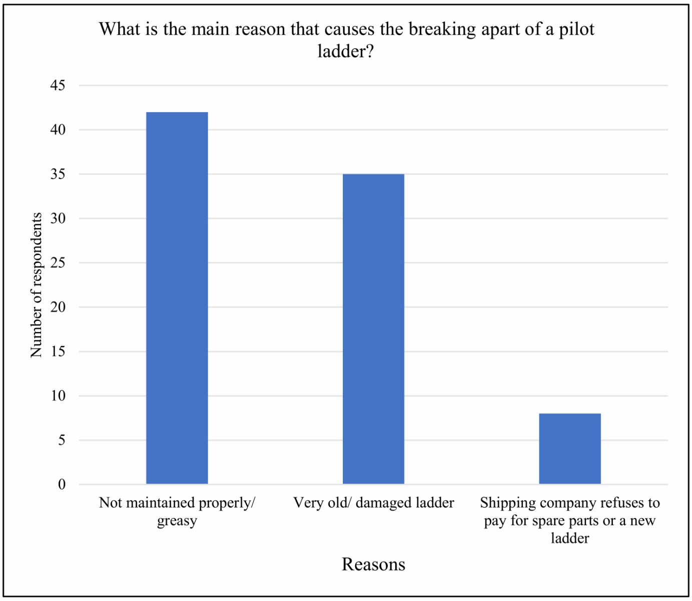

Figure 5: Causes of pilot ladder failures

There are many standards and requirements regarding the pilot ladder and its rigging. Nevertheless, as Figure 5 indicates, seventy-seven respondents believe that most of the accidents are due to the use of the damaged ladder or a lack of maintenance on pilot ladders. As the last bar depicts, nine respondents believe the casualties happened as the shipowners refuse to purchase a new ladder. Three participants did not answer this question. Making a more frequent and thorough inspection of the ladder by the ship staff, port state controls, and classification surveyors is essential.

3.2 Interviews with maritime professionals

To gain the opinion of professionals about the author's new idea, online interviews conducted with two Master mariners and one pilot who are directly dealing with pilotage operations.

The following question prepared and asked from them:

- ◊ How practical is this innovation?
- ◊ What are the advantages of smart pilotage?
- ◊ What are the disadvantages of this new idea?
- ◊ What are the challenges for you if one day this system implements in your port/ your ship arrive at a port using smart pilotage?

Initially, the author briefed participants on the innovative idea.

Interviewee 1:

He is an experienced pilot and a Ph.D. researcher at Madrid polytechnic university.

Question 1: This idea looks great, but the leading and most advantageous of having a pilot on board is to handle vessels in the congested area, especially in emergencies that may happen due to failure of mechanical or electro-mechanical instruments onboard ships. Therefore, you must assess the efficiency of this idea in various cases of emergencies involving vessels and tugboats.

Question 2: The advantages are:

Safeguarding the pilot's life, reducing fuel consumption, less depreciation of pilot vessels, saving time and energy to arrange a pilot for inbound or outbound ships.

Question 3: Preparing infrastructures for this idea and delivering cameras and other hardware to vessels require time, energy, and a considerable amount of money. Parties ashore and onboard required appropriate training to deal with emergencies.

Question 4: The availability of appropriate proficiency training courses to make sure pilots are well familiar with the new method.

Interviewee 2:

He is a Master mariner with thirteen years of command on board ocean-going vessels.

Question 1: Of course, it is practical but requires using very sophisticated navigational equipment as every ship has different maneuvering characteristics.

Question 2: As you mentioned, it can protect pilots from the hidden dangers threatening the safety and life of a pilot.

Question 3: If it requires someone from ashore to install the cameras, it is again risky. The delay or error that may happen to the electronic equipment may result in wrong or ambiguous pilot decisions.

Question 4: First, as we see, the world is moving very fast in all respects of technology, and I am particularly not very happy with that. What I mean is that technology works along with appropriate training and experience.

Interviewee 3:

He is a Master mariner with thirteen years of command on board ocean-going vessels.

Question 1: Several crewless spaceships traveled a hundred million miles in space and successfully landed on other planet's surfaces, just controlled remotely from the Earth. So, I presume distance-piloting is a practical plan that provides standards and facilities to both ports and vessels.

Question 2: It will eliminate pilot transportation from/ to the vessels, reducing related expenses. Moreover, it directly affects pilot boat crewing and other costs such as boat maintenance and running costs. There will be no accident involving the pilot transfer. It avoids delays in berthing/ unberthing ships due to bad weather or in pandemic situations.

Question 3: The main drawback is the quality of the communication between vessel and Pilot. The swift reply of Pilot's order is crucial, and communication through VHF or phone may sometimes be disrupted and expose the ships to unsafe situations. Another disadvantage is the uncertainty of the capability of cameras installed on buoys in the fairway. They are likely to be affected by sea spray and may be blocked and unable to record and transfer the clear footage of the scene. Next is the risks associated with berthing / unberthing operation. Port authorities may use experienced pilots in the early stages of implicating the idea.

Question 4: Masters must have undergone sophisticated training to berth & unberth a vessel without a pilot on board. Therefore, I will take the following actions:

- ◊ Check the readiness and test the proper working of the cameras and means of communication.
- ◊ Adhere to the rules and standards related to the intelligent pilotage.
- ◊ Analyze and prepare a list of the risks associated with this unique operation.
- ◊ Ensure that the bridge team is familiar with the contingency plans, especially in failure to communicate with the Pilot.

3.3 Testing the idea in the simulator

The idea of smart pilotage came from the author's fifteen years of command on board ocean-going vessels and his experience and knowledge in working in the full mission navigation bridges' simulator. The instructor sitting in the workplace (station control) has full access to the engine and navigational equipment in the training bridges and can control the scenario's ships. The instructor can control a vessel as well as monitor the actions taken by the bridge team.

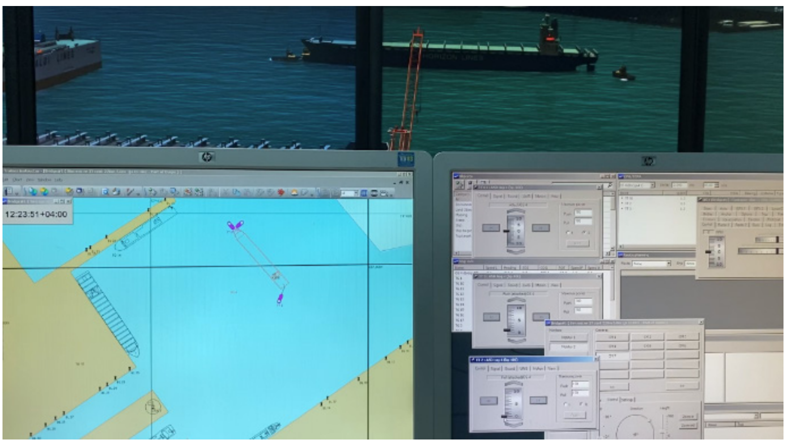

Figure 6: Ship, Tugboats, view from the port
Photo taken by Capt. Behforouzi/ IMCO

He/she can check the surrounding environment visually, hear the bridge team voices, hear the engine, check the speed, and even monitor and assess the traffic on RADARs.

Figure 7: Vessel movement and surroundings (simulator view)
Photo taken by Capt. Behforouzi/ IMCO

As shown in figure 7, the instructor can see the Rate of Turn, depths sounding, and mainly communicate effectively with the Master. In other words, the instructor can take control of the vessel's movement directly from his/ her control station.

As indicated in figure 8, the instructor can monitor or control the maneuvering and movements and tugboats from the workplace station. He/ she has access to cameras on board and in the port area.

In the author's opinion, we can implement a smart pilotage system by incorporating digital technology and by using temporary and fixed cameras onboard and in the port area during the operation. The smart pilotage requires good network coverage (telephone and high-speed internet) from the pilot station to the jetty. The pilot sitting in the office or VTS station can monitor the electronic chart's vessel movement in his/ her monitor. He can also visually check ship surroundings and the bridge environment by logging on to portable cameras that are temporarily installed in the bride and wings. The pilot is in continuous verbal communication with the Captain of the ship and the bride team. Besides, when the vessel is in the port area, the pilot can log on to the port area's fixed cameras and monitor a vessel's movement and progress. The pilot keeps continuous communication with the tugboats made fast to the ship using a walkie-talkie or VHF set.

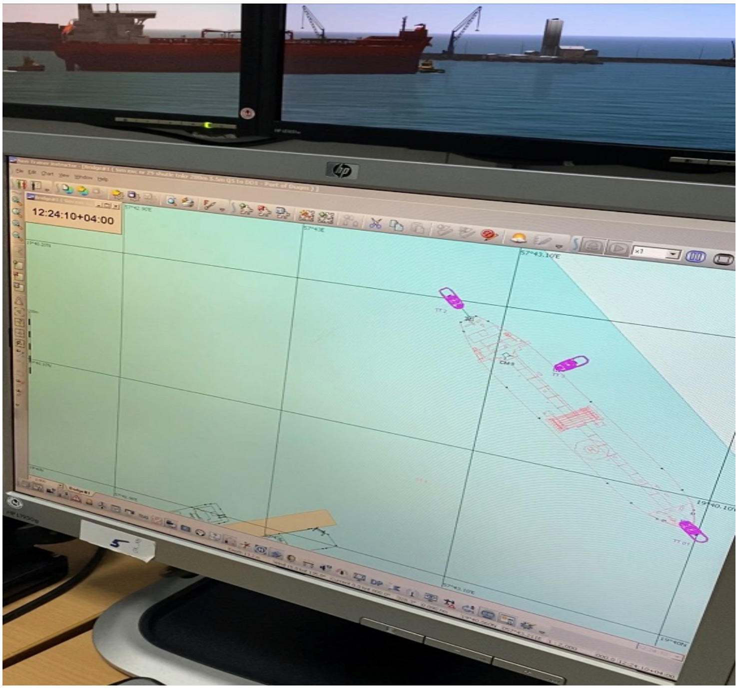

Figure 8: Vessel/ tugboats movement and maneuvers (simulator view)
Photo taken by Capt. Behforouzi/ IMCO

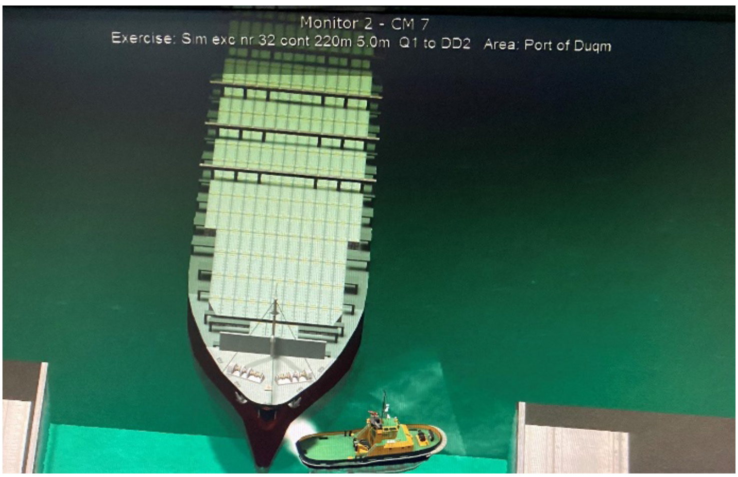

Figure 9: Ship and Tugboats/ entering dry dock (simulator view)
Photo taken by Capt. Behforouzi/ IMCO

Figure 9 is an example of how a pilot can access the cameras in port and ensure safe movement while entering a dry dock. The safe operation and management of a vessel's movement, including the pilotage operation, requires knowledge, competence, experience, and resources. Besides, all actions shall take place in proper and ample time. The experienced pilot sitting in the office has knowledge, competence and experience but does not have access to other essential data from the ship, mainly a visual view of the bridge and surroundings.

The idea is to send and deliver the following equipment to a vessel approaching or departing from a port:

1-Seven sets of cameras. Each is fitted with a strong magnet at its base. The cameras are wire-free, battery-powered, and high-resolution with night vision. The cameras have an Internet Protocol address (IP). The Master of the ship makes sure to install them as below:
 - a-Two cameras in each bridge wing. One of them facing forwards and the other astern.
 - b-One set above the RADAR and ECDIS.
 - c-Another set enables the pilot to monitor the helmsman's actions, the rate of the turn indicator, the rudder angle indicator, the echo sounder, and the speed log.
 - d-The last one to be deployed is amidship inside the bridge. It enables the pilot to monitor and feel a vessel's change of course or turn.

2-A smartphone (tablet) is fitted with Bluetooth or a headset. The required application, such as the "Fing application", is already downloaded on a smartphone or tablet, enabling it to connect to the cameras. The mentioned types of equipment will be delivered to the vessel by a pilot boat or a drone.

The pilot sitting in VTS, or port control office uses an electronic chart to monitor and track a vessel's movement. The pilot can monitor the routes and observe all trends. He/ she is in continuous communication with the Master of the ship and advises the Captain. In the meantime, the pilot checks the vessel's movement and monitors the bridge team activity and navigational aids to make sure the bridge team is following orders correctly.

The smart pilotage requires access to a robust and reliable network coverage in the area between the pilot station and inside the port area. Figure 10 shows a reliable 4G network coverage in and outside the Port of Sohar in Oman.

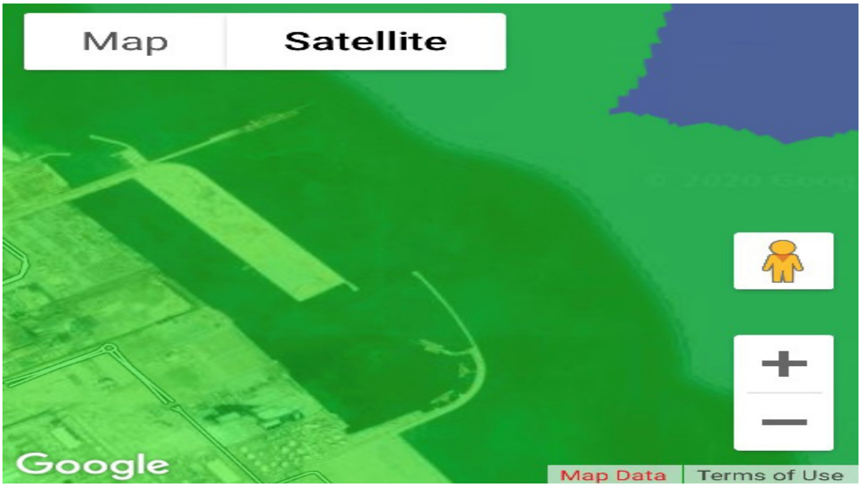

Figure 10: 4G network coverage in port of Sohar
Source:http://ooredoo.om/Personal/Mobile/ShababiahPrepaid/OtherPrepaidServices/Mousbak/4G/tabid/1292/Agg2734_SelectTab/3/Default.aspx

For this study, we decided to design two scenarios about the berthing and unberthing of a cargo vessel in Sohar's port. The cargo vessel is approaching the pilot station, and a pilot boat or a drone is assigned to deliver the required instruments mentioned earlier.

For the sake of the scenarios, we chose a fully laden container vessel model, with a length of three hundred and forty-seven meters and a draft of fifteen meters. The cameras were installed in the bridge wings and inside the bridge. The container carrier approaches Sohar pilot station where two tugboats are waiting for her. The means of communication between the pilot, the approaching vessel and the tugboats are VHF.

An experienced senior pilot from Sohar's port agreed to carry out the smart berthing and unberthing scenarios. He was briefed on our idea and familiarized with the available options in the control station. The author was also sitting beside him to facilitate the operation and attend to the training bridge to carry out his orders.

Figure 11: The pilot is checking the vessel's movement.
Photo taken by Capt. Behforouzi/ IMCO

Initially, there was a brief Master/ pilot information exchange, and the pilot explained the approaching and berthing plan to the Master. The exercise started, and he monitored the surrounding area by the cameras in the vessel (Figure 11). He was supervising and checking the track and trend of the ship. As shown in figure 12, he could also check the trends and future trends of the vessel's movement on his monitor. When the boat passed the breakwater, the pilot could check and monitor the surroundings inside the port area. The cameras at the bridge facing astern were handy for the pilot to check the vessel's aft movement and check the distance from other ships when berthing (figure 13). As shown in figure 14, the ship berthed easily and smoothly as planned after forty-one minutes. All the movements were under constant observation in the system (figure 14). Continuous and robust communication was available between the pilot and bridge team during the whole operation. The pilot's orders were received efficiently, acknowledged, and followed up by the bridge team.

Figure 12: The pilot is checking the vessel's trend.
Photo taken by Capt. Behforouzi/ IMCO

Figure 13: The Pilot is checking the aft area, proceeding to the berth.
Photo taken by Capt. Behforouzi/ IMCO

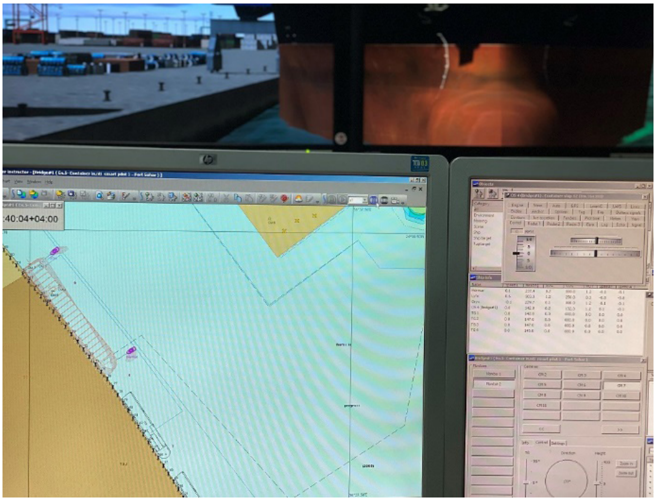

Figure 14: Container vessel berthed.
Photo taken by Capt. Behforouzi/ IMCO

The second scenario was created assuming that the same vessel model is unberthing. Two tugboats were ready and made fast to the container vessel under the pilots' orders. As shown in figure 15, our large container vessel unberthed smoothly and comfortably and proceeded outwards to the pilot station. The exercise ran with more confidence and faster as the pilot had more reliance on the system.

Figure 15: Container vessel unberthed and is heading outwards.
Photo taken by Capt. Behforouzi/ IMCO

4. Findings

The two scenarios were carried out smoothly. It took forty-one minutes for the vessel to get alongside the berth. The pilot was very confident and comfortable during the operation. He trusted the simulation. The trend feature was continuously active because it was essential for him to monitor the vessel's movement. The rate of turn, side movement's speed, relative wind speed, and wind direction were other data that he was frequently checking.

The new idea has advantages over previous and current studies such as:

◊ Seven sets of cameras enable the pilot to feel the ship's motion, especially from the camera located midship in the bridge.
◊ Continuous and uninterrupted communications between Master and pilot that make both parties comfortable.
◊ The smart pilotage does not require constant maintenance and inspection, as in the case of the intelligent fairway.
◊ Smart pilotage will cost less for the owners/ charterers.

The following are the findings and comments to consider when implementing the smart pilotage:

◊ The pilot needs to make sure that the Captain and crew are following up on his orders. (The camera installed inside the bridge will provide an inside view for the pilot sitting in his office)
◊ To install two additional cameras in the jetty. Their locations can be eighty meters from the bow and eighty meters from the stern facing down towards the water.
◊ The Captain of the vessel shall be able to see the pilot. (The video communication with using a tablet which sent onboard)
◊ The camera and tablet are to be delivered to the vessel in advance as it takes time to install them onboard. (Use of drone)
◊ Those involved in the smart pilotage operation must have undergone adequate training, including simulated proficiency training.
◊ The Captain shall send the passage plan and maneuvering characteristics to the pilot's office before reaching the pilot station.
◊ The Master/ pilot information checklist is to be discussed and understood.
◊ A contingency plan, in case of monitoring or communication failure, shall be ready to use.

5. Conclusion

The results of this study assist us in following up on our objective. There are thousands of pilot transfer operations daily and we have the responsibility to keep them safe by introducing or inventing new technology to protect their health and lives.

In the author's opinion, we can use smart pilotage innovation which enables pilots to guide and advise the Captain to enter and leave ports safely without endangering their lives. However, the Captain of the ship always has the right to refuse the smart pilotage.

The author recommends that additional options, such as "trend" or "ship movement prediction," should be developed and installed in RADAR/ ECDIS to monitor the ship's movement for using the smart pilotage.

This paper's findings and recommendations rely on the author's research based on a survey study with eighty-nine professional seafarers in the maritime and port industries, virtual interviews with three maritime experts, and two simulated trials. Further investigations, research, and actual field tests with the presence of a pilot and ship's crew, are to be done by other researchers, investors, maritime industries, and pilot associations.

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