Exploring Competencies for Thai Navigation Officers in Digital Age

Tanan Kuntasa[1], and Kittisak Makkawan[2,*]

Abstract

The world is currently entering the digital age, where automated systems and artificial intelligence play significant roles in various industries, including the maritime industry. The competencies of navigation officers currently available are not sufficient to perform tasks in an era with rapid technological changes. Therefore, it is essential to expedite the development of competencies for navigation officers. This acceleration is necessary to ensure that they are aligned and capable of adapting to evolving technologies. The objective of this research is to identify the competencies required for Thai navigation officers in digital age and to develop a conceptual model of navigation officers' competencies. This will equip navigation officers with essential competencies for safe operations and additional competencies to align with future technological advancements. This research employed triangulation of data sources and used content analysis for data interpretation. The research findings revealed that ship navigation officer competencies in digital age consist of three essential standard competencies required, namely Navigation, Cargo Handling and Stowage, and Controlling the operation of the ship and care for persons on board. Additionally, it is crucial to incorporate two additional domains in the digital age, which are soft skills and information technology. These domains encompass a total of 31 competencies. Furthermore, the competencies identified in this research can be utilized as a guideline to enhance the training and development programs for Thai navigation officers in the future.

Keywords: navigation officers, International Maritime Organization (IMO), IMO model course, Standards of Training Certification and Watchkeeping for seafarers (STCW), seafarers

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[1,2] Faculty of Logistics, Burapha University, Chonburi

* Corresponding author. E-mail: kittisakm@go.buu.ac.th

ก ารศึกษาสมรรถนะสำหรับนายประจำเรือ ฝ่ายเดินเรือของประเทศไทยในยุคดิจิทัล

ฐานันดร์ กัณฑะษา[1] และ กิตติศักดิ์ มัฆวาล[2,]*

บทคัดย่อ

      โลกปัจจุบันก้าวเข้าสู่ยุคดิจิทัลที่ใช้ระบบอัตโนมัติและปัญญาประดิษฐ์เข้ามามีส่วนในการปฏิบัติงาน รวมถึงการนำมาใช้ในอุตสาหกรรมการเดินเรือ สมรรถนะของนายประจำเรือฝ่ายเดินเรือที่มีอยู่ในปัจจุบัน ยังไม่เพียงพอที่จะสามารถปฏิบัติงานในยุคที่มีการเปลี่ยนแปลงไปอย่างก้าวกระโดดของเทคโนโลยีได้ ดังนั้น การพัฒนาสมรรถนะนายประจำเรือฝ่ายเดินเรือจึงมีความจำเป็นอย่างยิ่งที่จะต้องเร่งพัฒนาสมรรถนะเพื่อรองรับ กับเทคโนโลยีที่เปลี่ยนแปลงไป การวิจัยนี้มีวัตถุประสงค์เพื่อหาสมรรถนะที่จำเป็นสำหรับนายประจำเรือ ฝ่ายเดินเรือในยุคดิจิทัล และพัฒนาแบบจำลองแนวคิดสมรรถนะของนายประจำเรือฝ่ายเดินเรือของประเทศไทย เพื่อให้นายประจำเรือฝ่ายเดินเรือมีสมรรถนะพื้นฐานที่จำเป็นสำหรับการทำงานให้มีความปลอดภัย และมีสมรรถนะ เพิ่มเติมเพื่อปฏิบัติงานให้สอดคล้องกับเทคโนโลยีที่เปลี่ยนแปลงไปในอนาคต งานวิจัยนี้ใช้การตรวจสอบสามเส้า ด้านข้อมูล และการวิเคราะห์เชิงเนื้อหาในการวิเคราะห์ข้อมูล ผลการวิจัย พบว่า สมรรถนะของนายประจำเรือ ฝ่ายเดินเรือประกอบไปด้วย 3 ด้าน พื้นฐานที่จำเป็นต้องมี ได้แก่ การเดินเรือ การจัดการ และจัดเก็บสินค้า การปฏิบัติการเรือและการดูแลคนประจำเรือ นอกจากนี้ ยังมีความจำเป็นต้องเพิ่มเติม 2 สมรรถนะที่จำเป็นในยุค ดิจิทัล คือ สมรรถนะด้านทักษะทางสังคมและด้านเทคโนโลยีสารสนเทศ รวมทั้งหมด 31 สมรรถนะ แบบจำลอง แนวคิดที่ได้จากการวิจัยนี้ แสดงถึงสมรรถนะที่มีความจำเป็นต่อการปฏิบัติงานในปัจจุบัน และรองรับการปฏิบัติ การเดินเรือในอนาคต รวมถึงสามารถนำสมรรถนะจากงานวิจัยนี้ไปใช้เป็นแนวทางในการยกระดับการฝึกอบรม นายประจำเรือฝ่ายเดินเรือของประเทศไทยได้ในอนาคต

คำสำคัญ: นายประจำเรือฝ่ายเดินเรือ องค์กรทางทะเลระหว่างประเทศ หลักสูตรต้นแบบขององค์การทางทะเล ระหว่างประเทศ อนุสัญญาระหว่างประเทศว่าด้วยมาตรฐานการฝึกอบรม ใบรับรอง และการเข้ายาม สำหรับคนประจำเรือ คนประจำเรือ

[1,2] คณะโลจิสติกส์ มหาวิทยาลัยบูรพา

* Corresponding author. E-mail: kittisakm@go.buu.ac.th

Introduction

Maritime transportation plays a vital role in global cargo transportation, accounting for 80% of worldwide transportation when compared to other modes of transport. In the case of Thailand, international shipping is considered of utmost importance both in terms of cargo volume and value (Makkawan & Maungpan, 2021), facilitated primarily by a diverse type of ships such as general cargo ships, container ships, tanker ships, and passenger ships. These ships enable the transportation of various types and sizes of cargo, including dry cargo, liquid cargo, and refrigerated cargo, and can transport large volumes of cargo on each voyage, making sea transport an efficient option. The successful transportation of cargo by ship depends on the knowledge and skills of seafarers to navigate and operate the vessel. Seafarers with good knowledge and high skills can help ensure safe and efficient maritime transportation (Choe, Lee, & Kim, 2021). The International Maritime Organization (IMO) has established standards and regulations, such as the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) (International Maritime Organisation (IMO), 2011) which require individuals to undergo extensive training and certification to ensure they possess the necessary skills and knowledge. However, despite the fact that the STCW Convention serves as an international agreement including Thailand, to certify and establish training standards for seafarers (IMO, 2011), there have been safety issues in the maritime transportation sector over the past period. These issues have resulted in loss of life, ships, crew property, damage to and loss of cargo, as well as significant environmental impact (Deng, Liu, Xie, & Liu, 2022; Khan, Yin, Mustafa, & Liu, 2020). Consequently, the shipping industry has embraced the integration of technology in maritime operations to reduce losses caused by human error. This technology aims to provide additional data to navigation officer and ship captains, serving as decision-making support for safer and more accurate navigation.

Thailand has adopted the STCW 2010 Convention and implemented it domestically to establish training and certification standards for seafarers. The STCW 2010 Convention outlines the knowledge, skills, and competencies required for seafarers in three domains: Navigation, Cargo Handling and Stowage, and Controlling the operation of the ship and caring for persons on board (IMO, 2011). Furthermore, the convention only includes one soft skill competency, which is leadership and managerial skills, and does not specifically address other soft skills and information technology competencies. Therefore, the existing competencies of navigation officers are insufficient for effectively navigating in the digital age (Fonseca, Lagdami, & Schröder-Hinrichs, 2019; Kongsvik, Haavik, Bye, & Almklov, 2020).

Thai seafarers serving as navigation officers are required to undergo theoretical and practical training in accordance with the STCW Convention in order to have the necessary qualifications for obtaining a Certificate of Competency (COC) from the Thai marine department. However, since the competencies defined by STCW are basic competencies that may not align with the evolving technology and changing nature of work, it is necessary to establish additional essential competencies for navigation officers. This will ensure compliance with future maritime operations that increasingly utilize advanced technologies, enhance vessel performance, and elevate the safety standards for ships, crew, cargo, and the environment. Failing to improve the competencies of navigation officers would hinder their ability to perform their duties efficiently in the future, thus impacting not only Thailand's maritime transportation but also global shipping as a whole. Therefore, the objective of this research is to identify competencies required for Thai navigation officers in digital age and develop a conceptual model of navigation officers' competencies. The research utilizes a content analysis approach by examining data obtained from a review of literature from the years 2018-2023, semi-structured interviews, and onboard observations.

Literature Review

Maritime Industry in Digital Age

The digital age is a period where the world places significant importance on incorporating technology into work and daily life. The term "digital" encompasses various new technologies and innovations that aim to make people's lives more convenient and meet the demands of modern society. In the maritime industry, there is a current trend of embracing new technologies and innovations to enhance ship operations. This includes utilizing advanced technology for autonomous ships and implementing them in the navigation process. The main objective is to provide transportation services for cargo and passenger ships, serving various destinations worldwide. Additionally, there are ongoing efforts to test advanced technology-based navigation methods (Cicek, Akyuz, & Celik, 2019; Yoshida, Shimizu, Sugomori, & Umeda, 2020).

Many organizations are driving the development of autonomous ship projects, such as the Maritime Unmanned Navigation through Intelligence in Networks (MUNIN) project, The Advanced Autonomous Waterborne Applications Initiative (AAWA) project, and Nippon Yusen Kaisha (NYK). Research has been conducted in various areas, including technology development, remote operation, education, safety, legal issues, and human factors. The operational system of an autonomous ship includes the following components: stability and integrity system, cargo handling

and monitoring system, autonomous engine monitoring and control system, maintenance planning system, anchoring and mooring system, PNT system, navigation situation awareness, collision avoidance system, dynamic positioning system, route planning system, reporting and communication system, and weather monitoring and interpretation system (Chaal, et al., 2020; Shaobo, Yingjun, & Lianbo, 2020). These technologies are new technologies that are beginning to play a significant role in shipping and will be further amplified in the future. It demonstrates that ship operators will have to work more extensively with advanced technologies than in the current era. The existing competencies alone will not be sufficient for the evolving technological landscape. Therefore, it is necessary to develop competencies that keep pace with the changes occurring. Consequently, in the maritime industry, in addition to utilizing technology for shipping operations, there is also a focus on developing the competencies of navigation officers to align with the leaps and bounds of changes in the maritime industry.

Seafarers' Competency

Competencies for seafarers are specified in the STCW Convention. The STCW Convention sets standards for the training of seafarers worldwide, ensuring they have the necessary knowledge and skills (IMO, 2011; Yoshida et al., 2020) The STCW for navigation officer competencies cover three domains: Navigation (9 competencies), Cargo Handling and Stowage (2 competencies), and Controlling the operation of the ship and care for persons on board (8 competencies). IMO Model Course is the program of model training courses following the adoption of the 1978 STCW Convention, as amended. The IMO Model Course provides guidelines for training programs for seafarers, and the training for navigation officers should be conducted in accordance with IMO Model Course 7.03. In Thailand, navigation officers must undergo training and pass the theoretical portion in according to the IMO Model Course 7.03 which specified the content, subjects, and number of hours of study for navigation officers at an institution certified by the Marine Department of Thailand. Once the navigation officers complete the required hours of training and passes each subject's test, they must undergo onboard training on a seagoing vessel of at least 500 gross tonnage for at least 12 months. After completing the onboard training, they can take a competence assessment test as per STCW Table A-II/1 to evaluate their knowledge and abilities (IMO, 2014; IMO, 2011; Sharma, Kim, Nazir, & Chae, 2019). Cicek et al. (2019) conducted a study focusing on the future competencies required by navigation officers, considering both functional and behavioral aspects to adapt to the evolving automated navigation systems. The research involved 214 navigation officers from various regions worldwide. The findings highlighted the importance

of functional competencies associated with technical skills for ensuring safe navigation operations. Additionally, individual competencies such as teamwork, leadership, communication, and language skills were identified as crucial for maintaining operational safety on board. The study also aligns with the research conducted by Jo, D'agostini, and Kang (2020) to propose measures that align with technological advancements in the maritime industry, aiming to enhance these competencies. Furthermore, the study emphasizes the significance of exploring behavioral competencies that are essential for navigation officer to work professionally.

Soft Skills

Soft skills are important skills that include desirable human qualities that benefit oneself, colleagues, and the working environment by promoting better teamwork, safer work conditions, and reduced incidents. This is particularly important in ensuring that shipping companies have quality seafarers when placing emphasis on developing soft skills among crew members (Kipper et al., 2021; OCIMF & INTERTANKO, 2018). OCIMF has identified six soft skill competencies for tanker seafarers, which are team working, communication and influencing, situation awareness, decision making, result focus, leadership, and managerial skill. In addition to these, the ability to work under pressure is particularly important for seafarers due to the risks associated with working in adverse weather conditions, mental and emotional stress, distance from home, inadequate rest, and other factors that can contribute to accidents and losses (Alroomi & Mohamed, 2018; Magnavita, Maurizio, Ricciardi, & Antonelli, 2020).

Information Technology

The field of Information Technology has become increasingly important for maritime personnel due to the prevalence of technology-driven equipment on board ships. As the shipping industry moves towards automation, seafarers must possess a basic understanding of various technological tools such as remote-operate systems, Internet of Things (IoT), cargo condition monitoring, dynamic position systems, and bridge control systems, among others (Chaal et al., 2020; Shaobo, et al, 2020; Sharma et al., 2019). According to Cicek et al. (2019), the emergence of Industry 4.0 has also led to changes in the skills required for maritime personnel. Considering these developments, it can be inferred that Information Technology is one of the domains in which navigation officers must possess proficiency in order to keep pace with the changing technological landscape and adapt to the future of work at sea (Kongsvik et al., 2020; Oksavik et al., 2020).

Objective

    1. To identify competencies required for Thai navigation officers in digital age.

    2. To develop a conceptual model of Thai navigation officers' competencies.

Thai Navigation Officer Training Process

The training process of Thai navigation officers can be explained through the process flow shown in Figure 1. The training process starts with the navigation officers undergoing training according to the IMO Model Course 7.03. The training institute will contact shipping companies to consider accepting the navigation officers for onboard training. Next, the shipping company will send the deck cadet (trainee navigation officer) to undergo onboard training on a cargo ship, which must be completed for a minimum of 12 months. After completion, a preliminary evaluation will be conducted by the assessor onboard and shipping company, and the deck cadet will be sent back to the training institute for further evaluation of the sea training. If the evaluation is successful, the deck cadet can use the evidence to apply for a certificate of competence from the Thai Marine Department to work on ships. If the evaluation is unsuccessful, the deck cadets must be assessed until they pass.
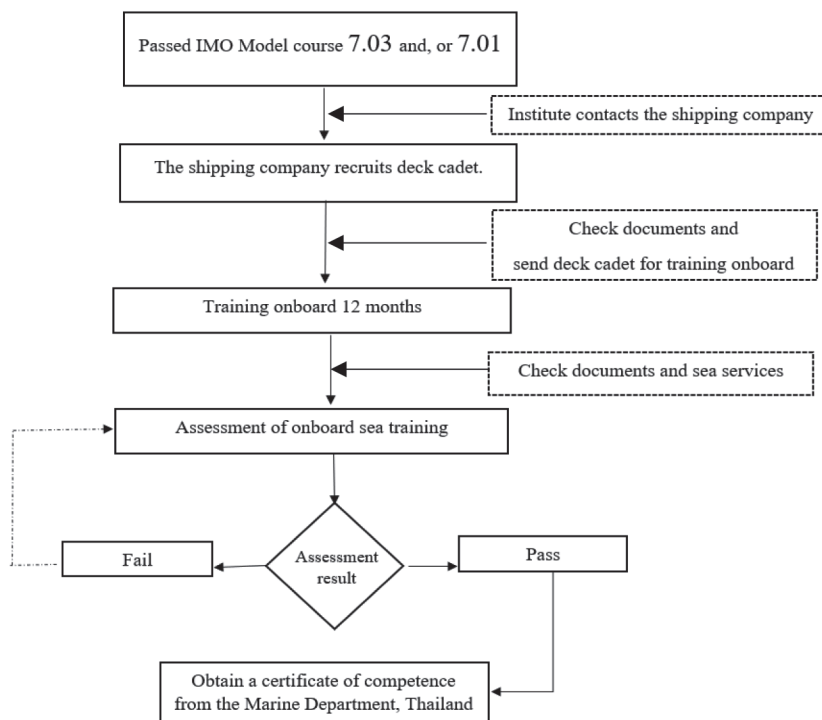
Figure 1 Thai Deck Cadet (Trainee Navigation Officer) Training Process

Source: Faculty of Logistics, Burapha University

Based on the aforementioned research review, the researchers have found that the development of the competencies for navigation officer in the digital age includes fundamental competencies that navigation officers must have as specified by the STCW Convention. Additionally, there is a need for additional competencies in information technology and soft skills. Furthermore, the Thai navigation officer training process helps in understanding the training procedures for navigation officers to enable them to perform digital ship operations. This process plays a crucial role in achieving the research objectives of identifying the competencies required for Thai navigation officers in the digital age and helps the researchers develop a conceptual model of navigation officers' competencies.

Research Methodology

In this research, qualitative research methods were utilized to establish the competencies necessary for Thai navigation officers. The initial stage involved utilizing the Triangulation method to gather data from literature reviews, semi-structured interviews, and onboard ship observations. Content analysis was employed to identify the suitable competencies and create an all-inclusive conceptual model.

Research Design and Analysis

The researchers gathered data from three sources: literature reviews, semi-structured interviews, and onboard ship observations. In the data collection process, two aspects were divided.

The first aspect involved studying in an academic manner, which was further divided into two parts. The first part focused on academic journal reviews, specifically examining academic articles published from 2018 to 2023. Databases such as Science Direct, Scopus, Emerald Insight, IEEE, and ThaiJo were utilized to conduct keyword searches on "navigation officer" and "seafarer's competency." The researchers found a total of 46 research articles, of which 21 articles are directly related to navigation officer competencies. The second part of the data studied the regulations related to the competencies of ship personnel from the STCW Code and the IMO model course, as well as announcements from the Thai marine department regarding the standards and requirements of knowledge and competency for Thai navigation officers.

The second aspect in practical manner, this research conducted interviews with key stakeholders involved in all aspects of navigation officer competencies. These stakeholders included representatives from training institutions for navigation officers (a senior navigation lecturer),

practicing navigation officers (a senior captain), and navigation officer employers (a senior crew manager). All the experts involved possess direct expertise in training and utilizing navigation officers, including the hiring process. These experts were selected based on their minimum 20 years of experience in the navigation field. The information about the interview was recorded during a video conference and took around one hour. The data collection process involved conducting semi-structured interviews. The interviews aimed to gather opinions on the essential competencies of a navigation officer as outlined by STCW and to identify additional competencies required in the digital age. The interviews followed an open-ended interview guideline covering areas such as navigation, cargo handling and stowage, controlling the operation of the ship and caring for persons on board, information technology, and soft skills. The interviews were conducted in April 2023, and the researchers recorded them for analysis. To gain a clearer understanding of the practical aspects, the researchers also conducted on-board ship observations. Non-participant observations were conducted on an international shipping vessel after obtaining permission from ship captains. The observations focused on five different types of vessels: bulk carriers, container ships, tankers, general cargo ships, and reefers. Two vessels of each type, with a gross tonnage exceeding 500 tons, were observed, resulting in a total of 10 vessels being included in the study. The purpose of these observations was to survey the work characteristics related to the necessary competencies in the present time and the competencies required for navigation officers in the digital age. The survey covered various areas, including navigation, cargo handling and stowage, controlling the operation of the ship and caring for persons on board, information technology, and soft skills. The researchers conducted on-board observations on these international shipping vessels, collecting data through direct observation and detailed note-taking. The observation period took place from January to April 2023.

Finally, this research collected data through the triangulation data which was analyzed using content analysis as the research methodology. This analysis aimed to identify primary domains and define competencies within each domain, leading to the construction of a conceptual framework for the essential competencies of navigation officers in digital age. Content analysis involves a thorough examination of relevant ideas and contextual factors, allowing for a comprehensive understanding of the subject matter. This approach is instrumental in creating initial models and identifying research needs and objectives. It is widely recognized for its ability to enhance the credibility of analysis results, as demonstrated in previous studies (Makkawan & Maungpan, 2021; Pariafsai & Behzadan, 2021). By employing this research methodology, the researchers

successfully developed a conceptual model for Thai navigation officers, contributing to a clearer comprehension of the required domains and competencies for Thai navigation officers in digital age.

Result and Discussion

The findings of this research are divided into two sections. The first section presents competencies required for Thai navigation officers in digital age and their domains. The second part provides a conceptual model of Thai navigation officer competencies.

1. Competencies required for Thai navigation officers in digital age Navigation officer competencies and domains from reviewed literature.

This research collected data from a literature review encompassing 21 articles published between 2018 and 2023, which were relevant to the competencies of navigation officers. Additionally, information was obtained from sources such as STCW Code, the IMO model course, and announcements from the Thai Marine Department. The findings indicated that navigation officers must have standard competencies in three domains: Navigation (9 competencies), Cargo handling and stowage (2 competencies), and Controlling the operation of the ship and care for persons on board (8 competencies). Moreover, beyond the aforementioned three standard competencies, it was identified that navigation officers require additional competencies in two other domains to effectively perform their duties in the digital age. These additional competencies include a total of 12 competencies in the Soft Skills domain and 11 competencies in the Information Technology domain. These findings contribute to a more comprehensive understanding of the competencies required for navigation officers in the digital age. Based on the study mentioned above, it was possible to identify the competencies for navigation officers in the digital age across five domains. This was done to obtain a diverse and more reliable set of information. Therefore, the researchers further conducted studies and collected additional data in the practical aspect by utilizing semi-structured interviews with experts and making observations on board ships. This enable researchers to compare and analyze the competencies obtained from both academic and practical perspectives.

Semi-structural Interviews

The researchers took the competencies obtained from the literature review and sought the opinions of three experts. The data collected from these interviews showed a consensus on the importance of identifying the competencies of Thai navigation officers and using them to

enhance their capabilities. The experts emphasized the primary focus on STCW Competencies, as they are internationally recognized standards that must be met. They also emphasized the need to further develop these competencies to improve knowledge and abilities. Additionally, the researchers conducted further inquiries into competencies related to Information Technology and Soft Skills. The experts shared similar opinions, emphasizing the importance for navigation officers to enhance their IT capabilities in order to effectively adapt to emerging automated systems. They also highlighted the essentiality of soft skills such as teamwork, clear communication, goal-oriented work, leadership, and the ability to perform under pressure. These skills were considered crucial for navigation officers to be skillful in their individual roles and contribute effectively to teamwork onboard. In summary, the findings from the interviews aligned with the result from literature review, emphasizing the importance of identifying and developing the necessary competencies for Thai navigation officers.

Observations on Board Ships

The researchers conducted observations on various types of ships, totaling 10 vessels, including 2 container ships, 2 general cargo ships, 2 tankers, 2 reefers, and 2 general cargo ships. The observations focused on cargo operations, ship navigation, controlling the operation of the ship, and the care of persons onboard. The research also encompassed the technologies used, including various electronic equipment, and emphasized the importance of soft skills for effective teamwork and enhancing efficiency in ship operations. It was found that the 31 competencies identified from the literature review are necessary and sufficient for the job performance of navigation officers. Additionally, the researchers also observed found that working on cargo ships requires a high level of safety awareness, and therefore, ship officer in each ship type must possess comprehensive competencies to ensure safe operations. In addition to fundamental competencies in cargo operations, ship navigation, controlling the operation of the ship, and the care of persons onboard, technological competencies are essential due to the prevalence of modern electronic navigation equipment. Moreover, soft skills are necessary for effective collaboration with others on the ship and enhancing work efficiency, particularly in team organization and ship navigation practices. Effective and succinct communication plays a vital role in conveying critical information to the ship controller, making timely decisions, and providing clear instructions to the crew. This is essential for ensuring efficient and secure ship operations. However, the research revealed that trainee ship officers exhibit deficiencies in some competencies, particularly in their proficiency with electronic navigation equipment and the technology utilized in ship operations and cargo handling.

Thus, it is imperative to enhance their knowledge and skills in these domains to enhance their expertise.

The researchers then analyzed the data from all three sources and identified the necessary competencies through content analysis. The research findings revealed that the competencies for navigation officers in the digital age consist of two parts. Part one includes the standard competencies that navigation officers must have in three domains: Navigation (9 competencies), Cargo handling and stowage (2 competencies), and Controlling the operation of the ship and care for persons on board (8 competencies). Part two consists of additional competencies required in the digital age, specifically in the areas of soft skills (7 competencies) and information technology (5 competencies). These additional competencies are clearly defined and appropriate for practical implementation, as shown in Table 1.

Table 1 Competencies Required for Navigation Officers in Accordance with STCW and Adding Competencies

Domain	Competencies	Reference
Standard competencies		
Navigation	NV01 Plan and conduct a passage and determine position NV02 Maintain a safe navigational watch NV03 Use of radar and ARPA to maintain safety of navigation NV04 Use of ECDIS to maintain the safety of navigation NV05 Respond to emergencies NV06 Respond to a distress signal at sea NV07 Use the IMO Standard Marine Communication Phrases and use English in written and oral form NV08 Transmit and receive information by visual signaling NV09 Manoeuvre the ship	(Cicek et al., 2019; Fai, Bai, & Wang, 2020a; IMO, 2014; IMO, 2011; Saha, 2021; Sharma et al., 2019; Sharma & Kim, 2021; Thansuvan, Siribunpitak, & Suebsakul, 2021; Wongpet & Moungpan, 2021; Yoshida et al., 2020)
Cargo handling and stowage	CS01 Monitor the loading, stowage, securing, care during the voyage and the unloading of cargoes CS02 Inspect and report defects and damage to cargo spaces, hatch covers and ballast tanks	(Cicek et al., 2019; IMO, 2014; IMO, 2011; Saha, 2021; Sharma et al., 2019; Sharma & Kim, 2021; Thansuvan et al., 2021)

Table 1 Competencies Required for Navigation Officers in Accordance with STCW and Adding Competencies (cont.)

Domain	Competencies	Reference
Controlling the operation of the ship and care for persons on board	CP01 Ensure compliance with pollution prevention requirements CP02 Maintain seaworthiness of the ship CP03 Prevent, control and fight fire on board CP04 Operates Life-saving appliance CP05 Apply medical first aid onboard ship CP06 Monitor compliance with legislative requirement CP07 Application of leadership and Teamwork skill CP08 Contribute to the safety of personnel and ship	(Cicek et al., 2019; IMO, 2014; IMO, 2011; Kim & Mallam, 2020; Saha, 2021; Sharma et al., 2019; Sharma & Kim, 2021; Thansuvan et al., 2021)
Additional competencies		
Soft Skill	SS01 Team working SS02 Communication and influencing SS03 Situation awareness SS04 Decision making SS05 Results focus SS06 Leadership and managerial skill SS07 Ability to work under pressure	(Fai et al., 2020a; Fai, Li, Ma, & Wang, 2020b; Kipper et al., 2021; OCIMF & INTERTANKO, 2018; Vasanthakumari, 2019)
Information Technology	IT01 Computing, Information and Data Processing IT02 IT Skill IT03 IT security and safety IT04 Knowledge regarding electronic equipment IT05 System Integration knowledge	(Cicek et al., 2019; Kipper et al., 2021; Kongsvik et al., 2020; Oksavik et al., 2020; Sharma & Kim, 2021; Wongpet & Moungpan, 2021)

Table 1 presents the standard competencies (3 domains) and additional competencies (2 domains) required for navigation officers in the digital age. These competencies are derived from data collected through triangular data gathering and analyzed using content analysis. The competencies are organized into five domains, encompassing a total of 31 competencies. First domain; The Navigation involves planning and conducting a passage, determining position, watch keeping, collision regulations, communications, and ship handling. Second domain; The Cargo handling and stowage involves cargo calculation, securing cargo and care during voyage,

cargo operations, ballast operation and management, and cargo hold inspection. Third domain; The Controlling the operation of the ship and care for persons on board involves pollution prevention, fire prevention and extinguishing, operation of life-saving equipment, and ensuring the safety of crew on board. Forth domain; The Soft Skill for navigation officers mainly concerns teamwork, effective communication, and decision-making. Fifth domain; Information Technology covering topics such as computing, information and data processing, IT skills, and IT security and safety. Once the domains and competencies for each domain were defined, a conceptual model was created for better understanding.

2. The Conceptual model of required competencies for Thai navigation officers.

The conceptual model provides a significant component that illustrates an overview of the competencies required for navigation officers in digital age, making it easy to understand and applicable in practice. This conceptual model highlights the relationships between domains and Thai navigation officer's competency required. The competencies are categorized into five domains: navigation (NV), cargo handling and stowage (CS), controlling the operation of the ship and care for persons on board (CP), Soft Skill (SS), and information technology (IT), as presented in Figure 2.
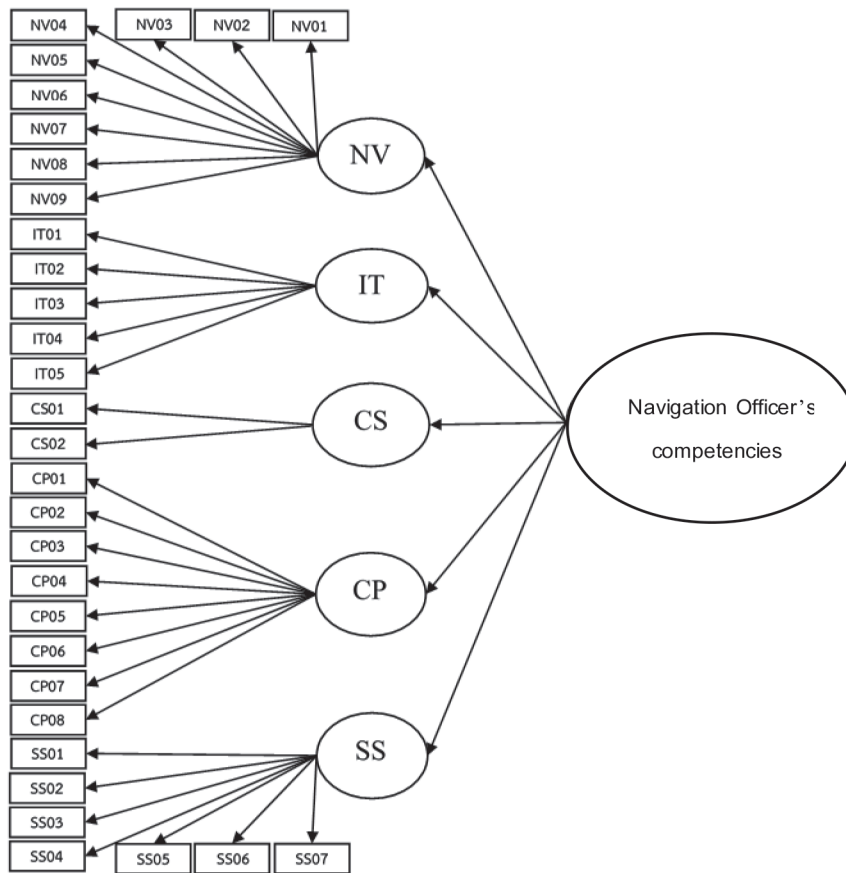
Figure 2 Conceptual Model of Required Competencies for Thai Navigation Officers in Digital Age

Firstly, Navigation domain is concerned with ship operation with the objective of safely navigating the vessel from its port of origin to its destination. These competencies are particularly crucial for navigation officers who need to learn and practice in order to serve as qualified navigation officers. The competencies include the following: Plan and conduct a passage and determine position (NV01), Maintain a safe navigational watch (NV02), Use of radar and ARPA to maintain safety of navigation (NV03), Use of ECDIS to maintain the safety of navigation (NV04), Respond to emergencies (NV05), Respond to a distress signal at sea (NV06), Use the IMO Standard Marine Communication Phrases and use English in written and oral form (NV07), Transmit and receive information by visual signaling (NV08), Manoeuvre the ship (NV09).

Secondly, Cargo handling and stowage domain, is one of the key competencies that navigation officers must possess. They must ensure that the cargo is loaded, discharged, and stowed in a proper manner to prevent damage and ensure the safety of the ship, crew, and

the environment. Therefore, it is imperative that navigation officer is equipped with the skills required to handle cargo operations effectively and efficiently. The competencies include the following; Monitor the loading, stowage, securing, and care during the voyage and the unloading of cargoes (CS01), and Inspect and report defects and damage to cargo spaces, hatch covers, and ballast tanks (CS02).

Thirdly, Controlling the operation of the ship and care for persons on board domain. This domain prioritizes the safety of the vessel, persons onboard, and environment protection. Aim to prevent potential hazards and emergencies that may arise during its operations. This includes ensuring preparedness for providing first aid in case of any untoward incidents. The competencies include the following: Ensure compliance with pollution prevention requirements (CP01), Maintain seaworthiness of the ship (CP02), Prevent, control and fight fire on board (CP03), Operates Life-saving appliance (CP04), Apply medical first aid onboard ship (CP05), Monitor compliance with legislative requirement (CP06), Application of leadership and Teamwork skill (CP07), Contribute to the safety of personnel and ship (CP08)

Fourthly, Soft Skill domain is an area that enables navigation officers to be skillful and effective, allowing them to work in various environmental conditions, which results in safe and successful work for themselves and their fellow crew members. The competencies include the following: Team working (SS01), Communication and influencing (SS02), Situation awareness (SS03), Decision making (SS04), Results focus (SS05), Leadership and managerial skill (SS06), Ability to work under pressure (SS07).

Finally, Information Technology domain is very importance today because ship technology is accelerating towards automation. The ship's equipment and navigation aids use modern technology that requires fundamental technology skills to work on board ships. The competencies include the following: Computing, Information and Data Processing (IT01), IT Skill (IT02), IT security and safety (IT03), Knowledge regarding electronic equipment (IT04), System Integration knowledge (IT05)

The research findings have demonstrated that the research objectives were met, which were to identify the competencies of Thai navigation officer in digital age as presented in Table 1, and to develop a conceptual model of Thai navigation officer, as depicted in Figure 2. The results revealed a total of 31 competencies in five domains, all of which are aligned with Oksavik et al. (2020) where the three main domains including navigation, cargo handling and stowage, controlling the operation of the ship, and care for persons on board are necessary for navigation officers to

work on ships as required by STCW regulations (IMO, 2011; IMO, 2014). The other two domains, soft skills and information technology, are also essential for navigation officers to have in order to perform efficiently and respond to the changing ship technology, according to the studies conducted by Sharma et al. (2019), Yoshida et al. (2020), Wongpet and Moungpan (2021), Kipper et al. (2021), OCIMF, and INTERTANKO (2018).

Expected Benefits and Application

The research findings have revealed that the competencies possessed by Thai Navigation Officers are not sufficient to perform effectively in the digital age. Therefore, educational institutions and training departments of shipping companies, which are responsible for training navigation officers, should focus on improving their onboard training programs. These programs should aim to ensure that navigation officers acquire all 31 competencies identified in this research. The competencies required for Thai navigation officers can be used as a standard to assess whether they have fulfilled all the necessary aspects. If any areas are found to be lacking, steps should be taken to develop courses that help navigation officers acquire the required competencies. It is also important for these training programs to keep up with the advancements in technology in the maritime industry.

Conclusion

This research has found that the competencies required for navigation officers according to the STCW convention is insufficiency with the current needs of ship operations. This aligns with the findings of previous studies of Cicek et al. (2019) and Jo et al. (2020) that go beyond the competencies outlined in the STCW code. It is necessary to incorporate additional competencies in the areas of soft skills and information technology, resulting in a total of 31 competencies that are essential for effective work in digital age. Regarding Information Technology, the research highlights the importance of keeping pace with the rapid advancements in maritime equipment. This includes proficiency in advanced automation systems for navigation, collision avoidance, ship stability, dynamic positioning, cargo handling, ballast and de-ballast operations, fire suppression, and auxiliary systems. On the other hand, soft skills play a crucial role in facilitating smooth coordination during ship operations. These skills encompass effective communication, teamwork, accurate decision-making, and ensuring safety on board. By prioritizing the development of these competencies, Thai navigation officers can enhance their professionalism and collaborate effectively with the global shipping industry.

The research has identified the necessary competencies for Thai navigation officers and developed a Conceptual Model that illustrates these competencies. Educational institutions can use this model to improve their training programs and produce well-prepared navigation officers by adding on Information Technology and soft skills. The model consists of 31 competencies that can be used to define the expected learning outcomes and design specific courses. Similarly, shipping companies can use these competencies as a guide when selecting candidates for the navigation officer position. This ensures that candidates have the required qualifications to perform the job effectively and adapt to evolving technologies in the industry. Furthermore, these competencies can be utilized to create training programs that address any areas where navigation officers may be lacking in their skills.

Suggestions

1. Due to the limited number of research studies conducted globally and in Thailand on the development of navigation officer competencies, as well as the rapid advancement towards automated ship navigation, this research represents the latest study in Thailand that investigates the competencies of navigation officers to keep pace with the changing dynamics of the maritime industry. It also serves as a valuable source of information for other researchers interested in related topics. They can refer to the findings of this research as an additional reference, benefiting both the academic and practical aspects of the maritime industry.

2. This research utilized a qualitative research approach, specifically employing the triangulation data technique, to gather and consolidate information. This approach enabled the researchers to identify the necessary domains and competencies. However, in order to validate the accuracy of the research findings, future research will involve testing the conceptual model of competencies required for Thai navigation officers in digital age. This validation process aims to confirm the validity and effectiveness of the identified competencies, ensuring that they accurately reflect the skills and knowledge needed for Thai navigation officers of their roles in digital age.

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