The Role of Human Resources in Sea Transport Safety and Security: Literature Review

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ABSTRACT

Humans play an important role in maintaining the safety and security of lives on board ships. Most of the causes of accidents in the shipping sector are human elements. Improving shipping and navigation safety can be done by strengthening and focusing on human factors. Approximately 80% of world trade is on sea routes so that the safety and security of lives at sea and the protection of the marine environment are highly dependent on the professionalism and competence of a sailor. The study will focus on human resource governance issues that are very important in the planning and operation of marine transportation systems. Marine environmental safety is one of the focuses studied in this study. The study aims to determine the role of humans in improving safety and security in marine transportation systems by using variables of improving vocational college institutions, improving sailor competence and improving the propriety of operators and users of marine transportation services. The approach taken in this study is the literature review method and observation of problems and cases of accidents in marine transportation as well as interviews with several academics and practitioners who have experience in the world of shipping. The results of this study provide a comprehensive picture of the contribution of human resources in reducing accidents and maintaining the sustainability of the maritime environment in the marine transportation system by strengthening the institutional system of educational and training institutions in improving the professionalism and competence of marine transportation human resources.

INTRODUCTION

Human resources have a very large contribution to the occurrence of an accident that occurs at sea [1]. Humans are in control of the operational process of ships at sea. The occurrence of an accident is caused by several factors that are closely related to the existence of humans as controllers of marine transport activities. Errors can occur due to misinformation about site conditions, lack of awareness, lack of teamwork [1].

Human influence is one of the most important causes of accidents [2] because humans are the leaders and operators of marine transport activities and are responsible for most of the communication and operational tasks in the marine transport system. The first equipment that causes safety interference due to human factors is skill, decision and perception [2]. The main cause of maritime transport accidents is caused by human factors based on the identification carried out by A.Galierikova [2] outlining that 70% of maritime accidents are caused by humans. The approach that is widely used to explore the factors that cause these accidents is the *Human Factor Analysis and Classification System* (HFACS). Human nature and character are not the same so that in perceiving an order and procedures and rules that apply are also different. This difference is very unpredictable by anyone involved in making a policy [2].

According to Sanders and McCormick (1993), in A.Galierikova's research [2] outlines that human error is an inaccurate or unacceptable human decision or action that has an impact on reducing system efficiency, safety, or performance. Rasmussen (1982), in A.Galierikova's research [2] described 3 levels of human behaviour, namely humans with a knowledge base that can be directly involved in making plans to solve a problem, based on human rules representing activities that use instructions or procedures and based on behaviour where humans have a skill base which means routine activities carried out spontaneously. Based on this knowledge base, humans have the ability to plan things well and carefully and can provide the right solution to the problems faced in their work. Armed with knowledge, humans can also carry out instructions and procedures that apply in an activity that is carried out. Routine activities carried out daily spontaneously can produce a skill and competence for the perpetrator [2].

In a study conducted by D.Guevara [3] based on a logistic regression model approach to find the relationship between factors that determine the seriousness of marine accidents. Armed with data from accident investigation reports around the world for the period 2010-2019. The results found that the seriousness of marine accidents is closely related to ship sinking, distance from the harbour, strong winds, choppy seas, strong currents and/or good visibility [3]. In addition, the results of his study also found that the vessels involved in many accidents include ship types, fishing vessels, cruise ships and sailing ships. The most serious highlights that aggravate the accident rate are vessels that do not have seafarers' certificates and are incomplete and invalid, inadequate human resources, ship administration completeness such as ship

certificates that do not meet the requirements or are invalid and vessels that are over 30 years old. Seafarers who have a poor level of theoretical knowledge and less sea experience are more likely to be involved in accidents with serious consequences [3].

Based on the above background, it can be concluded that all accidents experienced by sea transport from the past until now are dominated by human resource factors that control the planning and operational processes in sea transport. Thus, strategic steps need to be taken by educational institutions, especially vocational higher education institutions under the authority of the Transportation Human Resources Development Agency (BPSDMP) and in general, vocational higher education institutions that have a major contribution to increasing the knowledge and competence of human resources for sea transportation operators. The quality of vocational college outputs should be part of what must continue to be closely monitored and supervised so that the quality of services provided to users of sea transportation services and operators who use output services as an outcome benefit and processes that run in accordance with the needs of sea transportation today and in the future. Of course, this expectation is not only imposed on the managers of vocational education institutions but the involvement of all stakeholders who have the same interest, namely improving the safety and security of Indonesian marine transportation services nationally and the world maritime community internationally. In addition to human error, there are several other causes of accidents in marine transportation services, namely violations , environmental, condition of operators, personnel factors.

CHALLENGES

Based on the background described above, there are several challenges faced in improving the quality of human resources (HR) for sea transportation, which determines the improvement of sea transportation services for the future of Indonesia. The first is the problem of the output of vocational education institutions under the Ministry of Transportation being less competitive with educational institutions in other countries, even though the Ministry of Transportation has set HR development as a priority programme in all directorates. The development of competent, professional, ethical, and integrity human resources is the key to improving the nation's competitiveness. Improving the quality of education and training [4]. Second is the problem of improving the competence of seafarers held by

most authorised institutions that do not focus on improving the competence of training participants but are more focused on achieving realisation as a public service agency (BLU), so that the output also does not produce the required quality, meaning that the certificate of improvement obtained by training participants is not proportional to the quality of competence possessed so that it has an impact on service on board. The third is the lack of appropriateness and implementation of regulations carried out by companies engaged in sea transportation. Companies have a contribution to the safety and security of sea transport. Many accidents at sea are caused by inappropriate regulations, such as ships that are not fit to sail but are still being forced.

RESEARCH OBJECTIVE

The purpose of writing this scientific work is to find out the extent of the role of human resources in improving the safety and security of marine transportation so as to minimise the occurrence of accidents at sea and can improve the sustainability of the aquatic environment through three approaches, namely increasing education, institutional development and increasing training. The synergy of the three approaches used is expected to make a more tangible contribution to realising safety and security and the sustainability of the marine environment. In addition, this research reviews several literacies related to the role of regulators and operators as well as service users in realising the safety and security of marine transportation.
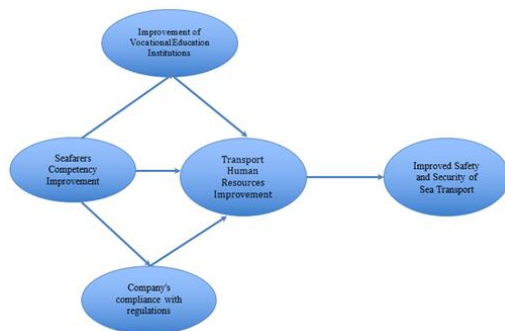

Fig 1. Research Objective Framework

RESULTS AND DISCUSSION

4.1 Improvement of Vocational Education Institutions

The institutional improvement of sea transportation vocational education under the authority of the Ministry of Transportation, in this case the Sea Transportation Development Agency, has increased significantly. The hope of increasing the statute from the shipping science education and training centre to the shipping polytechnic is to improve the quality of graduates in meeting national and international market needs and globally applicable standards. The sea transportation vocational education of the transportation human resource development agency has two main objectives, namely as an educational institution and as an educational institution that is pursued through achieving the realisation of a public service agency (BLU). From a maritime business point of view, of course this institution is very promising with a large distribution of Indonesian seafarers, both outputs from their own alma mater and from other vocational institutions. However, the main tasks and functions as an educational institution that has a moral responsibility for the quality of competitive outputs are not necessarily ignored and become an obligation, and become an important foothold in preparing quality human resources and being able to face the complexities and dynamics that are growing rapidly in the maritime industry today. This commitment must be built into a comprehensive vision and mission of the urgency and relevance of vocational education in building competencies that meet the needs of the maritime transport sector, carefully mapping the challenges that become obstacles, and providing solutions and strong recommendations in improving the quality of maritime transport vocational education to answer the calls of the maritime industry efficiently and effectively [5].

4.1.1 Implementation of quality education and global competitiveness

Some concrete efforts that must be made in creating quality and globally competitive graduates include:

a. Qualifications of teaching and education personnel that are in accordance with the competence and expertise of their field of knowledge in the learning process. Qualifications in the field of science that are not in accordance with what is given in the classroom will have an impact on the students who receive it. Many educators teach not in accordance with their classification. Vocational education in marine transportation based on the applicable curriculum requires a face-to-face learning process of only 30% while the practical learning process requires 70%, the problem is that the lecturer teaching the course in the classroom is also a lecturer teaching practical activities so that it does not run effectively and efficiently and the process of teaching and learning activities. Employees who have the main task as lecturers should be

encouraged not to be given other workloads as administrators so that these employees can focus on teaching without dividing their minds with other jobs.

b. Universities should encourage teaching staff or lecturers to continue to improve their competence through internships in the maritime industry on a regular basis as the programme that has been running in the human resource development agency of transportation, but needs to be improved in international companies in order to share knowledge to improve the quality and competence of lecturers. Building collaboration with industry provides very significant benefits for universities including adjusting the curriculum based on current industry needs [6]. Universities experience a dilemma in curriculum development because it stands on two interests, namely on the other hand having to follow the standardisation made by international maritime organisations and on the other hand having to meet accreditation from the higher education database (PDDikti). This process continues despite the confusion between the needs so it needs to be encouraged to synergise with each other to improve the quality of graduates.

c. Improving education facilities and infrastructure
Educational facilities and infrastructure are an important factor in improving the quality of education that is globally competitive. One perspective on quality educational institutions is the availability of adequate educational facilities and infrastructure as a support for improving the quality of graduates [7]. A measure of service quality can be seen from the amount of utilisation of facilities and infrastructure of an institution. If this is not addressed quantitatively, domestic and foreign competitors will benefit greatly from this competition.

d. Information Technology Utilisation
Information technology plays a very strategic role in the world of education today. The rapid development of information technology in the current era of globalisation is inevitable in its influence on the world of education. Global demands require the world of education to always adapt technological developments to efforts in improving the quality of education, especially the adjustment of the use of information and communication technology for the world of education, especially in the learning process.

learning process. This research is a library research method. Educational technology is the application of scientific knowledge to learning which results in learning objectives being achieved effectively and efficiently, which is not only limited to tools and goods or hardware (hardware) but also software, and brainware [8]. Information technology innovations that are developing rapidly and accompanied by very rapid changes in the shipping industry in particular and the world of work in general require educational institutions to adapt quickly otherwise they will be left behind by these changes [9]. The development of current information technology such as by examining cutting-edge innovations such as Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), Automation, Blockchain [9].

4.2 Improving Seafarers' Competence Improving seafarers' competence is a necessity that cannot be separated from the seafaring profession. Individual and organisational competencies will be increasingly needed in the future, given the rapid development of the industrial world with technological changes that require adjustments according to current and future market needs. EU SkillSea report suggests that the competencies required by STCW will not be sufficient for future seafarers [10].

1. Personal skills and competencies
    a. Skills
    The seafarer profession in the future will have a big challenge in facing technological advances and changes in work methods that apply to shipping companies so that they must have the ability to take advantage of these new work methods. Likewise, a seafarer's ability to innovate and creativity in interacting socially with others and last but not least, a seafarer must have the ability to be multilingual in communicating globally for the operational activities carried out.

    b. Competence
    An innovation mindset to understand business development and utilise digital technology is one of the competencies that must be possessed by people who work as seafarers in the future and have analytical thinking (including risk and system analysis) to interpret and understand the need for change and the steps needed.

2. Organizational and management skills and competencies
   a. Skills
      The ability to communicate and negotiate, to promote the necessary changes to colleagues and customers and the ability to market and promote greener products and services. The ability to consult and advise end-users on green solutions and spread the use of green technologies are necessary skills.
   b. Competencies
      The ability to apply change management in the shipping business world is a must-have for current and future seafarers. As well as the ability to develop and implement human resource management and knowledge management systems, advanced knowledge in project management in applying new technologies so as to work strategically, as well as enabling business policy makers to set the right incentives and create conditions to achieve goals. A seafarer must have the ability to manage teams and people working remotely and/or in dispersed teams. The ability to coordinate and manage a holistic and interdisciplinary approach that combines economic, social and ecological objectives is essential.

3. Safety skills and competencies
   a. Skills
      Seafarers on vessels operating with conventional fuels should adopt the safety mindset of the tanker/gas fleet when working with new fuel types as well as the ability to apply current emergency preparedness procedures such as first aid, fire detection and fire fighting.
   b. Competencies
      Knowledge of potential fuel hazards on ships and how these apply to equipment operation and maintenance and knowledge of gas testing and atmospheric monitoring procedures and knowledge of fuel-specific chemistry and physics to understand potential safety hazards. Knowledge of the basic concepts and properties of different types of fuels.

4. Skills and competencies to master complex maritime operations
   a. Skills
      Ability to perform safe maintenance of vessels and equipment with more hazardous fuels on board as well as the ability to handle digital and manual systems for platforms, decks, engines, manoeuvring and propulsion introduced with new fuel technologies. In addition, the ability to master new refuelling methods and the ability to operate complex hybrid and zero-emission engines as well as the Ability to operate hydraulic components and pneumatic equipment.
   b. Competences
      Knowledge of engine functions and manoeuvring characteristics and knowledge of how to operate the vessel in an energy-efficient manner.

5. Sustainability competencies
   Knowledge of emissions monitoring and documentation should also be fundamental to a seafarer's understanding. Knowledge of environmental economics and the use of performance management systems. As well as knowledge of logistics and optimisation methods to achieve high vessel utilisation and sophisticated routes. Knowledge of environmental awareness and sustainable business development is one of the important competences now and in the future.

6. Digital skills and competencies
   a. Skills
      Information technology and digital skills are data fluency and the ability to interpret and analyse large amounts of data. Likewise, the ability to operate equipment using digital controls as well as the ability to complete tasks digitally through monitoring system operation and management and the ability to update, repair and maintain digital systems.
   b. Competencies
      Remote operation control, recording and analysing data from multiple sources. Knowledge of basic digital technologies (IoT, sensors, networking, cybersecurity, connectivity). Advanced analysis and use of data to optimise fleet. In-depth technical knowledge to understand complex systems (sailors as system managers). Knowledge of cybersecurity.

7. Automation skills and competencies
   a. Skills
      Manage automation failures, with onshore support through detailed knowledge and proficiency in the use of automated systems. Ability to monitor and repair its functioning
   b. Competences

Knowledge to diagnose malfunctions and repair them through automated systems. Advanced knowledge of electrical systems. Knowledge of programmable logic controllers (PLCs).

Based on the description above, it can be concluded that there are six skills and seven competencies that must be understood and possessed in improving the skills and competence of a seafarer. Upskilling is done through the process of learning new skills or teaching new skills to workers. Re-skilling is done through the process of learning new skills to enable someone to do a different job, or training people to do a different job. Future alternative fuel technologies, such as hydrogen, ammonia, batteries and biofuels, are expected to provide new training for all seafarers, in addition to on-board familiarisation, specifically for the vessel they are on. To operate new technology systems on board and properly manage new fuels, seafarers will need the necessary skills, knowledge, training and familiarisation. If not properly addressed, this can pose serious risks to the health and safety of seafarers, vessels, communities and the environment. A 10-point action plan can help the industry achieve a Just Transition for Seafarers on shipping's decarbonisation journey, according to a position paper by the Maritime Just Transition Task Force.

The results of observations and interviews with academics and sea transportation practitioners, obtained information that the cause of an accident both at the port and accidents that occur on the way from the port of making to the port of unloading dominantly occurs due to overload in line with what has been described by Kim Hyungju [11] causing the ship to sink, technical specifications of a ship or economic umar of a ship causes many ships to sink, *human error* and extreme weather causes the ship to crash. Many ship fire accidents are caused by technical ship problems.

According to S.Sea.com [10] in its description it is stated that there are several key actions in supporting the green transition to shipping to ensure fair transition planning in line with global labour standards. Need to champion diversity and equality and be inclusive on board. Focus on an approach that prioritises health and safety by establishing a consensus to open up training. Seafarers' careers must be considered and supported to avoid gaps. Recruitment and attrition must be controlled. Invest in competency and skills upgrades that support the green transition. Competence and knowledge must be kept up to date. Provide all seafarers with equal opportunities for training. Keep abreast of additional developments and skills required to handle alternative fuels.

4.3 Improved compliance with applicable regulations

a. Role of Regulator/Government

All transport activities in waters, ports, shipping safety and security, and protection of the maritime environment in Indonesian waters [12]. Shipping laws have comprehensively regulated all activities carried out in the water environment. Shipping activities are clearly outlined based on the purpose of shipping in the shipping law, namely as protection of defence and security in the waters of a country and society, as well as developing the country's economy. The provisions of Law No. 17/2008 on shipping can accommodate all sea transport operations, ports, and shipping safety and protection, as well as how to be sustainable in the Indonesian and global marine environment. This law provides protection not only within Indonesian waters, but including external Indonesian waters for all Indonesian flag vessels. In addition, Law No. 17/2008 [12] also regulates any vessel outside of Indonesia that does not carry the Indonesian flag sailing in Indonesian maritime territory under a foreign flag. The state has absolute control over its maritime waters through regulation, monitoring, and supervision of the mechanisms used by the government to provide safety and security guidelines regulated and supervised shipping through navigation to support shipping safety and security where the government has established navigation facilities so that shipping can operate smoothly and safely [12]. Security and safety protection measures in the waters, have been implemented but the protection measures have not been maximised some cases about the issuance of ship transportation certificates and ship transportation feasibility certificates have not been implemented optimally. Thus, for safety and security in Indonesian waters, it is necessary to carry out inspections strictly by the party holding the authority for this. Supervision that is carried out thoroughly can reduce the incidence of danger and casualties in the future.

b. Role of the Company

The company as an operator has a great responsibility in creating a conducive climate for the safety and security of sea transport. One form of responsibility that must be maintained and dispatched is to implement in a disciplined manner with a full sense of responsibility all applicable regulations as a sea transportation operator. ports, operators, and service users must be equally disciplined and orderly in the

realisation of *zero to accident* that has been launched by the Ministry of Transportation [13]. According to data released by the directorate general of sea transportation, it is stated that approximately 80% of shipping accident cases are due to negligent human factors, either on the part of operators or regulators. Service users also greatly contribute to the occurrence of sea transportation accidents because sometimes they do not have patience in receiving services from operators, often force themselves and violate predetermined rules [14]. affirmation of the importance of familiarising obedience and discipline to regulations both as regulators and as operators and service users [13].

a. Role of Service Users

Service users have a great responsibility for accidents in marine transportation. Service users must understand all applicable terms and conditions when using marine transportation services. Operators are required to convey everything related to the safety and security of marine transportation so that with this understanding, service users can be more careful and self-aware in traveling with the marine transportation services. Stability problems due to technical changes in ships can cause accidents in addition to overloading and ballast water discharge, as well as unsafe cargo. The results show that the root cause of the ship sinking is in the approval clearance out procedure, crew recruitment procedures, ship maintenance, and maritime education that has not implemented the Maritime Education Quality Standards System (QMS). The most appropriate preventive action to overcome the root causes of ship sinking is to create a system and use technology to assess seaworthiness, create a system to ensure that shipping companies carry out a selection process when accepting ship crew and use technology in the ship crew selection process, create a system and technology to ensure the authenticity of ship crew documents and ensure that ship crew have the appropriate competencies, create a system for testing ship crew competencies randomly and periodically on ships, and create a system so that ship crew can report if they find deficiencies or damage to the ship or its equipment, especially critical equipment [15]
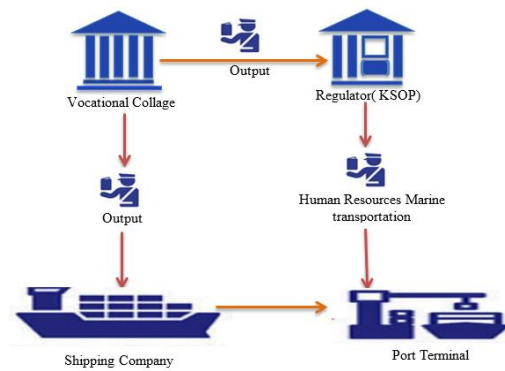

Fig.2. Operational technical ecosystem for marine transportation safety and security

CONCLUSION

The quality of human resources greatly contributes to creating *zero accidents* in sea transportation can be improved by taking 3 (three) approaches, namely improving the institutional governance of vocational colleges through digitalisation of services in the acceptance of formation training participants and seafarer upgrade training participants. In addition, at the level of the learning process, an effective and efficient way must also be carried out by providing qualified teaching staff and experts with their scientific fields so that the output produced has a globally competitive capacity that can contribute to improving the safety and security of transportation services in the future. Strengthening the institutional pillars of vocational universities can be at the forefront in overseeing the quality improvement and competency development of marine transport human resources. Similarly, increasing the propriety of operators and users of sea transport services towards the implementation of applicable laws and regulations through increased supervision and discipline of regulators over implementation in the field. Regulators must stand independently to avoid becoming involved as operators among service users and operators themselves. The synergy between the three elements of the approach used is expected to reduce the incidence of sea transport accidents to zero accidents in the future. Thus, further research needs to be carried out to find out how much influence the human resources variable through the variables of increasing the institutionalisation of vocational universities, increasing competence, increasing the appropriateness of operators and users of sea transportation services to improve the safety and security of sea transportation services. In validating the role of human resources in improving the safety and security of maritime transport services, further research is needed to find out whether maritime

transport human resources have a high and positive significance in supporting the safety and security of maritime transport services.

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