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Safety Equipment Technology and Planned Maintenance Systems on the Performance of International Shipping Ship Crews

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Abstract: Research related to safety training, planned maintenance systems, and safety equipment technology in influencing ship crew performance by mediating work competency. The research method is quantitative, the data analysis method used is SEM – PLS. Correspondence of 90 crew members from PT. Pertamina International Shipping. The research results show that safety training influences competence, namely increasing life safety at sea and reporting the position of the ship when sailing via radio and GPS. The maintenance system influences work competency, the findings show that the ship maintenance planning procedures are running well. Safety equipment technology significantly positively influences work competency. Planned safety training can improve the quality of ship operational performance. The arranged upkeep framework appears great transport support administration that underpins the smooth operation of the transport to progress the execution of the ship's team. Security gear innovation impacts the execution of dispatch group, finding ideal security gear contributes to moving forward security and team execution. Work competency intercedes the positive and critical impact of security preparing, arranged support frameworks and security gear innovation on transport group execution. Work competency plays an important role as a mediator in the relationship between safety training, planned maintenance systems, and safety equipment technology and the performance of ship crew at PT. Pertamina International Shipping.

Keywords: Safety Equipment Technology, Planned Maintenance Systems, Ship Crew Performance.

INTRODUCTION

Letter from the Minister of BUMN Number S-616/MBU/08/2021 regarding Approval of Subholding Shipping Restructuring to Subholding Integrated Marine Logistics (Watts & VA, 2021) which was originally a professional charter out business, based on shipping that applies in practice, officially PT Pertamina Internasional Shipping (PIS) became Subholding Integrated

Marine Logistics. PT PIS in its capacity as Subholding Integrated Marine Logistics oversees six main terminals (Slattery et al., 2021; Zhu et al., 2018).

Not only regarding shipping at the port but also related to certified safety training for human resources on ships. In 2021 there will be 209 certificates and in 2022 there will be 1855 certificates compared to 3207 in 2020. Based on the facts above, PT PIS certainly needs a strong fleet with personnel or crew who are highly qualified in their fields to support safe shipping activities (Nathanael, 2023). On this basis, it is very important to build and develop human resource competencies in the maritime transportation sector that meet international scale knowledge, skills and competency requirements.

The company for ship crews before working on ships and to develop ship crew skills, namely the Pertamina Maritime Training Center managed by PT PIS which is related to ship management training for ship crews. The importance of training is also supported by the International Maritime Organization (IMO) convention on Standards of Training Certification and Watchkeeping in 1978 (SCTW '78) implemented globally for human resources in ship fleets, and in 1989, the Pertaminan Shipping Special Education and Training Agency as manager IMO member countries (Maemunah et al., 2021; Philipp, 2020).

The training program is a planned maintenance system to support the smooth operation of the ship, and of course this requires engines or aircraft propulsion or ship safety equipment. This needs to be supported by the availability of good, effective and efficient work and maintenance systems. Shipping accidents or ship accidents are events that can threaten the safety of ships and human lives. Ship accidents can be in the form of: Ship sinking, Ship burning, Ship collision, Ship running aground (Caamaño et al., 2018; Dilaver et al., 2023).

Carrying out maintenance functions to maintain optimal engine performance (Maemunah et al., 2022). In order for maintenance work to be carried out quickly and precisely, it needs to be carried out in an integrated and systemized manner. Requires a detailed schedule regarding the main engine parts to make maintenance easier. Distance and time in caring are just general standards. To create information collection less demanding, this type of upkeep is laid out within the shape of a arranged upkeep framework (Dilaver et al., 2023). The arranged support framework portrays the arrange of work to be carried out. For this reason, its execution requires group individuals who get it and are gifted. Transport teams are required to get it the capacities and benefits of the arranged support framework By understanding this, the crew will understand the reasons why they carry out routines together, such as cleaning coolers, cleaning filters, checking machinery and so on (Bezuidenhout et al., 2020; Caamaño et al., 2018) .

Incidents of ship damage to the PT fleet. PIS where the planned maintenance system is not implemented properly. Several reasons for not implementing a well-planned maintenance system are due to 1). The cost of maintaining and repairing ships can sometimes approach the cost of building a new ship due to the high frequency of maintenance. 2). Low crew understanding of the planned maintenance system. 3). Low Soft skills ability means that the ship's crew cannot work together optimally in carrying out maintenance in accordance with the planned maintenance system(Lindau et al., 2021).

Related to research objects on board ships where the function of the planned maintenance system is in the maintenance and repair of ship and deck equipment and machinery, namely 1) emphasis on planning and analysis by considering operational challenges that are different from ships; 2) Unexpected maintenance or replacement schedules; 3) The incident affected the winch brake which is very important when the ship is docked, as evidenced by damage to the brake pad on the windlass machine; 4) Black out due to failure to carry out routine maintenance on the diesel generator auxiliary engine, 5) The crew fell into the water when the monkey ladder was damaged or disconnected (Hanzu-Pazara et al., 2016; Ricardianto et al., 2021).

Apart from that, there is the technological factor of safety equipment (Maemunah et al., 2021), in this case the remot control lifeboat, according to accident data in Indonesia, it

provides evidence that the level of ship safety has not really been optimized. Actually, a ship is a means of transportation that is equipped with many safety features, such as life jackets, fire extinguishers, life rafts, lifeboats, and so on. Many organizations or institutions regulate this safety equipment, including the IMO (International Maritime Organization) for mandatory ISPS code (International Ship Security & Port Facility) regulations, as well as class regulations such as BKI (Indonesian Classification Bureau).

Frequent maritime incidents require attention. The Germanischer Lyoyd (GL) Law specifically regulates lifeboats—one of the ship's lifesaving devices—separate from the rest of the ship (Maemunah et al., 2023). The ship had an accident in the middle of the sea, a remotely controlled lifeboat became one of the rescue tools available (Baştuğ & Yercan, 2021; Caamaño et al., 2018). Germanischer Lloyd regulations, which are the reference for domestic classification regulations, especially BKI, limit the travel speed of lifeboats. For a fully loaded lifeboat, the speed is limited to 6 knots or 3.08 km/h, and for a lifeboat that can accommodate 25 people, the speed is limited to 2 knots or approximately 1.02 km/h. Lifeboat remote control speed is accompanied by 24 hour fuel capacity. In other words, the remote control life bouy can only cover a distance of approximately 74 kilometers. The ship evacuation process also begins when passengers or crew members receive a danger signal at the initial position where they are, then escape to a position where they are placed as close as possible to the remote control lifeboat. Lifeboat is the main rescue vessel on a ship. Therefore, the remot control life buoy must be placed in the most effective position to reduce the time required for the evacuation process.

Safety equipment on board; otherwise, in the event of unfavorable conditions, for example the ship leaks or sinks, the necessary equipment will not be available, which could have a very dangerous impact on the lives of passengers (Oroye et al., 2022).

Major problems can arise if remote control life bouy safety equipment is not provided properly or is in poor condition. Loss or damage to the lifeboat remote control can threaten the safety of the crew and company operations. Safety equipment technology, including lifeboats, requires regular maintenance and testing. Problems can arise if maintenance is not carried out regularly or if the life bouy remote control test does not go well.

Competence is needed for a ship's crew to be able to carry out their duties and obligations effectively to avoid accidents and problems as described above and avoid unexpected accidents. New technology in maritime safety equipment can help minimize accidents (Bachtiar et al., 2021; Cicek et al., 2023; Maemunah & Nekrasov, 2023).

The root of the problem is the performance of the crew members in the company's fleet of vessels which are reported to have repeatedly experienced work accidents by PT Pertaminan International Shipping. Three workers died in work accidents in September 2011. A contractor lost his life in January 2013 after falling from a tank. Contractor negligence can pose a risk to the business and result in accidents that reduce the company's K3 performance (Maemunah & Cuaca, 2021). In order to ensure the safety of all contractor work activities within the company, contractor activities must be managed effectively. It is important to plan safe work practices to minimize and control work accidents (Maemunah & Endri, 2025).

Previous research gaps (Caamaño et al., 2018), show the minimal implementation of ship maintenance management which can affect the smooth operation of ships and the implementation of ship maintenance by deck departments that differ from provisions/procedures. The second research by Anggoro & Supriyadi, (2022) found that transactional leadership and competence influenced crew satisfaction and performance at Miclyn Express Offshore Pte.Ltd.

Research by (Onakpojeruo et al., 2023; Siti Maemunah, 2022) shows how important safety equipment is for a ship's ability to sail, especially when facing the danger of fire, people falling overboard, ships sinking, and so on. So that safety equipment can operate as it should, routine maintenance should be carried out.

METHODS

The population in this study were 111 crew members from 5 ships that were onboard more than 5 times in 2023, namely: 1. VLGC Pertamina Gas 2 with 11 crew members, 2. MT. Gas Attaka with 25 crew members; 3. MT. Gas Arar with 25 crew members; 4. MT. Gas Arimbi with 25 crew members and 5 MT. Gas Walio with 25 crew members. The Slovin formula (Sugiono et al., 2023) was used to calculate the number of samples required, namely 90. The quantitative data that had been collected was then analyzed using Structural Equation Model (SEM) analysis (Asghar et al., 2020). Respondents based on gender, age and education level in a study of 90 ship crew members. Overall, the majority of respondents were men (expressed by code a), with the majority age being in the range 31-50 years, especially those over 40 years old. Most respondents had a minimum of a Diploma, reflecting the relatively high level of education among ship crew.

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RESULTS AND DISCUSSION

Testing the direct influence hypothesis above can be explained as follows.

H1: Direct effect of safety training on work competency at PT. Pertamina International Shipping.

Security preparing on work competency with a parameter coefficient of 0.305 which appears that the impact of security preparing on work competency is positive at 0.305. This implies that in the event that there's an increment in security preparing, work competency will increment by 0.305. Besides, based on T-Statistics H1 of 4.958 which is more prominent than the level or 4.958 > 1.96, and P-values H1 of 0.000 which is littler than the genuine level or 0.000 < 0.05, this appears that the coordinate impact of security preparing on work competency is critical. Hence, it can be concluded that H1 is accepted, so there's a positive and critical coordinate impact of security preparing on work competency at PT. Pertamina Universal Shipping.

H2: Direct influence of the planned maintenance system on work competency at PT. Pertamina International Shipping.

Based on the impact of the arranged support framework on work competence, it is positive with a parameter coefficient of 0.511, which demonstrates that the course of impact between the arranged support framework and work competence is positive at 0.511. This implies that in the event that there's an increment within the arranged support framework, work competency will increment by 0.511. Besides, based on T-Statistics H2 of 7.670 which is more prominent than the level or 7.670 > 1.96, and P-values of H2 of 0.000 which is littler than the genuine level or 0.000 < 0.05, this appears that the coordinate impact of the arranged support framework on work competency is critical. Hence, it can be concluded that H2 is acknowledged, so there's a positive and noteworthy coordinate impact of the arranged support framework on work competency at PT. Pertamina Worldwide Shipping.

H3: Direct influence of safety equipment technology on work competency at PT. Pertamina International Shipping.

The impact of security hardware innovation on work competency is positive with a parameter coefficient of 0.194, which demonstrates that the course of impact between security gear innovation and work competency is positive at 0.194. This implies that in case there's an

increment in security gear innovation, work competency will increment by 0.194. Besides, based on T-Statistics H3 of 2.562 which is more prominent than the level or 2.562 > 1.96, and P-values of H3 of 0.011 which is littler than the genuine level or 0.011 < 0.05, this appears that the coordinate impact of security hardware innovation on work competency is critical. Hence, it can be concluded that H3 is accepted, so there's a positive and critical coordinate impact of security hardware innovation on work competency at PT. Pertamina Worldwide Shipping

H4: Direct effect of safety training on crew performance at PT. Pertamina International Shipping.

The effect of safety training on crew performance is positive with a parameter coefficient of 0.267, which indicates that the direction of influence between safety training on crew performance is positive at 0.267. This means that if there is an increase in safety training, the performance of the ship's crew will increase by 0.267. Furthermore, based on T-Statistics H4 of 5.898 which is greater than the level or 5.898 > 1.96, and P-values of H4 of 0.000 which is smaller than the real level or 0.000 < 0.05, this shows that the direct effect of safety training on crew performance is significant. Therefore, it can be concluded that H4 is accepted, so there is a positive and significant direct effect of safety training on the performance of ship crew at PT. Pertamina International Shipping

H5: Direct influence of the planned maintenance system on crew performance at PT. Pertamina International Shipping.

The impact of the arranged support framework on group execution is positive with a parameter coefficient of 0.184, which shows that the heading of impact between the arranged support framework on group execution is positive at 0.184. This implies that on the off chance that there's an increment within the arranged support framework, the execution of the ship's team will increment by 0.184. Moreover, based on T-Statistics H5 of 2.785 which is more noteworthy than the level or 2.785 > 1.96, and P-values of H5 of 0.006 which is littler than the genuine level or 0.006 < 0.05, this appears that the coordinate impact of the arranged upkeep framework on the execution of the ship's team is critical. Subsequently, it can be concluded that H5 is acknowledged, so there's a positive and noteworthy coordinate impact of the arranged support framework on the execution of dispatch group at PT. Pertamina Universal Shipping.

H6: Direct influence of safety equipment technology on crew performance at PT. Pertamina International Shipping.

The influence of safety equipment technology on crew performance is positive with a parameter coefficient of 0.290, which indicates that the direction of influence between safety equipment technology on crew performance is positive at 0.290. This means that if there is an increase in safety equipment technology, the performance of the ship's crew will increase by 0.290. Furthermore, based on T-Statistics H6 of 4.439 which is greater than the level or 4.439 > 1.96, and P-values of H6 of 0.000 which is smaller than the real level or 0.000 < 0.05, this shows that the direct influence of safety equipment technology on the performance of the ship's crew is significant. Therefore, it can be concluded that H6 is accepted, so there is a direct positive and significant influence of safety equipment technology on the performance of ship crew at PT. Pertamina International Shipping.

H7: Direct influence of work competency on crew performance at PT. Pertamina International Shipping.

The influence of work competency on crew performance is positive with a parameter coefficient of 0.278, which indicates that the direction of influence between work competency

on crew performance is positive at 0.278. This means that if there is an increase in work competency, the performance of the ship's crew will increase by 0.278. Furthermore, based on T-Statistics H7 of 3.329 which is greater than the level or 3.329 > 1.96, and P-values of H7 of 0.001 which is smaller than the real level or 0.001 < 0.05, this shows that the direct influence of work competency on crew performance is significant. Therefore, it can be concluded that H7 is accepted, so there is a positive and significant direct influence of work competency on the performance of ship crew at PT. Pertamina International Shipping

H 8: Indirect effect of safety training on crew performance at PT. Pertamina International Shipping through work competencies.

The indirect effect of safety training on crew performance through work competency is positive with a parameter coefficient of 0.085, which indicates that the direction of influence between safety training on crew performance through work competency is positive at 0.085. This means that if there is an increase in safety training through crew performance, work competency will increase by 0.085. Furthermore, based on T-Statistics H8 of 2.455 which is greater than the level or 2.455 > 1.96, and P-values of H8 of 0.014 which is smaller than the real level or 0.014 < 0.05, this shows that the indirect effect of safety training on crew performance through work competency is significant. Therefore, it can be concluded that H8 is accepted, so there is a positive and significant indirect effect of safety training on the performance of ship crew at PT. Pertamina International Shipping through work competencies

H9: Indirect influence of the planned maintenance system on crew performance at PT. Pertamina International Shipping through work competencies.

The indirect influence of the planned maintenance system on crew performance through work competency is positive with a parameter coefficient of 0.142, which indicates that the direction of influence between the planned maintenance system on crew performance through work competency is positive at 0.142. This means that if there is an increase in the planned maintenance system through the performance of the ship's crew, work competency will increase by 0.142. Furthermore, based on T-Statistics H9 of 3.124 which is greater than the level or 3.124 > 1.96, and P-values of H9 of 0.002 which is smaller than the real level or 0.002 < 0.05, this shows that the maintenance system has an indirect effect planned impact on crew performance through work competency is significant. Therefore, it can be concluded that H9 is accepted, so there is a positive and significant indirect effect of the planned maintenance system on the performance of ship crew at PT. Pertamina International Shipping through work competencies.

H10: Indirect influence of safety equipment technology on crew performance at PT. Pertamina International Shipping through work competencies.

The indirect influence of safety equipment technology on crew performance through work competency is positive with a parameter coefficient of 0.054, which indicates that the direction of influence between safety equipment technology on crew performance through work competency is positive at 0.054. This means that if there is an increase in safety equipment technology through the performance of the ship's crew, work competency will increase by 0.054. Furthermore, based on T-Statistics H10 of 2.109 which is greater than the level or 2.109 > 1.96, and P-values of H10 of 0.035 which is smaller than the real level or 0.035 < 0.05, this shows that the indirect influence of tool technology safety on crew performance through work competency is significant. Therefore, it can be concluded that H10 is accepted, so there is a positive and significant indirect effect of safety equipment technology on the performance of ship crew at PT. Pertamina International Shipping through work competencies.

The discussion of this research is structured according to the ten research hypotheses:

The Effect of Safety Training on Work Competence

1. H1 is accepted, then there is a positive and significant direct effect of safety training on work competency at PT. Pertamina International Shipping. The magnitude of the influence of safety training on work competency with a parameter coefficient of 0.305 means that the direction of influence between safety training and work competency is positive at 0.305. This means that if there is an increase in safety training by 1 unit, work competency will increase by 0.305. This is in line with findings from other research which found that safety training for ship crew had a significant positive relationship with good operational performance. This emphasizes the importance of safety training in improving work competency in the maritime sector (Morgan et al., 2016; Rahman et al., 2018)

2. H2 is accepted, so there is a positive and significant direct influence of the planned maintenance system on work competency at PT. Pertamina International Shipping. The magnitude of the influence of the planned maintenance system on work competency is positive with a parameter coefficient of 0.511. This means that if there is an increase in the planned maintenance system by 1 unit, work competency will increase by 0.511. Although there is no direct research that includes planned maintenance systems in the same context, the concept of implementing ship maintenance management (Poulsen & Lema, 2017; Semuel & Ernst, 2019) highlights the importance of planned maintenance to support overall ship operations

3. H3 is accepted, so there is a positive and significant direct influence of safety equipment technology on work competency at PT. Pertamina International Shipping. The influence of safety equipment technology on work competency is positive with a parameter coefficient of 0.194. This means that if there is an increase in safety equipment technology by 1 unit, work competency will increase by 0.194. This finding is consistent with research results which show that optimizing the function of safety equipment on ships has a direct impact on effectiveness in emergency situations (Yuste et al., 2019). This shows that investment in safety equipment technology can improve the work competence of ship crews (Mohsin & Yellampalli, 2017).

4. H4 is accepted, then there is a positive and significant direct effect of safety training on the performance of ship crew at PT. Pertamina International Shipping. The magnitude of the influence of safety training on crew performance is positive with a parameter coefficient of 0.267, meaning that the direction of influence between safety training on crew performance is positive at 0.267. This means that if there is an increase in safety training by 1 unit, the crew's performance will increase by 0.267. Although not directly at PT. Pertamina International Shipping, but research that shows a positive relationship between safety training and ship crew performance (Dewanto et al., 2017) provides the perspective that improving the quality of training can improve ship operational performance.

5. H5 is accepted, then there is a positive and significant direct influence of the planned maintenance system on the performance of ship crew at PT. Pertamina International Shipping. The magnitude of the influence of the planned maintenance system on crew performance is positive with a parameter coefficient of 0.184, meaning that the direction of influence between the planned maintenance system on crew performance is positive at 0.184. This means that if there is an increase in the planned maintenance system, the performance of the ship's crew will increase by 0.184. However, the focus on ship maintenance management (Caamaño et al., 2018) indicates that a good maintenance system

can support the smooth operation of the ship and indirectly influence the performance of the ship's crew.

6. H6 is accepted, so there is a positive and significant direct influence of safety equipment technology on the performance of ship crew at PT. Pertamina International Shipping. The magnitude of the influence of safety equipment technology on crew performance is positive with a parameter coefficient of 0.290, meaning that the direction of influence between safety equipment technology on crew performance is positive at 0.290. This means that if there is an increase in safety equipment technology by 1 unit, the performance of the ship's crew will increase by 0.290. This can be seen in research which suggests that the optimal function of safety equipment contributes to the operational safety of ships (Maemunah et al., 2021; Onakpojeruo et al., 2023), where safety is an important factor in improving the performance of ship crew.

7. H7 is accepted, then there is a positive and significant direct influence of work competency on the performance of ship crew at PT. Pertamina International Shipping. The magnitude of the influence of work competency on crew performance is positive with a parameter coefficient of 0.278, meaning that the direction of influence between work competency on crew performance is positive at 0.278. This means that if there is an increase in work competency by 1 unit, the crew's performance will increase by 0.278. This finding is consistent with studies showing that the relationship between competency and crew performance is very relevant in the context of human resource management in the maritime industry (Rudianto, Suhalis, & Pahala, 2014).

8. H8 is accepted, so there is an indirect effect of safety training on the performance of ship crew at PT. Pertamina International Shipping through work competencies. The large indirect effect of safety training on crew performance through work competency with a parameter coefficient of 0.085 means that the direction of influence between safety training on crew performance through work competency is positive at 0.085. This means that if there is an increase in safety training through work competency by 1 unit, the crew's performance will increase by 0.085. Although not directly explained in previous research, the concept that training increases competence which in turn influences performance has been proven in other contexts (Rasulov et al., 2021).

9. H9 is accepted, so there is an indirect influence of the planned maintenance system on the performance of ship crew at PT. Pertamina International Shipping through work competencies. The large indirect influence of the planned maintenance system on crew performance through work competency with a parameter coefficient of 0.142 means that the direction of influence between the planned maintenance system on crew performance through work competency is positive at 0.142. This means that if there is an increase in the planned maintenance system through work competency by 1 unit, the ship crew's performance will increase by 0.142. These findings illustrate that good maintenance planning can support the readiness of ship crews to face operational challenges (Cole, 2023).

10. H10 is accepted, so there is an indirect influence of safety equipment technology on the performance of ship crew at PT. Pertamina International Shipping through work competencies. The indirect influence of safety equipment technology on crew performance through work competency with a parameter coefficient of 0.054 means that the direction of influence between safety equipment technology on crew performance through work

competency is positive at 0.054. This means that if there is an increase in safety equipment technology through work competency by 1 unit, the crew's performance will increase by 0.054. This is in line with findings that the right technology can increase efficiency and safety in the maritime sector (Antonius Fernando et al., 2022).

Based on the R Square value for the work competency variable (Z) it is 0.941. These results explain that the percentage of work competency is 94.1%. Based on this, the R^2 calculation results show that the value is strong. This means that the safety training and planned maintenance system variables have a direct influence on work competency by 94.1%, and the remaining 5.9% is influenced by other variables.

This indicates that the model built is strong enough to explain the relationship between the independent variables (safety training and planned maintenance system) and the dependent variable (work competency). From this R Square value, it can be concluded that safety training and planned maintenance systems contribute significantly to work competency. About 94.1% of the variation in work competency can be explained by these two variables. The remaining 5.9% of variation or variability that is not explained by safety training and planned maintenance systems is likely influenced by other factors not included in this research model.

The R Square value for the crew performance variable (Y) is 0.961. These results explain that the percentage of crew performance is 96.1%. Based on this, the R^2 calculation results show that the value is strong. This means that the variables safety training, planned maintenance system, safety equipment technology and work competency have a direct influence on crew performance by 96.1%, and the remaining 3.9% is influenced by other variables.

This shows that the model has a very strong ability to explain the relationship between independent variables (safety training, planned maintenance system, safety equipment technology, and work competency) and the dependent variable (ship crew performance). From this R Square value, it can be concluded that safety training, planned maintenance systems, safety equipment technology, and work competency contribute significantly to crew performance. About 96.1% of the variation in crew performance can be explained by these four variables. The remaining 3.9% of variation or variability that is not explained by these four variables is likely influenced by other factors outside this research model.

The high R Square value (0.941 for work competency and 0.961 for crew performance) indicates that the model used is very effective in explaining the relationship between the variables studied. The direct influence of variables such as safety training, planned maintenance systems, safety equipment technology, and work competency on the work competency and performance of ship crew is very significant.

Even though the model has a high R Square value, there is still a small portion of variation that cannot be explained by the included variables. This shows that there are other factors outside the model that can also influence the work competence and performance of ship crew.

These results provide a clear view to PT management. Pertamina International Shipping believes that investment and improvements in safety training, planned maintenance systems, safety equipment technology and work competency development will have a very positive impact on ship crew performance. Management can focus on continuing to improve these variables to maximize employee potential and overall company performance (Baştuğ & Yercan, 2021; Maemunah & Marta Anggoro, 2022).

1. Highest Coefficient: Planned Maintenance System (X2) on Work Competency (Z): 0.511 (H2) and Safety Equipment Technology (X3) on Ship Crew Performance (Y): 0.290 (H6).
2. Lowest Coefficient: Safety Equipment Technology (X3) on Ship Crew Performance (Y) through Work Competency (Z): 0.054 (H10) and Safety Training (X1) on Ship Crew Performance (Y) through Work Competency (Z): 0.085 (H8)

3. Most Influential Variable: Planned Maintenance System (X2) is the variable that has the most influence on Work Competency (Z) with the highest parameter coefficient of 0.511 (H2). With a coefficient of 0.511 and a T-statistic of 7.670, and a p-value of 0.000, the influence of the planned maintenance system on work competency is very significant and strong. This shows that improvements in the planned maintenance system will provide a significant increase in employee work competency at PT. Pertamina International Shipping.

CONCLUSION

The research concluded that the most influential variable was the Planned Maintenance System on Work Competency with the highest parameter coefficient of 0.511. On the other hand, even though all hypotheses are accepted, the indirect influence of Safety Equipment Technology on Ship Crew Performance through Work Competency has the lowest parameter coefficient of 0.054. This shows that the direct influence of independent variables on the dependent variable is generally stronger than the indirect influence through mediating variables. Therefore, to improve performance and competence, the main focus should be on direct improvements in the most influential areas, such as planned maintenance systems and safety equipment technology.

REFERENCES

Asghar, F., Shamim, N., Farooque, U., Sheikh, H., & Aqeel, R. (2020). Telogen effluvium: a review of the literature. In *Cureus*. cureus.com. https://www.cureus.com/articles/32514-telogen-effluvium-a-review-of-the-literature

Bachtiar, A. I., Marimin, M., Adrianto, L., & Bura, R. O. (2021). Strategi Peningkatan Daya Saing Industri Perkapalan (Shipbuilding Industry). *Jurnal Aplikasi Bisnis Dan Manajemen*, *7*(1), 121–134. https://doi.org/10.17358/jabm.7.1.121

Baştuğ, S., & Yercan, F. (2021). An explanatory approach to assess resilience: An evaluation of competitive priorities for logistics organizations. *Transport Policy*. https://www.sciencedirect.com/science/article/pii/S0967070X21000226

Bezuidenhout, C. N., Martin, M. R., Williams, A. H., Peiris, A., & ... (2020). *A Scholarly Review of Supply Chain Integration within the New Zealand Blueberry Industry*. mro.massey.ac.nz. https://mro.massey.ac.nz/handle/10179/15875

Caamaño, L. S., Míguez González, M., & Díaz Casás, V. (2018). On the feasibility of a real time stability assessment for fishing vessels. *Ocean Engineering*, *159*, 76–87. https://doi.org/10.1016/j.oceaneng.2018.04.002

Cicek, K., Celik, M., & Demirci, S. M. E. (2023). Digital Maturity Assessment of Ship Management Companies Towards Organizational Intelligence: Blue Digital Focus. *Lecture Notes in Networks and Systems*, *549*, 537–560. https://doi.org/10.1007/978-3-031-16598-6_23

Cole, B. (2023). Assessing the need for an increased sovereign commercial airlift capability. In *Contemporary Issues in Air and Space Power*. ciasp.scholasticahq.com. https://ciasp.scholasticahq.com/article/82218.pdf

Dewanto, Y. A., Faturachman, D., & Kelautan, F. T. (2017). Analisis Kecelakaan Transportasi Laut Di Indonesia Tahun 2003 - 2013. *Lembaga Penelitian, Pengabdian Masyarakat Dan Kemitraan Universitas Darma Persada*, *Volume V*(No. 1), 1–16.

Dilaver, H. M., Akçay, A., & van Houtum, G. J. (2023). Integrated planning of asset-use and dry-docking for a fleet of maritime assets. *International Journal of Production Economics*, *256*. https://doi.org/10.1016/j.ijpe.2022.108720

Hanzu-Pazara, R., Duse, Varsami, C., Andrei, C., & Dumitrache, R. (2016). The influence of ship's stability on safety of navigation. *IOP Conference Series: Materials Science and Engineering*, *145*(8). https://doi.org/10.1088/1757-899X/145/8/082019

Lindau, S. T., Makelarski, J. A., Boyd, K., Doyle, K. E., Haider, S., Kumar, S., Lee, N. K., Pinkerton, E., Tobin, M., Vu, M., Wroblewski, K. E., & Lengyel, E. (2021). Change in Health-Related Socioeconomic Risk Factors and Mental Health during the Early Phase of the COVID-19 Pandemic: A National Survey of U.S. Women. *Journal of Women's Health*, *30*(4), 502–513. https://doi.org/10.1089/jwh.2020.8879

Maemunah, S., & Cuaca, H. (2021). Influence of epidemic COVID–19 on business strategy, information technology and supply chain agility to firm performance in medical device industry. *Linguistics and Culture Review*, *5*. https://doi.org/10.37028/lingcure.v5nS1.1452

Maemunah, S., Damanik, A. I. N., Yuliyanto, A., Sembiring, H. F. A., Sugiyanto, S., & Setiawan, E. B. (2023). Price Competitiveness and Service Quality Have an Impact on Ship Agency Contributions. *Jurnal Manajemen Transportasi & Logistik (JMTRANSLOG)*, *10*(2), 186. https://doi.org/10.54324/j.mtl.v10i2.1137

Maemunah, S., & Endri, E. (2025). *Impact of Standard Operating Procedures on Accident Risk in the Transportation of Hazardous Materials : The Moderating Role of Aviation Safety and the Mediating Role of Accident Risk*. *June*. https://doi.org/10.5281/zenodo.15579012

Maemunah, S., Indrayanto Baka, J., Najoan, D., & Setyawati, A. (2021). Shipping Safety in Tanjung Pinang, the Singapore Strait, Riau Islands, Indonesia. *Jurnal Manajemen Transportasi & Logistik (JMTRANSLOG)*, *08*(03), 247–257. https://journal.itltrisakti.ac.id/index.php/jmtranslog

Maemunah, S., Juhri, A., Mudjiarjo, Agusinta, L., & Yuliantin. (2022). Prioritas Pengangkutan Komoditas Kargo Umum Di Divisi Ekspor Pengangkutan Udara- General Cargo Commodity Transport Priorities. *Jurnal Ilmiah Kedirgantaraan*, *19*(1), 45–54.

Maemunah, S., & Marta Anggoro. (2022). Transportation Modes During Pandemic Covid-19 in Indonesia. *SOSMANIORA: Jurnal Ilmu Sosial Dan Humaniora*, *1*(1), 44–47. https://doi.org/10.55123/sosmaniora.v1i1.201

Maemunah, S., & Nekrasov, K. (2023). Competitiveness based on logistics and supply chain in medical device industry during the Covid-19 period in Indonesia. *AIP Conference Proceedings*, *2624*(1). https://doi.org/10.1063/5.0132304

Mohsin, A., & Yellampalli, S. S. (2017). IoT based cold chain logistics monitoring. *2017 IEEE International …*. https://ieeexplore.ieee.org/abstract/document/8392059/

Morgan, T. R., Jr, R. G. R., & Autry, C. W. (2016). Developing a reverse logistics competency: The influence of collaboration and information technology. *… Physical Distribution & Logistics …*. https://doi.org/10.1108/IJPDLM-05-2014-0124

Nathanael, M. A. (2023). Service Quality Analysis to Increase Customer Satisfaction at Government-Owned Fuel Filling Stations in Indonesia. *Journal of Current Research in Business and …*. https://www.jcrbe.org/index.php/rbe/article/view/35

Onakpojeruo, D., Jeong, B., & Park, C. (2023). Mental wellbeing; Human reliability assessment of seafarers during the COVID-19 era. *Journal of International Maritime Safety, Environmental Affairs, and Shipping*, *7*(1). https://doi.org/10.1080/25725084.2023.2184604

Oroye, O. A., Sylvester, B. O., & Farayibi, P. K. (2022). Total productive maintenance and companies performance: a case study of fast moving consumer goods companies. *Jurnal Sistem Dan Manajemen Industri*, *6*(1), 23–32. https://doi.org/10.30656/jsmi.v6i1.4185

Philipp, R. (2020). Blockchain for LBG Maritime Energy Contracting and Value Chain Management: A Green Shipping Business Model for Seaports. In *Environmental and Climate Technologies* (Vol. 24, Issue 3, pp. 329–349). sciendo.com. https://doi.org/10.2478/rtuect-2020-0107

Poulsen, T., & Lema, R. (2017). Is the supply chain ready for the green transformation? The case of offshore wind logistics. In *Renewable and Sustainable Energy Reviews* (Vol. 73,

pp. 758–771). Elsevier. https://doi.org/10.1016/j.rser.2017.01.181

Rahman, A. R. A., Rashid, S. A., & ... (2018). Agility and digitalization competency in logistics 4.0 in military setting: the challenge, risks and opportunities. In *Asian Journal of Social …*. researchgate.net. https://www.researchgate.net/profile/Abdul-Rahim-Abdul-Rahman/publication/331634349_Agility_and_digitalization_competency_in_logistics_40_in_military_setting_the_challenge_risks_and_opportunities/links/5c83e106458515831f95871d/Agility-and-digitalization-c

Rasulov, M., Masharipov, M., & ... (2021). Optimization of the terminal operating mode during the formation of a container block train. *E3S Web of …*. https://www.e3s-conferences.org/articles/e3sconf/abs/2021/40/e3sconf_conmechydro2021_05025/e3sconf_conmechydro2021_05025.html

Ricardianto, P., Martagani, M., Teweng, N. M., Maemunah, S., & Kurniawan, J. S. (2021). *Strategy to Increase Passenger Attractiveness at Kertajati International Airport , West Java*. *9*(9), 31–37.

Semuel, L., & Ernst, W. (2019). Inventory on banana (Musa spp.) as trading commodities in Maluku islands, Indonesia. In *African Journal of Agricultural Research*. academia.edu. https://www.academia.edu/download/105069153/C0AB18A62036.pdf

Siti Maemunah, M. A. (2022). *Transportation Modes During Pandemic Covid-19 in Indonesia*. *1*(1), 44–47. https://journal.literasisains.id/index.php/sosmaniora

Slattery, M., Dunn, J., & Kendall, A. (2021). Transportation of electric vehicle lithium-ion batteries at end-of-life: A literature review. In *Resources, Conservation and Recycling*. Elsevier. https://www.sciencedirect.com/science/article/pii/S0921344921003645

Sugiono, A., Masykuroh, E., & ... (2023). Developing model of logistics capability, supply chain policy on logistics integration and competitive advantage of SMEs. *Uncertain Supply …*. http://m.growingscience.com/beta/uscm/6138-developing-model-of-logistics-capability-supply-chain-policy-on-logistics-integration-and-competitive-advantage-of-smes.html

Watts, C. J., & VA, M. C. U. Q. (2021). *Unmanned Logistics System-Air: A Family of Systems with a Wide Range of Requirements and Possibilities*. apps.dtic.mil. https://apps.dtic.mil/sti/citations/AD1178347

Yuste, P., Campbell, J., Canyon, D., Childers, M., & Ryan, B. J. (2019). Synchronized humanitarian, military and commercial logistics: An evolving synergistic partnership. *Safety*, *5*(4). https://doi.org/10.3390/safety5040067

Zhu, Z., Chu, F., Dolgui, A., Chu, C., Zhou, W., & ... (2018). Recent advances and opportunities in sustainable food supply chain: a model-oriented review. *International Journal of …*. https://doi.org/10.1080/00207543.2018.1425014