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Investing in a Safer Tomorrow

The Premise

This paper's premise is multifaceted and requires the involvement of several institutions across the maritime industry. These areas include insurance companies, vessel management companies, maritime training institutions, and individual mariners. The premise involves a chain of events that begins with insurance companies. It is estimated that almost ninety percent (this number fluctuates depending on the source, but the percentage always remains high) of maritime related accidents are attributable to human error.¹ Currently, individual human competence is not accounted for in quoting marine insurance rates because there has never been a sailing record for mariners similar to a driving record for automobile owners.

Many factors are taken into consideration when quoting shipping rates, but the majority of them only pertain to the condition of the vessel. Joseph P. Kennedy once said that "you can have a first-class merchant marine with first-class men, even if they sail second-class ships, but second-class men cannot be trusted with the finest ships afloat;" a statement that holds true to this day. With such high percentages of maritime accidents attributable to human error, it is time to consider the individual mariner when quoting insurance rates.² When buying car insurance, one's personal driving record is a major factor in determining their rate. After all, the quoted rate

¹ Veysey, Sarah. "Human error factors into most marine accidents; Safety improving, but challenges remain." *Business Insurance*, 9 Sept. 2013, p. 21.

² Raunek. "Maritime Ship Collision Cases Explored - Causes and Effects." *Brighthub Engineering*, 12 Nov. 2018.

and premium is an assessment of how much risk the insurance company bears by taking someone on as a client. If a majority of accidents are caused by a mariner's action, then why do insurance companies calculate the rate off of a fraction of what causes losses? Due to the fact that mariners do not have a sailing record at this time, it is difficult to quote a rate or see how it will make shipping safer. If a system is created that can accurately quantify mariner competence and predict the probability of accident, then shipping rates can, and should, consider individual mariner ability.

To create this system, a series of procedures and examinations can be implemented to place competence and safety at the forefront of the maritime industry. Better mariners on ships will lead to a decrease in maritime incidents attributable to human error, the major cause. As the maritime incidents decrease, so will the number of claims insurance companies are required to pay out. As the insurance claims reduce, insurance companies will be able to financially reward companies with competent mariners and clean records. If companies then alter their hiring process in an effort to receive more favorable insurance rates, a more competitive job market will emerge and shift personal responsibility onto the individual mariner to become the best prospective employee. Lastly, as a part of the changing incentives, maritime training institutions and academies will be motivated to place a greater emphasis on mariner effectiveness.

This paper has two distinct effects, both of which are predicated off of insurance rates being based off of mariner ability. The chain reaction of sliding incentives and the system outlined in this paper will allow it to happen. This series of events can be accelerated by using the proposed system below, which aides in the creation of a formula to predict and rate mariner competence for the purpose of creating more accurate insurance rates. If implemented properly,

it is possible that a movement will begin to develop a more experienced and effective body of mariners across the globe, thus increasing the safety of shipping for all.

Mariner Training and Credentialing

Many of today's United States flagged shipboard officers are graduates of one of the five maritime academies in the United States. After four years of class work and trainings, prospective mariners sit for a credentialing exam issued by the United States Coast Guard. After passing all required exams, graduates are awarded either their unlimited tonnage third mates or third assistant engineers license. Earning such a credential is the only thing that prevents anyone from operating a vessel in the United States. The concept of a maritime academy is popular across the globe, but there are several issues with the current system of credentialing. First, all of the credential exam questions and answers are known before the exam. This allows professors and students to teach to the exam and memorize the entire test bank to ensure passage.

Maritime academies boast high passage rates as part of an advertising campaign to help draw prospective students to their campus. Due to the fact students know the bank of questions and answers before going into the exam, they only study and put emphasis into what will be on the exam. Passing this exam does not necessarily reflect nautical competence. Furthermore, there is no distinction between people who pass the exam with high scores versus those who pass with low scores.³ Ultimately, all students receive the same license despite students earning different exam grades and different grades within their prior coursework. There is no advantage to scoring one hundred percent over eighty percent, because the outcome is still the same. Moreover, one student may receive high marks in one section testing certain skills, but low marks in another

³ Reyes, Maria R., et al. "Classroom Emotional Climate, Student Engagement, and Academic Achievement." *Journal of Educational Psychology*, vol. 104, no. 3, 2012, pp. 700

which indicates they are better prepared to handle certain situations over others. There is currently no incentive to score any higher than the minimum overall passing score on these exams, thus causing poor habits in students. These poor habits also enter into the classroom as students only look to obtain passing grades in their coursework (seventy percent or higher) rather than learn to retain information. Maritime institutions and other training outlets main intent should be to create effective members of the global shipping fleet. Unfortunately, this intent has been altered and schools are more akin to a factory seeking to produce high exam scores, not well qualified mariners.

With the recent United States college bribing scandal, college and university standards are drawing more attention. While maritime academies are comparatively more difficult than most other higher education institutions, there are still areas that can be improved. From experience in the United States, educational institution's expectations for students have declined over the years. Institutions often scale⁴ grades in order to pass students through their degrees, and the students often fail to retain information covered during their time in school.⁵ They only retain the material tested on their credentialing exam.

Colleges, and maritime academies, are businesses and seek to make money. Failing students is not good for business. Failing students prevents schools from collecting future tuition payments. Moreover, low graduation rates deter future applications further resulting in a loss of tuition revenue. In the current practice, a prospective mariner would choose the school that is most likely to help them receive their credential, not make them the most effective mariner since

⁴ Scaling Grades- Also known as grading on a curve, grading on the "Curve" is a method of grading that is based on the belief that letter grades in any given class should be distributed along a bell curve. Typically, an assignment or test is scored, and the average score automatically becomes an average grade (typically a B- or C+).

⁵ "College and test standards too low; The Public Pulse." Grand Rapids Press [Grand Rapids, MI] 8 June 2005: A12. Business Insights: Essentials. Web. 25 Mar. 2019.

the credential is the only item needed for employment. Contrarily, not failing students lowers standards that ultimately allows unqualified mariners into the fleet, which creates potential dangers and an increased chance of costly insurance payouts. The National Transportation Safety Board (NTSB) annual publication, the *Safer Seas Digest*, publishes reports on annual marine accidents within the United States. For their 2018 *Lessons Learned*, they state that “this year’s edition could arguably be titled Lessons Relearned, as many of the issues noted in 2017 accident reports were recurring topics. Issues such as poor bridge resource management and distraction are not new and deserve emphasis.”⁶ Many of these issues are promulgated by a normalization of deviance perpetuated by the current system of mariner training. Diana Vaughan proposed the concept in 1996 and defines it as a situation where “people within an organization become so much accustomed to a deviation that they don’t consider it as deviant, despite the fact that they far exceed their own rules for the elementary safety.”⁷ This phenomenon is prevalent in the maritime institutions as inflated or scaled grades are common and allow normally failing scores to pass. Some professors are more difficult than others and uphold high student standards, but students can circumvent teachers that may issue failing grades.

Once mariners enter the industry, they are often subject to further trainings. These trainings seek to either teach new skills or serve as refresher courses. Many of these trainings are online. Online trainings are not always effective and allow people to easily skip through course material. If people skip through the course material, they are not retaining or learning the required information. There is no incentive for individuals to spend ample time on trainings because all that matters to the company is that they have the certificate of completion. This may

⁶ “Safer Seas Digest 2017: Lessons Learned from Marine Accident Investigations.” *National Transportation Safety Board*, 2017.

⁷ Wilcutt, Terry, and Hal Bell. “The Cost of Silence: Normalization of Deviance and Groupthink.” *National Aeronautics and Space Administration (NASA)*, 3 Nov. 2014.

give legal cover to both the individual and company, but it does little to actually prevent losses. Companies should not simply require more training, but rather employ more effective training methods in their on the job training and refresher courses.

To illustrate the point, consider the following situation. There are two students at a maritime academy; student A and student B. Student A is a hardworking student who reads and studies the textbook to master all concepts covered in class. Student A does not avoid intense teachers who will hold him or her to a high standard. Student A is a responsible person overall, and studies to learn the material rather than to just pass the upcoming exam. Student A knows that they will need to apply this information from memory, likely in a stressful situation, so they study to remember and retain the information.

After four years at the maritime academy, they pass their classes and credentialing exams with very high marks. On the other hand, student B is not a motivated student. Student B never studies and looks to cut all possible corners including taking teachers he/she knows will give less work and grade less stringent. Student B cheats on their tests and does not even own the books to study from. Student B's final semester at the maritime academy begins, and he/she only studies the credentialing exam test bank. Student B barely passes their exam, but earns their license, nonetheless.

Now, Student A and Student B both apply to the same steamship company where both of their resumes read "Licensed Third Mates or Licensed Third Assistant Engineers" and graduate of their respective Maritime Institution. Who should be hired? Who do you think will operate the ship in the safest manner? In the current state of affairs, it is difficult to differentiate between Student A and Student B. If asked, current maritime students would likely be able to differentiate between Student A and Student B, but there is no such system for employers. Further, if the

company's insurance rates are predicated off the ability of the mariner, everyone would want Student A. The system outlined in this paper below seeks to create a quantitative method an employer can use to ensure only the best mariners are in the fleet and that mariner competence is accurately rewarded in insurance rates.

The System

The proposed system is an attempt to account for individual mariner competence as a part of a company's risk assessment. Each step in the process collects data on individual mariners as well as provides opportunities for mariners to continue learning. The system is composed of a series of tests to include a pre-employment test, continual practice exams, and random evaluations. The exams and data collected will eventually culminate in a percentile score for an individual mariner that can then be used in conjunction with current actuarial models and data to create a more accurate insurance rate as well as make better hiring and risk management decisions. This information can then be kept and stored on an online database for future use and easy access.

Companies could then use this rating, based on their ability to perform essential tasks, to select the highest quality mariner to man their ships. The percentile system would rank mariners based on their relative knowledge compared to other mariners taking the exam and the global fleet. Following the examinations, the mariners would be given feedback on areas which require improvement. This system of extra testing is not designed to keep mariners from going to work. Instead it is designed to ensure that mariners are competent enough to handle their tasks and responsibilities before going to sea. This also gives individual shipping companies the ability to

minimize risks by selecting the best qualified mariner while also collecting data to be used for insurance purposes.

Pre-Employment Examinations

The system would begin with an exam before shipping companies hire a mariner. Exam material would be agreed upon between individual companies, third party companies, and insurance companies to the satisfaction of all parties. Exam material would be created by a contingent of maritime professionals that deem certain skills as essential. Some of these essential topics pertain to various different areas, including knowledge of the Electronic Chart Display and Information System (ECDIS), manual charting, firefighting, Global Maritime Distress Signals (GMDS), the rules of the road, cargo handling, radar, bridge resource management, celestial navigation, and even company policies such as ethics and security.⁸

These preliminary examinations would allow employers to filter out poor mariners immediately, so that there is never an instance where an uneducated mariner is allowed onto a vessel. Employers would have access to an online portal where they can view the skill breakdown of prospective employees as well as their rank before hiring a mariner. Additionally, the exams should be more comprehensive and practical than a multiple choice exam to test for skill proficiency as well as knowledge of concepts. Exams would also be specific to the individual mariner's position on the ship. For example, an able-bodied seaman would not be asked questions at the same level as the captain. Instead, specific duties of each position would be tested to ensure that the mariner has a base level of competence.

⁸ Herwadkar, Nihar. "Pros and Cons of ECDIS Or Paperless Navigation of Ships." *Marine Insight*, Marine Insight, 29 Sept. 2017.

As previously discussed, the credentialing exam does not necessarily reflect a mariner's ability because they know the exam questions and answers prior to testing. Further, the exam does not show a differential in mariner ability. Furthermore, preventing the questions from being leaked, shared, or disseminated is paramount. In order to accurately test a mariner's knowledge, no two exams should be the same. If this is not the case, it is likely that mariners will simply memorize information as opposed to understanding it similar to the phenomenon observed with the credentialing exam.

Continual Practice

For the second stage, the selected mariners would then be continuously tested and trained through hands-on exercises while underway. These trainings would be conducted by a particular vessel's master, chief mate or chief engineer. These trainings would ensure that all mariners are fully prepared to not only perform their daily tasks safely and correctly, but also to effectively handle any potential disasters such as a fire or grounding. Fire and abandon ship drills are already mandated, but regular training should be conducted regularly on preventative scenarios and essential skills. The most effective way to ensure that mariners do not forget their training is through a continuous application of the learned skills.⁹

Training and practice are two different ideas. Training aides in the teaching process of something new, while practice ensures that students continually understand and retain the information. The mindset for training and practice should not be to teach people how to perform certain tasks but ensure that they train and practice until they cannot perform those tasks incorrectly. The decisions mariners are trained to make are often under stressful conditions. This

⁹ "Hands-on learning for a new economy Education." Sydney Morning Herald [Sydney, Australia], 10 Dec. 2016, p. 11.

is especially relevant as many of the accidents detailed in the aforementioned *Safer Seas Digest* are a result of mariner performance in abnormal sailing conditions. Because of this, it is paramount that their training has a solid foundation backed by practice repetitions. Again, these trainings should not be solely lecture, but should be viewed more as training repetitions. They should include situational exercises to ensure nuances from prior training is not forgotten.

As an example, scenarios involving docking or maneuvering in high winds could be discussed while docking in normal conditions. It is vital that each crew member be versed in their particular responsibilities and for all potential situations that may arise during a voyage. By conducting scenario trainings during individual work, it gives employees the opportunity to practice their skills. If there are areas that crew members are not fully trained in or skills crew members have not practiced enough, it is possible that the vessel, crew, and environment could be at risk. The scores of these underway evaluations from high ranking officers have the ability to improve a mariner's overall score and add to the database that will assist in the creation of an overall insurance score. While it is important to have this area of practical education, practices may fall below standards in some areas or not be properly enforced, so a third form of training is also applied.

Quality Control

This third stage of training comes in the form of random evaluations, or REV's. These REV's would be conducted by either third party companies or insurance companies. Their purpose would be to conduct oral examinations of crew members to help test real-time thinking. In the second stage, the training is conducted in house, but to ensure scores and grades are not inflated or scaled, an outside party performs quality control checks. Oral examinations would test

how much a mariner truly knows and understands about their particular vessel, its cargo, and the safety required to keep the vessel and the crew safe. Typically, a compliance officer would board the vessel with a pilot during transit, or while the vessel is conducting cargo transfer operations.

These are the times when a vessel's crew is most active, and it is vital that during each operation, the mariners are able to provide answers that could mean the difference between life and death should an emergency situation arise.¹⁰ Furthermore, the evaluator can give a score on how the ship crew operates overall. Ultimately, REV's would ensure that each mariner is continuously learning and understanding the importance of their actions at sea to a high standard. Third party evaluations decrease the likelihood that chief officers on the ship give inflated scores and prevents the ships standards declining and the ship normalizing their deviance. Furthermore, the random aspect of the evaluation ensures that mariners cannot quickly study vital information to pass a test.

Culmination in a Percentile Score

In the system, there are three major stages. The first stage is to prove that the mariner is qualified to undergo voyages, the second stage ensures that mariners do not forget the essential skills to safety and navigation, while the third stage acts as a quality control system to prevent complacency and the decline of standards. All three stages will create a series of data points that when combined with a series of other safety related data points, can create a new insurance formula to create more accurate insurance rates. These new data points will help create a sailing record for mariners that will attempt to close the gap on causes of incident and insurance rates. Once a sailing record is established, an online mariner portal can be created for easy access to

¹⁰ Suell Dutra, Max, Ivanovich Lache, Katrin Ellermann, & Ricardo Ramírez Heredia. "Research in offshore transfer cargo operations; challenges, developments, and new frontiers." *Ciencia y tecnología de buques* [Online], 5.10 (2012): 9-17.

professional histories as well as rank and standing in the maritime community. Other data points that can be taken into consideration include years of experience at sea and near miss data in addition to the already collected vessel particulars.

We cannot propose a clear cut formula with determined formula weights, as this data has not yet been collected, and we do not have access to private company's individual data. The formula to include test scores needs to be refined and tested against historical data until certain scores correspond to a risk level and subsequently an insurance rate. The system is designed to be difficult. Only a small percentage of mariners should receive the highest marks and receive the largest insurance discount for their company. While top mariners may receive the biggest insurance discount, the discount levels would need to be decided upon by the insurance companies to ensure their profitability.

The method in which they mathematically interpret the percentile ranking and mariner scores to correlate to an insurance rate would be a decision left to the insurance company. For example, the median range of percentile scores may correlate to the current insurance while scores above and below are rewarded with a certain percentage discount. It is important to note that not all mariners will be earning rate reductions for their companies. Mariners who score poorly and present a larger risk to the company should be charged accordingly as well. Ultimately, the feasibility of this project will be decided through the economic implications and partnerships agreed upon by insurance companies and carriers. If the investment made into more effective training decreases the amount of losses paid, the idea will be beneficial to insurance companies. If the investment into more effective training lowers premiums and incident related expenses for shipowners, the project will be successful.

This formula would be conducted as follows. All exams would be weighted to a certain degree. For example, the first stage exam may be worth fifteen percent, the second stage worth five percent, and the random evaluations be worth twenty percent. All exams would be scored out of 100 possible points. The score out of 100 multiplied by the weight percentage would be calculated and added to all other exam and weights. All weights must add up to 100%. The total possible points would then be summed. Taking the mariners earned points divided by the total would then produce a score that would correspond to insurance risk and mariner score. All collected scores could then be placed into a percentile system for display and interpretation. The exam scores could even be broken down further into proficiency in certain subject areas. The weights and formula could be tested by collecting the necessary data and then running them against previous accidents and refining the weights and data points until the most accurate model is achieved. The score and weights of an individual mariner would also change over time.

As a mariner gains years of experience, that should weigh more heavily in his or her score than exam scores from previous years. After the individual mariners have received their scores, each of the crewmembers scores on a specific ship can be averaged and create a new insurance rate. The scale that reflects the final score and insurance rate can also be scaled to a level that is sustainable for business for the insurance company, but beneficial for the client to undertake such efforts. This model can then be implemented into current actuarial models that account for particular physical aspects of vessels. The combination of these two techniques would help to provide a predictive index for insurance rates that considers the individual vessel as well as the mariner on board. The final outcome would give a specific insurance rate based on the specific mariners on board a vessel on a specific trade route during a specific time period.

Potential Problems

One obvious area that presents a potential issue is how crew changes would be accounted for. The proposed system takes an average of all mariners on board and combines it with the specific ship. Mariners continually board and change ships, so the formula for the amount of risk the ship currently has would need to be adjusted. Two solutions to this problem include the mariner portal or aggregating risk. The mariner portal would be an online database that keeps track of all mariners within a company. Using this information, the ships could be grouped from the database with their corresponding crews. From shoreside, a company employee could make changes to the database to reflect a vessels crew and automatically send it to the insurance company for adjustment.

Another solution is that each company could pay a single premium based on their average employees score, so each ship's rate does not need to be adjusted after every crew change. The system has the ability to give each ship a very specific rate that is a combination of the vessel particulars and the crew. If the company takes an average of all of their employees scores, the rate can be predicated off of the average score instead of a sum of all of their individual rates. Regardless, a company's mariner competence is reflected in their insurance rate. Another potential issue that may arise pertains to the exams themselves. Not all students who test well are the most effective mariners, and not all mariners who perform poorly on exams are unsafe.

There are multiple factors that can affect exam scores that do not reflect an individual's knowledge base. This is why the exam must be combination of both physical and practical performance. Ultimately, the exams must accurately test the actual level of mariner competence. Furthermore, as simulators become more common, they should be used more frequently for training purposes as a means to get more practice repetitions in a safe environment.

One other potential problem may be encountered when implementing the system. Obviously, there are many mariners already in the fleet that would not be subject to the pre-employment exam. While the pre-employment exam is useful to new mariners looking to enter the fleet, it will not measure already operating mariners. If the system operates for the long term, the already existing mariners will eventually retire or leave the fleet which makes this a short to medium term issue. These mariners should still be assessed which is why once the formula is determined more weight and emphasis should be placed on their years of experience, sailing history and second and third phase exams.

Conclusion

This system is an opportunity for the insurance sector to drive industry change that is traditionally handled by public and academic partners. This system aims to drive down the number of preventable marine accidents caused by a mariner's inability to act or prepare while rewarding mariners and shipping companies for their hard work in displaying continual mariner competence. While the majority of the work may be involved in the implementation of the system for quantifying mariner competence, the greatest impact is likely to come through the change in individual motivation. If rates are determined by mariner competence and companies only hire the best, this introduces competition that will raise the standard of the average mariner. This idea of creating a higher standard adds to the responsibility individual mariners hold, which creates a sense of pride and respect among the crew. Ultimately, individual mariners are the only ones that can prevent claims and accidents. The best ships and technology can be implemented, but if the mariner is not prepared to act these efforts will prove futile. Marine accidents will always occur, but let them be accidents, not a result of something preventable. With this system,

future maritime incidents attributable to human error may be prevented, and insurance companies will be able to play a major role in ensuring the safety of the crew, ship, and the environment.

References Cited

"College and test standards too low; The Public Pulse." Grand Rapids Press [Grand Rapids, MI] 8 June 2005: A12. *Business Insights: Essentials*. Web. 30 Nov. 2018.

Finn, Kristin Voelkl, and Michael R. Frone. "Academic Performance and Cheating: Moderating Role of School Identification and Self-Efficacy." *Journal of Educational Research*, vol. 97, no. 3, Jan. 2004, pp. 115–122.

"Hands-on learning for a new economy Education." *Sydney Morning Herald* [Sydney, Australia], 10 Dec. 2016, p.11.

Herwadkar, Nihar. "Pros and Cons of ECDIS Or Paperless Navigation Of Ships." *Marine Insight*, Marine Insight, 29 Sept. 2017.

Karan, C. "A Detailed Explanation of How a Ship Is Maneuvered to a Port." *Marine Insight*, Marine Insight, 9 Oct. 2017.

Raunekk. "Maritime Ship Collision Cases Explored - Causes and Effects." *Brighthub Engineering*, 12 Nov. 2018.

Reyes, Maria R., et al. "Classroom Emotional Climate, Student Engagement, and Academic Achievement." *Journal of Educational Psychology*, vol. 104, no. 3, 2012, pp. 700

"Safer Seas Digest 2017: Lessons Learned from Marine Accident Investigations." *National Transportation Safety Board*, 2017.

Suell Dutra, Max, Ivanovich Lache, Katrin Ellermann, & Ricardo Ramírez Heredia. "Research in offshore transfer cargo operations; challenges, developments, and new frontiers." *Ciencia y tecnología de buques* [Online], 5.10 (2012): 9-17.

Veysey, Sarah. "Human error factors into most marine accidents; Safety improving, but challenges remain." *Business Insurance*, 9 Sept. 2013, p. 21.

Wilcutt, Terry, and Hal Bell. "The Cost of Silence: Normalization of Deviance and Groupthink." *National Aeronautics and Space Administration (NASA)*, 3 Nov. 2014.