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# Decision Making of Maritime Junior Watch Officers: A Phenomenological Study


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*ABSTRACT*

The tanker Exxon Valdez and cruise ship Empress of the North were each involved in a major incident involving poor decision making by junior officers on watch, resulting in the grounding of their vessels. The purpose of this hermeneutic phenomenological qualitative study was to describe the decision-making process of 15 maritime junior watch officers in a high-resolution simulation in adverse-condition scenarios. Data collection utilized observations, interviews and a self-efficacy assessment. For data analysis I used the constant comparative method, developing codes, which were analyzed and reduced to 3 key themes: (a) the Decision-Making Process, (b) Factors in Decision Making, and (c) Motivations and Solutions to Decision Making. The findings suggested working or short-term memory; emotional intelligence; self-efficacy; and skills, rules and knowledge were major factors of how successfully novice decision makers made their choices. At least 2 of these factors are within the affective domain. The results indicated maritime educators should utilize teaching aids and methods that stimulate the affective domain, as early as possible in the education process, to promote growth in student decision-making skills. The results also indicated that implementation of a mentoring program within the maritime industry and making it a part of normal practice for new officers will foster strong decision-making skills. To that end, curriculum for leadership and managerial skills courses required in maritime education should include benefits of a mentoring program and how such a program should be implemented.


## 1. Overview.

John Konrad (2007), an experienced deck officer, posed some poignant questions in a blog comparing the groundings of the Exxon Valdez and the Empress of the North. Konrad pondered:

Did the mate attempt to contact the captain when he first sensed trouble and if not why was the captain not on the bridge at the time of the grounding?.

Was the mate experienced in this turn, and if not why the captain did not wake up for the maneuver? (para. 9).

According to the National Transportation Safety Board (NTSB 1990) investigation, fatigue was the major contributing factor in the grounding of the Exxon Valdez. However, why did no one investigate the problem resulting from the decision made by the third officer. "Maybe if the journalists and public had determined the true cause of the Exxon Valdez different regulations would have been in place and the Empress of the North incident would not have happened" (Konrad 2007, para. 10).

Human error is one of the primary reasons for maritime incidents. Both international and federal laws exist to enforce safety management systems and require education and hands-on training; nevertheless, little evidence shows any positive changes from these laws in the number of maritime incidents (Giziakis Goulielmos Lathouraki 2012). Because issues regarding human elements are vast, this investigation focused on a small segment of the industry with greatest potential for incidents, the junior officer (UK P&I Club 1996).


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### 1.1. Problem Statement.

The problem is human error accounts for as much as 80% of maritime incidents. The maritime industry and education need to seek ways to reduce these incidents, saving lives and the environment, and reducing costs in doing business (Grech Horberry Koester 2008, Hetherington Flin Mearns 2006, Lin 2006, Rothblum 2000, Wang and Zhang 2000). Ship's crews caused 44% of the maritime incidents attributed to human error. Deck officers were responsible for 25% of those incidents (UK P&I Club 1996). Inexperience was a key factor with 20% of second officers having less than five years of sea time experience, and of those, 70% having less than five years in their current rank (UK P&I Club 1996).

The UK P&I Club (1990) recommended the industry seriously reexamine the training process of junior officers, specifically second officers. Oddly, the reports did not address third officers, even though they are one third of the bridge watch officers' team. This study examined the decision-making process of all bridge officers with less than two years' sea-going experience.

Investigation teams cited various reasons for the human-error-related incidents. Yet, none examined the deeper question of why poor critical decisions were made (Giziakis et al. 2012, Konrad 2007). Several studies have investigated unfamiliar, complex, and time-critical decision making in other fields (Chalko Ebright Patterson Urden 2004, Gillespie and Paterson 2009, Kosowski and Roberts 2003).

### 1.2. Purpose Statement.

The purpose of this study was to describe the decision-making process of maritime junior watch officers navigating a vessel in adverse conditions on a high-resolution, full mission bridge simulator. Understanding the underlying reasoning behind decision-making can help maritime educators devise new teaching methods to reduce poor decision making, potentially reducing maritime incidents. Some research has suggested self-efficacy plays a role in the decision-making process (Boscardin O'Sullivan Plant Sliwka van Schaik 2011, Feltz and Helper 2012). Self-efficacy is the level of confidence individuals have in their ability to execute certain courses of action or achieve specific outcomes (Bandura 1997).

### 1.3. Research Questions.

The following three research questions (RQ) examined factors and motivations of the decision-making process of junior officers:

RQ1: *While navigating their vessel, how do maritime junior watch officers describe their decision-making process in an adverse situation*? This main question of the study explored how the participants described their experience and how well they understood the reasons for their decision making within an adverse, simulated environment.

RQ2: *What factors do participants identify as affecting (positively or negatively) their critical decision-making process?* A decision, whether good or bad, by a novice decision maker reveals insights into the process used to come to the decision. The participants described their thoughts and subsequent actions that led to a particular decision.

RQ3: *What motivated the participant's decision when choosing one solution over another?* This question was adapted from the Critical Decision Model by Klein et al. (1989). When novice decision makers have made a decision, why did they choose one option over another or what motivated one decision over another?

## 2. Summary of the Literature.

Current theories with both heuristic and naturalistic decision making, as well as intuition, all depend on experienced decision makers responding to their situation (Azuma et al. 2006, Hall 2010, Klein 2008, Klein et al. 1989). Situation awareness is a process involving a feedback loop with a sequence of perception, comprehension, and execution driving that loop (Grech et al. 2008). Officers on watch must be able to perceive the condition of all the vessels around them, the relationship of their vessel to any hazards, their vessel's operational condition, and the comprehension of those perceptions and executions of actions to avoid hazard or collision. This process is an ongoing cycle of reassessing the situation and the environment. New officers may not have the experience to recognize and react to a developing situation in a timely manner. Watchkeeping classes for new junior officers should include situation awareness training. Recognizing shortcomings and applying them to new or revised educational techniques may assist in reducing marine casualties (Giziakis et al. 2012, Iordanoaia 2010, Wang and Zhang 2000).

## 3. Methodology.

### 3.1. Design.

This qualitative hermeneutic phenomenological research was oriented towards deck officers who make key decisions for the ongoing safe operation on their vessel.

### 3.2. Settings.

This field study was conducted at a northeastern maritime academy, pseudonym of North East Maritime Academy, with an international student body seeking to enter the maritime profession or to advance their careers. The research required a facility with a state-of-the-art, high fidelity, full mission, ship-handling simulator using Transas NTPRO 5000 simulation software on Windows® 7 platforms.

### 3.3. Participants.

Using maximum variation sampling, the researcher selected 15 junior watch officers attending the North East Maritime Academy. Participants were completing their Officer-in-Charge of a Navigation Watch (OICNW) assessments and were enrolled in a capstone class required for graduation (Servidio 2014). The participants, 14 males and one female, ranged in age from 21 to 26 years, and came from a variety of social-economic backgrounds, cultures and ethnicities. One was Asian/Pacific, two

Table 1: Overview of the Participants.

| Pseudonym | Age | Gender | Race | Home of Origin | Completed Simulation | GSE Scores |
|---|---|---|---|---|---|---|
| Alan | 24 | Male | Caucasian | Long Island, NY | S | **38 H** |
| Ben | 24 | Male | Caucasian | Long Island, NY | S | 36 H |
| Carl | 22 | Male | Caucasian | U.S. | U | 31 H |
| Diane | 22 | Female | Black | Jamaica | U | **24 L** |
| Edward | 22 | Male | Caucasian | U.S. | U | **29 L** |
| Frank | 21 | Male | Caucasian | Long Island, NY | S | 35 H |
| Gary | 22 | Male | Caucasian | Pennsylvania | S | 34 H |
| Henry | 21 | Male | Caucasian | U.S. | U | **28 L** |
| Ike | 24 | Male | Caucasian | New Jersey | S | 32 H |
| Jason | 21 | Male | Asian | New York | S | **28 L** |
| Ken | 22 | Male | Caucasian | North Carolina | U | **29 L** |
| Lamont | 22 | Male | Black | Bahamas | S | 31 H |
| Mark | 22 | Male | White | Long Island, NY | S | 30 H |
| Nat | 21 | Male | White | Long Island, NY | S | 32 H |
| Oscar | 26 | Male | White | Virginia | U | **28 L** |
| | | | | | S = Successful<br>U = Unsuccessful | **≥30 = High**<br>**≤29 = Low** |
| **Mean** | **22.4** | | | | | **31** |
| **Mode** | **22** | | | | | **28** |
| **Median** | **22** | | | | | **31** |

Source: Authors.

Black, and 12 Caucasian. Participation was voluntary. All participants received a pseudonym to protect their identity (see Table 1).

The simulator experience, part of the capstone course, required participants to safely navigate an 870-foot container ship with a deadweight of 60,000 long tons through the Puget Sound at night with heavy traffic. Each participant served as the mate on watch with a support team of three other students, and was either inbound from sea to Seattle, Washington, or outbound from Seattle to sea. Each participant had previous seagoing experience from either the school's training ship or a private company's vessel. Ten of the 15 participants had already passed their United States Coast Guard (USCG) Third Officer exams. All participants had already attended classes in radar, collision avoidance, and electronic chart plotting, as well as standard paper chart navigating techniques. Additionally, they all had received training as both helmsman and lookout, and were knowledgeable of maritime rules

### 3.4. Data Collection.

#### 3.4.1. Observations.

The researcher first conducted a passive observation of the class's simulation exercises from an observation booth with video and audio feeds from the simulation bridges, where the course instructor was overseeing the exercises. Having no direct contact between researcher and students at this stage reduced the influence of a stranger's presence during the simulation exercises. The researcher noted student activity and significant events such as collisions or groundings, along with personal thoughts and opinions.

Prior to the observations, the participants completed two exercises in the simulator and were accustomed to observers. The course instructor took notes of participants' errors of judgment, whether omission or commission, and later used the notes for debriefing with the students. The researcher's notes focused on errors of judgment and concurrent behaviors throughout the exercise, whether verbal or non-verbal.

The instructor briefed the students on the simulator controls and discussed the requirements set forth in the assessment. The visual system of the simulator produced a seascape of 240 degrees in a horizontal view and 40 degrees in a vertical view. Visualization of the ship's simulator-produced movement led to physical reactions mimicking those seen with true ship motion, including body swaying, and even vertigo among students. The simulated bridge had consoles, controls, and displays replicating equipment used on actual vessels. The bridge team consisted of a mate, a navigator, a radar operator, and a helmsman. For this study, the observations focused solely on the mate on watch.

Students' roles and the navigation situation aligned with the course syllabus. The junior officer was in control of the vessel for one hour, during which course instructor evaluated each student encountering various events, including estimating times of arrival, safe navigation of the channel, giving orders to the helmsman, coordinating traffic avoidance with the radar operator, and maintaining awareness of changing weather conditions. The instructor's assessment of the student's success was subjective. However, if the student failed to follow the captain's standing orders, failed to communicate or used inappropriate communication, or caused a critical incident such as a collision or grounding, the student failed the exercise. Even with a critical incident of a grounding or collision, the student could still pass the assessment by using the checklist for dealing with the emergency.

#### 3.4.2. Questionnaires.

Each participant completed the General Self-Efficacy Questionnaire (GSE), which examined self-efficacy level influenced the participants' decision making during the simulation. Previous literature suggested low self-efficacy could result in failure to act or increased reaction time (Bandura 2006, Brown 1999, Bruce Sachin Srivastava Stellern 2007, Lanigan 2008).

The GSE is a self-reporting measure created to assess perceived self-efficacy, to predict ability to cope and adapt behavior after stressful events (Schwarzer 2008). The scoring of the responses consisted of a four-point Likert-type scale, ranging from 10 to 40 points. A sum score of 30 points was the cutoff used to establish low self-efficacy and the average time to complete the GSE was four minutes (Schwarzer 2008).

The GSE score reflected an individual's self-efficacy. According to Bandura (2006), those participants with high self-efficacy believed they could perform their duties and make appropriate decisions regardless of the circumstance. Participants scoring low on the scale, below 30, may not make decisions as effectively or efficiently (Bandura 2006, Brown 1999, Bruce et al. 2007). The goal of this research was to use the observations of the participants in the simulator, the GSE score, and interviews to examine consistency between actual performance and participants' perception of their self-efficacy.

*3.4.3. Questionnaires.*

Interviews, lasting between 30 and 120 minutes, were audiotaped, then transcribed by a professional transcriber for later analysis by the researcher. Reflection allowed the participants to review the events to ascertain what they could have done differently and how to improve next time. The participants' feedback was helpful in formulating improvement to the curriculum.

*3.5. Data Analysis.*

*3.5.1. Scoring.*

The initial step in data analysis was to total the scores the GSEs. A score over 30 was considered high self-efficacy.

*3.5.2. Coding.*

The NVIVO 10 software assisted with the analysis of data from the observations, field notes, interviews and questionnaires. The researcher looked for patterns, repeated or contrasting words or phrases, and assigned a heuristic code to emerging categories. The researcher created a list of significant statements, reducing to eliminate overlapping statements, clustering into themes and finally creating textural and structural descriptions of the phenomena.

*3.5.3. Trustworthiness.*

Techniques for insuring trustworthiness included bracketing, triangulation, member checking and peer review. The study triangulated information from the observations, field notes, GSE scores, and interviews. The participants reviewed transcripts of their interviews, allowing them to check for accuracy. Finally, a colleague conducted a peer review to provide an external check of the research process

## 4. Summary & Discussion of Findings.

During the simulation, more than half of the participants safely navigated the channel. However, 11 of the 15 participants had trouble both communicating on the VHF radio with the other vessels and identifying the positions of those vessels. Three major themes, each with sub-themes, emerged from the data: (a) the decision making process, (b) factors in decision making, and (c) motivations and solutions.

*4.1. The Decision-Making Process.*

*4.1.1. Preparation.*

The first subtheme contributing to the decision-making process was preparation. Participants were required to be prepared with a voyage plan consisting of their personal notes, required calls, course and speed changes, and list of navigational aids. During the watch turnover and throughout the watch, watch officers "must follow a formal checklist to avoid missing important details" (Price 2013 p. 5). The participants recognized the importance of preparing for the watch and using a checklist. Nonetheless, at least six participants were not ready for the simulation. Reasons given for lack of preparation were: they were rushed between one group and another; the other team members did not prepare their part for the exercises; or they were not motivated to put any effort into preparing for the simulation.

Participants who did have a plan used it to assist them in their decision making. When they encountered unexpected traffic, the plan assisted those participants in knowing which radio frequency to use to make the appropriate call, being aware of their current location, and understanding what course they needed to use to get back on their original track.

Preparation also came into play with learning and practice of requisite skills. Rasmussen's (1983) skill, rule, and knowledge-based behaviors (SRK) model assisted in describing behaviors. Skill-based behaviors are those that are usually subconscious, well-rehearsed, routine activities. In this study, the participants, who were the mates on watch, did incorporate some well-rehearsed activities acquired in previous classes and during summer cruises. Operating radar or talking on the VHF radio would be considered skilled behavior.

*4.1.2. Self-awareness.*

The second subtheme identified for the decision-making process was self-awareness, identified in Goleman's (1995) Emotional Intelligence Model. People with good self-awareness are cognizant of their own moods, allowing people in the midst of turmoil to take an internal step back and to reflect on their behavior. Personality traits and past experiences contribute to levels of emotional awareness. When decisions are impossible through rationalization or formal logic, they are often guided by a gut feeling, emotional wisdom based upon past understandings (Goleman 1995). Even when individuals do not recall specific experiences, the emotions associated with those experiences can become an intuitive signal, guiding a person's emotions in a specific direction, allowing that person to choose to attend to or ignore the emotion. Mariners on the bridge of a ship, while trying to formulate a decision, may use their gut feelings when dealing with an unfamiliar event. One component of improper self-awareness became evident when participants faced a stressful situation and were less able to reason because of emotional hijacking, which arrested the cognitive processes and restricted or shut down working memory (Goleman, 1995).

Some people are so overwhelmed by their emotions that they feel helpless and out of control. Chalko et al. (2004) noted time constraints contributed to people feeling overwhelmed and losing the big picture. The participants in Chalko et al. were not able to describe what they were experiencing when they lost track of the larger picture, while the participants in this study did describe their decision making when they lost the big picture. Some participants were able to make suggestions about what they could have done to remedy the situation. Participants who did succeed in their voyage plan described what they did to prevent losing the big picture, which in the maritime industry is situation awareness.

Self-awareness is similar to situation awareness in that both are internal behaviors of watchstanders; however, situation awareness is more global, meaning people know what is going on around them. Situation awareness considers all visual cues, displays, communications, traffic, navigation, personal availability, and capabilities of the vessel to help the watchstander prioritize and formulate a possible solution (Chauvin Clostermann Hoc 2008, USCG Auxiliary 1998). Self-awareness describes how the person will react to information provided by situation awareness.

More than two thirds of the participants were aware of the traffic around them; however, less than half of that traffic was observed and described. The interviews revealed some indecisiveness, which caused four maneuvers to be either delayed or missed. While the participants were engaging in a situation, their inner self-talk was either providing a solution or telling them they were in dire straits. The participants who were in control of the situation felt less stress and more confidence and were able to convince themselves they were doing the right thing. Those who were less than successful experienced conflicting thoughts and feelings, which many of the participants called being double minded. Even though they were aware of their state of mind, they lacked the skill to dispel their mental anxiety. Five participants appeared to have good self-awareness, because when encountering unexpected traffic, they were able to communicate effectively and maneuver their ships for a safe passage between vessels.

#### *4.1.3. Simulated versus real world experience.*

The third subtheme identified for the decision-making process was the extent to which the participants took the simulated experience seriously. High resolution, full-scale bridge simulators have been used in maritime education for over 25 years as an effective tool for training bridge personnel. These simulators help teach new mariners how to stand a watch at sea or at anchorage and provide experience for mariners in critical and adverse situations. Simulation gives the mariner a chance to react and experience a scenario that would otherwise be life threatening or catastrophic to the vessel or environment.

Seven of the 15 participants accepted the simulation as a real world experience. Those who did not take the simulation seriously felt it was too much like a video game or the visuals and the controls were not effective. They explained that the simulator did not give a proper feel for depth perception and a sensation of actual motion, and the simulator's console and equipment was limited. Looking aft or around obstructions required the operator to use visual controls to rotate the view, not an option in a real scenario.

### *4.2. Factors in Decision Making.*

RQ2 inquired about which factors could be identified as affecting the participants' decision-making process. From the interviews, three subthemes were identified: confidence, workload, and team cooperation.

#### *4.2.1. Confidence vs. Self-efficacy.*

The first subtheme influencing decision making was confidence. Bandura (1997) contrasted confidence and self-efficacy, explaining confidence was a strength of a belief; however, "perceived self-efficacy refers to belief in one's agentive capabilities that one can produce given levels of attainment" (Bandura 1997 p. 382). In this study results of a self-efficacy questionnaire were compared with participants' statements about confidence. The levels of participants' self-efficacy are provided in Table 2.

All participants expressed confidence as a factor; however, those who scored highly on the self-efficacy scale were more likely to complete their voyage successfully.

Table 3 indicates those participants with high self-efficacy were most likely to have a successful voyage. Those who were most likely to not complete their voyage had low self-efficacy as well as workload issues as a factor in their decision making. Even though confidence was described by most of the participants as a factor in good decision making, Table 3 indicates confidence did not have any effect on the completion of a voyage.

#### *4.2.2. Workload.*

A second key factor influencing decision making was workload. Twelve of the 16 participants felt workload was a factor overlooking or delayiing making a decision. They described becoming focused on traffic in front of the ship but practically ignoring those vessels coming from behind the ship. Workload also became a factor in the navigation. When the mate was focused on traffic, navigation was often overlooked, and turns were delayed or forgotten. When required to call the captain at specific points or respond to other vessels calling the ship, the mate on watch often was preoccupied and did not seem to prioritize the necessary responses to the situation.

Workload plays an important role in Working Memory (WM). A person can hold between five and nine items in immediate memory, with overload causing confusion (Miller 1994). The simulation presented the following workload demands: (a) traffic density increased, (b) other vessels communicated with each other, (c) the voyage plan had required reporting points, and (d) the standing order required specific reports be made to the captain or engineers. Nine of the 15 participants expressed workload frustration, with six not completing their voyage. Several of those were distracted with collision avoidance, communication, or other navigation issues. Stressful workload is one of the key reasons for maritime incidents (Grech et al. 2008, Lin 2006, Rothblum 2000, Wang and Zhang 2000).

#### *4.2.3. Team Cooperation.*

Team cooperation emerged to be another factor in the decision making. When a team member did not provide information or ignored information, the mate on watch failed to make a good decision. Seven of the 15 participants had effective teams assist them in their decision making. Two participants who had good communication with their teams, but had low self-efficacy, failed their voyage. These participants wavered in their decision making regardless of team recommendations. Five participants

Table 2: General Self-Efficacy Questionnaire Results.

| **Question Number** | | | | | | | | | | | **Totals** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | |
| **Names** | | | | | | | | | | | |
| *Alan* | 4 | 4 | 4 | 3 | 4 | **4** | 3 | 4 | 4 | 4 | **38** |
| *Ben* | 3 | 3 | 4 | 4 | 4 | **4** | 3 | 3 | 4 | 4 | 36 |
| *Carl* | 3 | 3 | 3 | 3 | 3 | **4** | 3 | 3 | 3 | 3 | 31 |
| *Diana* | 1 | 1 | 2 | 3 | 3 | **3** | 2 | 3 | 3 | 3 | ***24*** |
| *Edward* | 3 | 3 | 3 | 3 | 3 | **3** | 2 | 3 | 3 | 3 | ***29*** |
| *Frank* | 4 | 2 | 4 | 3 | 3 | **4** | 3 | 4 | 4 | 4 | 35 |
| *Gary* | 3 | 3 | 4 | 4 | 3 | **3** | 3 | 3 | 4 | 4 | 34 |
| *Henry* | 3 | 2 | 3 | 3 | 2 | **4** | 3 | 2 | 3 | 3 | ***28*** |
| *Ike* | 3 | 3 | 4 | 3 | 3 | **4** | 3 | 3 | 3 | 3 | 32 |
| *Jason* | 3 | 1 | 3 | 3 | 3 | **4** | 3 | 3 | 2 | 3 | ***28*** |
| *Ken* | 3 | 2 | 4 | 3 | 3 | **3** | 3 | 2 | 3 | 3 | ***29*** |
| *Lamont* | 3 | 2 | 4 | 3 | 3 | **4** | 3 | 3 | 3 | 3 | 31 |
| *Mark* | 3 | 3 | 3 | 2 | 3 | **4** | 3 | 2 | 4 | 3 | 30 |
| *Nat* | 3 | 3 | 4 | 3 | 4 | **4** | 3 | 2 | 3 | 3 | 32 |
| *Oscar* | 3 | 3 | 3 | 3 | 3 | **3** | 2 | 3 | 2 | 3 | ***28*** |
| | 45 | **38** | 52 | 46 | 47 | **55** | **42** | 43 | 48 | 49 | |
| | | 2.53333 | | | | 3.66667 | 2.8 | 2.86667 | | **Mean** | 31 |
| | | 3 | | | | 4 | 3 | | | **Mode** | 28 |
| | | 3 | | | | 4 | 3 | | | **Median** | 31 |

Source: Authors.

Table 3: Factors in Decision-Making Themes.

| | *Alan* | *Ben* | *Carl* | *Diana* | *Edward* | *Frank* | *Gary* | *Henry* | *Ike* | *Jason* | *Ken* | *Lamont* | *Mark* | *Nat* | *Oscar* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Self-Efficacy | H | H | H | L | L | H | H | L | H | L | L | H | H | H | L | H=High Self-Efficacy<br>L= Low Self-Efficacy |
| **Voyage Completion** | **S** | **S** | U | U | U | **S** | **S** | U | **S** | U | **S** | **S** | **S** | **S** | U | **S= Successful**<br>**U= Unsuccessful** |
| Confidence | C | C | C | N | C | N | C | C | C | C | C | C | N | C | N | C=Confident<br>N=Not Confident |
| Teamwork | P | P | P | P | P | G | P | G | P | P | G | G | G | G | G | G=Good Teamwork<br>P=Poor Teamwork |
| Workload | I | I | | I | I | I | I | I | I | I | I | | I | | I | I=Considered an Issue |

Source: Authors.

had good teamwork and a successful voyage, while three with seemingly ineffective teamwork still completed their voyages. Those three participants reported they decided to make their own decisions regardless of the lack of communication from the other team members. Four participants who had poor teamwork and failed the voyage explained their team was not prepared or familiar with the equipment and failed to communicate.

### *4.3. Motivations and Solutions to Decision Making.*

RQ3 examined the motivations and solutions of participants in decision making. The observations and the interviews suggested three subthemes motivated the participants to a particular solution: rules, knowledge, and self-motivation.

#### *4.3.1. Rules.*

The primary action to solving a problem was guided by procedures, official guidelines, instructions, and other rules. Given an event or situation, participants used rule-based behaviors to guide action, as observed in the simulations when the participants made a collision-avoidance maneuver or made calls as prescribed by the standing orders.

Aligning with Rasmussen's (1983) model of Skills, Rules and Knowledge, the use of rules was recognized by all of the participants. For example, the participants obeyed the standing orders or followed collision avoidance regulations, such as the rules of the road, which are " protocol designed to keep vessels apart... to defend yourself, your vessel and the lives of others" (Price 2013 p. 4). Participants based decisions on the captain's standing orders, even when knowing they may incur the captain's ire. For example, participants like Diane and Oscar made considerable calls to the captain; even though Diane had the lowest GSE score and received scorn from the captain for her mistakes, she still made several calls. Diane's actions demonstrate people often depend on established rules to help guide their decisions.

Knowing the rules was important, even when the participant knew the rules yet took a risk in a decision (Kosowski and Roberts 2003). Deck officers were aware of the rules, yet a few took risks in their maneuvers or navigation, in half of which the risk worked. When Edward was the mate on a container ship inbound to Seattle, he encountered a vessel overtaking his ship at high speed. He was supposed to contact the other ship and if that failed, he was required to maneuver his ship to avoid a collision and allow for a distance between the two vessels for a safe passage. From my display in the control room, a collision seemed obvious; however, the system did not register as such. In the interview he reported while he could have made the gap wider between the two vessels, he made an assumption he had enough clearance.

#### *4.3.2. Knowledge.*

Another subtheme motivating participants to a solution was knowledge. According to Rasmussen's Skills, Rules, and Knowledge model, when rules no longer applied and a novel situation developed, participants used knowledge-based behaviors. The participants who were able to cope effectively with a new situation referred to previous knowledge, created a plan, then through trial and error came to a satisfactory conclusion. Even though all participants primarily used rules to avoid collision, several traffic situations did not fall under typical rules. Nonetheless, those participants who successfully completed their voyage demonstrated good, knowledge-based behaviors, because they were able to cope with time-sensitive, unpredictable, stressful situations. Conversely, mates who failed to demonstrate their knowledge of standing orders, navigation, collision avoidance, or radio communication, had adverse effects on decision making and success of the voyage.

#### *4.3.3. Self-Motivation.*

The final subtheme in motivation in decision making was self-motivation or how much participants dealt with and controlled their emotions. Those participants who appeared to have good self-motivation had a less stressful time when they encountered unexpected traffic and events. Goleman's (1995) theory suggested self-motivation allows individuals to direct emotions in order to master a goal. Emotions can paralyze the brain and overwhelm concentration, which in turn can overpower the cognitive processes of working memory, resulting in a failure to think effectively. Two of the participants discussed self-motivation, observing that preparation and getting the most out of their educational experiences should continue throughout their maritime careers.

### *4.4. Competency.*

Even though not directly addressed in the study, competency became apparent as a factor in good decision making. Competency is difficult to define, but some suggest it measures the success of one's ability or knowledge. The STCW Code stated the standard of competence "means the level of proficiency to be achieved for the proper performance of functions on board ship in accordance with the internationally agreed criteria" (International Maritime Organization 2011 p. 4). For junior officers to be recognized as competent officers, they must demonstrate their knowledge of the rules of the road, the equipment on the bridge, and proper navigation and watchstanding procedures. The eight participants who successfully completed their voyage would be considered competent.

## 5. Implications.

Maritime commerce has been a global occupation since ancient times, with incidents being as old as recorded history and often involving loss of lives, damage to cargo or passengers, or damage to or destruction of the vessel. With each incident, the cost of indemnification of the ship and crew rises, affecting consumers all along the economic chain (UK P&I Club 1996). The findings in this study has global implications for both the industry and maritime education.

### *5.1. Maritime Educators.*

When mariners become an officer, training is crucial for when they stand alone on the bridge of a ship. Maritime training facilities should help the mariners from day one of their training to understand their obligations and responsibilities to their own education. This emphasis should continue throughout their training as they transition to becoming officers. Students with a high sense of self-motivation typically take their studies seriously.

Most maritime educators utilize learning objectives within their courses. Many use the STCW for their instruction follow the Knowledge, Understanding and Proficiency (KUP) of column 2 of the STCW tables to achieve the learning objectives of the class. These KUPs are related to Bloom's Taxonomy, which outlined three areas of learning domains: cognitive, affective, and psychomotor (Bloom 1956). Most maritime education learning objectives focus primarily on the cognitive and psychomotor domains. This study showed emotional intelligence, the affective domain, influences decision making; therefore, educators need to include more affective learning objectives.

Holden and Van Valkenburg (2004) noted affective education develops critical thinking and professional judgment that stimulates excellence in students' abilities. Affective education inspires officers to preserve professional standards and ethics. From the students' perspective, affective education fosters self-awareness. Self-awareness, an identified theme in this study, if properly cultivated, helps the students recognize when their emotions are impeding their ability to reason, thus interrupting the process of emotional hijacking (Goleman 1995).

Table 4 indicates which affective learning objectives be incorporated and which key words be used in writing the course syllabus. Training needs to include new technology as often as possible, with simulations, which stimulates the affective domain more than learning from textbooks and lectures. The participants discussed that because their generation grew up around electronics, instructors need to develop online simulation for homework, using virtual and artificial reality training systems, with desktop and full mock-up simulators (Dunleavy Dede Mitchell 2009). Instructors should also reconstruct scenarios from case studies and let the students determine what to do given similar conditions.

Courses like terrestrial and coastal navigation are primarily hands-on learning experiences. Prior to the students taking final exams, courses should include a series of practical assessments. Students should conduct navigation exercises in a full bridge simulator, given inbound and outbound scenarios. Instructors can divide teams into various rotating roles: navigational aid bearing taker, bearing recorder, chart plotter, and navigation evaluator. Upon completion of the exercises, both students and instructors should evaluate the team's performance and make recommendations for self and group improvement. This approach facilitates incorporating into maritime courses established affective education learning objectives, such as in responding, valuing, and organizing (Holden and Van Valkenburg 2004).

Participants in this study presented an interesting point about the use of electronic aids on the bridge. They noted focusing on one piece of gear over another stemmed from how the instructor presented its importance and how to use it effectively. Instructors are a significant part of affective education, role models these new mariners will emulate. Instructors should include the following strategies in their instruction. (1) Be nonjudgmental and non-threating. (2) Emphasize events, like how upcoming exams are significant to the course and will relate to the success of maritime endeavors, not merely contribute to the grade. (3) Utilize quizzes and exams as learning experiences rather than punitive devices. (4) Use cooperative rather than competitive learning environments (Holden and Van Valkenburg 2004).

Curriculum at the earliest level should include frequent use of case studies, role-playing, and videos to dramatize shipboard incidents and solutions. Regular use of labs and exercises requiring constant application of problem-solving skills is important. Frequent exercise of problem solving using the affective domain increases new officers' ability to rapidly build self-awareness and confidence in making decisions.

### *5.2. The Maritime Industry.*

Diane expressed the benefit of learning from other officers on the bridge. This insight stemmed from her experience working as a mentor with high school students learning about safe boating. She desired opportunities to walk around with experienced officers to see how they conducted their watches, being free to ask why they made one decision over another. She wanted to learn from other officers the best solutions to difficult problems encountered on a ship. Nevertheless, she expressed apprehension that a senior officer may be unreceptive and less than cooperative due to her inexperience on the vessel.

New officers joining a vessel normally do not have the experience or comprehensive knowledge that senior officers have acquired over time. Unfortunately, more experienced officers are not always accepting of new junior officers as part of their team. This lack of initial acceptance is because some senior officers have unrealistic expectations that juniors should be able to stand their watch alone, having already acquired necessary knowledge and decision-making skills (Hetherington et al. 2006, Schröder-Hinrichs Hollnagel Baldauf 2012). These unrealistic expectations are based on the assumption that simply being an officer means full knowledge and competence to stand the watch independently.

The standing orders state that when the captain is not on the bridge, the third officer is to call the captain either to keep him informed or to request assistance (Schröder-Hinrichs et al. 2012). Information from the interviews indicated reasons junior officers decide not to call the captain were: they think they should know what to do; they do not want to look incompetent; or they are afraid of upsetting the captain by calling him. Several participants expressed this view of fear and inadequacy, suggesting an alternative solution to alleviate apprehensions: have someone help them get established and comfortable with their watch at least for the first several months onboard.

The long-term solution is to educate intermediate and senior level officers about benefits their operations gain by effectively mentoring new officers, which include teaching senior officers how to mentor and educate the junior officer. Goldberg (2013) stated 70% of professional knowledge comes from informal training. Even though mentoring is an under-utilized prac-

Table 4: Suggested STCW Course and Associated Affective Learning Objectives.

| STCW Courses | Affective Learning Objectives | Affective Objectives Key Works | Affective Education Methods |
|---|---|---|---|
| Personal Safety and Social Responsibility (PSSR) | Receiving, Responding, and Valuing | acknowledge, asks, attentive, listens, understands answers, assists, complies, conforms, discusses, labels, performs, presents, tells, appreciates, demonstrates, initiates, justifies, proposes | Role Play, Discussions that may include ethical dilemmas, Emphasize the significance of the class to actual shipboard experience. |
| Basic and Advanced Firefighting. | Receiving, Responding, Valuing, and Organization | acknowledge, asks, attentive, listens, understands answers, assists, aids, complies, conforms, discusses, labels, performs, presents, tells, appreciates, demonstrates, initiates, justifies, proposes, compares, relates, synthesizes | Role Play, Case Studies, Discussions, Emphasize the significance of the class to actual shipboard experience. |
| Personal Survival Techniques and Proficiency in Survival Craft. | Receiving, Responding, Valuing, and Organization | acknowledge, asks, attentive, listens, understands answers, assists, aids, conforms, discusses, labels, performs, presents, tells, appreciates, demonstrates, initiates, justifies, proposes, compares, relates, synthesizes | Role Play, Case Studies, Discussions, Emphasize the significance of the class to actual shipboard experience. |
| First Aid / CPR and Medical Care Provider. | Receiving, Responding, Valuing, and Organization | acknowledge, asks, attentive, listens, understands answers, assists, complies, conforms, discusses, labels, performs, presents, tells, appreciates, demonstrates, initiates, justifies, proposes, compares, relates, synthesizes | Role Play, Identify problems and discuss solutions, Emphasize the significance of the class to actual shipboard experience. |

Source: Authors.

tice, the maritime industry would benefit greatly from the practice of transferring knowledge from one generation of mariners to another. The International Maritime Organization (IMO) requires captains and chief officers to attend the leadership and managerial skills course that includes shipboard management and training. Nevertheless, the curriculum for that course does not specifically address how to help a new officer through the transition of becoming a functional independent watchstander, nor does it teach senior officers how to be a mentor for these new officers. The curriculum addresses decision making but has nothing to explain the degree of experience a person needs for making competent decisions (IMO 2011).

First, the curriculum should emphasize the importance of mentoring, which benefits both the captain and the company through developing and retaining talent for the organization. Furthermore, mentoring is personally beneficial to the mentors in enhancing their skills from sharing their knowledge and experiences. The relationship is not without conflicts. For the protégés to reach their full potential, they will at times require some firmer guidance, which should include constructive feedback. By investing in protégés, the mentors can develop long-lasting relationships (Goldberg 2013).

Next, the curriculum should emphasize this relationship for developing new officers may take several years, due to the complexity of watchstanding. Knowledge is not enough. Experience is what helps new officers form competent decisions, which can be expedited by having the mentors find ways to challenge and coach their new officers through new experiences.

Stopping to teach someone less experienced to do the job takes discipline and patience from the captain. However, the rewards are not just for the trainee, but also for the captain. Training someone new to do what the captain does strengthens the team by having one more experienced officer on the bridge. Remembering this person does not have the years of experience to draw from for reliable decision making should be standard practice. These new officers require additional support both intellectually and emotionally, rather than chastising for what they do not know or fail to do (Iordanoaia 2010, Wang and Zhang 2000).

### *5.3. Limitations.*

One limitation within this study is the nature of the survey used. The GSE is a self-reporting instrument and has the potential for the participants to report false positives about themselves. Another limitation was the small sample of participants. The industry includes diversity in gender, ethnicity, nationality, and educational paths to becoming officers. Some mariners, known as Hawsepipers, follow a non-traditional education path where they must complete three years of sea service, over 100 hands-on assessments, and five to six months of intense classroom training. With the small number of participants and lack of diversity, the results of this study may not be generalizable to the entire maritime community.

### *5.4. Recommendations for Future Research.*

This study investigated decision making of novice decision makers in the maritime domain. Future research should include other levels of experience. Therefore, additional studies should investigate decision makers at the intermediate level with three to 10 years of experience, and experts with more than 10 years, because the UK P&I Club report cited that captains are involved in 33% of the incidents. Moreover, other roles could be investigated, such as junior engineering officers who stand as officer in charge of an engineering watch. Even though Giziakis et al. (2012) reported that engineering officers were involved in less than 5% of shipboard incidents, more recent events with Carnival cruise ships resulted from engineering failures, suggesting additional studies with engineering personnel.

Furthermore, self-efficacy was a descriptive component of this study related to participants' reaction to a situation. Because the study was qualitative research, the sample size used was too small to determine any statistically significant findings. To determine significance, a quantitative study should be conducted with a large sample size to determine possible correlation between completion of a voyage and self-efficacy scores. Quantitative studies could compare the GSE with other similar instruments. By using three different measures, a researcher might determine if a correlation exists between self-efficacy, confidence, and emotional intelligence when determining success of an officer's decision making in an adverse situation.

This study's participants were from a traditional education pathway to becoming junior officers. Future studies should conduct similar research of mariners who follow a non-traditional path, i.e., Hawsepipers. The research should consider a facility that has a high-resolution, full bridge simulator. The training equivalent for NAUT 416 would utilize the USCG required watchkeeping course and the associated assessments. Additionally, similar research should focus on other regions of the US and other countries.

**Summary.**

This In as much as 80% of maritime incidents, human error has been considered the primary cause. Of that number, 25% are attributed to deck officers and watchstanders, of whom one third are considered junior and inexperienced decision makers. This research study described the maritime junior officer's decision making. The study presented three themes: the Decision-Making Process, Factors in Decision Making, and Motivations and Solutions to Decision Making. Each theme had three subthemes or key points. The Decision-Making Process was based on how well participants were prepared for the exercise, how well they knew themselves and their abilities, and whether or not they took the simulation seriously. Factors in Decision Making included confidence, workload, and team cooperation. Finally, Motivations and Solutions to Decision Making depended on rules, knowledge, and self-motivation. Specifically, junior officers who were lacking in any of these key points faced barriers decision making when encountering a complex and unfamiliar situation.

Interestingly, many of the key points were related to the affective domain, an area often neglected in maritime education. Maritime educators should begin all courses emphasizing the need for taking advantage of teaching aids that stimulate the affective domain. By using the affective domain, the educator makes an appeal to the students' emotions. Knowing intellectually how to make a decision is not enough. Emotion has the ability to influence long-term retention of information.

The maritime industry has realized the traditional hierarchy with the captain as absolute authority may need to be updated. The methods of Captain Bligh have proven to be ineffective; likewise, abusing and berating junior officers today is just as ineffective if not unethical. For new junior officers to make better decisions, the industry should implement a mentoring program and make it policy for shipping companies. The curriculum for the leadership and managerial skills course should include the benefits of a mentoring program and how such a program is implemented. By including instruction in the affective domain and by implementing formal mentoring programs, the maritime industry can help ensure a future of better-prepared leaders and decision makers.

**References**


Azuma R, Daily, M, Furmanski C (2006) A review of time critical decision-making models and human cognitive processes. Paper presented at the Aerospace Conference, 2006 IEEE, Big Sky, MT. doi:10.1109/AERO.2006.1656041

Bandura A (1997) Self-efficacy: The exercise of control. WH Freeman and Company, NY.

Bandura A (2006) Toward a psychology of human agency. Assoc for Psych Sci. doi:10.1111/j.1745-6916.2006.00011.x

Bloom BS (1956) Taxonomy of educational objectives. Allyn & Bacon, Boston

Boscardin CK, O'Sullivan PS, Plant JL, Sliwka DC, van Schaik SM (2011) Validation of a self-efficacy instrument and its relationship to performance of crisis resource management skills. Adv in Health Sci Ed. doi:10.1007/s10459-011-9274-7

Brown BL (1999) Self-efficacy beliefs and career development. ERIC Digest No. 205. ERIC Clearinghouse on Adult Career and Vocational Education, Columbus. Retrieved from http://www.ericdigests.org/1999-4/self.htm

Bruce MA, Sachin J, Srivastava N, Stellern J (2007) Self-efficacy as a function of attributional feedback. J of School Couns, 5(**??**), 1-22.

Chalko B, Ebright PR, Patterson E, Urden L (2004) Themes surrounding novice nurse near-miss and adverse-event situations. J of Nurs Admin. doi:10.1097/00005110-200411000-00010

Chauvin C, Clostermann J, Hoc JM (2008) Situation awareness and the decision-making process in a dynamic situation: Avoiding collisions at sea. J of Cog Eng and Dec Making. doi:10.1518/155534308X284345

Dunleavy M, Dede C, Mitchell R (2009) Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. J of Sci Ed & Tech. doi:10.1007/-s10956-008-9119-1

Feltz DL, Hepler TJ (2012) Take the first heuristic, self-efficacy, and decision-making in sport. J of Experl Psych: Applied.doi:10.1037/a0027807

Gillespie M, Paterson PL (2009) Helping novice nurses make effective clinical decisions: The situated clinical decision-making framework. Nurs Ed Persp. PMid:19606659

Giziakis C, Goulielmos AM, Lathouraki G (2012) The quest of marine accidents due to human error, 1998-2011. Intl J of Emerg Serv. doi:10.1108/20470891211239317

Goleman D, (1995) Emotional intelligence: Why it can matter more than IQ. Bantam Books, Inc., NY

Grech MR, Horberry T, Koester T (2008) Human factors in the maritime domain. CRC Press, Bocca Raton doi:10.1201/978-1420043426

Hall KA (2010) The effect of computer-based simulation training on fire ground incident commander decision-making. Doctoral dissertation, University of Texas at Dallas

Hetherington C, Flin R, Mearns K (2006) Safety in shipping: The human element. J of Safty Res. doi:10.1016/j.jsr.2006.04.007

Holden LK, Van Valkenburg J (2004) Teaching methods in the affective domain. Rad Tech. PMid:15202341

International Maritime Organization (2011) International convention on standards of training, certification and watchkeeping for seafarers (STCW), and the STCW code, includes 2010 Manila amendments. International Maritime Organization, London

Iordanoaia F (2010) Master of the ship, manager, and instructor. Mgt & Markt. 1, 133-155. Retrieved from www.mnmk-.ro/documents/2010special/13IORDANOAIA-LUCRAREFFF-.pdf

Klein GA (2008) Naturalistic decision-making. Hum Fact and Ergon Soc. doi:10.1518/001872008X288385

Klein GA, Calderwood R, Macgregor D (1989) Critical decision method for eliciting knowledge. IEEE Trans on Syst, Man and Cybern. doi:10.1109/21.31053

Konrad J (2007, May 18) Alaska cruise ship incident has ties to Exxon Valdez grounding. [Web log comment]. Retrieved from http://gcaptain.com/alaska-cruise-ship-incident-has-ties-to-exxon-valdez-grounding/

Kosowski MM, Roberts VW (2003) When protocols are not enough: Intuitive decision-making by novice nurse practitioners. J of Hol Nursing. doi:10.1177/0898010102250275

Lanigan ML (2008) Are self-efficacy instruments comparable to knowledge and skills tests in training evaluation setting? Perform Impr Qtly. doi:10.1002/piq.20005

Lin B (2006) Behavior of ship officers in maneuvering to prevent a collision. J of Marine Sci and Tech. 14(**??**), 225-230. Retrieved from http://jmst.ntou.edu.tw/marine/14-4/225 – 230.pdf

Miller GA (1994) The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psych Rev. doi:10.1037/0033-295X.101.2.343

National Transportation Safety Board (1990) Grounding of the U.S. Tankship Exxon Valdez on Bligh Reef, Prince William Sound near Valdez, Alaska March 24, 1989. Marine Accident Report NTSB/MAR-90/04. Washington, DC.

Price SPM (2013) How to be a good collision avoider. The Navigator, 2, 4-5. Retrieved from http://www.scribd.com/doc/211508958/The-Navigator-Issue-2-Avoiding-Collisions-pdf#scribd

Rasmussen J (1983) Skills, rules, and knowledge; signals, signs, and symbols, and other distinctions in human performance models. IEEE Trans on Syst, Man, and Cybernetics. doi:10.1109/TSMC.1983.6313160

Rothblum AM (2000, October) Human error and marine safety. In National Safety Council Congress and Expo, Orlando, FL.

Schröder-Hinrichs J, Hollnagel E, Baldauf M (2012) From Titanic to Costa Concordia: A century of lessons not learned. WMU J of Maritime Aff. doi:10.1007/s13437-012-0032-3

Schwarzer R. (2008) Psychometric scales. [Freie Universität Berlin website]. Retrieved from http://userpage.fu-berlin.de-/health/

Servidio, J. A. (2014). Guidelines on qualification for STCW endorsements as officer in charge of a navigational watch on vessels of 500 gt or more. US Coast Guard, Navigation and Vessel Inspection Circular No. 12-14. Washington, DC.

UK P&I Club (1990) Large Claims Analysis/Major Claims 1990. Retrieved from http://www.ukpandi.com/fileadmin/uploads/uk-pi/LP%20Documents/ Large_Claims_Analysis/Major%20Claims%201990.pdf

UK P&I Club (1996) The Human Factor: A Report on Manning. Retrieved from http://www.ukpandi.com/loss-prevention-/article/the-human-factor-a-report-on-manning-789/

US Coast Guard Auxiliary (1998) Team coordination training student guide. United States Coast Guard Pamphlet No. G65303, Washington, DC. Retrieved from http://www.uscg.mil/auxiliary/training/tct/

Wang J, Zhang, SM (2000) Management of human error in shipping operations. Prof Safety, 45(10), 23-28. Retrieved from http://search.proquest.com/docview/200455881?accountid=12-085