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P&I Loss Prevention Bulletin

The Japan Ship Owners' Mutual Protection & Indemnity Association Loss Prevention and Ship Inspection Department

4M4(5)E Analysis

Analysis of Accident Cases

Contents

Attachments

Please use the following attachments and blank form of the 4M4(5)E Analysis List using the QR code below or by downloading them from the follow URL:

https://piclub.box.com/s/qkc4c4w88m9izvmkegymyunpe7m93yd6

Please note that the attached documents and data are provided by an external service and that publication may be suspended without prior notice.

§1 Introduction: Safety and Casualty Mechanism & Maritime Accident Prevention

In our previous Loss Prevention seminars and Loss Prevention Bulletins, we introduced the definition of "safety", mechanisms behind maritime accidents, how to prevent maritime accidents and so on. (Please see our Loss Prevention Guides "Thinking Safety (Vol.35)" published in 2015 and "A Psychological Approach to Safety Behaviour" (Vols. 46 and 47) published in 2020.

1−1 What Is Safety?

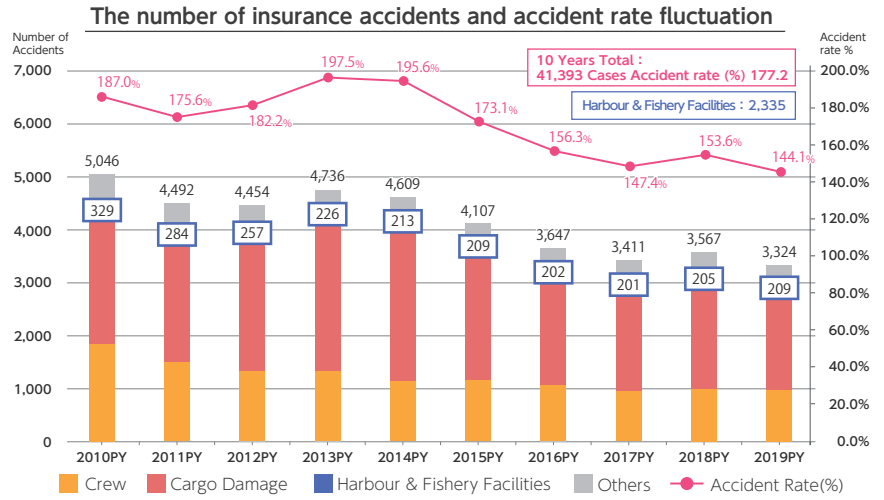
In the world, absolute safety does not exist, and we are always exposed to all hazards. According to the International Basic Safety Standards 1st Edition (ISO/IEC GUIDE 51: 1990) published in 1990, safety is defined as:

> **"Quality is not a synonym for safety and consequently the respective roles of quality and safety should not be confused." "There can be no absolute safety." and "There is no freedom from unacceptable risk."**

Also, thinking of "Safety" has been discussed in various different fields, but, in summing them up, "Safety can be defined as the result or evaluation of all danger being avoided."

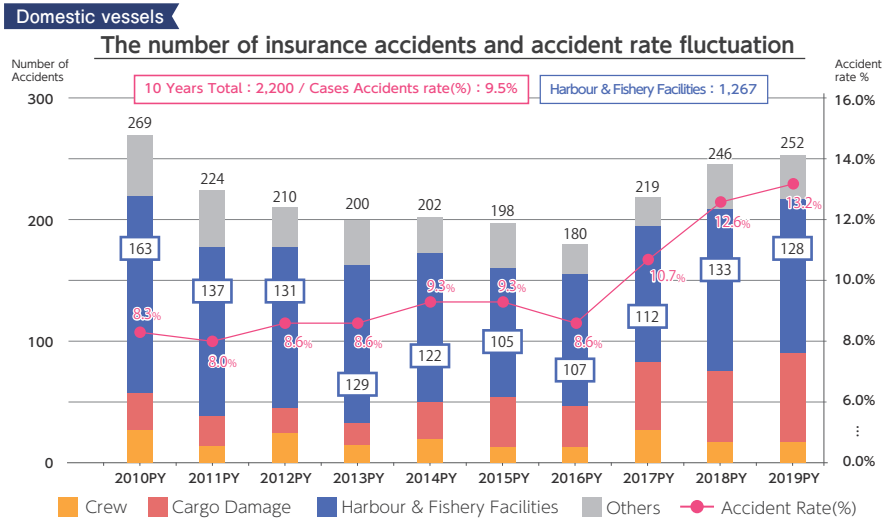
Although each related person, not only those on the vessel but those also working in the offices on land, is always in pursuit of safe operation, unfortunately, "zero marine accidents" have not been achieved yet. Looking at the statistics of P&I accidents reported to us, the accident rate which was calculated by dividing the total number of accidents that occurred over the last 10 years by the number of entered ship underwriting at the beginning of the term was 171.7% for oceangoing vessels and 9.5% for coaster vessels. This means that, with regards to some P&I accidents, oceangoing vessels caused 1.8 accidents per vessel per year, while this amounted to less than one in ten coaster vessels per year. (See Graphs 1 and 2)

Ocean going vessels



Graph 1

Domestic vessels



Graph 2

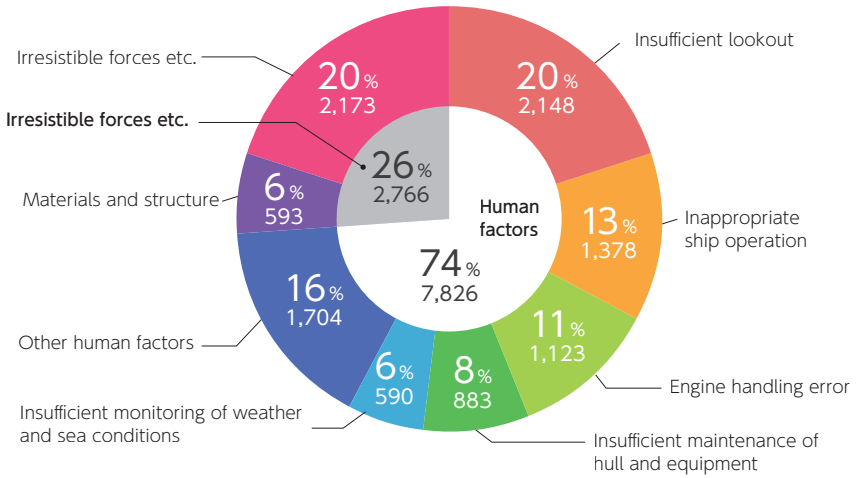
It is concerning that the number of accidents have been increasing since 2017/18 Policy Year for oceangoing vessels and 2016/17 Policy Year for for coaster vessels.

1−2 As a Mechanism behind Maritime Accidents Caused by Human Error

Why then do marine accidents still occur, even though we are aiming to eradicate them every day by taking all possible safety measures? It is necessary to consider the mechanisms that trigger marine accidents.

According to a guidebook called “Facts and countermeasure against maritime accidents in 2017 (provisional translation)” issued by the Japan Coast Guard, the ratio by types of causes as accumulated over the last five years of total maritime accidents reported to the Japan Coast Guard shows that approximately 74% of the causes were those of Human factors. (See Graph 3)

The ratio by type of cause of total accidents as accumulated over the last five years



Graph 3

In addition, those which are caused by Force Majeure (unforeseeable circumstances) are also almost all related to human errors. Then, it may be presumed that 94% of all maritime accidents are caused by human factors.

Therefore, it follows that if there were no human errors, most maritime accidents should not occur. However, unfortunately, it is not possible to realize zero human errors, as the following four aspects are behind the main root cause.

Causes behind Human Error

1 Common characteristics among the people who have acquired advanced skills such as Master, Navigation Officer, aeroplane pilot, medical doctor and so on.

(80th Cultural lecture held by the Japan Captains’ Association: Ensuring safety in a proud profession — Why BRM is paramount — from a person with a proud profession (provisional translation.)

These common characteristics of technicians, which are shown in Figure 4, sometimes cause human error.

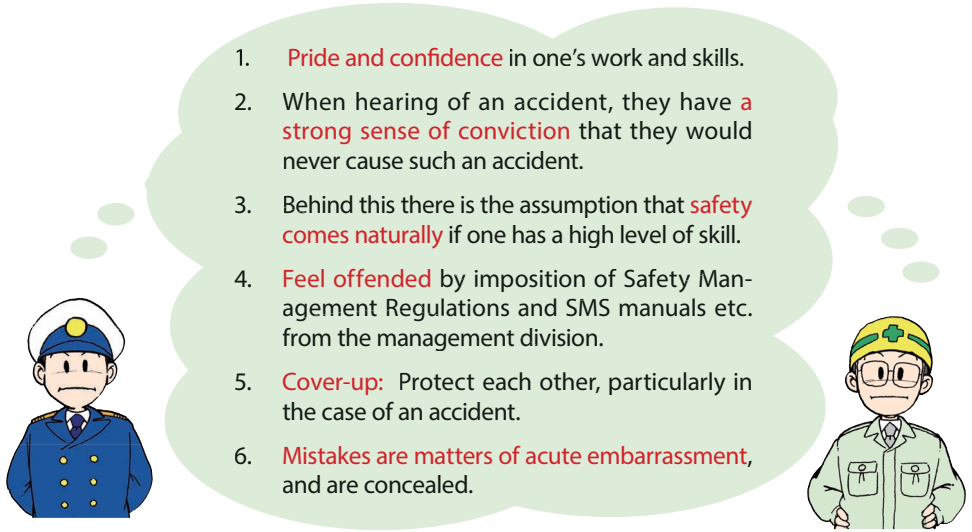


Fig. 4

2 Human characteristics (Nihon VM (Visual Motivation) Centre Co., Ltd from Anzen-no-komado 18 (Safty Loopholes) dated 30 June, 2002 (Provisional translation)

Figure. 5 shows the "human characteristics that everyone has" which are likely to cause human error.

Twelve human characteristics

1. Human beings sometimes make mistakes
2. Human beings are sometimes careless
3. Human beings sometimes forget
4. Human beings sometimes do not notice
5. Human beings have moments of inattention
6. Human beings sometimes are able to see or think about only one thing at a time
7. Human beings are sometimes in a hurry
8. Human beings sometimes become emotional
9. Human beings sometimes make assumptions
10. Human beings are sometimes lazy
11. Human beings sometimes panic
12. Human beings sometimes transgress when no one is looking

Fig. 5

3 Psychological Factors

The following psychological factors mainly induce human error.

① **Psychological reactance**（**self-efficacy**）

This is when people do not wish to do something that is not of their own volition. They may be inclined to say, "I won't do what you tell me."

② **Entrainment, Peer Pressure and Normalcy Bias (justification and cognitive dissonance**）

Anyone else would do the same and the psychology of, "What will the neighbours think?" and "I'm special, nothing can hurt me!"

③ **Confirmation bias**

People are unconsciously prone to believe only "what they want to believe" and "information that supports what they believe" rather than purposefully seeking information to the contrary. They may say something like, "Stop exaggerating!"

④ **Social loafing**

This is when someone does not choose to take the initiative. They may say, "Someone will do it for me."

4 Human Brain Capacity

The reason why we can say that the human brain is a very inefficient organ is because it occupies only 2% body weight, yet consumes 20% of all the energy. Our brains are programmed to save as much energy as possible, while aiming to achieve maximum energy efficiency. The following are examples of its energy-saving mode, and it is these that are responsible for optical illusions and perceptual errors.

Since Neoanthropic man (Cro-Magnon man) was born 70,000 years ago, human beings have been making a living from hunting, pasturage and farming. In 1769, which is just 250 years ago, a Scottish mathematician and engineer, James Watt invented the steam engine, which was epoch making for humanity. In other words, problems in the era of farming and pasturage were mainly only floods, fires, and natural disasters, but now, new disasters can be added to this. It is said that human beings inhabited the earth approximately 40,000 years ago. If this were compressed into 1 year, and human beings started to inhabit the earth from 00:00 on January 1, the industrial revolution would have begun at 17:15 on December 29. Meaning that only 2 days and 6 hours and 45 minutes have passed since human beings came into contact with machines. It is true that technological advances in machinery and equipment are becoming more upgradable and complex, however, we should still think of our DNA and brain capacity as "first-generation processes that cannot keep up with these changes".

- **Avoids thinking deeply (it gets tired)**
- **Is not good at thinking logically**
- **Forgets and does not remember easily**
- **Not able to reject our assumptions**
- **Tends to believe that our choice is correct**
- **Tends to make choice based on first impression etc.**

Fig. 6

Optical illusions

Human beings sometimes make assumptions

Fig. 7

When looking at the illusion in Figure. 7, we recognize that there are two different women: one is a young lady who is facing away from us, and the other a profile of an elderly lady. If you can only see a young lady, try focussing on her ear to then see an eye, and her chin to then notice a nose, and then her necklace to see a mouth. On the other hand, if you can only see an elderly lady, try focussing her eye and you will notice an ear, her nose to reveal a chin and her mouth to reveal her necklace. Now it is possible to recognize both ladies, but isn't it hard to switch to seeing the other lady, once your mind is set on either of them at one time?

Interestingly, there is a strong tendency that someone of a younger generation will recognize the young lady at first and that someone of a senior generation will rather recognize the older woman first.

It is an old painting from the 19th century, and as of 2016, it is the oldest confirmed drawing on a German postcard from 1888. The author is unknown, but what is known is that this postcard's illustration was used for a US automobile manufacturer advertisement for the Anchor Buggy Company at around that time in 1890.

Source from Wikipedia: Trompe l'oeil (deceive the eye) "My Wife and My Mother-in-Law"

Optical illusions

Observe the black and white tiles that are separated by grey lines. The grey lines appear as though they are crooked. This is an optical illusion. Really, each of these grey lines are in fact straight and not crooked. This is one example of a geometric illusion. The straight lines between the rows of alternating black and white "bricks" appear to be tilting, when they are in fact parallel.

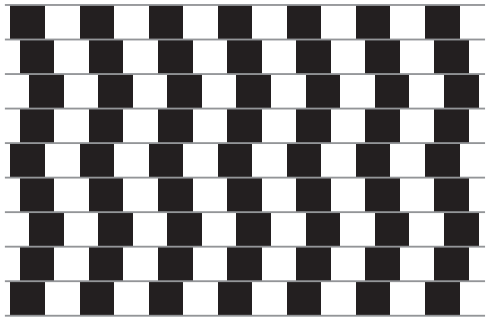


Fig. 8: Café Wall illusion

This illusion was first described under the name of Kindergarten illusion in 1898, and was re-discovered in 1973 by Richard Gregory. According to Gregory, this effect was observed by Steve Simpson, a member of his laboratory, on the wall tiles of a cafe at the foot of St. Michael's Hill in Bristol. This is a variant of the "shifted-chessboard illusion" originated by Hugo Münsterberg.

Source from Wikipedia: Cafe wall illusion

As a Mechanism behind Maritime Accidents

Unlike traffic accidents that may be caused by a single driver, casualties at sea are seldom caused by one single human error. In most cases, there is a chain of human errors that leads to an accident, and unless the error chain is broken, as a result, an accident is likely to occur.

An example of a collision accident is shown in Figure 9. It is understood that an accident occurs when several errors overlap.

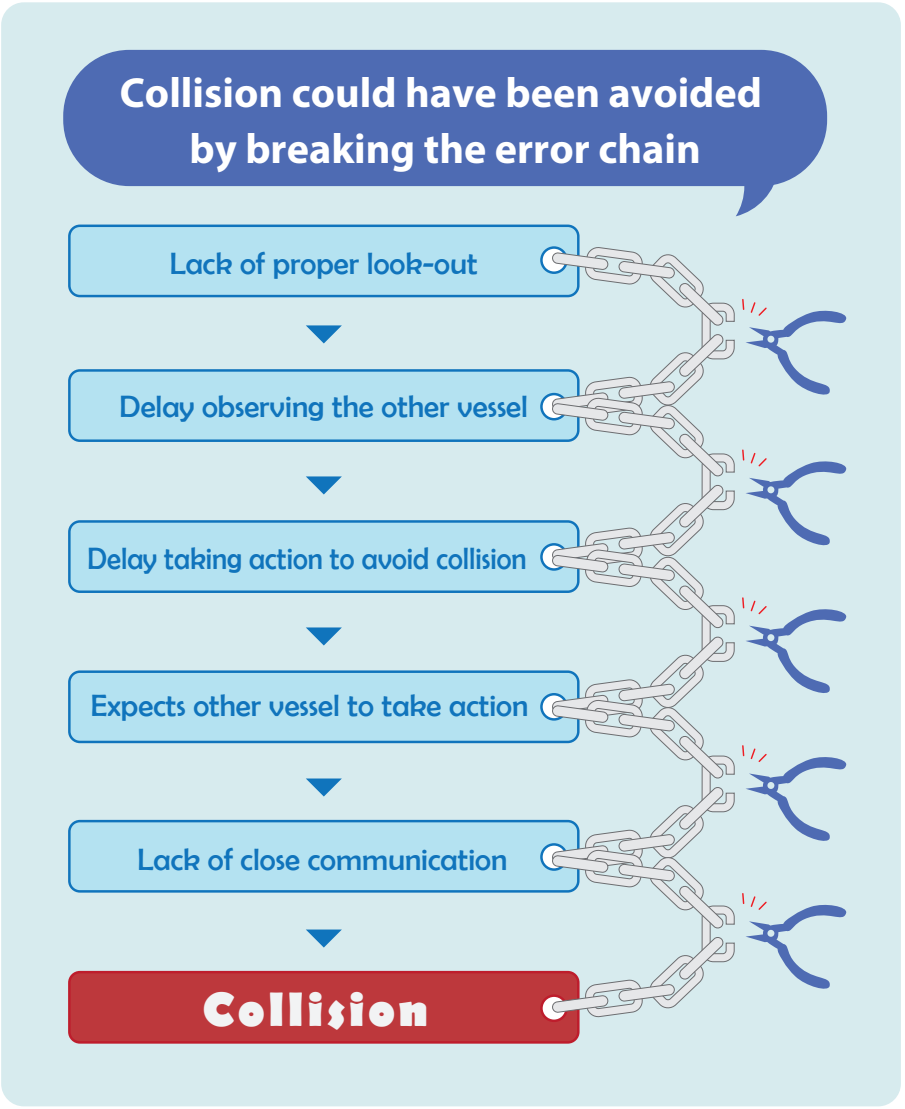


Fig. 9

1−3 Prevention of Maritime Accidents

Basic approach

Herbert William Heinrich (1886-1692). When working as an assistant superintendent of the engineering and inspection division of a non-life insurance company in America, his law Heinrich's Law was derived from his thesis which was published on 19 November, 1929.(Heinrich's Law: Figure 10)

Behind every serious accident or disaster, it is said that there are 29 minor ones and that there are 300 near misses that fortunately do not lead to any accidents. Hazardous "unsafe acts" referred to as "unsafe situations" number in their thousands, meaning that even more dangers lurk in the background.

Thus, if we are able to decrease the several thousands of unsafe conditions and 300 near misses, maritime accidents either minor or major, could definitely be reduced.

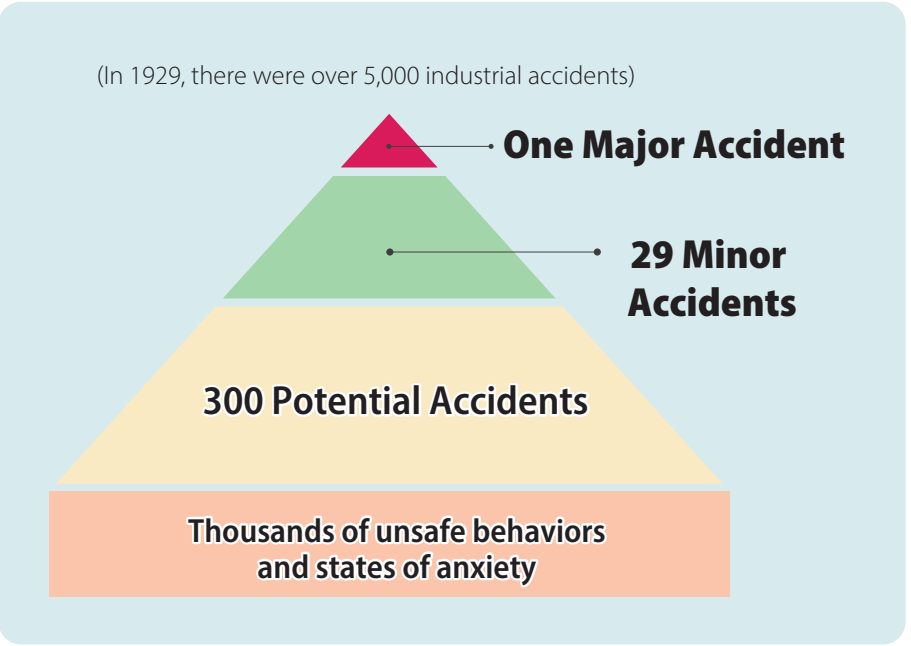


Fig. 10

There can be no “absolute safety” and “Safety can be defined as the result or evaluation of all danger being avoided”, as explained above in 1-1. Then, how can we achieve the safe operation of vessels which are always exposed to a variety of dangers? By understanding the Johari Window (see Figure 11) in the field of psychology, we can see that it is possible to “heighten the level of safety”.

Considering the scope of activities in vessel operation, there are many dangers lurking in the Johari Window. This consists of four window-panes: ① Known to self (Open area), ② Not known to self (Blind spot), ③ Known to others (Hidden area) and ④ Not known to others (Unknown area). The most dangerous area is the “Unknown area”. Namely, the unknown area is an area that no one knows about (or a danger that no one notices) where safety measures are yet to be taken.

A requirement that would heighten the level of safety would be to enlarge the Open area. In other words, the Open area specifies that all members within the range of activity, including the vessel and its land management department, are equally aware of the danger, thus proactive measures can be taken.

The “Blind spot” can be narrowed by learning from each other’s knowledge and experience, thus expanding the “Open area” of the team. Also, by opening our Hidden areas (what we know that others don’t) and by being aware of others’ blind spots, the Open area will be expanded, which will in turn bring about improved safety, eventually.

If we remain unaware of the “Unknown” area and its inherent dangers, this will render us defenceless.

However, if we enlarge the Open area, the Unknown area will reduce. At the same time, the Blind spot and Hidden area will also reduce. This means that the level of safety will improve.

Johari Window

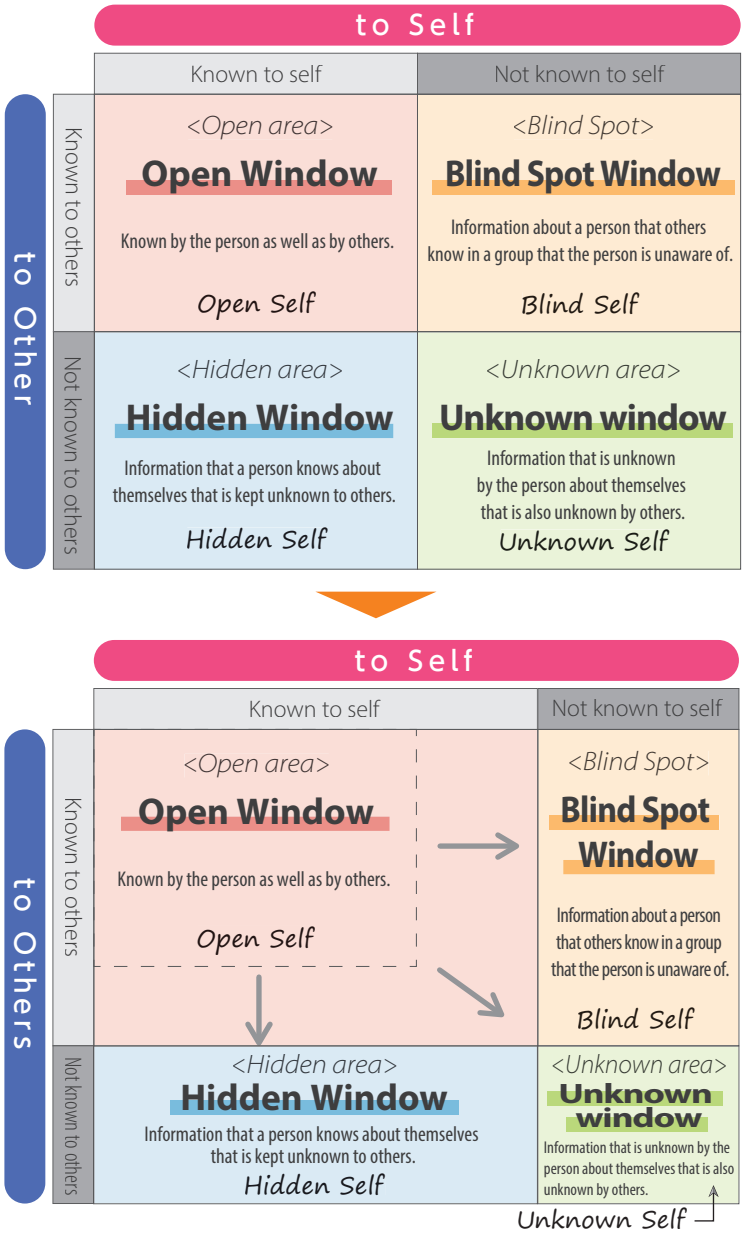


Fig. 11

BTM and ETM

Bridge/Engine Room Team Management

BTM and ETM have been introduced as methods to prevent maritime accidents from occurring by breaking the chain of human errors (error chain). This method seeks to acknowledge that it is a) impossible not to generate human error, b) that the team unite and work together so that one person's mistake does not create a dangerous situation, c) that mistakes be noticed and corrected in a timely manner, and d) that everyone find a way to support each other and break the error chain.

The concept of BTM and ETM is based on communication with the resources surrounding the subject. (See Figure 12)

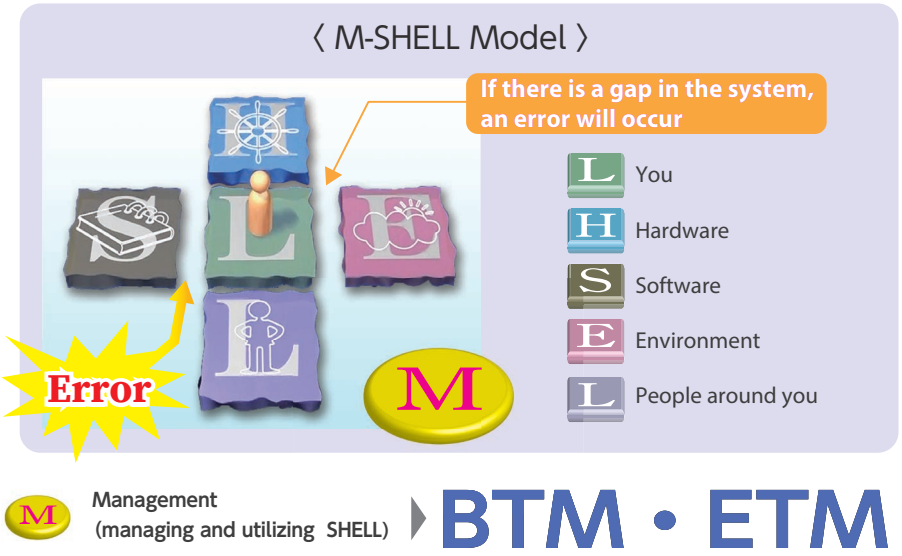


Fig. 12

The person at the centre (L : Person responsible for the accident) is surrounded by those resources such as: (H: Hardware) , (S: Software) , (E: Environment) , and (L: Persons other than the person responsible for the accident) . Each resource is always in a state of change. This situation can be shown in terms of quivering rectangles.

If there is insufficient communication and cooperation between the person responsible for the accident (L) and each resource, and if the team does not gel, this will create a gap and safety cannot be established when a human error occurs.

If the squares (H, S, E, L) are well aligned, then even when a person causes a human error (L), the resources surrounding him/her will be aware of it and will communicate this so that L is aware.

BTM and ETM training are effective methods that help us address communication issues, however, there are many who still say that it is difficult to carry this out in practice. The main reason has to do with the difficulty of communication. Figure 13 illustrates this.

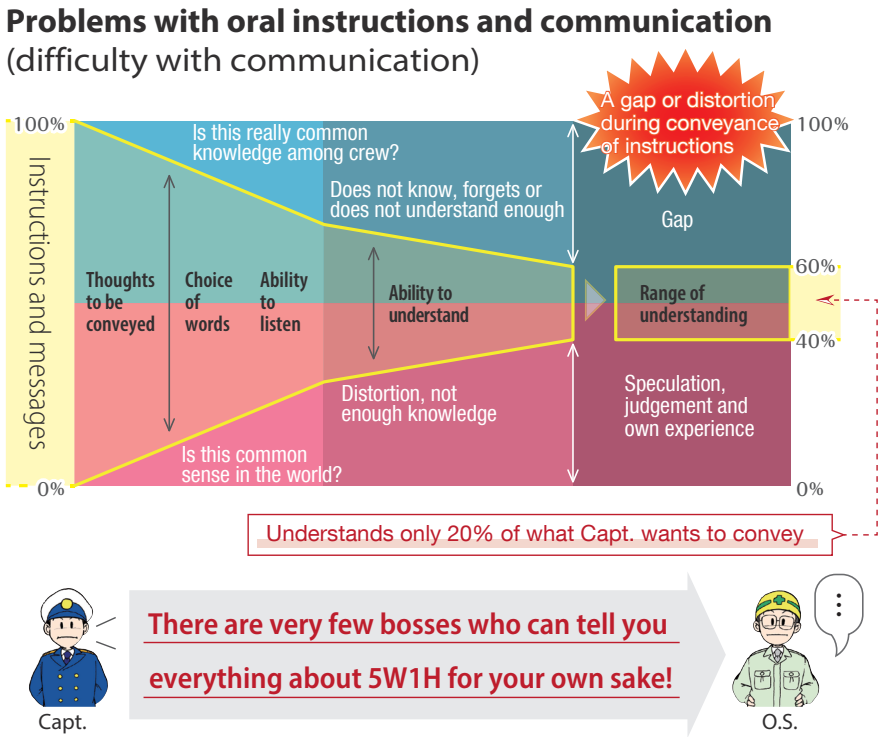


Fig. 13 Problems with oral instructions and communication (difficulty with communication)

The yellow coloured area on the extreme left shows what a Master intends to order or what message he intends to convey (Full understanding is shown as 100%). Even when the Master tries to relay information to an Ordinary Seaman (O/S), only 20% of the information may be understood due to a misunderstanding, a lack of understanding or knowledge that the O/S may think is common sense, a lack of communication, speculation or judgement on the part of the O/S, or he/she may compare what was relayed to their own experience. Why is this the case?

It seems most likely that the reason why information cannot be conveyed successfully is down to a difference in their level of understanding regarding technology. For example, if the Master tries to convey the same message to another Master, his message will be conveyed to the full (100%), because their technical backgrounds are almost the same.

One preventive measure that we can use is the 4M4(5)E Analysis. This model takes into account lessons learned from similar past accidents. This is a countermeasure (method) that seeks to prevent a re-occurrence of the same or a similar accident based on lessons learned, in the event that such an accident should occur.

"Safety" is management's top priority. In order to realize this, it is important to correctly identify "the bud of a potentially new accident" and to prevent a re-occurrence based on the lessons learned. Most accidents at this bud forming stage can be referred to as events that require attention or risky events and are often due to human error. Thus, it would be vitally necessary to analyse such phenomenon thoroughly from a human factor perspective.

This method is derived from an accident investigation method adopted by the US National Transportation Safety Board (NTSB) and has been used in various fields including the industrial arena. With this method, we can not only look at error factors from multiple perspectives but also examine preventive measures from a wide range of viewpoints.

2−1 Errors Made by an Involved Party and Organizational Errors

Although we have established preventive measures for every time an accident occurs, why then has the 4M4(5)E analysis been the subject of recent interest?

According to The Hudson Model: Types of Safety Culture (See Figure 14), Safety Culture has been developed as follows:

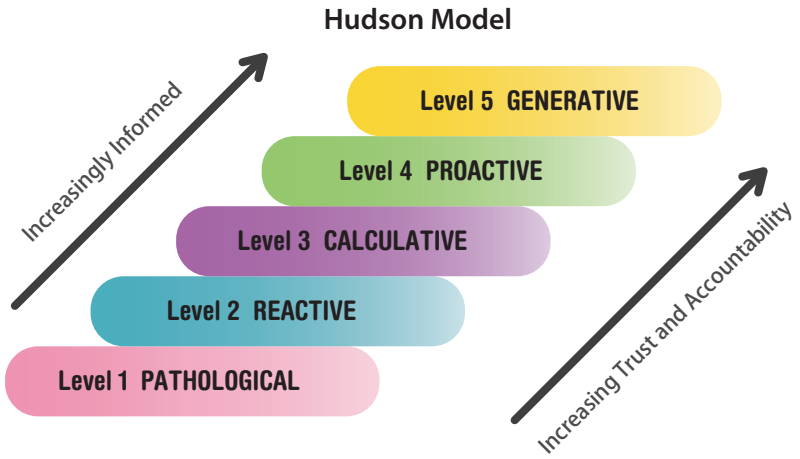


Fig. 14

Level 1 Pathological	Safety problems are caused by the workers. Safety concerns only the Safety department.
Level 2 Reactive	Safety is important, but we activate it only after an incident. Mistakes are punished.
Level 3 Calculative	Safety driven by SMS and safety is improved through PDCA. Emphasis on continuous monitoring using safety measures.
Level 4 Proactive	All staff understand the importance of safety. The organization tries to prevent accidents with proactive measures (manpower, equipment and cost to be included).
Level 5 Generative	Safety is an inherent aspect of a sustainable organization. All staff unconsciously give priority to safety.

In other words, in the past, when an accident occurred, because almost all accident causes were due to human error, the person who caused the accident was identified and the mistakes that led to the accident investigated. Then, the case would have been closed after having reprimanded the individual by saying something like, “Be careful in future” or holding the individual to account by punishing him/her (“grave-post type”). The above Level 1 (Pathological) and Level 2 (Reactive) are applicable to this.

But, we have learned that this kind of preventive measure lacks in efficacy. Therefore, it is a must that we examine the factors behind human error and explore further as to why an individual causes a human error. Then we can take effective countermeasures (“preventive type”) to prevent future re-occurrence.

Figure 15 illustrates this.（Why are accidents repeated - the analysis of the human factor written by Akira Ishibashi; from Japan Industrial Safety and Health Association (JISHA)）(Provisional translation)

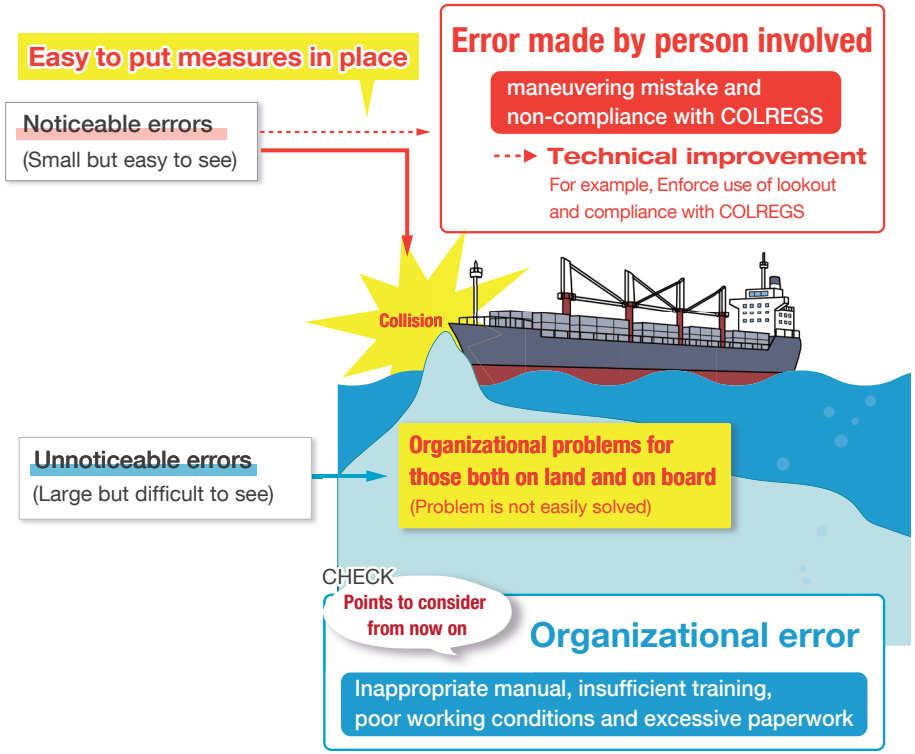


Fig. 15 Why are accidents repeated - the analysis of the human factor written by Akira Ishibashi

Source: Seminar on Analysis and Countermeasures of Accidents Learned from Case Studies, by Japan Industrial Safety and Health Association (JISHA) (Provisional translation)

In the event that an accident is considered to have been caused by human error, it is easy to take remedial measures for visible and technical errors. Moreover, it seems clear at first glance that the parties involved should be punished and that the technology should be improved.

For example, as for collision accidents, most of their direct causes are related to human error such as insufficient lookout and non-compliance with the navigation act. As a result, compliance with Article 5 of the Act on Preventing Collision at Sea (Lookout) and its 2nd Chapter (Navigation act) are followed, and the party involved is punished, then the case is closed.

However, each Master and Navigation Officer who has a seaman's competency certificate fully understands the importance of lookout and compliance with the Navigation act. True preventive measures cannot be established unless we analyse in depth as to why professional qualified mariners "neglected appropriate lookout and could not comply with the navigation act". For example, as organizational errors that are not readily apparent manifest themselves, shown in Figure 15, we must construct recurrence preventive measures by analysing the "Underlying causes", to establish if there are errors in the organization or team, such as an inappropriate manual, insufficient training, poor working conditions and excessive paperwork.

2−2 4M4(5)E Analysis

As mentioned above, the 4M4(5)E analysis considers the cause of the accident to be a result of organizational error. A matrix table of specific causes behind the accident and countermeasures is formulated. The specific causes behind the accident are described (4M)、and then countermeasures (5E) in terms of training, technology, reinforcement/enforcement, examples, and environment (organization both within the company and onboard), are added.

4M

Shows specific factors behind an accident

- Man
- Machine
- Media (Environment)
- Management

4 (5) E

Reveals countermeasures

- Education
- Engineering
- Enforcement
- Example
- (5) Environment (within company and on-board ship etc.)

When considering the conditions that cause occupational accidents, it can be said that 85.6% occur as a result of a combination of "unsafe behaviour" and "unsafe conditions". (See Figure 16)

〈When Workplace Accidents Occur〉

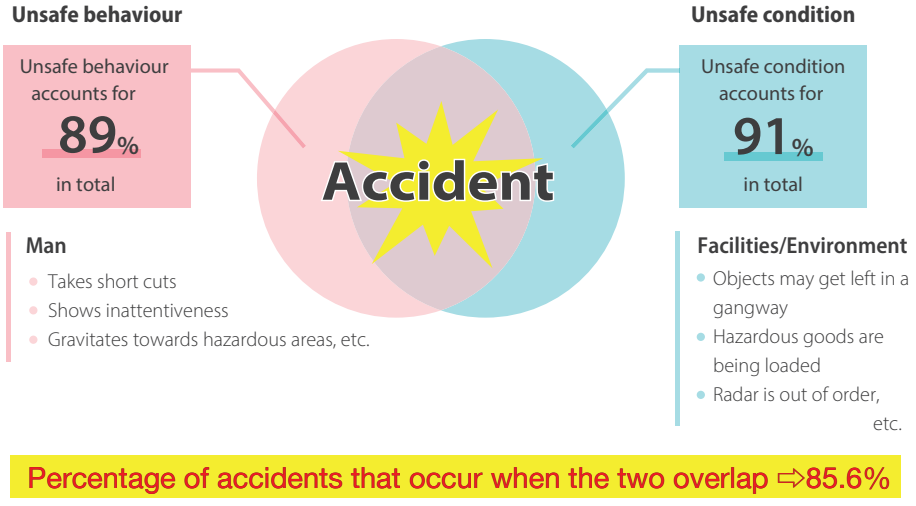


Fig. 16

Source: Seminar on Analysis and Countermeasures of Accidents Learned from Case Studies, by Japan Industrial Safety and Health Association (JISHA) (Provisional translation)

On considering the reasons behind “unsafe behaviour” or “unsafe conditions”, the root cause is often found in an “organization’s safety management deficiencies”. (See Figure 17) for 4M4(5)E analysis, whereby these “root causes” and “direct causes” are organized into a table, analysed, and preventive measures formulated.

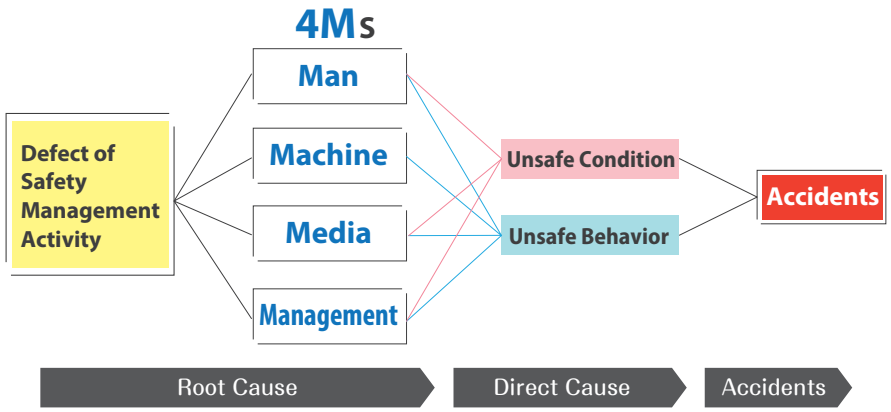
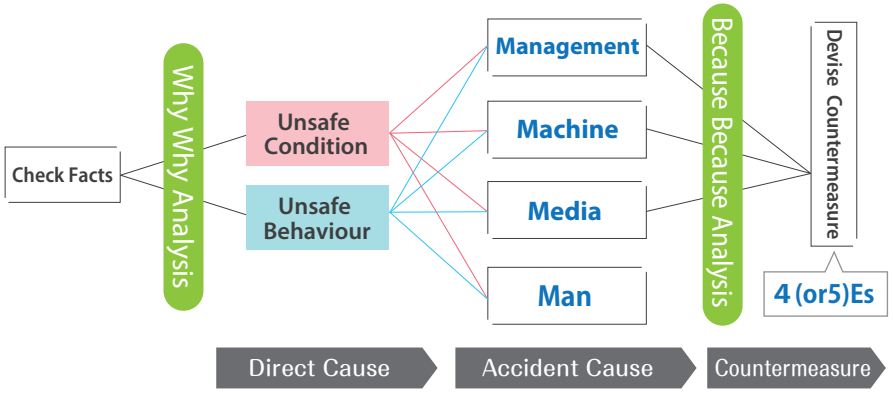


Fig. 17

2−3 4M4(5)E Analysis Plus Why Why Analysis: Investigation, Analysis and Countermeasures

The 4M4(5)E analysis and countermeasure planning workflow is shown in Figure 18.



＊Because it is important to check the facts, countermeasures are not to be made based on own speculation. Conduct a further investigation, if necessary.

Fig. 18

An outline of the analytic procedure will be explained below. (See Attachment 1 P.93)

1. Site investigation

Carry out investigation in as much detail as possible, ideally by a third party (such as a surveyor or marine consultant etc.)

2. Analysis of site investigation report

- Clarify accident cause/s (4M), using a classification table and so on.
  (See Attachments 2-1, 2-2 and example in Figure 19.)
- Organize these into a matrix to examine the facts (See Attachment 3).

1. Facts extracted from the accident investigation report that caused the accident have been identified and listed under each factor in the table to the right.
2. Classify into Unsafe Behaviour or Unsafe Conditions by factor.
3. After clarifying the accident cause/s, in order to analyse this, assess accident cause by prioritizing according to the scale of the cause.
4. Furthermore, clarify which items need to be inspected/investigated again.

＊Accident Reports

Ship reports, ship management company reports, survey reports, attorney (maritime auxiliary) reports, transportation security reports, and as much information as possible, such as accident investigation reports of all committees and decisions of the Japan Marine Accident Tribunal, are to be collected.

Example

Vessel superintendent was aware of the low visibility weather forecast, but, as he assumed that the Master also knew, he did not report it.

2 radars were equipped on board, but the magnetron of No.1 radar was to be replaced by the manufacturer at the next port. The Master was requested to navigate using only No. 2 by the vessel superintendent, and agreed despite feeling uneasy about it.

Attachment 3

Maritime Accident Summary of Related Facts

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	Unspecified date	Approx. 3 p.m.	Vessel superintendent	Did not report a forecast of low visibility to the Master	○		4	
2	Unspecified date	Approx. 4 p.m.	Vessel radar	No. 1 radar was out of order	△	○	3	○
3	Unspecified date	Approx. 5 p.m.	Vessel superintendent	Requested the Master to navigate using only No. 2 radar until next port, because arrangement to fix No. 1 radar at the port had been made	○		5	○
4	Unspecified date	Approx. 5 p.m.	Master	Approved navigation to the next port using only one radar.	○		6	
5	Unspecified date	Unspecified time	2/O	Did not report to the Master, although there was the low visibility (less than 2 nautical miles) (According to the Safety Management Code, low visibility is defined as less than 3 nautical miles.)	○		2	
6	Unspecified date	Unspecified time	2/O	Searched for the other vessel at 6.6 nautical miles via radar, but did not notice the image captured on ARPA, because he believed he could pass starboard to starboard	○		1	

Example

Accident cause assessment: Prioritized according to the scale of the cause

At XX:XX (unspecified time), the 2/O knew that there was low visibility of less than 2 nautical miles, but he did not report it to the Master.

At XX:XX (unspecified time), Although the 2/O searched for Vessel △△ at approximately 6.0 degrees on their starboard bow in the vicinity of <015> 6.5 nautical miles via radar, he believed he could pass starboard to starboard, but did not notice the image captured on ARPA.

Fig. 19 (P.98 Attachment 3)

3. Once the above have been established, compile this information into an accident cause/s matrix (unsafe behaviour and unsafe conditions).

(See Attachments 4 and 5)

Pick out the relevant facts, and compare "unsafe behaviour" and "unsafe conditions" using the 4M classification table and carry out a "Why Why Analysis". Circle the corresponding items.

1. Enter relevant factors into Analysis Tables 1 to XX, and enter why these occurred in (2) to (6) below.
2. Then, circle each applicable column.
3. Enter the sub-item number of each item in the 4M Classification List for Machine, Media, and Management.
4. For items requiring re-investigation, circle the corresponding column to the right.

4. Once the above 3 has been completed, analyse and devise countermeasures.

(See Attachments 6 and 7)

- Classify the direct cause and indirect/root cause of the accident referring to the 4M4(5)E table.
- Devise a countermeasure for every 4(5) item.

1. Copy over the risk factors from the analysis chart (including the applicable numbers).
2. Copy over countermeasures to reduce or improve the risk factors into the 4(5)E table.

Why Why Analysis

The Why Why Analysis method is a way of finding and verifying the efficacy of solutions to a certain problem. By repeatedly asking the question "Why?", the method seeks to identify what caused the problem, what factors led to that cause, and so on and so on. This is a mainstay component of the Toyota Production System.

Method (Figure 20)

- The first stage is to present the problem in question. In order to make a logical progression to the next stage, it is helpful at this point to go through a process of elimination of irrelevant causative factors.
- A list of potential causes can then be created. This is the result of the first "Why?" There may be multiple causes but they must all have a logical connection to the original problem.
- The next stage is to come up with the potential factors which led to those causes. This is the result of the second "Why?" As with the first stage, there may be a number of different factors involved, but each must have a logical connection to the subsequent cause.
- This process is repeated in the same manner with the 3rd and 4th stage of "Why?s".

It is difficult to say at what point it is best to suspend this repeated process, but in practical terms the ultimate goal is to find a logically proven solution whereby removal of the causative factors leads to elimination of the original problem.
During the "Why Why" process, some causative factors, be they a particular phenomena or something of a more systemic nature, may well be deemed unavoidable. In which case, the analytic process should be suspended. Conversely though, through this same process, it is also possible that factors, which were thought to be unavoidable, are actually shown to be no more than a preconception.

The Toyota Motor Corporation first pioneered this methodology and advocated a 5 "Whys" technique. However, this method is now employed in a variety of different fields and is not restricted to a set number of whys. The important thing is to arrive at the root cause of the problem.

〈 Analysis Chart for Incident & Cause Factors (Model) 〉

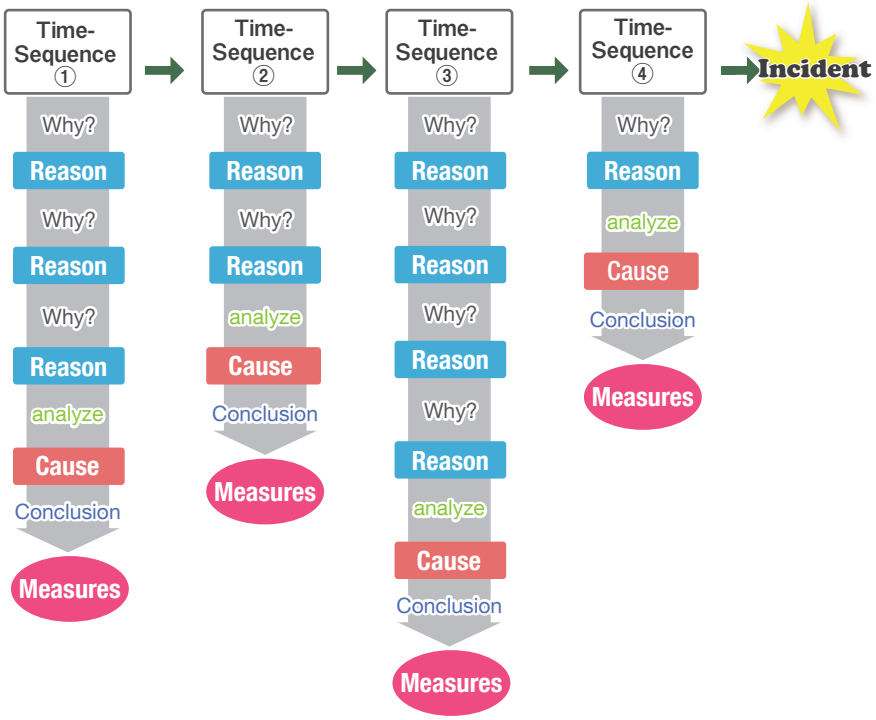


Fig. 20

Devise a countermeasure

Devise a countermeasure for each factor below regarding unsafe behaviour and conditions. The following items from ① to ⑤ are to be extracted from Attachment 4.

❶ **Education :**
Education and training
Measures to improve the competency, awareness and knowledge required to perform the task.

❷ **Engineering :**
Technology and engineering
Technical measures of handling equipment for safety improvement and improvement of equipment etc.

❸ **Enforcement :**
Thorough guidance and enforcement
Measures related to thoroughly enhanced regulation in order to ensure the work done and revision of the SMS etc.

❹ **Examples :**
Case studies, countermeasures and rules
Measures to show specific cases such as lead by example, experience of success, introducing model cases etc.

❺ **Environment :**
Measures related to working environment, office internal management, on-board organization, etc.

Figure 21 shows an example of recurrence prevention countermeasures.

Example

Risk factors (direct cause and indirect/root cause)

It is considered effective to have them attend training programs such as behavioral psychology to learn awareness.

Risk factors (direct cause and indirect/root cause)

Vessel

1. Why wasn't this captured by ARPA?
(1－③,⑧,⑨,⑩,⑪,4－1－③)
2. Why was the problem of poor visibility not reported to the Master?
(1－②,⑥,⑪,⑫,2－①,3－③)
6. Why did he approve navigating with a single radar?
(1－①,⑤,⑥,⑧,⑨,⑪,4－1－③,4－3－②)

Shipowner and ship management company

5. Why did they request a single radar for navigating?
(1－①,⑥,⑦,⑨,⑪,4－1－①,②,③,④,4－2－①,4－3－②,③)

Education and training Knowledge, skills, consciousness, being given information, etc.	Example Case studies, countermeasures and rules
● Training in behaviour psychology ⇒ Learn to notice things ● Education to reinforce habitually that optical illusions/errors and assumptions can cause a risky behaviour	Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc. ● Gain a sense of experience using navigation simulations, for example

Fig. 21

5. Carry out and verify countermeasures based on the devised example above, and Brush up using a PDCA cycle.

The key is (1) to ensure that the proposed countermeasures are always implemented, (2) that their effectiveness is evaluated and verified and (3) that any defects are corrected. That is to say, PDCA (Plan・Do・Check・Action（for improvement）shall be performed. If this is not done, the hard-earned measures to prevent recurrence will quickly become a mere formality. In the event of a major accident, it will be of value to have a recurrence prevention campaign annually (so as not to forget).

When considering methods of prevention, for example the PDCA cycle mentioned in Attachment 7, be sure to carry out the following to ensure that the intended preventive measures do not become a mere formality.

Enforcement (thorough guidance and enforcement)
Thoroughly clarify procedures for low visibility in the procedure manual.

Plan

Here, we will examine how to ensure that the existing procedures are reviewed and clarified, as well as how to ensure compliance with the revised procedures at sea. In order to achieve this, 4 root causes (Technicians characteristics, Human behavioural traits, Psychological factors and Human brain capacity）described in 1-2 As a Mechanism behind Maritime Accidents Caused by Human Error, shall be considered. For example, a review of training programmes, internal audit frequency, the launching of an evaluation committee etc. could be considered. The most important is annual scheduling. If the scheduling is vague, these kinds of tasks will be easily put off.

Do

It is important to carry out the planned schedule with certainty.

Check（evaluation）

An assessment committee will be held every 3 to 4 months in order to manage the work plan progress and to assess the implementation report. It is important to identify the problems by providing a general overview of the fiscal year at the end of the year.

Action（improvement）

Analyse the problems identified in the evaluation（including the Why Why Analysis), and formulate measures for improvement.
This outcome will be the Plan for the following fiscal year.

§3 Case Study = Collision Accident =

Japan Transport Safety Board Report MA2019-6-02
Japan Transport Safety Board Report
http://www.mlit.go.jp/jtsb/ship/rep-acci/2019/MA2019-6-2_2018tk0004.pdf

The collision accident of the outgoing large size container which occurred off the port of Kobe on XX May, 2018 is to be analysed.

3−1 Accident summary (See Attachment 8)

Date and time (See Figure 22)

XX May, 2018 at approximately 07:02:49 (JST)

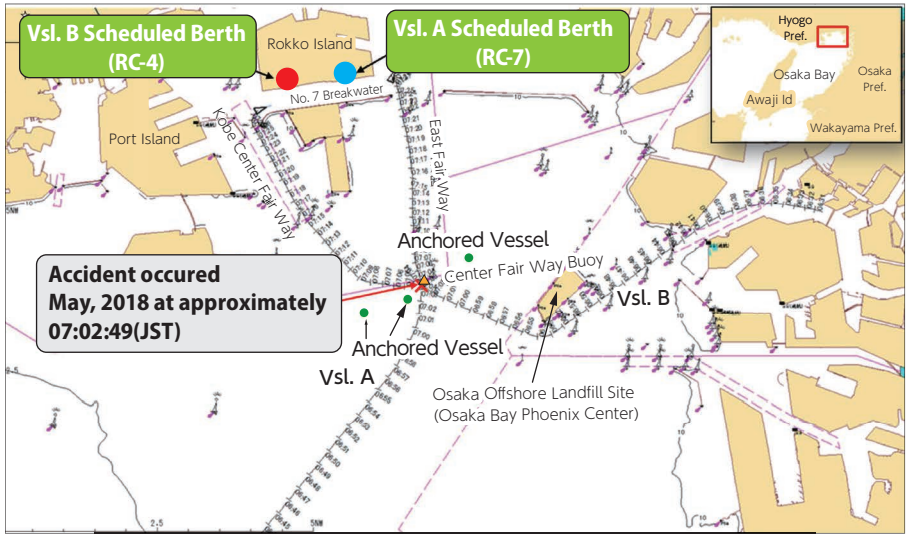


Fig. 22

Point of Occurrence

Near Kobe Rokko Island East Fairway Central FW Buoy

Movement of Both Vessels

Pilot A boards at Tomogashima Channel, and when navigating northeast of Osaka Bay toward RC-7 (Kobe Rokko Island) for mooring, he was trying to head for south of Kobe Rokko Island East Waterway and steered to port side while reducing speed（ship speed: 11.3 knots (approx.).

Vessel B departed Osaka bound for Kobe RC-4 (Kobe Rokko Island) via Kobe Central Fairway. While navigating northwestward and westward, at 13 knots of speed, S/B Full, the starboard bow of Vessel A collided with the accommodation space near the astern port side of Vessel B. (See Figure 23)

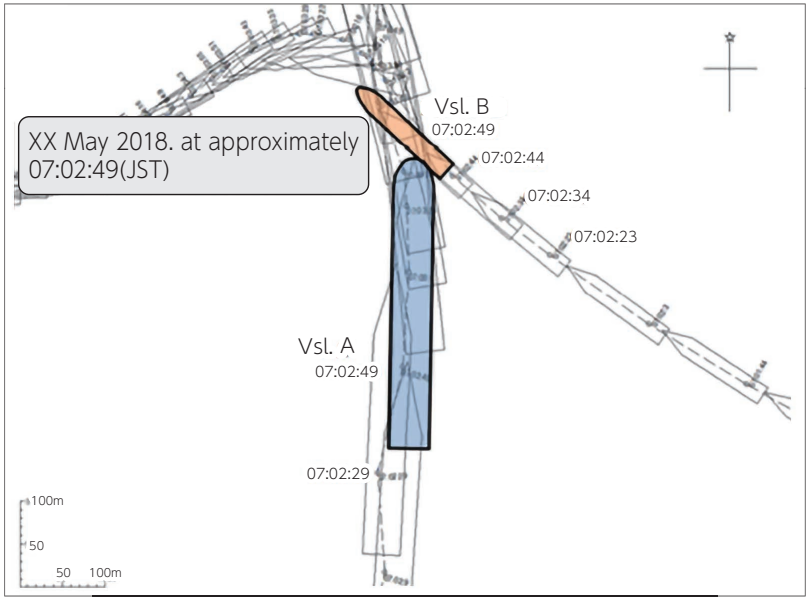


Fig. 23

The weather and sea conditions and visibility at that time were as follows, and did not contribute to the cause of the accident.

05:06 Fine SW ～ WSW 3.8 ～ 4.1m/s (wind force 2 ～ 3) Visibility 30km or more (more than 16 nautical miles)

Container Vessel A Summary

Photograph 24

Gross tonnage	:	97,825GT
L×B×D (Length) (Breadth) (Depth)	:	338m×46m×25m
Port of origin	:	Singapore
Port of destination	:	Kobe RC-7
Cargo	:	20FT CTNR×1,360 40FT CTNR×2,441
Draft	:	12.85m Aft 13.35m
Crew arrangement	:	3 Croatian, 2 Russian, 16 Filipino, 2 Indian, 1 Romanian and 2 Chinese Subtotal 26 crewmembers + 3 accompanying passengers (Indian) and 1 Pilot Total of 30 crewmembers on board
Ship's Bridge on duty personnel at the time of the accident	:	Master A, Pilot A, 3/O A, AB A and Cadet A
Master A	:	Croatian nationality at the age of 54 : Captain since 2003, boarded the vessel on March 2018 and had 8 times experience of entering Hanshin Port of Kobe as Master
Pilot A	:	Japanese nationality at the age of 70 has been an active Pilot since 2002 (15 times per month)
3/O A	:	Filipino nationality at the age of 24
Cadet A	:	Chinese nationality at the age of 25

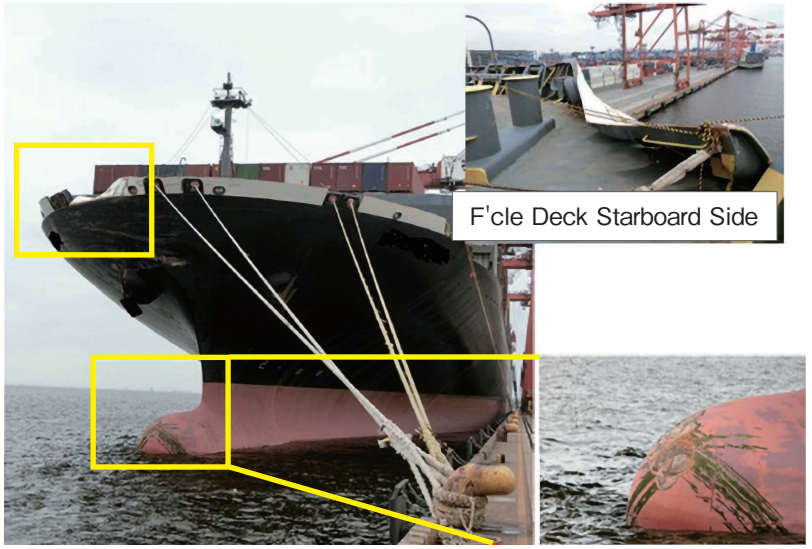
Container Vessel B Summary

Photograph 25

Gross tonnage	:	9,566GT
L×B×D (Length) (Breadth) (Depth)	:	141m×23m×12m
Port of origin	:	Osaka
Port of destination	:	Kobe RC-4
Cargo	:	20FT CTNR×197 40FT CTNR×208
Draft :	:	Fore 5.19m Aft 7.05m
Crew arrangement	:	Master and 17 other crew members, all Chinese nationals
Ship's Bridge on duty personnel at the time of the accident	:	Master B, Navigation Officer B and AB B
Master B	:	Master B was at the age of 45 with experience as Master since 2002. He boarded the Vessel on November 2017 and had more than 100 times experience as Master of calling at Hanshin Port in the Kobe area.

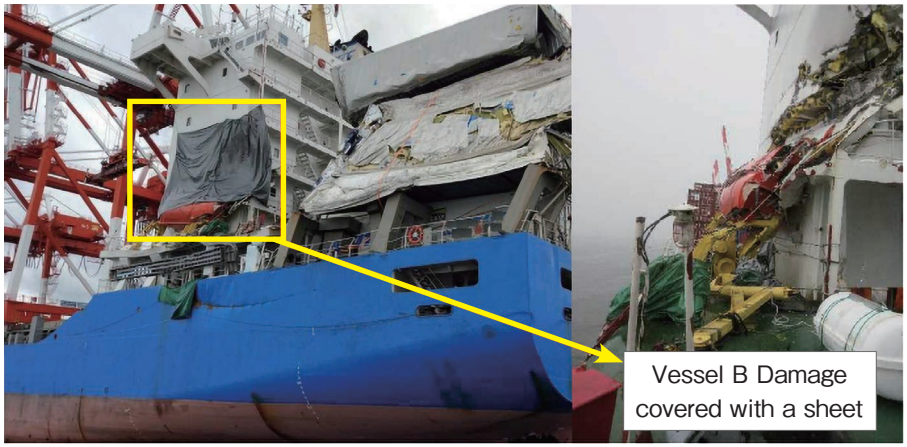
Damage

■ Vessel A was damaged due to a bent and dented bulwark at the starboard bow with scratched shell plating and concave loss on the bulbous bow. (Photograph 26)



Photograph 26

■As for Vessel B, her accommodation spaces at the astern of port side and the shell plating on the port side was cracked. (Photograph 27)



Photograph 27

3−2 Events that Led to the Accident (See Attachments 8 and 9)

In the table of events leading up to the accident (Attachment 9), items related to the accident cause are shown in red.

Ship handling to be applied

Although the conclusion is not yet known, as the decision of the Marine Accident Inquiry is still currently being deliberated (while the author is writing this Guidebook), relative position which seems to be applicable to a Crossing Situation（Rule 15 of Act for Preventing Collisions at Sea) would appear to be the case. However, considering the fact that both Vessel A and B frequently changed headings, increased or decreased speed, etc., and given the outcome of similar accidents, there is a high possibility that "Article 39 of the same law: Liability for negligence of caution, etc. (Managing officer of a seafarer)" will be applied. For reference, a crossing situation, actions by the give-way vessel and stand-on vessel, text regarding Crew responsibilities related to Act for Preventing Collisions at Sea and Marine Accidents Inquiry Law Article 1（Purpose）will be shown below:

Reference: Extracts from the Act on Preventing Collisions at Sea and the Marine Accidents Inquiry Law

-Sea and the Marine Accidents Inquiry Law

■ (Crossing Situation)

Rule 15

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel. In this case, the vessel that must avoid the course of the other vessel shall not cross the bow of the other vessel unless it is unavoidable (Provisional translation).

■ (Action by give-way vessel)

Rule 16

In accordance with the provisions of this Act, every vessel which is directed to keep out of the way of another vessel (stand-on vessel defined in the following article) shall, as far as possible, take early and substantial action to keep well clear.

■ (Action by stand-on vessel)

Rule 17

(i) Where one of two vessels is to keep out of the way the other shall keep her course and speed.

(ii) The latter vessel (hereinafter, "stand-on vessel" in this Rule) may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules. In this case, if the requirements of Rule 15.1 apply to these vessels, the stand-on vessel shall turn to port unless impossible.

(iii) When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take the best possible cooperative action to avoid a collision.

■ (Neglect of duties: Crew responsibilities)

Article 39

This article stipulates that in the event of any consequences resulting from neglect of any of the following listed below, neither the vessel structure or materials, or vessel owner, or Master, or crew will be exempt from responsibility: appropriate navigation, observance of any lights or shapes displayed, the sending of signals, or any of the duties of the crew, be they either routine or those required in special circumstances.

Marine Accidents Inquiry Law

Article 1 (Purpose)

This article stipulates that in the event of any marine accidents caused either in the course of duties or through negligence, disciplinary proceedings against either maritime officers, or small vessel operators, or pilots, shall be determined at a maritime tribunal established by the Ministry of Land, Infrastructure, Transport and Tourism. The main purpose of which will be to help prevent further accidents from happening again.

3−3 Causes behind Maritime Accidents

By extracting the accident causes from the Japan Transport Safety Board Report (MA2019-6-02), the parts considered as the accident cause are highlighted in red. (See Attachment 9)

Container Vessel A

05:00 (approx.) Pilot A

Boarded Vessel A at Tomogashima pilot station. After conducting the information exchange about Vessel A and its port entry work with Master A, he started his pilotage of Vessel A. Through his pilotage on various vessels, he felt that the crew of Vessel A had received thorough training in BRM and assumed them to be trustworthy. Also, he assumed that Master A had a shared understanding of the navigation plan.

06:44 (approx.) Pilot A

Informed port radio via VHF No. 2 in Japanese as follows:

- He had arrived outside Hanshin Port of Kobe area, and
- planned to pass through the breakwater to RC-7 of Hanshin Port Kobe at approximately 07:20

The Pilot also heard that a vessel would pass Vessel A's bow from port radio; that "Vessel B would enter Kobe Central Fairway at approximately 07:15." The Pilot visually confirmed Vessel B, but did not inform the Master.

06:53 (approx.) Master A

After visually confirming Vessel B on starboard bow at a distance of approximately 3.0 nautical miles, he also confirmed Closest Point of Approach (CPA) (hereinafter, DCPA) with Vessel B via No.1 Electronic Chart Display and Information System at 0.84 nautical miles (approx. 1,556 meters). Because Vessel B was heading in a southwest direction, and his Vessel was going to steer to port, the Master thought he could pass starboard to starboard with ample distance.

But, he did not mention the movement of Vessel B to Pilot A. Also, because

Pilot A did not mention the movement of Vessel B as well, near the sea chart table, he started discussing port entry work with C/O A.

▶ 06:55 (approx.) Pilot A

Because Master A appeared to be keeping lookout via radar, Pilot A kept a visual lookout for Vessel B's movements. At approximately 06:55, although he felt that there was no change of bearing between Vessel A and Vessel B, he assumed that the crew of Vessel A were paying attention to the movement of Vessel B, because Master A and 3/O A were watching the radar (ARPA) and ECDIS. Also, because he visually pointed to Vessel B. Then he instructed the vessel to steer to port side in order to head for Kobe Rokko Island East Waterway (hereinafter East Fairway).

▶ 06: 57 (approx.) Pilot A

Cadet A reported to Pilot A, Master A and 3/O A, because he was worried about a risk of collision with Vessel B.

Although he could not predict where Vessel B was heading immediately after she steered to starboard, he visually confirmed Vessel B's relative position. Vessel B would pass the bow of Vessel A, and he continued to steer to port side while reducing speed. Therefore, he kept manoeuvring, believing that his instruction regarding navigation in preparation for port entry work had been approved by Master A. In addition, Cadet A confirmed the risk of collision with Vessel B via radar and reported it to Pilot A (by saying "Closer!! Closer!!"), but the Pilot did not notice Cadet A's report.

▶ 06:57 (approx.) Master A and 3/O A

Did not notice the Cadet reporting. * Cocktail-party effect

Note: Cocktail-party effect (psychology terminology)

Please imagine a situation such as being at a job-well-done party or wedding after party. An example of this would be the way in which a person at a lively party is able to filter out all of the surrounding background noise and still hear their own conversation. They will even notice if their name is called out from across the room, because they can focus on the talk that interests them most. Thus, it is thought that humans have the ability to segregate different sounds and re-arrange them in order of priority. In psychology, this is known as the "cocktail-party effect". It may be that he did not pay attention to Cadet A's reporting on a routain basis.

▶ 07:02 (approx.) Pilot A, Master A and 3/O A

Did not respond to Vessel B's VHF call. He might have got into a panic as the Vessel was about to collide.

Container Vessel B

▶ 06:50 (approx.) Master B

Confirmed Vessel A (at bow and distance of approximately 4.0 nautical miles) and started lookout both via radar and visually. Then, at 06:52 (approx.), he steered to starboard heading for Kobe Central Fairway.

▶ 06:54 (approx.) Master B

Recognized crossing point with Vessel A and that Vessel B was the stand-on vessel. He was concerned about the decreasing DCPA of approximately 06:57, but assumed that vessel B could pass the bow of Vessel A without trouble, according to Vessel's A predicted course on the radar (ARPA). Also, if the speed had been increased to Nav. Full, he assumed that the vessel would reach port too quickly.

3－4 Accident Causes

Taking the above 9 factors into account, the Japan Transport Safety Board summarised the accident causes as follows:

Container Vessel A

Headed for the entrance of Kobe Rokko Island East Waterway and started steering to port side while reducing speed, Pilot A thought that Vessel A could pass the bow of Vessel B, which became the direct cause.

Although Pilot A continued to steer to port side along with reducing speed gradually in preparation for port entry, he assumed his vessel could pass the bow in relation to Vessel B which was visually confirmed, but apparently he did not realize there was a risk of collision with Vessel B.

Furthermore, Master A visually confirmed Vessel B at the point of 3.5 nautical miles in the distance, without confirming the movement of Vessel B with Pilot A. Judging by his vessel's relative position, before Vessel B steered to starboard side (had already passed Vessel B's bow), there is the possibility that he assumed that Vessel B would pass starboard to starboard and that there would be no risk of collision.

Container Vessel B

While heading for the entrance of Kobe Central Fairway, he continued manoeuvring believing that he could pass the bow（front）of Vessel A, which we consider to be the direct cause.

From Vessel A's sailing route and predicted course via radar (ARPA data), Master B assumed that Vessel A would follow her original course. (In fact, Vessel A started steering to port side).

He confirmed the ARPA data via radar（vector diagram and DCPA and TCPA digital display), but there is a possibility that he believed that Vessel B was to be the stand-on vessel at the crossing point with Vessel A. This is why he completely believed that Vessel B could pass the bow of Vessel A without the need to confirm visually.

Information exchange via VHF

Another cause behind the accident could be that neither communicated one another's sailing route at an early stage using VHF.

Although Vessel A obtained the other vessel's information from port radio, neither paid attention to each other's Vessel's movements. Mutual communication might have prevented the accident.

3－5 Transport Safety Board Report ＝ Recurrence Preventive Measures ＝

The Japan Transport Safety Board Report (MA2019-6-02) summarises preventive measures to be taken as follows:

Pilot

- A constant watch must be kept both visually, and by means of radar and ECDIS navigation instruments.
- When another ship is passing in close proximity, the risk of collision must be considered. VHF contact should be made to the other vessel with a request for their co-operation to avoid such an outcome.
- The respective officers of the watch of the two vessels should verbally clarify each other's manoeuvres and headings.
- Communication should be in the local language (Japanese), and the contents relayed to the Ship's Master.

Photograph 28 courtesy of the Japan Captains' Association, DVD

Master A and Master B: Common characteristics of both vessels

- Together with the pilot, the respective officers of the watch should verbally clarify each others' manoeuvres and headings.
- Even when there is a pilot on board, both the crew and the Master himself must be aware that navigation is ultimately the responsibility of the Master and that constant surveillance must be maintained.
- When coming into close proximity to another vessel, both the Master and the Pilot must be aware that the "distance of closest approach" (DCPA), which is based on the location of each vessel's GPS antenna, does not take into account the length and width of either vessel. Sufficient separation must be maintained for both vessels to safely pass each other.
- To safeguard the storage of objective data in the event of any accident, the Master must ensure that the crew are fully competent with operating the VDR.

Vessel A switched off its VDR immediately after the accident in order to preserve the data, however the vessel set off on its next voyage before the data could be extracted (Kobe to Nagoya). The VDR was again switched on and the previous data overwritten and deleted.

Photograph 29

§4 4M4(5)E Analysis of a Case Study = Collision Accident =

4−1 Summary of Related Facts (See Attachment 10)

Related facts from the previous chapter "3-2 Events That Led to the Accident were summarised in the "Maritime Accident Summary of Related Facts." This brings us to the following:

- **There is nothing applicable to Unsafe conditions.**
- **Rather a number of unsafe behaviours of Pilot A are examined. Bias and assumptions are particularly noticeable.**

Attachment 10 Vessel A and Vessel B Collision Accident Summary of Related Facts

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
					Unsafe behaviour	Unsafe conditions		
	Date	Time	Caused by	Check facts and problem areas				
1	XX May	05：00 Approx.	Pilot A	Felt that the crew of Vessel A had received thorough training in BRM and assumed them to be trustworthy. Also, assumed that Master A had a shared understanding of the navigation plan.	○		4	
2	XX May	06：44 Approx.	Pilot A	Visually confirmed Vessel B, but did not inform the Master of port radio information (Vessel B bound for RC−7).	○		3	
3	XX May	06：53 Approx.	Master A	Assumed that Vessel B would keep its distance when passing the starboard side of Vessel A.	○		5	
4	XX May	06：53 Approx.	Master A	Did not mention the movement of Vessel B to Pilot A. Also, as Pilot did not talk to him about Vessel B, he started discussing port entry work near the sea chart table with I/O A.	○		6	
5	XX May	06：55 Approx.	Pilot A	Although he felt that there was no change of bearing between Vessel A and Vessel B, he assumed crew of Vessel A were paying attention to the movement of Vessel B, because Master A and 3/O A were watching the radar and ECDIS. Pilot A himself confirmed Vessel B visually by pointing.	○		1	
6	XX May	06：57 Approx.	Pilot A	Assumed that Vessel B would pass their bow, and continued to steer to port side.	○		2	
7	XX May	06：57 Approx.	Pilot A	Did not notice the Cadet reporting.	○		7	
8	XX May	06：57 Approx.	Master A and 3/O A	Did not notice the Cadet reporting earlier.	○		8	
9	XX May	07：02 Approx.	Pilot A, Master A and 3/O A	Did not respond to Vessel B's VHF call.	○		9	
10	XX May	06：57 Approx.	Master B	Was concerned about decreasing DCPA, but assumed that vessel B could pass the bow Vessel A, according to the predicted course Vessel A on the radar.	○		10	
11	XX May	06：57 Approx.	Master B	Assumed that the vessel would reach port quicker if speed was increased to Nav. Full.	○		11	
12			Master B and ship management company B	Did not instruct navigation officer to report and lookout thoroughly. (BRM is was not implemented)	○		12	○
13			Pilots' Associations	Were the pilots obliged to take BRM training periodically?	○		13	
14			Master A	Non−compliance with Safety Management Code	○		14	○
15			Ship management company A	Non−compliance with Safety Management Code	○		15	○

Accident cause assessment: Prioritized according to the scale of the cause

Fig. 30 (Attachment P. 112)

Regarding the examined behaviours in the list of related facts, each unsafe behaviour will be summarised while carrying out a Why Why Analysis.

4−2 “Analysis of Unsafe Behaviour” for Pilot A (See Attachment 11)

After carrying out the Why Why Analysis regarding Pilot A’s unsafe behaviour which was extracted from the “Maritime Accident Summary of Related Facts”, we can see that the causes of the unsafe behaviour are mostly associated with “Man” of the 4M. (Figure 31)

In addition, in this situation, Management（Management factors and organization）stipulates that Pilot A, as a member of the BTM structure, should exchange information, but this was not adhered to. Thus, there is a necessity to investigate as to whether the Pilots associations have such policies and operation manuals, and if so, ascertain as to why Pilot A could not follow them.

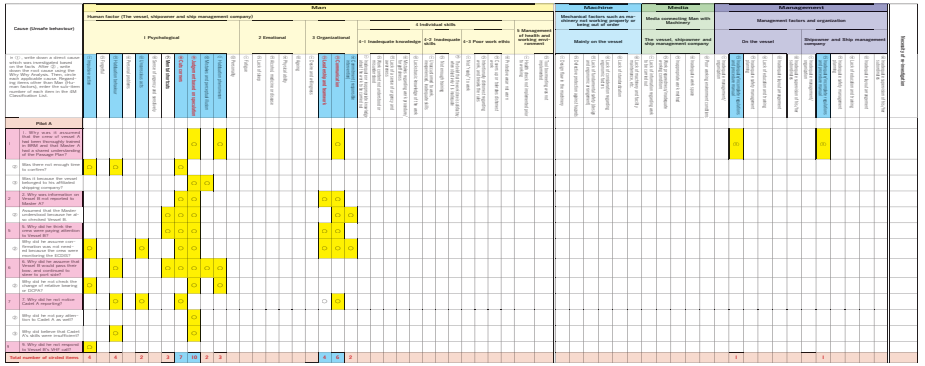


Fig. 31 (Attachment P. 113)

Looking at Human factors, it is possible to see that there is a concentration of factors that fall under 1 Psychological Factors ⑧ Cutting corners and ⑨ Judgement based on speculation. In addition, there are many issues related to ② Leadership and teamwork and ③ Communication, in 3 Organizational factors.

It is understandable that it may be difficult to exchange information with other members of the Bridge including the Master of the vessel because of such pilotage conditions in Osaka Bay where traffic is congested. However, ⑪ Habituation phenomenon and ⑤ Unconscious acts and Judgement based on speculation and so on, and each item applicable to the list here all contribute to the chain of human errors.

In addition, Cadet A reported the movement of Vessel B shortly before the collision, but they did not notice. “People are unconsciously prone to believe only what they want to believe” and “information that supports what they believe rather than purposefully seeking information to the contrary” from ③ Psychological factors on “P.6 1-2 As a Mechanism behind Maritime Accidents Caused by Human Error” of which Confirmation bias (psychology terminology) might have contributed as well.

4−3 “Analysis on Unsafe Behaviour” for Master A and Master B (See Attachment 12)

In the same way as Pilot A, the Why Why Analysis will be carried out here regarding the unsafe behaviour of Master A and Master B.

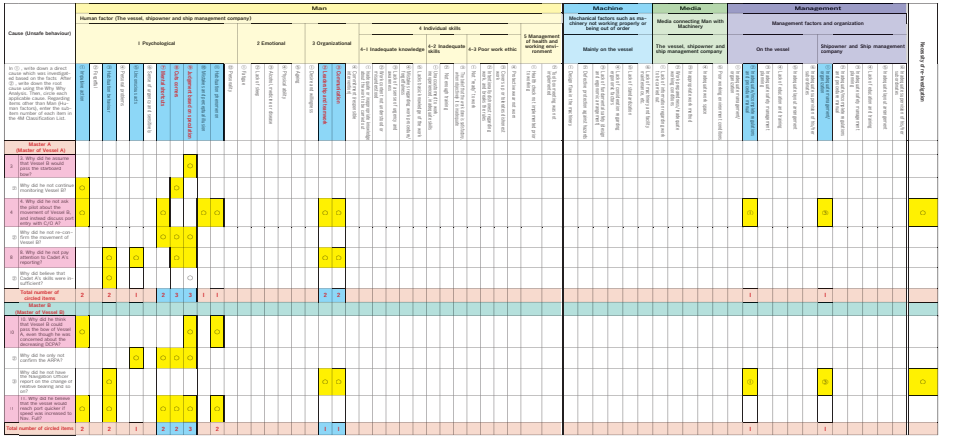


Fig. 32 (Attachment P. 116)

Master A

We can see that the causes of unsafe behaviour are mostly associated with "Man" of the 4M. As shown in Figure 31 and on close examination, we can see that there is a tendency for ⑦ Mental shortcuts, ⑧ Cutting corners and ⑨ Speculation and judgement in 1 Psychological factors. Also, similarly to Pilot A, problems can be identified in ② Leadership and teamwork and ③ Communication in 3 Organizational factors.

Vessel B's movement was confirmed only once. However, it was before Vessel B changed her direction bound for Kobe RC-4 (Kobe Rokko Island) and, at that point, the stem of the Vessel B was facing a southwesterly direction（Tomogashima Channel direction). This is why he believed Vessel B was an outgoing ship from Osaka Bay and that he could pass starboard to starboard.

As introduced in " 4 Human Brain Capacity " in "P.7　1-2　As a Mechanism behind Maritime Accidents Caused by Human Error", once he/she may have had a bias, we understand the difficulty in thinking differently about something once it set in one's mind.

He let Pilot A take care of the manoeuvring, and started discussing port entry work with C/O A. It must be said that he neglected his top priority of keeping lookout, which shows that the prioritizing of work proved to be challenging.

We presume that the importance of BTM is stated in the SMS manual at the ship management company. But as this is still unknown, we circled the column Re-examination necessary regarding: 1. Inadequate management/organization, 2. Inadequate/incomplete regulations and procedure manual, 3. Inadequate safety management planning, and 6. Inadequate supervision of his/her subordinates, in the items under Management.

Master B

Similarly to Master A, it is possible to see that there is a concentration of factors that fall under Man (Human factors) in 1　Psychological Factors ⑦ Mental shortcuts, ⑧ Cutting corners and ⑨ Judgement based on speculation. In particular, he was distracted in order to not be delayed for the port arrival time which caused him to neglect monitoring Vessel A. Also, another reason as to why he did not pay attention to the movements of Vessel A was because he neglected to confirm visually as a result of solely relying on the ARPA （CPA/TCPA) system.

4－4　Countermeasures for "Unsafe Behaviour" for Pilot A (See Attachment 13)

As there were no related facts applicable to unsafe conditions, regarding the unsafe behaviour of Pilot A and the pilots' association, we are going to consider measures with "Analysis using 4M5E and Countermeasure List (Unsafe behaviour)".

3-4-4　Analysis using 4M5E and Countermeasure List for Pilot Attachment 13

On listing up the examined factors, it is possible to ascertain countermeasures.

The root causes can be identified in the following:

- Human beings face difficulty thinking differently about something once they have it set in their mind.
- Lack of awareness that the pilot is also a member of the BTM structure.

Recurrence Prevention Countermeasures

- BTM re-training
- Training in psychology (mental state of mind)

The Pilots' Associations, as organizations, also need to take preventative measures

- Creation or review of the procedure manual
- Introduce BTM training and training that covers mental state of mind

Attachment 13 Vessel A and Vessel B Collision Accident Analysis using 4M5E and Countermeasure List (Unsafe behaviour): Pilot A

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/root cause)	1 Psychological 1. Why was it assumed that the crew of vessel A had been thoroughly trained in BTM and that Master A had a shared understanding of the Passage Plan? (1－①, ③ and ⑧～⑪) 2. Why was information on Vessel B not reported to Master A? (1－⑦～⑨) 5. Why did he think the crew were paying attention to Vessel B? (1－①, ⑤ and ⑦～⑨) 6. Why did he assume that Vessel B would pass their bow, and continued to steer to port side? (1－③, ⑤, ⑧ and ⑨) 7. Why did he not notice Cadet A reporting? (1－③ and ⑨) 9. Why did he not respond to Vessel B's VHF call? (1－①) 3 Organizational Related Facts 1, 2, 5, 5, 7 and 9 ② Why could he not exert leadership as a conning officer? ③ Why could he not communicate with the Master?			13. Incomplete BRM including pilot (2－①)	13. Incomplete BRM including pilot (2－①) 13. Not enough training about psychological factors invites human error (2－①)
Education Education and training Knowledge, skills, consciousness, being given information, etc..	Cause ・Human beings face difficulty thinking differently about something once they have it set in their mind. ・The pilot is also a member of the Bridge. It would have been naive not to have considered him part of the BTM structure. Recurrence Prevention Countermeasures ・BTM re-training ・Training in psychology (mental state of mind)				
Engineering Technology and engineering Engineering countermeasure					
Enforcement Thorough guidance and enforcement Standardization, procedurealization, alerting, reward and punishment KYT, Campagnes etc..					Recurrence Prevention Countermeasures ・Thorough guidance and creation of procedure manual for pilotage regarding BRM (Pilots' associations)
Examples Case studies, countermeasures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.					Recurrence Prevention Countermeasures ・Introduce model cases, BRM training and training that covers mental state of mind(Pilots' associations)
Environment Working environment, office internal management, onboard organization, etc.					

Each item number (bold and red coloured) corresponds to the Summary of Related Facts No. in the Attachment 3
The number applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)

Fig. 33 (Attachment P. 119)

After transcribing the results of the analysis in 4-2 "Analysis of Unsafe Behaviour" for Pilot A into the risk factors column (in the column of Direct and indirect/root causes (coloured in pale yellow) of "Analysis using 4M5E and Countermeasure List (Unsafe behaviour)", the Why Why Analysis will be carried out here regarding each risk factor. The root causes can be identified in the following two points:

- **Human beings face difficulty thinking differently about something once they have it set in their mind.**
- **Lack of awareness that the pilot is also a member of the BTM structure.**

The following numbers correspond with each Summary of Related Facts No.

Psychological Factors : Man

1 Pilot A assumed that the crew of vessel A had been thoroughly trained and that Master A had a shared understanding of the manoeuvring.

Although not stated in the report by the Japan Transport Safety Board, Vessel A's operation and ship management were both managed by the shipping company from where Pilot A belonged.

This would partly explain as to why he assumed that the BTM training had been thoroughly carried out.

2 06:45 (approx.) He visually confirmed Vessel B and checked the movement of Vessel B with port radio, but he did not report this to Master A.

Resource management via communication with "resources surrounding the subject" (P.14 See Figure 12), which is based on the concept of BTM, was not sufficient. This generated a gap between the subject and other people except the subject which is the most important resource where human error would be caused.

Not informing the movement of Vessel B to Master A, 3/O A, Cadet A and A/B A is applicable to the "Hidden area: risk factors which only one knows, that others do not" in the Johari Window (P.13 See Figure 11). Had such information been shared appropriately, this would have been changed to an Open area, which would have allow the ship's bridge on duty personnel of Vessel A to have kept paying attention to the movement of Vessel B and to report it to Pilot A. This exchange of information might have made it possible to make a give-way manoeuvre prior to being in a dangerous situation.

5 He thought that the crew were paying attention to Vessel B.

06:55 (approx.) Assumed crew of Vessel A were paying attention to the movement of Vessel B, because Master A and 1/O A were watching the ECDIS (Electronic Chart Display Information System). They also confirmed Vessel B visually by pointing.

However, Master A and C/O A moved away from the ECDIS just prior to this, and

they started discussing port entry work beside the sea chart table. Lookout was neglected.

6 06:55 (approx.) Headed for the entrance of the East Fairway and continued to steer to port, assuming that Vessel B would pass their bow

He instructed the vessel to reduce speed in preparation for port entry and docking work, but he did not allow the crew to report the actual speed, and did not check it himself. He assumed that the vessel could pass the bow of Vessel B owing to his pilotage experience.

7 Did not notice Cadet A reporting

06:57 (approx.) Cadet A reported “Closer” to mean that Vessel B was too close. The timing of the report was a little too late, however, since it was around five minutes prior to the collision, this would have been the crucial moment to have given way. It cannot be denied that not enough attention was paid to the report that was made by the cadet.

9 Did not respond to Vessel B's VHF call

Shortly before the collision, VHF calls were made twice by Vessel B, but non were returned. This presumably was not noticed because a collision was imminent and he panicked.

Workplace Factors: Man and Management

The root causes were (1) both Master A and Pilot A did not adequately perform their leadership duties as conning officers and (2) could not communicate with Vessel A’s bridge on duty personnel. Pilot A well understood the importance of BTM, but it is presumed that he could not carry it out in reality.

Recurrence Prevention Countermeasures

Pilot A felt deeply responsible for causing the accident. However, as mentioned above, the root cause behind the chain of human errors was caused by Psychological factors. Even though there were several chances to break such a chain of errors after having boarded Vessel A until the accident occurred, resource management (the foundation of BTM) was ineffective and the error chain could not be broken as a result, which inevitably lead to the collision accident. Because it was unknown as to what kind of safety measures had been implemented by the Pilots' Associations, we raised the issue that a Re-examination was necessary.

Recurrence Prevention Countermeasures through Education (education and training) in 4(5)E for Pilot A

After removing the above risk factors, the following two preventive measures remain.

- **BTM re-training**
- **Training in psychology (mental state of mind)**

After Pilot A took above mentioned training and lecture, had he have taken actions such as Self-analysis and told other pilots around him about his experiences, this may have been helpful in preventing a recurrence.

Management (Pilots' Associations) : Preventive measures by Management

According to the Japan Transport Safety Board’s report, Pilot A took BTM training 3 years prior to the accident (in 2015). We naturally assume that accident prevention activities are appropriately implemented by Pilots' Associations. However, it is still unknown if such accident prevention measures pertaining to Management were sufficient or not, therefore, it would be necessary to review the accident prevention measures through Re-examination. Thus, we have identified Re-examination necessary in the countermeasure list.

4−5 Countermeasures for "Unsafe Behaviour" for Masters A and B (See Attachment14)

The root causes can be identified in the following two points:

- Human beings face difficulty thinking differently about something once they have it set in their mind.
- Lack of awareness that pilot is also a member of the BTM structure. Collapse of communication (the foundation of BTM) Master A starts discussing port entry work with C/O
- Mistakes regarding work prioritization.

Recurrence Prevention Countermeasures

- BTM re-training
- Re-training of Safety Management System (SMS)

The Company, as organizations, also need to take preventive measures.

- Reviewand make the work procedure.
- Introduce BTM training and traing that covers mental state of mind.

Attachment 14 Vessel A and B Collision Accident Analysis using 4M5E and Countermeasure List (Unsafe behaviour): Master A and Master B

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
	Master A I. Psychological 3. Why did he assume that Vessel B would pass the starboard bow, without continuously monitoring Vessel B? 4. Why did he start discussing port entry work with C/O A? 8. Why did he not pay attention to Cadet A's reporting? (I-①, ③, ⑤ and ⑦~⑪) 3. Organizational factors (Related Facts No. 3, 4, 8 and 9) ② Why could he not exert leadership as a			Vessel A I4. Why did he not comply with the Safety Management Code? (2-①) 4. Why did he interrupt lookout duty to start discussing port entry work with C/O A in the middle of S/B? (2-①)	Ship management company A I5. Why did he not comply with the Safety Management Code? (I-③) 4. Why did he interrupt lookout duty to start discussing port entry work with C/O A in the middle of S/B?

Fig. 34 (Attachment P. 120)

Let's take a closer look at the preventive measures for unsafe behaviour of both Master A and Master B. Just as with Pilot A, Analysis using 4M4(5)E and Countermeasure List (Unsafe behaviour) will be used here. It is clear to see that the root cause underlying Psychological factors and Organizational factors has to do with Man on both sides.

Psychological Factors Regarding Master A: Man

The root causes can be identified in the following three points: Each number corresponds with a Summary of Related Facts No.

3 He assumed that Vessel B would pass the starboard bow, without continuously monitoring Vessel B.

06:53 (approx.) Master A visually confirmed Vessel B, but Master A did not watch continuously.

At this moment, Vessel B's bearing was <068> and her distance at approx. 3.4 nautical miles and steering to starboard, but she would have been heading in a southwest direction. Also, the ARPA showed Closest Point of Approach (CPA) to be 0.22 nautical miles on the starboard side and TCPA displayed 6.5 minutes later. Together with those and the vector, Master A assumed that Vessel B was an outgoing vessel from Osaka Bay and completely believed that he could pass starboard to starboard.

However, Pilot A was in contact with port radio via VHF at approx. 06:45 and understood that Vessel B was a shifting ship between Osaka Bay and Kobe RC-4.

Port radio communications with Pilot A was conducted in Japanese and Master A did not understand the contents. But, he would have noticed that Pilot A was using VHF to relay information. At that point, if he had confirmed with Pilot A what he was talking about, the chain of errors could have been broken at this stage.

4 He started discussing port entry work with C/O A.

06:53 (approx.), he let 3/O A man the bridge to take over from 1/O A and started discussing port entry work with C/O A beside the sea chart table. It is important that discussion immediately prior to work be conducted, so it is also known that the most important work to be done during S/B in a

congested area like this is lookout. Errors regarding work prioritization.

8 Did not notice Cadet A reporting

Similarly to Pilot A, it cannot be denied that not enough attention was paid to the report that was made by the cadet. As usual, and not just on this occasion, he did not notice the Cadet reporting.

Workplace Factors Regarding Master A: Man

Even when a Pilot is on board, the Master is ultimately responsible as navigator. But, just as with Pilot A, (1) leadership duties were not adequately performed, (2) communication with the vessel's bridge on duty personnel including Pilot A was insufficient. These underlay the root cause. It is considered that BTM was infeasible.

Risk Factors Regarding Management of Master A and Ship Management company A

The ship management company of A's SMS Manual clarifies the procedures during port entry work. Why was this not adhered to? Also, as mentioned earlier, why did he neglect to carry out important lookout work and management of the ship's bridge on duty personnel to start discussing port entry work with C/O A?

It is apparent that both Master A and the Safety management company are fully aware that compliance with the Safety Management Code is a top priority. However, why were they unable to realize this? As further examination and analysis to clarify the reason is necessary, we have designated this as Re-examination necessary.

Psychological Factors Regarding Master B: Man

The root causes can be identified in the following two points:

10 He thought that Vessel B could pass the bow of Vessel A, even though he was concerned about the decreasing DCPA. In addition, he checked ARPA data only and did not confirm it visually.

Furthermore, whilst Master B did appear to pay attention to the movements of Vessel A, he neglected to make a visual confirmation and believed blindly in the ARPA (CPA/TCPA) data alone. In addition, 3/O B on the bridge did not give the order to monitor the movements of Vessel A. When focusing on ship handling in congested sea areas, it is possible to lose sight of the surrounding circumstances, because it is very difficult for crew to perform 3 or 4 different tasks simultaneously. To deal with this problem, the bridge personnel need to form a team which can exert efficient BTM and raise the level of safety. However, this did not happen on this occasion.

11 Assumed that the vessel would reach port delayed or quicker if speed was decreased or increased

Although he believed that the vessel could have just passed the bow of Vessel A, based on the relative bearing of A, and if the speed was maintained, it would have been problematic to do such a manoeuvre using only ARPA data in such close quarters.

In addition, the Master steered to starboard while increasing speed just prior to the collision. The author understands that DCPA will increase when speed is increased, but it is impossible to rapidly increase speed for a large-sized vessel.

The author believes that Master B did his very best given the somewhat stressful circumstances and understands that he may have used the engine for better rudder effect due to there being more than 1 nautical mile to Kobe Central Fairway, but believes that his testimony regarding his concern as whether speed should have been increased (or decreased) to be questionable.

Recurrence Prevention Countermeasures

Recurrence Prevention Countermeasures through Education (education and training) using 4E for Master A

The Master is expected to handle the ship in congested areas until the Pilot arrives on board. However, there is a tendency due to language difficulties to just hand over responsibility to the pilot upon their arrival.

This author has also experienced entry into Kobe port on many occasions. Typically we would pick up the pilot at 04.00 in the morning, which would require some time rescheduling from around 23.00 the previous night at Cape Muroto or off the coast of Cape Shiono (adjustment of engine speed, change of course etc.). At this point I would take command of the bridge. However, it is said that the average human concentration span is around 40-50 minutes, with 90 minutes being an absolute maximum. Under busy continuous working conditions, that span begins to fade and become even shorter. The tendency to leave it all up to the Pilot when he comes on board is therefore understandable given the level of mental and physical fatigue of the crew.

That said though, the command of ship handling is not something which should be simply handed over to the Pilot. The Master must retain responsibility until safely docked at port. Exercising good BTM, including management of the Pilot, is one of the duties of the Master.

With this in mind, the measures needed to be taken by Master A, to prevent recurrence of this danger, can be summarised in the following two points.

・BTM re-training

When the pilot boards, is enough information exchanged, or would there have been enough information exchanged regarding a head-on situation like this?

The pilot checked port radio for the movement of Vessel B via VHF.

Although he knew that Vessel B was communicating in Japanese and that he could not understand what was being said, he could see that the pilot was communicating via VHF. At the time once they had finished speaking, he should have proactively asked the pilot if there was any information that needed to be shared with him.

Also, when he started discussing port entry work with C/O A, he let 3/O A take over from 1/O A immediately after he ascended and started manning the bridge. Was he really aware of the surrounding situation when he took over?

Although he took BTM training, he was unable to practise it in reality, which is the root cause behind the accident. Thus, he is required to take BTM re-training.

・Re-training of Safety Management System (SMS)

Details including the importance of BTM regarding duties on departure and entry, congested areas, reduced visibility would be written in the Safety Management System (SMS). Master A had also seemingly received training in the Safety Management System (SMS) several times. Still, it is necessary to analyse as to why he could not practice this on board and to recommend re-training.

Recurrence Prevention Countermeasures through Management (management and organization) Applying 4E to Ship Management Company A

The ship management company proactively provided the crew with BTM training and seminars on the Safety Management System(SMS). We have identified this as Re-examination necessary, because we do not know the contents of the program.

In other words, crew (those who attended lectures and training) vary in levels of competency, and, consequently, may not be able to apply such training to actual circumstances, thus leading to an accident.

This is the reason why there needs to be further investigation as to why the Safety Management System (SMS) was not adhered to and, furthermore, the following

countermeasures need to be examined and implemented if necessary.

Countermeasure through Guidance and Enforcement (Enforcement)

Review, disseminate, and carry out training of Safety Management System (SMS) procedures for Pilot duty when the Pilot is on board. Also, VDR data was overwritten, thus data at the time of the accident is not available. VDR operation skills and a review of the procedure manual may be required.
In addition, for the time being, it will be of value to continuously carry out internal audits and hold collision recurrence prevention campaigns. Moreover, the Master must realize that he is in charge even when a pilot is on board. However, he must also understand that it may be difficult to supervise a pilot as intended. The ship management company should check with the Pilots' Associations for any relevant improvements.

Recurrence Prevention Countermeasures through Education (education and training) Applying 4E to Master B

Similarly to Master A, one of the contributing root causes Psychological factors: Human beings face difficulty thinking differently about something once they have it set in their mind. Another contributing root cause would be the collapse in communication, such as bridge on duty personnel management and the exchange of information externally, which are the foundations of BTM. Therefore, the following have been identified as recurrence prevention countermeasures:

• BTM re-training

Similarly to Master A, although Master B appears to have taken BTM training, he was unable to practise this in reality. BTM re-training is one recurrence prevention countermeasure that could prove to be effective for those not ready to carry it out in practice.

• Re-training of Safety Management System (SMS)

It appears that the vessel was not able to carry out port departure and entry work in accordance with Safety Management System(SMS), and similarly to Master A, re-training will be necessary.

Recurrence Prevention Countermeasures through Management (management and organization) Applying 4E to Ship Management Company B

As in the case of Company A, the following recurrence prevention countermeasures could be considered: (1) to analyse why the Safety Management System(SMS) was not adequately performed at sea, and if necessary, (2) to review the Safety Management Code regarding duties on departure and entry, narrow channels, reduced visibility and so on, and (3) to disseminate and carry out training for improvement.

4-6 Accident Analysis from the Perspective of Human Factors and Human Error (See Attachment 15)

Attachment 15 Vessel A and B Collision Accident Human Behavioural Traits and Human Error (Psychological Analysis)

Time	Movement	Who?	Behaviour	Human characteristics	P sychology
06：10	Vessel A After passing Tomogashima Channel, changed course to the northeast for Kobe Rokko Island Berth.	Pilot A	From past experience as a pilot, he assumed the crew of Vessel A to be trustworthy.	⑨ Human beings sometimes make assumptions	③ Confirmation bias People unconsciously collect information that supports what they believe.
		Pilot A	Assumed that Master A had a shared understanding of the navigation plan.	⑨ Human beings sometimes make assumptions ⑩ Human beings are sometimes lazy. Did not explain procedure sufficiently enough to the Master after boarding.	② Normalcy bias Assumed everything would be fine, because this method had been fine up until now. ③ Confirmation bias Only collected information that supported what what he/she believed.
06：45 Approx.		Pilot A	Informed port radio via VHF of the approximate time he	③ Human beings sometimes forget	④ Social loafing
	Vessel B Steered north-westerly heading for the entrance of Kobe Central Fairway	Master B	Concerned about decreasing CPA, but assumed that the vessel could pass the bow, according to the vector indicated on ARPA.	⑨ Human beings sometimes make assumptions ⑤ Human beings have moments of inattention ⑩ Human beings are sometimes lazy. ⑥ Human beings are sometimes only able to see one thing at a time Only confirmed information via ECDIS and ARPA	② Normalcy bias People ignore negative information and underestimate phenomena saying "I'm special, nothing can hurt me!"

Fig. 35 (Attachment P. 122)

Each item number printed in the "Human Characteristics" and "Psychology" in the list corresponds with those numbers of "(2) Human characteristics（Nihon VM (Visual Motivation) Centre Co., Ltd from Anzen-no-komado 18 (Safety Loopholes) dated 30 June, 2002 (Provisional translation）（Figure 5）" which explains what causes human errors in "P.4 1-2 As a Mechanism behind Maritime Accidents Caused by Human Error" and "(3) Psychological Factors".

For example, at 06:10 (approx.) Pilot A thought that he had shared his understanding of manoeuvring with Master A, but they never actually communicated with each other in reality. We can assume that information exchange using the Pilot Card in accordance with the procedure manual was all but a formality. This can be analysed as follows:

Human characteristics

⑨ Human beings sometimes make assumptions, and

⑩ Human beings are sometimes lazy

He did not explain the procedure sufficiently enough to the Master after boarding, as he assumed it would not be necessary, despite the fact that the circumstances at that time were unknown. As a result, he probably simplified his usual explanationtion.

Psychological factors

② Normalcy bias

Psychologically, he assumed that everything would be fine, because this method had been fine up until now.

Did he not underestimate the importance of exchanging information?

Psychological factors

③ Confirmation bias

According to human behavioural characteristics, could it be that when he quickly observed Master A and other bridge personnel, that he may have had the bias that the crewmembers were all conversant in BTM?

Although mentioned earlier above, Master A visually confirmed Vessel B at approximately 25.0 degrees on its starboard bow at approx. 06:53. However, because Master A did not hear from the Pilot that Vessel B would head for Kobe Central Fairway, he assumed that there would be no risk of collision judging by his vessel's relative position with the other ship: that it would be heading in a southwest direction (Outgoing Osaka Bay). He also neglected paying attention to the movement of Vessel B afterwards. This, too, can be applied to human characteristics and psychological factors as follows:

Human Characteristics

⑤ Human beings have moments of inattention,
⑨ Human beings sometimes make assumptions and
⑩ Human beings are sometimes lazy.

Tracing the chain of human errors, it is possible to see that he neglected to keep monitoring the movement of Vessel B.

Psychological factors

② Normalcy bias

People unconsciously collect information that supports what they believe.

Psychological factors

③ Confirmation bias

He only collected information that supported what he believed by thinking everything was fine because she crossed the stem of Vessel B.

Psychological factors

④ Social loafing

Assumed that Pilot A would take care of the entire procedure.

In addition, as for Master B, at 06:52 (approx.), he steered to starboard for Kobe Central Fairway without checking the movement of Vessel A visually. This was also the result of the following human characteristics and psychological factors which contributed to the chain of errors.

Human Characteristics

④ Human beings sometimes do not notice,
⑤ Human beings have moments of inattention,
⑥ Human beings are sometimes only able to see one thing at a time,
⑦ Human beings are sometimes in a hurry.

He understood that the relative position would be risky, if he steered to starboard, but he was concerned about entering port late if he was to follow the originally scheduled course, and neglected to keep visual confirmation of Vessel A.

Psychological factors

② Normalcy bias

People ignore negative information and underestimate phenomena saying : "I'm special, nothing can hurt me!"
He simply confirmed the ARPA only.

As compiled in Attachment 15, when looking chronologically at the course of events, it is possible to see how each factor contributes to the chain of human errors. This accident might have been prevented had the chain been broken at some point. It can be said that BTM was not operational.

When analysing other collision accidents, it is possible to observe "accident analysis from the perspective of human factors and human error". These are almost identical to "4M4(5)E Analysis". In other words, the root causes that led to the collision accident can be found in the following Human Characteristics: ⑨ Human beings sometimes make assumptions, ⑤ Human beings have moments of inattention, ⑩ Human beings are sometimes lazy and ⑦ Human beings are sometimes in a hurry. There are also 4 psychological factors that are connected which make it impossible to eradicate human error.

Thus, even if the person "L", who is the centre of the M-Shell Model (P. 14 Figure 12) makes a mistake, the surrounding resources will notice and point it out via communication without hesitation. This is important, because it will break the chain of errors to prevent an accident, namely: practising BTM effectively.

§5 = Case Study = Bridge Collision Accident

Japan Transport Safety Board Report (MA2019-10-2)
Modified from the Japan Transport Safety Board Report:
http://www.mlit.go.jp/jtsb/ship/rep-acci/2019/MA2019-10- 2_2018tk0020.pdf

Let's analyse the Ōshima Bridge Damage in Yamaguchi Prefecture that occurred on October 22, 2018.

5-1 Accident Summary (See Figure 36)

On the 22nd of October 2018, at approximately 00:27 (JST), Cargo ship E (25,431 G/T) collided with Ōshima Bridge while navigating Obatake-Seto channel, heading from the port of Onsan (South Korea) to Etajima of Hiroshima Prefecture (navigating to the east). 3 cranes out of 4 on the vessel sustained damage. On the other hand, Ōshima Bridge sustained cracks and depressions in the bridge girders, and a water mains pipe ruptured as a result of the inspection corridor dropping down on it. Consequently, all areas of Oshima Town suffered approximately 40 days without water, and in addition, power cables and communications cables were also damaged.

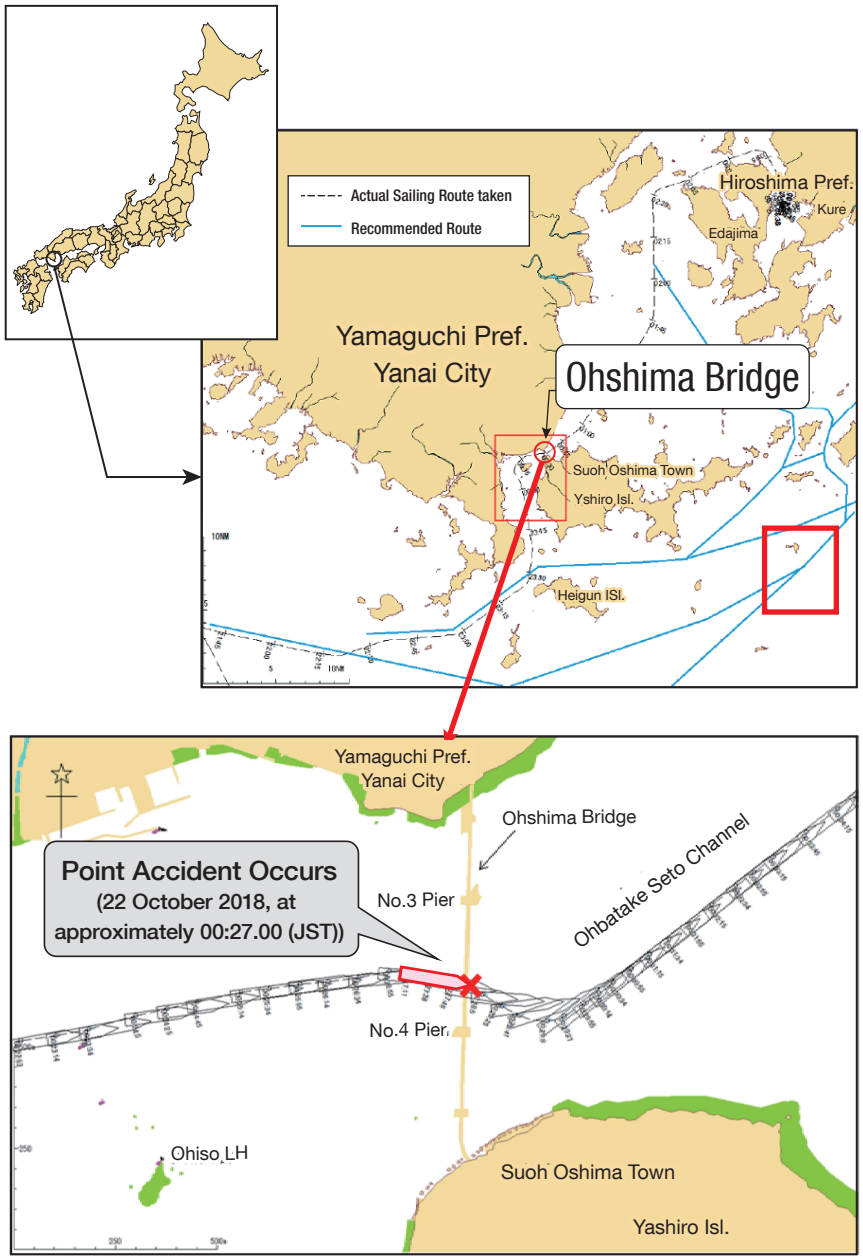


Fig. 36

5−2 Summary and Damage Sustained to a Vessel (Cargo ship E)

Photograph 37

Gross tonnage	:	25,431 G/T
L×B×D (Length) (Breadth) (Depth)	:	180m×30m×15m
Port of origin	:	The port of Onsan (Korea) on October 19, departed at 08:30
Port of destination	:	Etajima, Hiroshima Prefecture Private berth
Cargo	:	Oxidized aluminium Approximately 6,300KT
Draft	:	Fore 5.95m Aft 6.97m
Crew arrangement	:	Total number of 21 (12 Indonesian, 4 Filipino, 2 Russian, 1 Turkish, 1 Indian and 1 Ghanaian)
Ship's Bridge on duty personnel at the time of the accident.	:	Master E, 2/O and AB E
Master E	:	Indonesian national at the age of 44 joined as crew in 1998 and became Master in 2016 with a crew change at Qingdao (port before last) on October 16. He had a great deal of experience manoeuvring in the Seto Inland Sea area as a Master, but it was his first time to manoeuvre in the Obatake-Seto channel.
2/O E	:	Indonesian national at the age of 26 joined as crew in 2012 and boarded Vessel E from July, 2018. It was his first time to serve on board as 2/O.

Air Draft (Fig. 38) and Damage (Photograph 39)

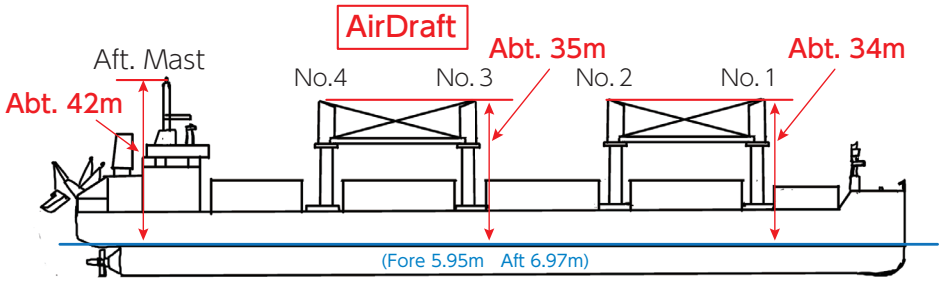
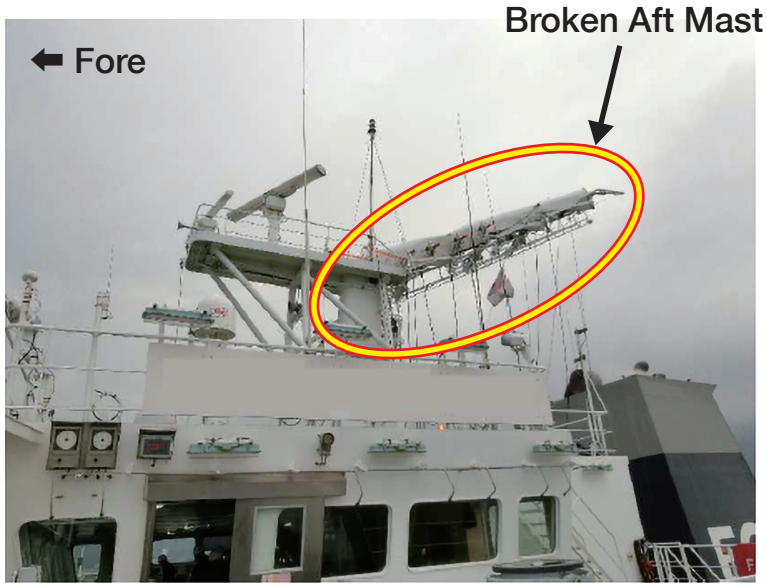
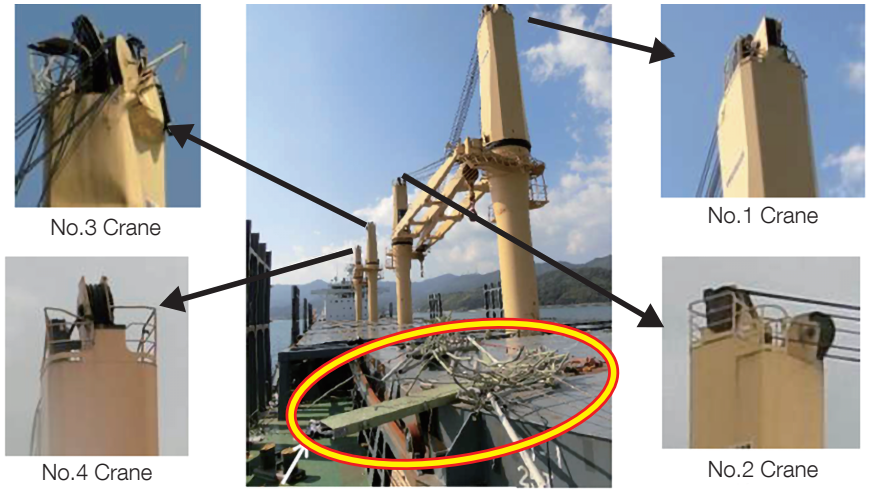


Fig. 38

No.1, No.2, No.3 cranes and the aft mast sustained damage. Air Draft (height from the water surface) is as shown in Figure 38.

Figure 39 illustrates damage sustained.





Photograph 39

5−3 Summary of Ōshima Bridge (Figure 40) and the Damage Sustained (Photograph 41)

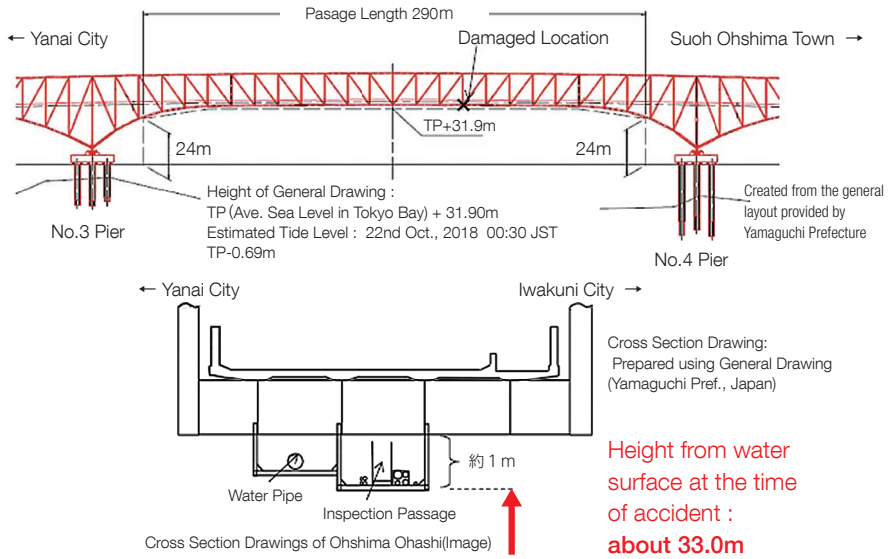
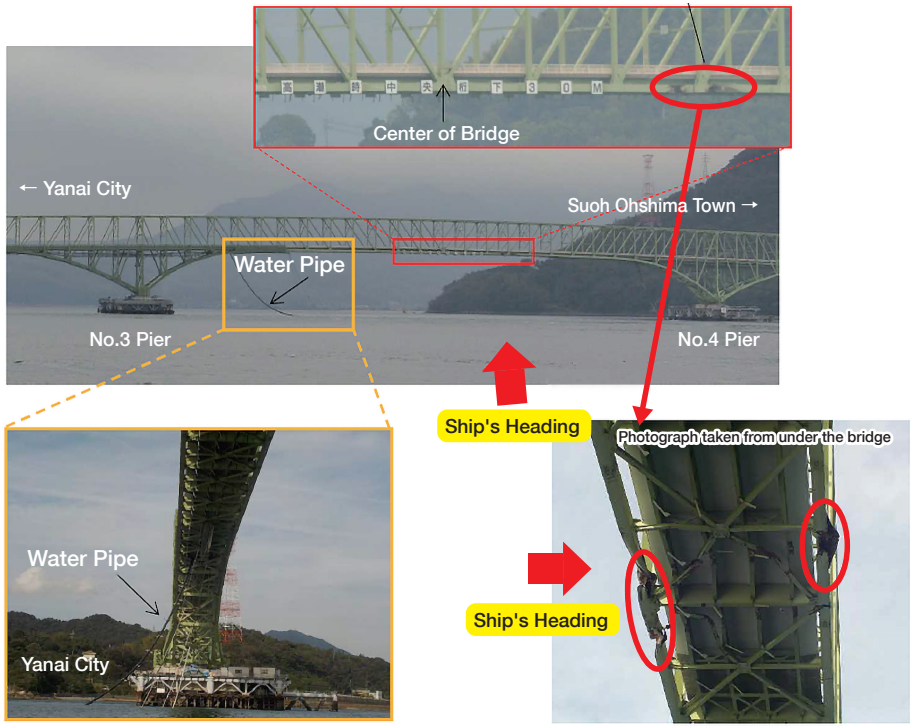


Fig. 40

Ōshima Bridge Damage

Bridge sustained cracks and depressions in the bridge girders, and an inspection corridor which was situated under the girders dropped down damaging a water mains pipe, power and communications cables etc.

In almost all parts of Suo-Oshima Town, 9,046 houses and 4,590 residents and local industry suffered approximately 40 days without water. In addition, in a part of Suo-Oshima Town, there were problems such as a temporary power outage, interruption of Internet connections and mobile phones, and electrical equipment such as bridge lights and so on.



Photograph privided : Yamaguchi Civil Engineering Office

Photograph 41

5－4 Events and Sailing Route that Led to the Accident

Timelines and sailing route that led to the accident are summarised in Figure 42 and Table 43.

- The passage plan was created just 1 week before the accident by the 2/O E.
- On the day of the accident, at around 22:00 on October 21, Master E ascended the bridge in the vicinity of Figure 42 ① in preparation for navigating the Obatake-Seto channel, and commenced ship handling command.
- At 00:00 on October 22, the duty was taken over by 2/O E at the point of 1 nautical mile south of Kasasa-jima.
- As Master E felt uneasy about the height of the Ōshima Bridge, he ordered 2/O E to confirm it. But he continued navigating. 2/O E tried in vain to ascertain information, regarding the height of the bridge beam using pilot directions and the ECDIS.
- 10:27 (approx.) On Octorber 27, the Vessel collided with Ōshima Bridge. Master E tried to make a call to the agency but no one answered at all. Master E kept navigating because it seemed that there was no appropriate point of anchor in the vicinity and at 04:00 (approx.) he finally anchored off the Port of Kure.

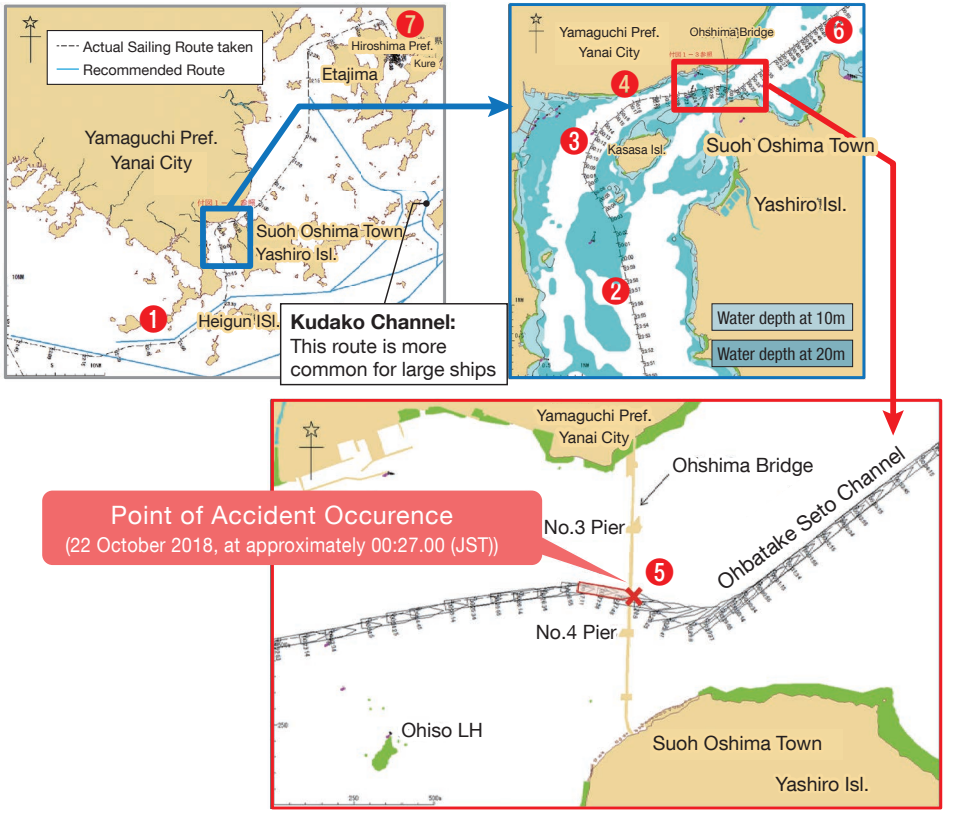


Fig. 42

Date・Time		No.	Occurrence of Events According to an Interview and Questionnaire
9/24 ～ 10/19		—	9/24 Departed Kwinana Quay (Australia) and arrived at the port of Onsan (Korea)via Isabela (Philippines) and Qingdao (China) on 10/19.
10/13 Approx.		—	2/O E made the Voyage Plan for Onsan - Etajima.
10/16			Master E took over from previous Master at Qingdao.
10/20			Master E and 2/O E confirmed the Passage Plan between Onsan and Etajima.
10/21	08：30		Departed the port of Onsan.

Date・Time		No.	Occurrence of Events According to an Interview and Questionnaire
10/21	22：00 Approx.	❶	In preparation for navigating the narrow channel the Master manned the bridge (Master, 3/O E and A/B E).
10/22	00：00	❷	Duty Officer 3/O E was relieved by 2/O E. As Master E felt uneasy about the height of the bridge, he ordered 2/O E to confirm it. 2/O E tried in vain to ascertain information regarding the height of the bridge beam using BA edition sailing directions.
	00：09	❸	Although 2/O E tried to check the height of the bridge beam operating the ECDIS, he did not notice how high the bridge was.
	Steered to starboard to the west of Kasasa-jima.	❹	Ship's Bridge on duty checked for bridge lights, but were unable to see them due to it being too dark. Master E worried about being pressed by the westerly current.
	00：26	❺	2/O E instructed hard to starboard and A/B E responded to the order.
	00：27		Shortly after Master E ordered midships, the No.1, No.2 and No.3 cranes and the aft mast collided with the bridge in succession.
	00：36	❻	Although Master E made a call to the agency requesting them to report this to the Japan Coast Guard, the person in charge at the agency could not hear what was being explained well, thus it did not get reported. Master E kept navigating because it seemed that there was no appropriate point of anchor in the vicinity and it would be safe to continue to the destination.
	04：00	❼	Anchored off the Port of Kure.

Table 43

5－5 Accident Causes

2/O E made the Voyage Plan with ECDIS and it was signed by the previous Master and Master E. Excerpts from the Japan Transport Safety Board Report (MA2019-10-2), summarise statements in Table 44 (2/O E) and Table 45 (Master E), so that we may compare their respective statements with the ship management company's procedure manual (SMS manual).

Passage Plan of 2/O E

Actual Passage Plan made by 2/O E	Ship Management Co. E Procedures (SMS Manual: ISM Code)
2/O E did not confirm the information regarding Obatake-Seto using Sailing Directions. ⇒ According to the Sailing Directions published by the Japan Coast Guard, the height of the bridge over the narrowest point of the Obatake-Seto is said to be 24 to 30 meters. ⇒ It is shown as 24 meters in the Sailing Directions of the BA edition.	Both the Master and duty officer(s) shall carefully review Sailing Directions anytime prior to and during the voyage, especially when operating ocean-going vessels.
When making the route plan from Onsan to Etajima, 2/O of E used software installed in the PC on board in order to operate the electronic chart and to place orders. At this point the route, from Onsan to Etajima via Obatake-Seto, that the software had automatically created was copied to the ECDIS to be used.	For small, medium and large scale electronic charts, the route is to be refined in stages.
2/O E used the route check function and noticed that there were several warnings, including shallows on this particular route, but, he missed the warning for Ōshima Bridge. ⇒ The registered height in the ECDIS was 24 meters. As the vessel's draft and air draft had not been input, when using the route check function, it showed up as "Unidentified". Later on, when inputting the draft and air draft, it had been verified as "Not Passed".	The duty navigation officer and the Master are to visually check the route that has been input into the ECDIS and must very carefully check this during the entire sailing route on the electronic chart using the appropriate scale. This is to be then reconfirmed using the route check function of the ECDIS.

Table 44

2/O E created the Passage Plan one week before the accident occurred. However, the following deviations from the procedure manual were identified:

- 2/O E did not confirm the information regarding Obatake-Seto using pilot directions.
- According to the SMS procedure manual for creating Passage Plans, it is specified that it be created by confirming each item of data before inputting it into the electronic chart. However, he created the Passage Plan using nautical chart ordering software and copied the data over to the ECDIS.
- When creating a Passage Plan, it is necessary to input the draft, safety isobaths and air draft information of the vessel to begin with, but he neglected to do this. As a result, he could not use the route check function of ECDIS successfully.

Master E

Checks carried out by Master E	Ship Management Co. E Procedures (SMS Manual: ISM Code)
The previous Master had checked and signed Passage Plan document for Qingdao. The Master was relieved by another master at Qingdao. (Checked only the summary and did not sign for it)	The Master is to confirm the Passage Plan first-hand by himself/herself in order to ensure that there are no errors. When the Master signs a Passage Plan document this means that it has been officially approved.
Master E believed that the former Master had confirmed this because the Passage Plan had already been made when he boarded on 16 October.	
Master E checked the Passage Plan to Etajima with 2/O E using the ECDIS when staying at the port of Onsan. However, this was not carried out in detail. Master E's signature was found dated 20 October (one day before departure) on the Voyage Plan for Onsan - Etajima.	

Table 45

The following deviations from the procedures are also found for both Master E and Management Company E.

- Master E boarded at Qingdao on 16 October (which was 5 days before the accident occurred). As the previous Master mentioned to Master E that the Voyage Plan for Onsan - Etajima had been created, Master E assumed that the previous Master had checked and confirmed the plan, meaning that Master E did not check it himself.
- The Master checked the Voyage Plan to Etajima with 2/O E using the ECDIS when mooring at the port of Onsan. However, this was not carried out in detail.
- Master E and 2/O E were not used to using the check-bridge-height function on the ECDIS.
- Ship Management Company E would not usually intervene during the creation of a Passage Plan which are created on board each vessel. At the time of the accident, they had no information about any of the Passage Plans, including the Passage Plan from Onsan to Etajima, in advance.

§6 4M4(5)E Analysis of Bridge Collision ＝Accident＝

6－1 Human characteristics (Human error) and Psychological factors (See Attachment 16)

Before starting a specific 4M4(5)E Analysis, let's look at the relationship between human characteristics (human error) and psychological factors.

In the same manner as the previous chapter, Attachment 16 was summarized with the results used in "(2) Human characteristics (Nihon VM (Visual Motivation) Centre Co., Ltd from Anzen-no-komado 18 (Safety Loopholes) dated 30 June, 2002 (Provisional translation) (Figure 5)" which explains Causes behind Human Error in "P.4 1-2 As a Mechanism behind Maritime Accidents Caused by Human Error" and "(3) Psychological Factors".

Attachment 16 Vessel E Ōshima Bridge Collision Accident: Human Characteristics, Human Error and Psychology

Date and time	Movement	Who?	Behaviour	Human characteristics	Psychology
13 Oct. approx.	Navigating en route to Qingdao.	2/O E	Created Passage Plan: Onsan – Etajima		
			· 2/O E did not confirm information regarding Obatake-Seto (including bridge beam height) using pilot directions	③ Human beings sometimes forget: Forgot the procedures of the Safety Management Code	
				⑩ Human beings are sometimes lazy: Knew the procedure, but cut corners	Normalcy bias Human beings have the characteristic to underestimate or ignore information regarding him or herself.
			· Worked according to the following procedure when creating a Passage Plan		
			1) Created using software for ordering charts h	① Human beings sometimes make mistakes: The software was not for creating Passage Plans	Peer pressure · Human beings are prone to make a judgement or decision influenced by somebody else's ideas and thoughts.
			Copied the data over to the ECDIS	⑩ Human beings are sometimes lazy: Knew the procedure, but cut corners	
			3) Did not input Draft and Air Draft data into the ECDIS	② Human beings are sometimes careless, ③ Human beings sometimes forget	
			As a result, although some warnings were detected by the route check function of ECDIS, as the vessel's Draft and Air Draft had not been input, the warning for Ōshima Bridge showed up as "Unconfirmed" and was thus overlooked.	While it may be easy to use convenient software for ordering charts, if ECDIS is not used correctly then it will return incorrect results	· When normalcy bias and peer pressure are combined, a deviation from what was the standard occurs. Then, as a result, and in no time at all, this then becomes the new standard.
16 Oct. approx	When moored at Qingdao	Master E	The next Master E took over from the previous Master		Normalcy bias Human beings have the characteristic to underestimate or ignore information regarding him or herself.
			· The previous Master had checked and signed the Passage Plan document for Qingdao under his command. He only checked a summary of the Passage Plan between Qingdao-Onsan, and Onsan-Etajima, and did not sign for it.	⑩ Human beings are sometimes lazy: Neglected to take over properly	
			· Master E believed that the previous Master had confirmed this because the Passage Plan had already been created.	⑨ Human beings sometimes make assumptions: It was assumed that the previous Master had approved the Passage Plan up until completion of voyage discharge	Social loafing There is the psychological tendency to cut corners in the belief that someone else will take care of it
20 Oct. approx	When moored at the port of Onsan	Master E	The Master E checked the Passage Plan between Onsan-Etajima with 2/O E using the ECDIS. However, this was not carried out in detail.	⑨ Human beings sometimes make assumptions: Based on the above, he assumed that the Passage Plan had been entered into the ECDIS correctly	
				⑩ Human beings are sometimes lazy: Knew the procedure, but cut corners	
21 Oct.					
08:30	Departed the port of Onsan.			No specific problem	No specific problem
22:00	The west of Heigun Island	Master E	Manned the bridge in preparation for navigating the narrow channel		
22 Oct.					

Table 46 (Attachment P. 124)

2/O E's Creation of the Passage Plan

While he may be versed in the Safety Management System (SMS)'s procedure manual, he was unable demonstrate this. When applying this with human characteristics, the following emerge. (Numbered Figure 5 on P. 6)

❶ Human beings sometimes make mistakes and
⑩ Human beings are sometimes lazy

Created Passage Plan using nautical chart ordering software and copied the data over to the ECDIS as is.

❷ Human beings are sometimes careless and
❸ Human beings sometimes forget

Before inputting specific data of sailing route, it is a requirement that basic information such as Draft, Air Draft、Safety isobaths of the vessel, be input. This was neglected.

In addition, as for psychological factors, overlaps of Normalcy Bias which is to ignore information that is inconvenient (e.g. following the procedure manual in the Safety Management System (SMS) is time consuming, etc.,) and Peer pressure such as the copying of data into the ECDIS from the Passage Plan using software for ordering charts by superiors and predecessors contributed to the above mentioned actions.

Master E

We can conclude that the following human characteristics invited human error.

❾ Human beings sometimes make assumptions

The previous Master checked and signed the Passage Plan up until Qingdao Port where the takeover Master boarded. The Master assumed that the Passage Plan created for Qingdao-Onsan-Kure (Etajima) was complete and that the previous Master had checked and signed it.

⑩ Human beings are sometimes lazy

The Safety Management System (SMS) specifies that the Master is to check the details

of the Passage Plan and sign for it. However, he neglected this duty because of his assumption.

The following psychological factors underlay the root cause behind these human characteristics.

- Normalcy bias : Similarly for 2/O E, he conveniently interprets the burdensome task at hand.
- Social loafing : Simply assuming that someone (in this case, the previous Master) was supposed to do it.

As Master E felt uneasy about the height of the bridge, he ordered 2/O E who just ascended the bridge to confirm it. But, it must be said that this was in vain, because it was too late. Let's proceed to the following 4M4(5)E analysis, while considering these underlying root causes.

6−2 Summary of Related Facts (See Attachment 17)

It is possible to list up the following related facts from the main accident causes summarised in 5-5.

Creation of Passage Plan by 2/O E

- Did not research the waterway enough.
- Did not input basic information such as draft, Air draft and safety isobaths of the Vessel into the ECDIS.
- Saved to the ECDIS only by copying the Passage Plan data which was created using nautical chart ordering software.

Attachment 17 Maritime Accident Summary of Related Facts (Collision with Ōshima Bridge)

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	13 Oct. approx.		2/O E	Created Passage Plan: Onsan – Etajima without checking the bridge beam height of Ōshima Bridge. Abort Point procedure was unclear	○		1	○
				Did not input Draft, Air Draft and Safety isobaths data into the ECDIS				
				Created Passage Plan using nautical chart ordering software and copied the data over to the ECDIS as is				
2	16 Oct.		Master E	Believed that the previous Master had checked and signed the Passage Plan both between Qingdao–Onsan and between Onsan–Etajima.	○		5	
3	20 Oct.		Master E and 2/O E	Passage Plan between Onsan–Etajima were not confirmed in detail on the ECDIS.	○		2	
4	22 Oct.	00:00	Master E	As Master E felt uneasy about the height of the Ōshima Bridge, he ordered his 2/O E to confirm it.	○		4	
5	22 Oct.	00:00	2/O E	2/O E did not confirm bridge beam height using pilot directions and the ECDIS	○		3	
6	22 Oct.	00:11	Master E	Continued navigating without confirming the height of the bridge beam	○		6	
7			Ship management company E	No intervention was taken into account whatsoever, regarding the vessel's Passage Plan	○		6	

Accident cause assessment: Prioritized according to the scale of the cause

Table 47 (Attachment P. 126)

Master E

- Believed that the previous Master had checked and signed the Passage Plan from Qingdao-Onsan-Kure (Etajima).

Passage Plan confirmation between Master E and 2/O E

- Both did not do a final check of the passage plan before departing the port of Onsan.
- Immediately before the accident, Master E ordered his 2/O E to confirm the height of the Ōshima bridge, but 2/O E could not confirm this with pilot directions and the ECDIS.
- Continued navigating without confirming the height of the Ōshima Bridge.

We can understand that the accident occurred, because the chain of human errors was not broken.

Ship Management Company E

- No intervention was taken regarding the creation and confirmation of the management of the vessel's Passage Plan

6−3 “Analysis Related to Unsafe Behaviour” for Master E and 2/O E (See Attachment 18)

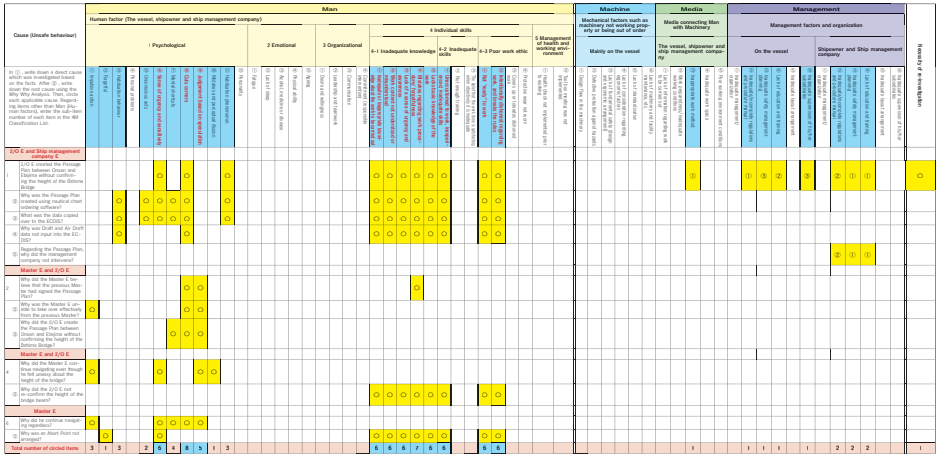


Table 48 (Attachment P. 127)

There is a tendency that causes are from “1 Psychological factors” and “4 Individual skill factors” in Human Factor (Man) of 4M.

Psychological Factors

Among the psychological factors, ⑥ Sense of urgency and sensitivity, ⑧ Cutting corners and ⑨ Judgement based on speculation, are the main causes.

- Created a Passage Plan using nautical chart ordering software and copied the data over to the ECDIS as is. ⑧ Cutting corners is applicable.
- Did not input Draft, Air Draft and Safety isobaths data into the ECDIS ⑧ Cutting corners is applicable.
- Before departing the Port of Onsan, Master E and 2/O E confirmed the final Passage Plan, but without checking the details. In addition, as a planned Abort Point had not been identified, it was also not input into the ECDIS. ⑥ Sense of urgency and sensitivity and to ⑧ “Cut corners” are applicable.

Ship Management Company E

The Safety Management System (SMS) specifies the creation procedure manual of the Passage Plan, and there was no problem with this in itself. However, regarding management at the office on land, it is clear that they were not involved in the Vessel including any other vessels. “2 Inadequate/incomplete regulations and procedure manual”, “3 Inadequate safety management planning” and “4 Lack of education and training” are applicable. As the problem lies in that of the operational method, we have designated this as Re-examination necessary.

6−4 Countermeasures for “Unsafe Behaviour” for Master E, 2/O E and Ship Management Company E (See Attachment 19)

Attachment 19 Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe behaviour) Collision with Oshima Bridge

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/root cause)	1. 2/O E created the Passage Plan between Onsan and Etajima without confirming the bridge beam height of the Hakata−Oshima Bridge (I− ③ and ⑤∼⑪) 2. Regarding the Passage Plan between Onsan−Etajima, Master E did not receive details from the previous Master. (I−①, ⑧ and ⑨) 6. Continued navigating while feeling uneasy about the height of the bridge. (I−①, ⑥, ⑧ and ⑨) 8. Abort Point: Was there a clear plan if the Passage Plan got interrupted or if there were non-returnable-points? (Re-examination necessary) (I−①, ② and ⑥∼⑧)		1. Vague setting method of ECDIS (input-ting basic da-ta) (I− ③, ⑤ ∼⑧ and ⑪)	3. Vague procedure for confirming and approving the Passage Plan (I−① and (7)∼⑨) 2. What the Master did receive from the previous Master was vague (I−①, ⑧ and ⑨)	7. No intervention was taken into account whatsoever regarding the vessel's Passage Plan (Management 2−②, 3−① and 4−①)
Education Education and training Knowledge, skills, consciousness, being given information, etc.	· Re-training for the personnel in charge of creating the Passage Plan (2/O E) · Re-training regarding handling of Abort Point procedure · Re-training on how to handle feeling uneasiness regarding navigation · Re-training for Master E regarding Safety Management Code				· Formulation of continued training and education for Crew
Engineering Technology and engineering Technological countermeasures					

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Enforcement Thorough guidance and enforcement Standardization, proceduralization, alerting, reward and punishment KY I, campagnes etc.	· Re-training for taking over from previous Master · In particular, procedure manual compliance regarding the approval procedure of Passage Plans. · Formulation of handling method (procedure) regarding the route check function of ECDIS		· Creation of Passage Plans using ECDIS and a procedure manual on how to utilize the route function	· Thorough compliance with the revised procedure manual	· Review of SMS procedure manual regarding creation, confirmation and approval of Passage Plans. (To include basic setting method of ECDIS) · Guidance and completeness of revised procedure manual for all ships under management · Enforcement of internal auditing
Examples Case studies, countermeasures and rules Lead by example, experience of success, introduce model cases, “Hyari−Hatto” (near misses), etc.					
Environment Working environment, office internal management, on-board organization, etc.					

Table 49 (Attachment P. 130)

When listing risk factors derived from a direct cause and indirect/root cause, countermeasures for improvement will emerge.

Recurrence Prevention Countermeasures through Education (education and training) for Master E and 2/O E

It is likely that there were no major deficiencies in the procedure manual on how to create the Passage Plan according to the Safety Management System (SMS). The root cause shows that the creator(s) did not have the foundations necessary to plan the Passage Plan according to the manual.

Therefore, it will be important for both Master E and 2/O E to receive re-training on creating a Passage Plan including the utilization of ECDIS.

Also, Master E continued navigating even though he felt uneasy about the height of Ōshima Bridge. Re-training on how to handle feelings of uneasiness while navigating will also be required.

Recurrence Prevention Countermeasures by Ship Management Company E

Regarding the creation of the Passage Plan, the fact that the management company was not directly involved poses a problem, since they relied on related parties only. Confirm if there any problems with regards to the ISM Code or SMS Manual. If there are any deficiencies, they need to be improved. This should include the following:

- A review of the Passage Plans procedure using the ECDIS and procedure manual. This is to include how to utilize the route function.
- This should not stop with work completion and an improved procedure manual, but that ongoing verification be carried out if it is to be practised reliably at sea (PDCA cycle). Namely, it is important to manage the following:
  - Thoroughly introduce accident summary and guidance and completeness of revised procedure manual for all ships under management.
  - Until the management company can confirm that they reliably practice this with each ship under management, the implementation frequency of internal audits is to be increased.
  - Moreover, it is important to evaluate these operation results and, if necessary, review in order to not forget the lessons learned from the accident.

Specific prevention countermeasures will be summarized here by adding the recurrence prevention countermeasures compiled in Japan Transport Safety Board's report (MA2019-10-2). (As the (X) numbered items are recurrence prevention countermeasures which are defined in the Japan Transport Safety Board Report, our recurrence prevention countermeasures with 4M4(5)E analysis are almost identical.)

1 When crew create the passage plan regarding a sea area where they are to navigate for the first time, it is a requirement that they carry out an in-depth investigation throughout the entire route, using nautical charts, sailing information and other oceanographic information in particular.

1 Recurrence Prevention Countermeasures Specific to (1)

When considering why they could not perform their duties, as mentioned above, psychological factors and individual skill factors of Master E and 2/O E underlay the root cause. Another direct cause, which is a result of insufficient knowledge and experience regarding Passage Plan creation by 2/O E (who firstly conducted the duty as 2/O on this vessel) can be identified. Thus, the following two points can be regarded as recurrence prevention countermeasures:

- Re-training for Master E and 2/O E regarding the creation procedure of the Passage Plan.
- Ship Management Company E to systematize crew education and training.

2 When creating the Passage Plan using the ECDIS, crew must not overlook the potential hazards en route. They must (1) confirm the electronic charts and (2) employ the ECDIS function. The contents of any cautions displayed should be thoroughly inspected.

3 It is sometimes the case that crew are not fully aware of the potential hazards

en route when using computer generated voyage plans. When using computer software for navigation, crew should pay attention to the aforementioned two points.

4 In order to prevent oversight of any aerial obstacles, crew should make full use of the ECDIS height check function, if so equipped. It is hoped that the ship owner will actively encourage implementation of this function.

One factor is the fact that both Master E and 2/O E had insufficient skill and knowledge to operate the ECDIS route check function. According to the Japan Transport Safety Board Inquiry, vessel E's ECDIS displayed the height above sea-level of the Oshima Bridge as 24m. However, neither vessel draft or air draft had been input and so cautions regarding the bridge were displayed as "Undefined".

When the route was rechecked following input of the vessel draft, air draft and safety isobath data, the display changed to "Not passed". Before departing Onsan Port, it appears that both Master E and 2/ O E did check the route with the ECDIS, but failed to notice the "Undefined" display.

From this author's history of being on board vessels, it can be said that although the route check function is useful, too many alerts are shown on screen (this could be related to the settings of basic information), and there is a tendency to get desensitized to the meaning of the alerts. Regarding this area, we hope to discuss how to improve this aspect via Machine (out of 4M) in the future. Considering this background information, the following have been identified as recurrence prevention countermeasures:

2～4 Recurrence Prevention Countermeasures Specific to (2) - (4)

- Re-training for obtaining safe isobaths and vessel information via ECDIS for not only the parties involved but also all Masters and navigation officers of contracted ships (including how to deal with draft, Air Draft and so on.)
- It is important to carry out not only temporary re-training, but ongoing and periodic training, also. It is necessary that Ship Management Company E create and review the education and training programme for crew.

5 When crewmembers feel uneasy during navigation, navigation should continue only after confirming satisfactory safety by the taking of necessary steps to change course, reduce speed, stop manoeuvring and so on asap, depending the circumstances.

Master E's continuing to navigate, even while feeling uneasy could be a direct cause. Because of the inadequate planning for an abort point, the information was not displayed on screen. At that time when checking the lights at the Ōshima Bridge, it might be possible to judge if she could keep manoeuvring by stopping navigation at that point, and take into consideration the manoeuvrability of the vessel (minimum stop distance, turning etc.).

5 Recurrence Prevention Countermeasures Specific to (5)

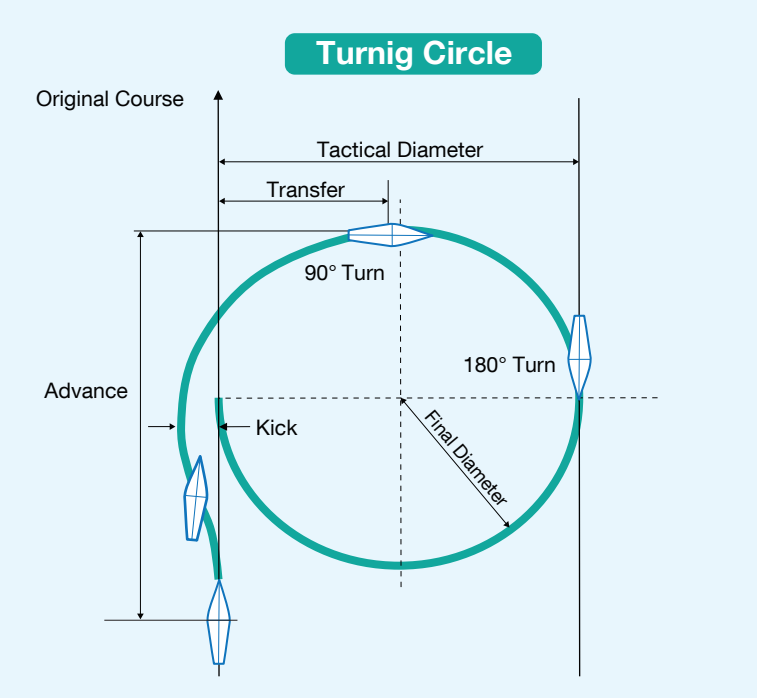
- When approaching port entry and passing narrow channels, it is necessary to clarify the location of an Abort Point and determine whether or not to continue navigation at that point.
- Ship Management Company E is to prepare the procedure manual and set up the Abort Point, and systematise further education and training for Masters and officers.

The ship's Sea Trial Results and the Turning and Stopping performance displayed on the bridge are as follows:

1. Turning performance

	Right (Starboard) Turn (Initial Spd 12.9kts Rudder Angle 35deg.)	Left (Port) Turn (Initial Spd 13.5kts Rudder Angle 35deg.)
90° Turn (Advance) (Req. Time)	about 543m (2 min. 10 sec.)	about 559m (2 min. 02 sec.)
180° Turn Tactical Diameter (Req. Time)	about 441m (4 min. 22 sec.)	about 463m (3 min. 52 sec.)

Table 50



2. Stopping performance

When operating full speed sternway during employing full speed ahead (14.3 knots), the distance forward until stopping the vessel was 2,116 meters and its time taken was 9 minutes and 53 seconds.

At approximately 00:00 (27 miniutes before the accident occurs) on October 21 when Master E felt uneasy about the height of the Ōshima Bridge, he ordered his 2/O E to confirm it; the vessel was at the point of 1 nautical mile south of Kasasa Island (Kasasa-jima). Considering this sea area, it would have been possible both to return by turning or stopping the vessel itself.

In addition, in the case of heading for Kure（Etajima) passing Kanmon Straits, as it is not suitable to navigate Obatake-Seto channel for large ships, for example, those that are more than 180 meters in length, i.e. Vessel E, it is common to pass via Kudako Suido（See Figure 42）instead. In the event of being unfamiliar with this sea area, it would be necessary to have a pilot on board.

§7 Conclusion

As explained in the Chapter 1, almost 90% of the root causes of all maritime accidents are said to be caused by a chain of human errors. In terms of accidents such as collisions, bridge damage and groundings, which were closely examined this time, it is no exaggeration to say that the root causes were down to human errors (100%). BTM/ETM and the 4M4(5)E analysis can break the error chain and prevent future accidents. By utilising the PDCA cycle and by analysing why the parties involved caused the accident and using lessons learned from past accidents to reflect and prevent the same type of accident occurring, it is our hope that these methods may serve to prevent similar accidents from happening in the future.

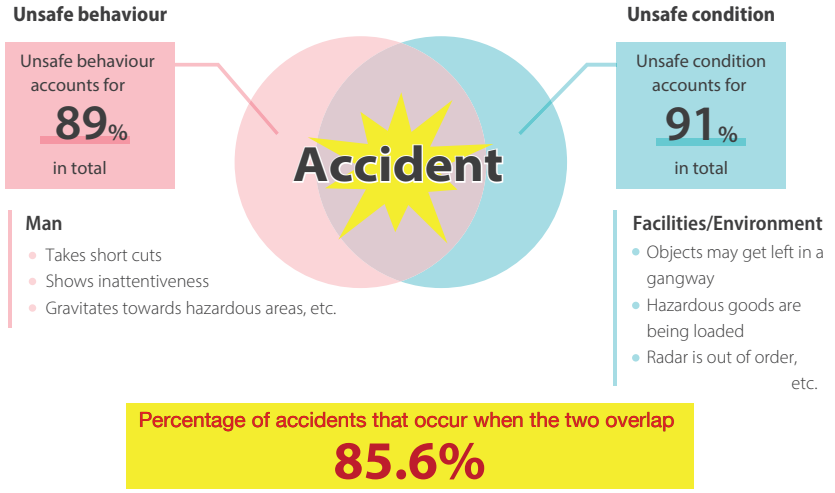
References

- Transport Safety Board Reports
- A collection of tribunals by the Marine Accident Inquiry Agency (MAIA) (Provisional translation)
- Cultural lectures held by the Japan Captains' Association：
  75th Human Error from a psychological perspective (Provisional translation)
  77th What is BRM? (Provisional translation)
  80th Cultural lecture：Ensuring safety in a proud profession ＝ Why BRM is required (Provisional translation) ＝
  81st Accident elimination caused by human factors (Provisional translation)
- The Maritime Human Resource Institute, Japan: Engine room resource management (Provisional translation)
- Bridge team management published by Seizando
- P&P Network: Meaning and object of OJT (Provisional translation)
- Japan Industrial Safety & Health Association　Training materials from a Cause analysis and prevention seminar through lessons learned from disaster cases (Provisional translation)

JISHA

Attachment 1

4M4(5)E Analysis



Percentage of accidents that occur when the two overlap
85.6%

1 Site investigation
- Carry out investigation in as much detail as possible, ideally by a third party (such as a surveyor or marine consultant etc.)

2 Analysis of site investigation report
- Clarify accident cause/s (4M) using a classification table and so on.
- Organize these into a matrix to examine the facts.
- Furthermore, clarify which items need to be inspected/investigated again.

3 Once the above have been established, compile this information into an accident cause/s matrix (unsafe behaviour and unsafe conditions).
- Refine relevant items.
- Carry out a Why Why Analysis.

4 Once the above 3 has been completed
- Classify the direct cause, indirect cause and root cause of the accident referring to the 4M5E table.
- Devise a countermeasure for every 5E item.

5 Carry out and verify countermeasure based on the above
⇒ Brush up with PDCA cycle.

Attachment 2-1

Causes behind Maritime Accidents (4M)

1. Man	2. Machine
1 Psychological factors 2 Emotional factors 3 Organizational factors 4 Individual skill factors 5 Management of health and working environment	1 Design flaw in the machinery 2 Defective protection against hazards 3 Lack of fundamental safety (design and ergonomic arrangement) 4 Lack of consideration regarding ergonomic factors 5 Lack of standardization 6 Lack of machinery and facility maintenance, etc.
3. Media **(Medium connecting Man and Machine)**	**4. Management (Control factors)** **Vessel, Ship Owner/Ship management company**
1 Lack of information regarding work to be carried out 2 Work preparedness. Inadequate working conditions 3 Inappropriate work method 4 Inadequate working space 5 Poor working environment conditions	1 Inadequate management (organizational) 2 Inadequate/incomplete regulations and procedure manual 3 Inadequate safety management planning 4 Lack of education and training 5 Inadequate layout arrangement 6 Inadequate supervision of his/her subordinates

Attachment 2-2 Maritime Accidents 4M Classification List

Man

Human factors that cause errors

The vessel, shipowner and ship management company

1 Psychological	**2 Emotional**	**3 Organizational**	**4 Individual skills**	**5 Management of health andworking environment**
① Impulsive action: ・Human instinct: where there is a tendency to concentrate on only one thing, unable to see what is occurring peripherally, unaware of hazards (Human beings are sometimes only able to see one thing at a time) ② Forgetful: ・Human beings are limited in that they cannot memorize everything (Human beings sometimes forget) ③ Habituation behaviour: ・Bad habit. Human beings have moments of inattention ④ Personal problems: ・Relationship between strength to resist stress and stress tolerance ⑤ Unconscious acts: ・Human beings are sometimes careless ・Effects of the human mind that one is unable to control (Carl Gustav Jung) ⑥ Sense of urgency and sensitivity: ・High ability to identify differences in sensory stimuli strength, and can identify factors that impair safety or life ⑦ Mental shortcuts: ・Human beings are sometimes in a hurry ・Does not properly complete a part of the work procedure in order to finish it quickly ・Use of unsafe behaviour to make haste (cutting corners) ⑧ Cuts corners: ・Breaks the rules due to extra work all of a sudden or fatigue ・Human beings are sometimes lazy and human beings sometimes transgress when no one is looking) ⑨ Judgement based on speculation: subjective decision and wishful observation (Human beings sometimes make assumptions) ・Confirmation bias and experience of success or failure influence subjective judgement and wishful observation ⑩ Mistakes and perceptual illusions: ・Visual and auditory (Human beings sometimes do not notice and occasionally make mistakes) ⑪ Habituation phenomenon: ・False success experience (Human beings have moments of inattention) ・The ability to acquire an experience of success is not only achieved by the person experiencing something first hand, but may also be acquired through observing another's experience ⑫ Personality: ・Unsafe behaviour caused by individual characteristics ・Human beings sometimes become emotional, etc..	① Fatigue ② Lack of sleep ③ Alcohol, medicine or disease ④ Physical ability (sight, forearm strength, muscle strength and good reflexes) ⑤ Ageing	① Desire and willingness ② Leadership and teamwork ③ Communication ④ Commitment (responsible intervention)	4-1 Inadequate knowledge ① Inadequate or inappropriate knowledge about the work to be carried out ② Work content not understood or misunderstood ③ Lack of a sense of urgency and awareness ④ Mistakes regarding work procedure and forgetfulness ⑤ Lacks basic knowledge of the work 4-2 Inadequate skills ① Unaccustomed to work, inexperienced, inadequate skills ② Not enough training ③ The belief that the work done is satisfactory, when objectively it is inadequate 4-3 Poor work ethic ① Not "ready" to work ② Intentionally dishonest regarding work, and breaks the rules ③ Covers-up or tolerates dishonest work ④ Protective wear not worn	① Health check not implemented prior to working ② Tool box meeting was not implemented

Example (1/3)

			1 Design flaw in the machinery	2 Defective protection against hazards	3 Lack of fundamental safety	4 Lack of consideration regarding ergonomic	5 Lack of standardization	6 Lack of machinery and facility maintenance, etc.
Machine	Mechanical factors such as machinery not working properly or being out of order	On the vessel mainly	① Inadequate safety consideration regarding facility and machinery design ② Inadequate protection functions on facilities and machines ③ Lacking in strength, durability and fatigue strength ④ Control program defect ⑤ Inadequate performance and functions ⑥ Defect in construction material and work carried out ⑦ Placement of inappropriate machines	① No protection (guard, cover, safety fence, insulating mat, etc.) ② Has protection, but it is easily deactivated ③ Has protection, but it is inadequate ④ Protection available, but the durability of this is problematic ⑤ Inadequate fixing (lashing), shielding or nothing at all ⑥ Inadequate indication of dangerous areas, range and levels	(design and ergonomic arrangement) ① Fool Proof Should function in a way so as not to cause a hazard even when operated incorrectly ② Fail-safe Maintain safety even if it breaks down ③ Fail Tolerance function Even during malfunction, the S/B machine has a back-up ④ Redundancy To have many backup systems ⑤ Safety Interlock	factors ① Affordance Intuitive structure or layout ② Usability Operability and a layout which is easy to access, yet difficult for errors to be made ③ Universal design Designed so that anyone can use it	① Facilities violating laws and regulations, ISO/JIS or standards on board (company-specific) ② Inadequate safety measures such as equipment failure (e.g. power cut, residual pressure treatment, etc.) ③ Danger warning on usage not relayed to the operator	① Failure or breakdown of equipment, machinery sensors etc. ② Unrepaired breakdown or operation during fixing ③ Inadequate machinery and facility maintenance ④ Deterioration of machinery, equipment etc. ⑤ Periodic maintenance has not been carried out ⑥ Lack of spare parts and supplies ⑦ Re-using of used spare parts which cannot be re-used
Media	Media connecting Man with Machinery	The vessel, shipowner and ship management company	1 Lack of information regarding work to be carried out ① Inadequate or no work method, work procedure or work standard ② Inadequate or no Safety Management Code or SMS Manual ③ Lacking or no information or instructions regarding necessary work ④ Information regarding work (safety) is not understood ⑤ Did not see information about work ⑥ No or difficult to see displays and signs ⑦ No signal or warning, or not audible enough ⑧ Vague and confusing working assignment or personnel allocation ⑨ Lack of information regarding work to be carried out ⑩ There is no safety standard on board (company-specific) ⑪ There is no operating manual or literature on safety precautions ⑫ Mistakes regarding the work procedure	2 Inadequate work preparedness and working conditions ① Unsuitable working posture (too narrow, high, low etc.) ② Working in the same position for an extended length of time ③ Monotonous work ④ "Unreasonableness," "waste" and "inconsistency" during work are to be eliminated ⑤ Inappropriate use of machinery and equipment ⑥ Inappropriate use of tools and equipment ⑦ Technical and physical hardship	3 Inappropriate work method ① Vital points of work not specified or not clear ② Floor condition (obstacles, bumps, uneven, slopes etc.) ③ Inappropriate placement, stacking or propping up of objects ④ Inadequate layout arrangement of machinery, equipment, containers, fixtures etc.) ⑤ Used beyond specification (use) limits ⑥ Inappropriate working environment management	4 Inadequate working space ① Work space is too narrow Keeping the work space neat and tidy while work is being conducted ② Dedicated or maintenance space not clearly specified ③ Machinery or arrangement of which may easily cause an error or an accident ④ Working in dangerous proximity (between people or between man and machinery) ⑤ Safety aisles, areas and passages for maintenance not secured ⑥ Acquisition of Work Permit and confirmation of Media (working environment)	5 Poor working environment conditions ① Uncomfortable temperature or humidity ② Inappropriate lighting (too dark, bright, or too changeable) ③ Working in bad weather ④ Noise and sever vibrations ⑤ Not neat and tidy (4S: sort, set in order, shine and kept spotless ⑥ Inappropriate arrangement of local ventilation and ventilating equipment ⑦ Inappropriate management of working environment (Media) ⑧ Powdery dust and harmful rays (e.g. during welding operations)	

			1 Inadequate management (organizational)	2 Inadequate/incomplete regulations and procedure manual	3 Inadequate safety management planning	4 Lack of education and training	5 Inadequate layout arrangement	6 Inadequate supervision of his/her subordinates
Management	Management factors and organization	On the vessel	① Inadequate itemized legal implementation (person responsible, visibly recognizable,inspection, etc.) ② Repeating the same or similar accidents ③ Risk assessment is not carried out ④ "Hiyari-Hatto" (near miss) scenarios not carried out ⑤ Violations and oversight of the rules on a daily basis ⑥ Inadequate communication and sharing of information between supervisors and work colleagues, among the vessel, shipowner and ship management company or between shipowner and ship management company	① Inadequate or inappropriate contents in Safety Management Code or SMS Manual. Or, is there a point of contact to report inadequate adherence to the Safety Management Code or SMS manual or non-compliance which may not be widely known among the crew? ② Inadequate education and creation of work method and procedure manual ③ Inadequate education and review of work method and procedure manual ④ Inadequate or no irregular work procedure manual	① Work schedule is vague ② Deviation between PMS (Planned Maintenance System) and implementation ③ Inadequate safety measures and risk assessment while working ④ Unexpected work or work which was not planned in the schedule ⑤ Unsuitable work that relies on excessive concentration and an individual's memory ⑥ Inappropriate or inadequate work time table and personnel assignment ⑦ Prolonged work ⑧ Inadequate communication or meeting prior to work (including between/among departments)	① Inadequate planning of education and training on board (pre-boarding, annually, every few years, etc.) ② Inadequate guidance and education (including OJT) for workers ③ Inadequate safety training for supervisors and managers ④ Daily safety guidance (e.g. provision for on-site inquiries, etc.) is not carried out	① Absence of on-site managers such as leaders and supervisors ② Inadequate consideration of qualifications (knowledge), experience (skills) and physical capacity (good health) ③ Inadequate consideration of work specifications and characteristics, and attitudes and behaviours of individuals ④ Lack of consideration and measures for aged or young crew	① Inappropriate work instructions (5W1H) ② Lack or shortage of Ho-Ren-So (reporting, contacting, and consultation) on board and between vessel and company ③ Inadequate communication between leaders and subordinates ④ Information about hazards is not shared ⑤ Inadequate take over regarding personnel assignment
		Shipowner and ship management company	1 Inadequate management (organizational) ① Inadequate safety management due to budget cutting and cost-cuts(Inadequate safety management due to personnel assignment and deterioration of machinery) ② Excessive quota for crew and unreasonable operations ③ Inadequate itemized legal implementation (person responsible, visibly recognizable, inspection, etc.) ④ Repeating the same or similar accidents ⑤ Risk assessment is not carried out ⑥ "Hiyari-Hatto" (near miss) scenarios not carried out ⑦ Violations and oversight of the rules on a daily basis ⑧ Inadequate periodical vessel inspections ⑨ Vague roles, responsibilities and competence regarding health and safety duty ⑩ Inadequate communication and sharing of information between supervisors and work colleagues, among the vessel, shipowner and ship management company or between shipowner and ship management company.	2 Inadequate/in-complete regulations and procedure manual ① Inadequate or inappropriate contents in Safety Management Code or SMS Manual ② Inadequate understanding of work method without proper procedure manual and education ③ Inadequate education and review of work method manual ④ Inadequate or no irregular work procedure manual	3 Inadequate safety management planning ① Work plan or schedule is vague ② Deviation between PMS (Planned Maintenance System) and implementation ③ Inadequate safety measures and risk assessment while working ④ Inadequate management for unexpected work or work which was not planned in the schedule ⑤ Unsuitable management of work that relies on excessive concentration and an individual's memory ⑥ Inappropriate or inadequate work time table and personnel assignment management at the office on land ⑦ Inadequate communication or meeting prior to work (including between/among departments)	4 Lack of education and training ① Inadequate planning of education and training from company departments (pre-boarding, annually, every few years, etc.) ② Inadequate guidance and education for workers ③ Inadequate safety training for supervisors and managers ④ Daily safety guidance (e.g. provision for on-site inquiries during vessel visits, etc.) is not carried out	5 Inadequate layout arrangement ① Inadequate of on-site managers such as leaders and supervisors ② Inadequate consideration of qualifications (knowledge), experience (skills) and physical capacity (good health) ③ Inadequate consideration of work specifications and characteristics, and attitudes and behaviours of individuals ④ Lack of consideration and measures for aged or young crew	Inadequate supervision of crew ① Inappropriate work instructions (5W1H) ② Lack or shortage of Ho-Ren-So (reporting, contacting, and consultation) on board and between vessel and ③ Information about hazards is not shared ④ Inadequate explanation for crew prior to boarding

The Japan Ship Owner's Mutual Protection & Indemnity Association, 14 January 2020 (revised)

Attachment 3 Maritime Accident Summary of Related Facts

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	Unspecified date	Approx. 3 p.m.	Vessel superintendent	Did not report a forecast of low visibility to the Master	○		4	
2	Unspecified date	Approx. 4 p.m.	Vessel radar	No. 1 radar was out of order	△	○	3	○
3	Unspecified date	Approx. 5 p.m.	Vessel superintendent	Requested the Master to navigate using only No. 2 radar until next port, because arrangement to fix No. 1 radar at the port had been made	○		5	○
4	Unspecified date	Approx. 5 p.m.	Master	Approved navigation to the next port using only one radar.	○		6	
5	Unspecified date	Unspecified time	2/O	Did not report to the Master, although there was the low visibility (less than 2 nautical miles) (According to the Safety Management Code, low visibility is defined as less than 3 nautical miles.)	○		2	
6	Unspecified date	Unspecified time	2/O	Searched for the other vessel at 6.6 nautical miles via radar, but did not notice the image captured on ARPA, because he believed he could pass starboard to starboard	○		1	

Example

Accident cause assessment: Prioritized according to the scale of the cause

Attachment 4 Maritime Accident Accident Causes (Unsafe Behaviour)

Man

Human factor (The vessel, shipowner and ship management company)

Cause (Unsafe behaviour)		1 Psychological												2 Emotional					3 Organizational			
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4 M Classification List.		① Impulsive action	② Forgetful	③ Habituation behaviour	④ Personal problems	⑤ Unconscious acts	⑥ Sense of urgency and sensitively	⑦ Mental shortcuts	⑧ Cuts corners	⑨ Judgement based on speculation	⑩ Mistakes and perceptual illusion	⑪ Habituation phenomenon	⑫ Personality	① Fatigue	② Lack of sleep	③ Alcohol, medicine or disease	④ Physical ability	⑤ Ageing	① Desire and willingness	② Leadership and teamwork	③ Communication	④ Commitment (responsible intervention)
1	Why did the 2/O not notice the image captured on ARPA?			○					○			○										
②	Why did he think he could pass starboard to starboard?									○												
③	Why did he think that the bearing of the other vessel was changing?								○		○											
④	Why did he not continue checking?								○			○										
⑤																						
⑥																						
2	Why was low visibility not reported to the Master												○	○							○	
②	Why did he not comply with the Safety Management Code?		○				○					○	○									
③																						
④																						
⑤																						
⑥																						
5	Why did the superintendent request that the vessel navigate with only one radar?	○					○	○				○										
②	Why was the radar not repaired before port departure?						○	○		○		○										
③																						
④																						
⑤																						
⑥																						
6	Why did the Master approve navigation with only one radar?	○				○	○					○										
②	Why did he not request that the radar be repaired prior to port departure?								○	○		○										
③																						
④																						
⑤																						
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XX																						
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⑤																						
⑥																						

Why Why Analysis to be conducted according to each item that was extracted from the Summary of Related Facts

Summary of Related Facts No.

Example (1/3)

Cause (Unsafe behaviour)		Man																		Machine					
		4 Individual skills													5 Management of health and working environment		Mechanical factors such as machinery not working properly or being out of order						
		4-1 Inadequate knowledge					4-2 Inadequate skills			4-3 Poor work ethic					Mainly on the vessel									
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4 M Classification List.		① Inadequate or inappropriate knowledge about the work to be carried out	② Work content not understood or misunderstood	③ Lack of a sense of urgency and awareness	④ Mistakes regarding work procedure/ forgetfulness	⑤ Lacks basic knowledge of the work	① Unaccustomed to work, inexperienced, inadequate skills	② Not enough training	③ The belief that the work done is satisfactory, when objectively it is inadequate	① Not "ready" to work	② Intentionally dishonest regarding work, and breaks the rules	③ Covers up or tolerates dishonest work	④ Protective wear not worn	① Health check not implemented prior to working	② Tool box meeting was not implemented	① Design flaw in the machinery	② Defective protection against hazards	③ Lack of fundamental safety (design and ergonomic arrangement)	④ Lack of consideration regarding ergonomic factors	⑤ Lack of standardization	⑥ Lack of machinery and facility maintenance, etc.
1	Why did the 2/O not notice the image captured on ARPA?			○																	
②	Why did he think he could pass starboard to starboard?																				
③	Why did he think that the bearing of the other vessel was changing?																				
④	Why did he not continue checking?																				
⑤																					
⑥																					
2	Why was low visibility not reported to the Master																				
②	Why did he not comply with the Safety Management Code?																				
③																					
④																					
⑤																					
⑥																					
5	Why did the superintendent request that the vessel navigate with only one radar?	○	○	○	○		○				○										
②	Why was the radar not repaired before port departure?			○								○									
③																					
④																					
⑤																					
⑥																					
6	Why did the Master approve navigation with only one radar?										○										
②	Why did he not request that the radar be repaired prior to port departure?			○							○										
③																					
④																					
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⑤																					
⑥																					

Example (2/3)

Cause (Unsafe behaviour)		Media					Management																Necessity of re-investigation
		Media connecting Man with Machinery					Management factors and organization																
		The vessel, shipowner and ship management company					On the vessel						Shipowner and Ship management company										
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4 M Classification List.		① Lack of information regarding work to be carried out	② Work preparedness/inadequate working conditions	③ Inappropriate work method	④ Inadequate work space	⑤ Poor working environment conditions	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates				
1	Why did the 2/O not notice the image captured on ARPA?																					
②	Why did he think he could pass starboard to starboard?																					
③	Why did he think that the bearing of the other vessel was changing?																					
④	Why did he not continue checking?																					
⑤																						
⑥																						
2	Why was low visibility not reported to the Master																					
②	Why did he not comply with the Safety Management Code?							①				①						①		③		
③																						
④																						
⑤																						
⑥																						
5	Why did the superintendent request that the vessel navigate with only one radar?													①		④		③				
②	Why was the radar not repaired before port departure?												⑤		④							
③																						
④																						
⑤																						
⑥																						
6	Why did the Master approve navigation with only one radar?							①														
②	Why did he not request that the radar be repaired prior to port departure?						③		④			③										
③																						
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⑥																						

The number in the circle applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List) e.g. : Vessel 2 Inadequate/incomplete regulations and procedure manual →① Inadequate or inappropriate contents in ISM Code or SMS Manual

Example (3/3)

Attachment 5

Maritime Accident Accident Causes (Unsafe Conditions)

Cause (Unsafe behaviour)		Man																				
		Human factor (The vessel, shipowner and ship management company)																				
		1 Psychological												2 Emotional					3 Organizational			
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Impulsive action	② Forgetful	③ Habituation behaviour	④ Personal problems	⑤ Unconscious acts	⑥ Sense of urgency and sensitively	⑦ Mental shortcuts	⑧ Cuts corners	⑨ Judgement based on speculation	⑩ Mistakes and perceptual illusion	⑪ Habituation phenomenon	⑫ Personality	① Fatigue	② Lack of sleep	③ Alcohol, medicine or disease	④ Physical ability	⑤ Ageing	① Desire and willingness	② Leadership and teamwork	③ Communication	④ Commitment (responsible intervention)
2	Why was No. 1 radar out of order?																					
②	Why was there no time to place a repair order while in port?																					
③																						
④																						
⑤																						
⑥																						
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⑤																						
⑥																						

Example (1/3)

Cause (Unsafe behaviour)																	Machine					
																	Mechanical factors such as machinery not working properly or being out of order					
		4 Individual skills												5 Management of health and working environment		Mainly on the vessel					
		4-1 Inadequate knowledge					4-2 Inadequate skills			4-3 Poor work ethic											
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Inadequate or inappropriate knowledge about the work to be carried out	② Work content not understood or misunderstood	③ Lack of a sense of urgency and awareness	④ Mistakes regarding work procedure/forgetfulness	⑤ Lacks basic knowledge of the work	① Unaccustomed to work, inexperienced, inadequate skills	② Not enough training	③ The belief that the work done is satisfactory, when objectively it is inadequate	① Not "ready" to work	② Intentionally dishonest regarding work, and breaks the rules	③ Covers up or tolerates dishonest work	④ Protective wear not worn	① Health check not implemented prior to working	② Tool box meeting was not implemented	① Design flaw in the machinery	② Defective protection against hazards	③ Lack of fundamental safety (design and ergonomic arrangement)	④ Lack of consideration regarding ergonomic factors	⑤ Lack of standardization	⑥ Lack of machinery and facility maintenance, etc.
2	Why was No. 1 radar out of order?																				①
②	Why was there no time to place a repair order while in port?			O							O										①
③																					
④																					
⑤																					
⑥																					
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⑥																					

The number in the circle applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)
e.g. : Vessel 2 Inadequate/incomplete regulations and procedure manual
→① Inadequate or inappropriate Education in ISM Code or SMS Manual

Example (2/3)

Cause (Unsafe behaviour)		Media					Management												Necessity of re-investigation
		Media connecting Man with Machinery					Management factors and organization												
		The vessel, shipowner and ship management company					On the vessel						Shipowner and Ship management company						
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Lack of information regarding work to be carried out	② Work preparedness/inadequate working conditions	③ Inappropriate work method	④ Inadequate work space	⑤ Poor working environment conditions	① Inadequate management/organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	① Inadequate management/organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	
2	Why was No. 1 radar out of order?							③	③					③	③				
②	Why was there no time to place a repair order while in port?							③	③					③	③				
③																			
④																			
⑤																			
⑥																			
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Example (3/3)

Attachment 6 Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe behaviour)

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/root cause)	**The vessel, shipowner and ship management company** 1. Why the did 2/O not notice the image captured on ARPA? (1- ③, ⑧, ⑨, ⑩, ⑪ and 4-1- ③) 2. Why was low visibility not reported to the Master? (1- ②, ⑥, ⑪, ⑫, 2- ① and 3- ③) 6. Why was navigation approved using only one radar? (1- ①, ⑥, ⑦, ⑨, ⑪, 4 — 1- ①, ②, ③, ④, 4-2- ① and 4-3- ②) Shipowner and ship management company 5. Why was it requested that the vessel navigate with only one radar?	2. △ Why was No. 1 radar left out of order? (Re-examination necessary)		1. Why was low visibility not reported to the Master? (2- ① and 6- ①) 4. Why was navigation approved using only one radar? (1- ③, 2- ①, 3- ④ and ⑥ -3)	1. Why was low visibility not reported to the Master? (2- ① and 6- ①) 3. Why was it requested that the vessel navigate with only one radar?
Education Education and training Knowledge, skills, consciousness, being given information, etc.	· Training in behaviour psychology ⇒ Learn to notice things · Education to reinforce habitually that optical illusions/errors and assumptions can cause a risky behaviour			· Thorough compliance with work procedure	· Thorough compliance with work procedure
Engineering Technology and engineering Engineering countermeasure		· Pursue the cause behind the failure and formulate measures (Re-examination necessary)			
Enforcement Thorough guidance and enforcement Standardization, proceduralization, alerting, reward and punishment KYT, campagnes etc.				· Thoroughly clarify procedures for low visibility in the procedure manual · Create a procedure manual that states that a vessel is not to leave port while an important nautical auxiliary instrument is out of order	· Thoroughly clarify procedures for low visibility in the procedure manual · An important nautical auxiliary instrument was also out of order
Examples Case studies, countermeasures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.	· Gain a sense of experience using navigation simulations, for example				· Implementation of navigational simulation training
Environment Working environment, office internal management, on-board organization, etc.				· Formulate a procedure for internal company reporting	· Formulate a procedure for internal company reporting

Attachment 7

Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe condition)

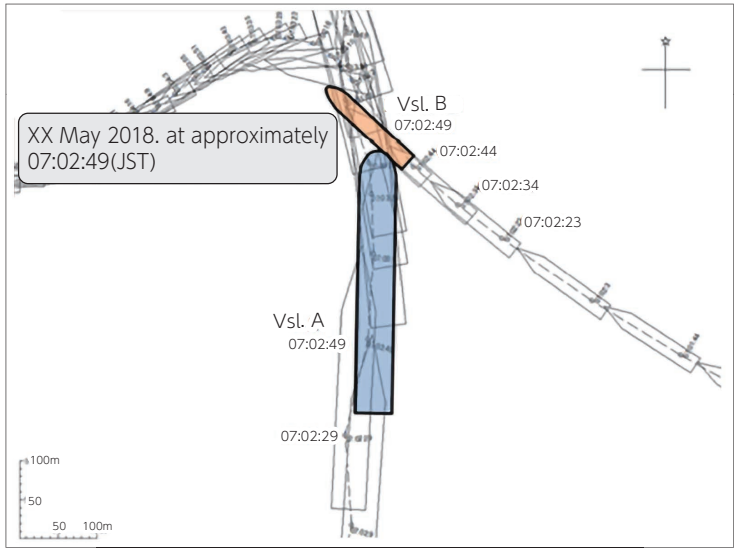
	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship manage-ment company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indi-rect/root cause)		2. △ Why was No. 1 radar left out of order?		2. Why was there no time to place a repair order while in port?	2. Why was there no time to place a repair order while in port?
Education Education and training Knowledge, skills, con-sciousness, being given information, etc..				・Lack of risk aware-ness regarding the danger of navigating with a radar left out of order Education about important nautical instruments	・Lack of risk awareness re-garding the dan-ger of navigating with a radar left out of order Education about important nautical instruments
Engineering Technology and engi-neering Engineering counter-measure		・Pursue the cause behind the failure and formulate measures (Re-examina-tion neces-sary)			
Enforcement Thorough guidance and enforcement Standardization, pro-ceduralization, alerting, reward and punishment KYT, Campagnes etc..				・Review Safety Management Code (handling important equipment)	・
Examples Case studies, counter-measures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.					
Environment Working environment, office internal man-agement, on-board organization, etc.					

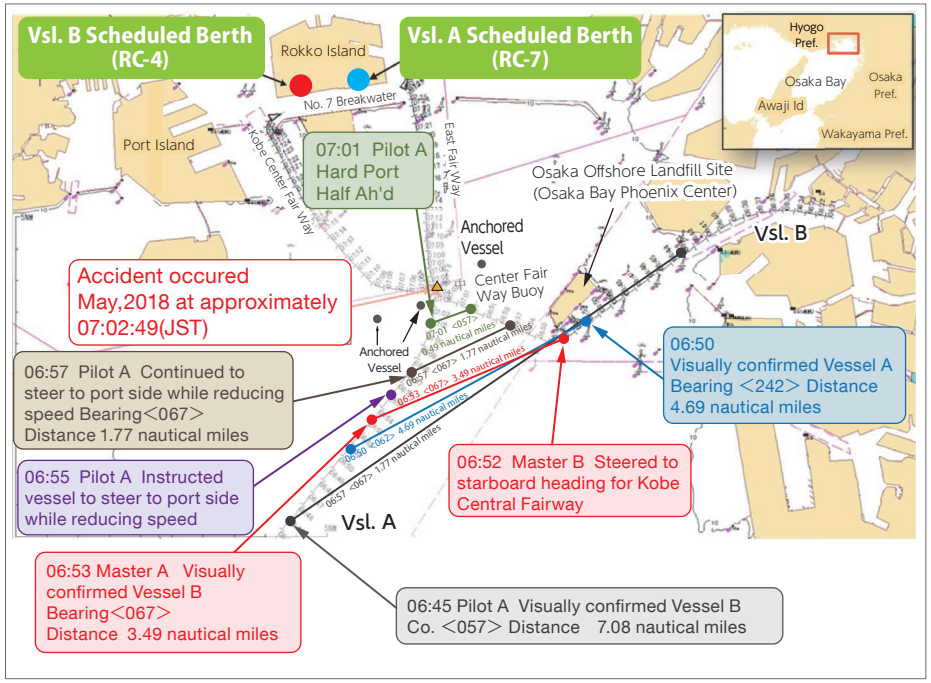
Each item number (bold and red coloured) corresponds to the Summary of Related Facts No. in the Attachment 3
The number in the circle applies to the number in Attachment 2-2 (Maritime Accidents 4 M Classification List)

Attachment 8

Movements of Vessel A and Vessel B

Time	AIS Position of Vessel A		AIS Position of Vessel B		Vessel B's bearing, distance, CPA and TCPA as observed from Vessel A				
	North latitude	East longitude	North latitude	East longitude	Bearing	Distance		CPA	TCPA
06:45:00	34° 34 min. 03.5 sec.	135° 15 min. 34.3 sec.	34° 37 min. 56.5 sec.	135° 22 min. 44.50 sec.	<056.6>	7.08	Nautical miles	–	–
	Ship's course <040> reducing speed at 15.1 kts Pilot A Visually confirmed Vessel B		Ship's course <235> at a speed of 14.1 kts						
06:50:00	34°35min. 02.2 sec.	135°16min. 33.4 sec.	34°37min. 14.9 sec.	135°21min. 33.80 sec.	<061.7>	4.69	Nautical miles	-	-
	Ship's course <040> reducing speed at 14.9 kts		Ship's course <235> at a speed of 14.2 kts Visually confirmed Vessel A						
06:53:00	34°35min. 35.6 sec.	135°17min. 06.8 sec.	34°36min. 55.4 sec.	135°20min. 8.90 sec.	<068.0>	3.35	Nautical miles	1.07 Nautical miles	6.64 mins.
	Ship's course <041> reducing speed at 14.8 kts		Ship's course <253> at a speed of 14.0 kts						
	Master A Visually confirmed Vessel B		Started steering to starboard side while heading for Kobe Central Fairway						
06:55:00	34°35min. 58.4 sec.	135°17min. 29.8 sec.	34°36min. 53.5 sec.	135°20min. 21.00 sec.	<069.1>	2.53	Nautical miles	0.22 Nautical miles	6.51 mins.
	Ship's course <041> reducing speed at 14.6 kts		Ship's course <293> at a speed of 13.8 kts						
	Pilot A Instructed vessel to steer to port side in order to head for Kobe Rokko Island East Waterway								
06:57:00	34°36min. 20.6 sec.	135°17min. 51.5 sec.	34°37min. 02.5 sec.	135°19min. 49.60 sec.	<068.1>	2.13	Nautical miles	0.22 Nautical miles	5.69 mins.
	Ship's course <032> reducing speed at 13.8 kts		Ship's course <294> at a speed of 13.8 kts						
	Pilot A Started steering to port side while heading for Kobe Rokko Island East Waterway								
07:00:45			Instructed vessel to starboard at an angle of 10°as he felt there was a danger of collision		-	-		-	-
07:01:00	34°37min. 08.5 sec.	135°18min. 17.5 sec.	34°37min. 24.6 sec.	135°18min. 47.80 sec.	<056.8>	0.49	Nautical miles	0.08 Nautical miles	1.81 mins.
	Ship's course <006> reducing speed at 12.3 kts		Ship's course <297> at a speed of 13.8 kts						
	Pilot A Half Ah'd Instructed Hard Port								
07:02:10			Called Vessel A twice via VHF Instructed Nav. Full		-	-		-	-
07:02:49	34°37min. 29.9 sec.	135°18min. 21.0 sec.	34°37min. 29.9 sec.	135°18min. 21.00 sec.	Collisions			0.00 Nautical miles	0.00 mins.





Attachment 9 Table of Events Leading up to the Accident

Time (hrs : mins)	Vessel B's bearing and distance as observed from Vessel A		Vessel A		Vessel B	
	Bearing	Distance	Pilot A	Master A, C/O A, 3/O A and Cadet A	Master B	Navigation Officer B
05 : 00 Approx.			Boarded south of Tomogashima Channel. Started discussing pilotage plan with Master A. Instructed Nav. Full up to 18.0 kts.	Master A Received pilotage plan instructions from Pilot A.		
			Bridge: Master A, Pilot A, C/O A, Cadet A and AB A		Bridge: Master B, Navigation Officer B and AB B	
06 : 10 Approx.			From past experience as a pilot, he assumed the crew of Vessel to be trustworthy. Assumed that Master A had a shared understanding of the navigation plan.		Departed Osaka bound for Kobe RC-4 (Kobe Rokko Island)	
06 : 31 Approx.						Informed port radio via VHF of the approximate time he would be passing through the breakwater to RC-4. Obtained information (e.g. vessel anchorage) from Vessel B.
06 : 35 Approx.			Instructed to gradually reduce the speed to S/B Full in the port			
06 : 44 ～ 45 Approx.	<057>	7.08 nautical miles	Informed port radio via VHF of the approximate time he would be passing through the breakwater to RC-7. Obtained information from Vessel B. Did not report it to Master A.			
			Visually confirmed Vessel B			
06 : 50 Approx.	<062>	4.69 nautical miles			Confirmed the Vessel A (at bow and distance approximately at 4.0 nautical miles) and started lookout of the movement via radar and visually.	

Time (hrs : mins)	Vessel B's bearing and distance as observed from Vessel A		Vessel A		Vessel B	
	Bearing	Distance	Pilot A	Master A, C/O A, 3/O A and Cadet A	Master B	Navigation Officer B
06 : 52 Approx.			3/O A ascended and manned the bridge to take over from C/O A 3/O A ascended and manned the bridge to take over from C/O A		Steered to starboard heading for Kobe Central Fairway.	
06 : 53 Approx.	<067>	3.49 nautical miles		Master A visually confirmed Vessel B at approximately 25.0 degrees on its starboard bow. Because Master A did not hear from the Pilot that Vessel B would head for Kobe Central Fairway, he assumed that there would be no risk of collision judging by the his vessel's relative position with the other ship and that it would be heading in a southwest direction (Outgoing Osaka Bay) . Started discussing port entry work with the C/O. A	While steering to starboard, instructed a course of <290>	
06 : 54 Approx.					Instructed a course of <293>. Recognized crossing point with Vessel A	
06 : 55 Approx.	<069>	2.53 nautical miles	Assumed crew of Vessel A were paying attention to the movement of Vessel B, because Master A and C/O A were watching the ECDIS. He also confirmed Vessel B visually by pointing. After that, he did not notice when Master A and C/O A were discussing port entry work at the sea chart table. Instructed vessel to steer to port side in order to head for Kobe Rokko Island East Waterway.		Concerned about decreasing CPA, but assumed that the vessel could pass the bow, according to the vector indicated on ARPA. Assumed that the vessel would reach port quicker if speed was increased to Nav. Full.	

Time (hrs : mins)	Vessel B's bearing and distance as observed from Vessel A		Vessel A		Vessel B	
	Bearing	Distance	Pilot A	Master A, C/O A, 3/O A and Cadet A	Master B	Navigation Officer B
06 : 57 Approx.	<067>	1.77 nautical miles	Because Vessel A was in the middle of reducing speed in relation to Vessel B, it was assumed that Vessel B could pass the bow, and Vessel A continued to steer to port side along with reducing speed. Did not notice Cadet A reporting.	**Cadet A** Reported to Pilot A and 3/O A, because he was worried about a risk of collision with Vessel B Master A, I/O A and 3/O Did not pay attention to Cadet A reporting.		
07 : 00 Approx.					Visually confirmed that Vessel A started steering to port side, felt there was a risk of collision, and instructed Nav. Full and hard to starboard 10°.	
07 : 01 Approx.	<057>	0.49 nautical miles	Sailing close to East Fairway, instructed to the main engine Half Ahead. Visually confirmed their position in relation to Vessel B. Ordered hard to starboard, because he felt there was a risk of collision with Vessel B.	Master A Heard Pilot A's instructions hard to port, but when looking in the direction of the bow, felt there was a danger of collision.		
07 : 02 Approx.	Dangerously close		Did not respond to Vessel B's VHF call	Master A Instructed 3/O A D.Slow Ahead. 3/O A According to the Master's order, operated engine telegraph for D.Slow Ahead Master A Operated engine telegraph for full speed sternway by himself	Blew a whistle Blew a whistle	Called Vessel A by VHF. Called Vessel A by VHF.
07 : 02 : 49 Approx.			**Collision**			

Attachment 10 Vessel A and Vessel B Collision Accident Summary of Related Facts

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	XX May	05：00 Approx.	Pilot A	Felt that the crew of Vessel A had received thorough training in BRM and assumed them to be trustworthy. Also, assumed that Master A had a shared understanding of the navigation plan.	○		4	
2	XX May	06：44 Approx.	Pilot A	Visually confirmed Vessel B, but did not inform the Master of port radio information (Vessel B bound for RC-7).	○		3	
3	XX May	06：53 Approx.	Master A	Assumed that Vessel B would keep its distance when passing the starboard side of Vessel A.	○		5	
4	XX May	06：53 Approx.	Master A	Did not mention the movement of Vessel B to Pilot A. Also, as Pilot did not talk to him about Vessel B, he started discussing port entry work near the sea chart table with I/O A.	○		6	
5	XX May	06：55 Approx.	Pilot A	Although he felt that there was no change of bearing between Vessel A and Vessel B, he assumed crew of Vessel A were paying attention to the movement of Vessel B, because Master A and 3/O A were watching the radar and ECDIS. Pilot A himself confirmed Vessel B visually by pointing.	○		1	
6	XX May	06：57 Approx.	Pilot A	Assumed that Vessel B would pass their bow, and continued to steer to port side.	○		2	
7	XX May	06：57 Approx.	Pilot A	Did not notice the Cadet reporting.	○		7	
8	XX May	06：57 Approx.	Master A and 3/O A	Did not notice the Cadet reporting earlier.	○		8	
9	XX May	07：02 Approx.	Pilot A, Master A and 3/O A	Did not respond to Vessel B's VHF call.	○		9	
10	XX May	06：57 Approx.	Master B	Was concerned about decreasing DCPA, but assumed that vessel B could pass the bow Vessel A, according to the predicted course Vessel A on the radar.	○		10	
11	XX May	06：57 Approx.	Master B	Assumed that the vessel would reach port quicker if speed was increased to Nav. Full.	○		11	
12			Master B and ship management company B	Did not instruct navigation officer to report and lookout thoroughly. (BRM is was not implemented)	○		12	○
13			Pilots' Associations	Were the pilots obliged to take BRM training periodically?	○		13	
14			Master A	Non-compliance with Safety Management Code	○		14	○
15			Ship management company A	Non-compliance with Safety Management Code	○		15	○

Accident cause assessment: Prioritized according to the scale of the cause

Attachment 11 Vessel A and B Collision Accident Maritime Accident Cause (Unsafe Behaviour): Pilot A

Man

Human factor (The vessel, shipowner and ship management company)

Cause (Unsafe behaviour)		1 Psychological											2 Emotional					3 Organizational			
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Impulsive action	② Forgetful	③ Habituation behaviour	④ Personal problems	⑤ Unconscious acts	⑥ Sense of urgency and sensitively	⑦ Mental shortcuts	⑧ Cuts corners	⑨ Judgement based on speculation	⑩ Mistakes and perceptual illusion	⑪ Habituation phenomenon	⑫ Personality	① Fatigue	② Lack of sleep	③ Alcohol, medicine or disease	④ Physical ability	⑤ Ageing	① Attitude and willingness	② Leadership and teamwork	③ Communication	④ Management (responsible intervention)
Pilot A																					
1	1. Why was it assumed that the crew of vessel A had been thoroughly trained in BRM and that Master A had a shared understanding of the Passage Plan?									○		○								○	
②	Was there not enough time to confirm?	○		○					○												
③	Was it because the vessel belonged to his affiliated shipping company?									○	○										
2	2. Why was information on Vessel B not reported to Master A?								○	○									○	○	
②	Assumed that the Master understood because he also checked Vessel B.							○	○	○										○	○
5	5. Why did he think the crew were paying attention to Vessel B?							○	○	○									○	○	
②	Why did he assume confirmation was not needed because the crew were monitoring the ECDIS?	○				○			○	○									○	○	○
6	6. Why did he assume that Vessel B would pass their bow, and continued to steer to port side?			○				○	○	○	○	○									
②	Why did he not check the change of relative bearing or DCPA?	○								○		○									
7	7. Why did he not notice Cadet A reporting?			○		○			○										○	○	
②	Why did he not pay attention to Cadet A as well?									○											
③	Why did believe that Cadet A's skills were insufficient?			○						○											
9	9. Why did he not respond to Vessel B's VHF call?	○																			
Total number of circled items		4		4		2		3	7	10	2	3							4	6	2

Summary of Related Facts No.

Cause (Unsafe behaviour)		Man													Machine					
		4 Individual skills											5 Management of health and working environment		Mechanical factors such as machinery not working properly or being out of order					
		4-1 Inadequate knowledge					4-2 Inadequate skills			4-3 Poor work ethic					Mainly on the vessel					
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Inadequate or inappropriate knowledge about the work to be carried out	② Work content not understood or misunderstood	③ Lack of a sense of urgency and awareness	④ Mistakes regarding work procedure/ forgetfulness	⑤ Lacks basic knowledge of the work	① Unaccustomed to work, inexperienced, inadequate skills	② Not enough training	③ The belief that the work done is satisfactory, when objectively it is inadequate	① Not "ready" to work	② Intentionally dishonest regarding work, and breaks the rules	③ Covers up or tolerates dishonest work	④ Protective wear not worn	⑤ Lack of standardization	① Health check not implemented prior to working	② Tool box meeting was not implemented	① Design flaw in the machinery	② Defective protection against hazards	③ Lack of fundamental safety (design and ergonomic arrangement)	④ Lack of consideration regarding ergonomic factors	⑤ Lack of standardization	⑥ Lack of machinery and facility maintenance, etc.
Pilot A																					
I	I. Why was it assumed that the crew of vessel A had been thoroughly trained in BRM and that Master A had a shared understanding of the Passage Plan?																				
②	Was there not enough time to confirm?																				
③	Was it because the vessel belonged to his affiliated shipping company?																				
2	2. Why was information on Vessel B not reported to Master A?																				
②	Assumed that the Master understood because he also checked Vessel B.																				
5	5. Why did he think the crew were paying attention to Vessel B?																				
②	Why did he assume confirmation was not needed because the crew were monitoring the ECDIS?																				
6	6. Why did he assume that Vessel B would pass their bow, and continued to steer to port side?																				
②	Why did he not check the change of relative bearing or DCPA?																				
7	7. Why did he not notice Cadet A reporting?																				
②	Why did he not pay attention to Cadet A as well?																				
③	Why did believe that Cadet A's skills were insufficient?																				
9	9. Why did he not respond to Vessel B's VHF call?																				
Total number of circled items																					

Cause (Unsafe behaviour)		Media					Management												Necessity of re-investigation
		Media connecting Man with Machinery					Management factors and organization												
		The vessel, shipowner and ship management company					On the vessel						Shipowner and Ship management company						
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Lack of information regarding work to be carried out	② Work preparedness/ inadequate working conditions	③ Inappropriate work method	④ Inadequate work space	⑤ Poor working environment conditions	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	
Pilot A																			
I	I. Why was it assumed that the crew of vessel A had been thoroughly trained in BRM and that Master A had a shared understanding of the Passage Plan?							①						①					
②	Was there not enough time to confirm?																		
③	Was it because the vessel belonged to his affiliated shipping company?																		
2	2. Why was information on Vessel B not reported to Master A?																		
②	Assumed that the Master understood because he also checked Vessel B.																		
5	5. Why did he think the crew were paying attention to Vessel B?																		
②	Why did he assume confirmation was not needed because the crew were monitoring the ECDIS?																		
6	6. Why did he assume that Vessel B would pass their bow, and continued to steer to port side?																		
②	Why did he not check the change of relative bearing or DCPA?																		
7	7. Why did he not notice Cadet A reporting?																		
②	Why did he not pay attention to Cadet A as well?																		
③	Why did believe that Cadet A's skills were insufficient?																		
9	9. Why did he not respond to Vessel B's VHF call?																		
Total number of circled items								1						1					

The number in the circle applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)

Attachment 12

Vessel A and B Collision Accident Accident Cause (Unsafe Behaviour): Master A and Master B

Example (1/3)

Cause (Unsafe behaviour)		Man																				
		Human factor (The vessel, shipowner and ship management company)																				
		1 Psychological												2 Emotional					3 Organizational			
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Impulsive action	② Forgetful	③ Habituation behaviour	④ Personal problems	⑤ Unconscious acts	⑥ Sense of urgency and sensitively	⑦ Mental shortcuts	⑧ Cuts corners	⑨ Judgement based on speculation	⑩ Mistakes and perceptual illusion	⑪ Habituation phenomenon	⑫ Personality	① Fatigue	② Lack of sleep	③ Alcohol, medicine or disease	④ Physical ability	⑤ Ageing	① Desire and willingness	② Leadership and teamwork	③ Communication	④ Commitment (responsible intervention)
Master A (Master of Vessel A)																						
3	3. Why did he assume that Vessel B would pass the starboard bow?									○												
②	Why did he not continue monitoring Vessel B?	○							○													
4	4. Why did he not ask the pilot about the movement of Vessel B, and instead discuss port entry with C/O A?	○						○			○	○								○	○	
②	Why did he not re-confirm the movement of Vessel B?							○	○	○												
8	8. Why did he not pay attention to Cadet A's reporting?			○		○			○											○	○	
②	Why did he believe that Cadet A's skills were insufficient?			○						○												
Total number of circled items		2		2		1		2	3	3	1	1								2	2	
Master B (Master of Vessel B)																						
10	10. Why did he think that Vessel B could pass the bow of Vessel A, even though he was concerned about the decreasing DCPA?	○								○		○										
②	Why did he only not confirm the ARPA?					○		○	○	○												
③	Why did he not have the Navigation Officer report on the change of relative bearing and so on?			○																○	○	
11	11. Why did he believe that the vessel would reach port quicker if speed was increased to Nav. Full?	○		○				○	○	○		○										
Total number of circled items		2		2		1		2	2	3		2								1	1	

Summary of Related Facts No.

Example (2/3)

Cause (Unsafe behaviour)																		Machine					
																		Mechanical factors such as machinery not working properly or being out of order					
		4 Individual skills												5 Management of health and working environment		Mainly on the vessel					
		4-1 Inadequate knowledge					4-2 Inadequate skills			4-3 Poor work ethic											
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Inadequate or inappropriate knowledge about the work to be carried out	② Work content not understood or misunderstood	③ Lack of a sense of urgency and awareness	④ Mistakes regarding work procedure/ forgetfulness	⑤ Lacks basic knowledge of the work	① Unaccustomed to work, inexperienced, inadequate skills	② Not enough training	③ The belief that the work done is satisfactory, when objectively it is inadequate	① Not "ready" to work	② Intentionally dishonest regarding work, and breaks the rules	③ Covers up or tolerates dishonest work	④ Protective wear not worn	① Health check not implemented prior to working	② Tool box meeting was not implemented	① Design flaw in the machinery	② Defective protection against hazards	③ Lack of fundamental safety (design and ergonomic arrangement)	④ Lack of consideration regarding ergonomic factors	⑤ Lack of standardization	⑥ Lack of machinery and facility maintenance, etc.
Master A (Master of Vessel A)																					
3	3. Why did he assume that Vessel B would pass the starboard bow?																				
②	Why did he not continue monitoring Vessel B?																				
4	4. Why did he not ask the pilot about the movement of Vessel B, and instead discuss port entry with C/O A?																				
②	Why did he not re-confirm the movement of Vessel B?																				
8	8. Why did he not pay attention to Cadet A's reporting?																				
②	Why did he believe that Cadet A's skills were insufficient?																				
Total number of circled items																					
Master B (Master of Vessel B)																					
10	10. Why did he think that Vessel B could pass the bow of Vessel A, even though he was concerned about the decreasing DCPA?																				
②	Why did he only not confirm the ARPA?																				
③	Why did he not have the Navigation Officer report on the change of relative bearing and so on?																				
11	11. Why did he believe that the vessel would reach port quicker if speed was increased to Nav. Full?																				
Total number of circled items																					

Cause (Unsafe behaviour)		Media					Management												Necessity of re-investigation
		Media connecting Man with Machinery					Management factors and organization												
		The vessel, shipowner and ship management company					On the vessel						Shipowner and Ship management company						
In ①, write down a direct cause which was investigated based on the facts. After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Lack of information regarding work to be carried out	② Work preparedness/Inadequate working conditions	③ Inappropriate work method	④ Inadequate work space	⑤ Poor working environment conditions	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	
Master A (Master of Vessel A)																			
3	3. Why did he assume that Vessel B would pass the starboard bow?																		
②	Why did he not continue monitoring Vessel B?																		
4	4. Why did he not ask the pilot about the movement of Vessel B, and instead discuss port entry with C/O A?							①					③						○
②	Why did he not re-confirm the movement of Vessel B?																		
8	8. Why did he not pay attention to Cadet A's reporting?																		
②	Why did believe that Cadet A's skills were insufficient?																		
Total number of circled items								1					1						
Master B (Master of Vessel B)																			
10	10. Why did he think that Vessel B could pass the bow of Vessel A, even though he was concerned about the decreasing DCPA?																		
②	Why did he only not confirm the ARPA?																		
③	Why did he not have the Navigation Officer report on the change of relative bearing and so on?							①					③						○
11	11. Why did he believe that the vessel would reach port quicker if speed was increased to Nav. Full?																		
Total number of circled items								1					1						

Example (3/3)

The number in the circle applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)

Attachment 13 Vessel A and Vessel B Collision Accident Analysis using 4M5E and Countermeasure List (Unsafe behaviour): Pilot A

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/ root cause)	I Psychological 1. Why was it assumed that the crew of vessel A had been thoroughly trained in BTM and that Master A had a shared understanding of the Passage Plan? (I-①, ③ and ⑧~⑪) 2. Why was information on Vessel B not reported to Master A? (I-⑦~⑨) 5. Why did he think the crew were paying attention to Vessel B? (I-①, ⑤ and ⑦~⑨) 6. Why did he assume that Vessel B would pass their bow, and continued to steer to port side? (I-③, ⑤, ⑧ and ⑨) 7. Why did he not notice Cadet A reporting? (I-③ and ⑨) 9. Why did he not respond to Vessel B's VHF call? (I-①) 3 Organizational Related Facts 1, 2, 5, 5, 7 and 9 ② Why could he not exert leadership as a conning officer? ③ Why could he not communicate with the Master?			13. Incomplete BRM including pilot (2-①)	13. Incomplete BRM including pilot (2-①) 13. Not enough training about psychological factors invites human error (2-①)
Education Education and training Knowledge, skills, consciousness, being given information, etc..	Cause ・Human beings face difficulty thinking differently about something once they have it set in their mind. ・The pilot is also a member of the Bridge. It would have been naive not to have considered him part of the BTM structure. Recurrence Prevention Countermeasures ・BTM re-training ・Training in psychology (mental state of mind)				
Engineering Technology and engineering Engineering countermeasure					
Enforcement Thorough guidance and enforcement Standardization, procedural-ization, alerting, reward and punishment KYT, Campagnes etc..					Recurrence Prevention Countermeasures ・Thorough guidance and creation of procedure manual for pilotage regarding BRM (Pilots' associations)
Examples Case studies, countermeasures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.					Recurrence Prevention Countermeasures ・Introduce model cases, BRM training and training that covers mental state of mind(Pilots' associations)
Environment Working environment, office internal management, onboard organization, etc.					

Each item number (bold and red coloured) corresponds to the Summary of Related Facts No. in the Attachment 3
The number applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)

Attachment 14

Vessel A and B Collision Accident Analysis using 4M5E and Countermeasure List (Unsafe behaviour): Master A and Master B

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/root cause)	Master A 1. Psychological 3. Why did he assume that Vessel B would pass the starboard bow, without continuously monitoring Vessel B? 4. Why did he start discussing port entry work with C/O A? 8. Why did he not pay attention to Cadet A's reporting? (1-①, ③, ⑤ and ⑦~⑪) 3. Organizational factors (Related Facts No. 3, 4, 8 and 9) ② Why could he not exert leadership as a Master A? ③ Why could he not communicate with the Ship's Bridge personnel including Pilot A? Master B 1. Psychological 10. Why did he think that Vessel B could pass the bow of Vessel A even though he was concerned about the decreasing DCPA? (1-①, ⑨ and ⑪) 10. Why did he not confirm visually and only check ARPA data? (1-⑤, ⑦ and ⑨) 11. Why did he believe that the vessel would reach port quicker if speed was increased to Nav. Full? (1-①, ③, ⑦~⑨ and ⑪) 3. Organizational (Related Facts No. 10 and 11) ② Why could he not exert leadership as a Master B ? ③ Why could he not communicate with the Ship's Bridge personnel?			Vessel A 14. Why did he not comply with the Safety Management Code? (2-①) 4. Why did he interrupt lookout duty to start discussing port entry work with C/O A in the middle of S/B? (2-①) Vessel B 12. Did not instruct navigation officer to report and lookout thoroughly. (BRM was not implemented) (2-①)	Ship management company A 15. Why did he not comply with the Safety Management Code? (1-③) 4. Why did he interrupt lookout duty to start discussing port entry work with C/O A in the middle of S/B? (1-③) Ship management company B 12. Did not instruct navigation officer to report and lookout thoroughly. (BRM was not implemented) (2-①)
Education Education and training Knowledge, skills, consciousness, being given information, etc..	Master A Cause ・Human beings face difficulty thinking differently about something once they have it set in their mind. ・Collapse of communication (the foundation of BTM) ・Mistakes regarding work prioritization Recurrence Prevention Countermeasures ・BTM re-training (especially leadership training) ・Re-training of Safety Management Code (SMS) Master B ・Human beings face difficulty thinking differently about something once they have it set in their mind. ・Collapse of communication (the foundation of BTM) Recurrence Prevention Countermeasures ・BTM re-training (especially leadership training) ・Re-training of Safety Management Code (SMS)				
Engineering Technology and engineering Engineering countermeasure					
Enforcement Thorough guidance and enforcement Standardization, proceduralization, alerting, reward and punishment KYT, Campagnes etc..				Vessel A ・Review and thorough compliance with work procedure regarding the Safety Management Code (SMS) when a Pilot is on board Vessel B ・Review and comply with the Safety Management Code regarding duties on departure and entry, narrow channels, reduced visibility and so on.	Ship management company A ・Review, training and education and make the work procedure commonly known regarding the Safety Management Code (SMS) when a Pilot is on board (duty system) Ship management company B ・Review, training and education and make the Safety Management Code commonly known regarding duties on departure and entry, narrow channels, reduced visibility and so on.
Examples Case studies, countermeasures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.					
Environment Working environment, office internal management, on-board organization, etc.					

Each item number (bold and red coloured) corresponds to the Summary of Related Facts No. in the Attachment 3

The number applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)

Attachment 15 Vessel A and B Collision Accident Human Behavioural Traits and Human Error (Psychological Analysis)

Time	Movement	Who?	Behaviour	Human characteristics	P sychology
06：10	Vessel A After passing Tomogashima Channel, changed course to the northeast for Kobe Rokko Island Berth.	Pilot A	From past experience as a pilot, he assumed the crew of Vessel A to be trustworthy.	⑨ Human beings sometimes make assumptions	③ Confirmation bias People unconsciously collect information that supports what they believe.
		Pilot A	Assumed that Master A had a shared understanding of the navigation plan.	⑨ Human beings sometimes make assumptions ⑩ Human beings are sometimes lazy. Did not explain procedure sufficiently enough to the Master after boarding.	② Normalcy bias Assumed everything would be fine, because this method had been fine up until now. ③ Confirmation bias Only collected information that supported what what he/she believed.
06：45 Approx.		Pilot A	Informed port radio via VHF of the approximate time he would be passing through the breakwater to RC− 7. Obtained information from Vessel B. Did not report it to the Master.	③ Human beings sometimes forget Forgot though he learned the effectiveness of sharing information during BTM training. ⑩ Human beings are sometimes lazy. Thought that it would be too tedious to explain the procedure to the Master.	④ Social loafing Thought he need not explain and that someone else would notice later.
06：52 Approx.	Vessel B After passing Osaka Offshore Landfill Site (Osaka Bay Phoenix Center), the Master steered to starboard heading for Kobe Central Fairway.	Master B	Steered to starboard without checking the movement of Vessel A.	④ Human beings sometimes do not notice ⑤ Human beings have moments of inattention ⑥ Human beings are sometimes only able to see one thing at a time ⑦ Human beings are sometimes in a hurry Although Master B understood that there might have been a risk of collision if he steered to starboard, he was concerned about entering port late if he was to follow the originally scheduled course.	② Normalcy bias People ignore negative information and underestimate phenomena saying “I’m special, nothing can hurt me!”
06：53 Approx.	Vessel A After passing Tomogashima Channel, changed course to the northeast for Kobe Rokko Island Berth.	Master of A	Visually confirmed Vessel B at approximately 25.0 degrees on its starboard bow. Because Master A did not hear from the Pilot that Vessel B would head for Kobe Central Fairway, he assumed that there would be no risk of collision judging by his vessel’s relative position with the other ship and that it would be heading in a southwest direction (Outgoing Osaka Bay) .	⑤ Human beings have moments of inattention ⑨ Human beings sometimes make assumptions ⑩ Human beings are sometimes lazy. Did not confirm movement of Vessel A.	② Normalcy bias People unconsciously collect information that supports what they believe. ③ Confirmation bias Only collected information that supported what what he/she believed. (Thought it was fine because she crossed the stem of the Vessel B. ④ Social loafing Assumed that Pilot A would take care of the entire procedure.
			Started discussing port entry work with I/O A.	⑥ Human beings are sometimes only able to see one thing at a time Prioritizing tasks proved to be difficult.	③ Confirmation bias ④ Social loafing Assumed that the Pilot A would take care of the entire procedure.

Time	Movement	Who?	Behaviour	Human characteristics	P sychology
06：55 Approx.	Vessel A Headed for the entrance of Kobe Rokko Island East Waterway and started steering to port side	Pilot A	Assumed crew of Vessel A were paying attention to the movement of Vessel B, because Master A and I/O A were watching the ECDIS. Pilot A himself confirmed Vessel B visually by pointing.	⑨ Human beings sometimes make assumptions ⑩ Human beings are sometimes lazy. Because of this assumption, he did not instruct crew clearly.	④ Social loafing Assumed bridge shift personnel were paying attention.
			Did not notice when the Master and I/O of A were discussing port entry work at the sea chart table.	④ Human beings sometimes do not notice	③ Confirmation bias Thought that the situation was not as sever as it may have seemed.
			Instructed vessel to steer to port side in order to head for Kobe Rokko Island East Waterway.	⑤ Human beings have moments of inattention Started steering to port side while cutting across. ⑨ Human beings sometimes make assumptions Assumed that the vessel could pass the bow of Vessel B, as they were reducing speed.	② Normalcy bias Assumed everything would be fine, because this method had been fine up until now. People ignore negative information and underestimate phenomena saying “I’m special, nothing can hurt me!”
06：57 Approx.	Vessel A Headed for the entrance of Kobe Rokko Island East Waterway and started steering to port side	Pilot A	Because Vessel A was in the middle of reducing speed in relation to Vessel B, it was assumed that Vessel B could pass the bow, and Vessel A continued to steer to port side along with reducing speed.	⑨ Human beings sometimes make assumptions Assumed that the vessel could pass the bow of Vessel B, as they were reducing speed.	② Normalcy bias Assumed everything would be fine, because this method had been fine up until now. People ignore negative information and underestimate phenomena saying “I’m special, nothing can hurt me!”
		Pilot A, Master A and 3/O A	Did not notice Cadet A reporting.	④ Human beings sometimes do not notice	① Psychological reactance Did not trust Cadet A’s reporting. Did not want to do what he was told. This may be the so called cocktail−party effect.
	Vessel B Steered north−westerly heading for the entrance of Kobe Central Fairway	Master B	Concerned about decreasing CPA, but assumed that the vessel could pass the bow, according to the vector indicated on ARPA.	⑨ Human beings sometimes make assumptions ⑤ Human beings have moments of inattention ⑩ Human beings are sometimes lazy. ⑥ Human beings are sometimes only able to see one thing at a time Only confirmed information via ECDIS and ARPA	② Normalcy bias People ignore negative information and underestimate phenomena saying “I’m special, nothing can hurt me!”

Attachment 16

Vessel E Ōshima Bridge Collision Accident: Human Characteristics, Human Error and Psychology

Date and time	Movement	Who?	Behaviour	Human characteristics	Psychology
13 Oct. approx.	Navigating en route to Qingdao.	2/O E	Created Passage Plan: Onsan – Etajima		
			・2/O E did not confirm information regarding Obatake–Seto (including bridge beam height) using pilot directions	③ Human beings sometimes forget: Forgot the procedures of the Safety Management Code	
				⑩ Human beings are sometimes lazy: Knew the procedure, but cut corners	Normalcy bias Human beings have the characteristic to underestimate or ignore information regarding him or herself.
			・Worked according to the following procedure when creating a Passage Plan		
			1) Created using software for ordering charts h	① Human beings sometimes make mistakes: The software was not for creating Passage Plans	Peer pressure ・Human beings are prone to make a judgement or decision influenced by somebody else's ideas and thoughts.
			Copied the data over to the ECDIS	⑩ Human beings are sometimes lazy: Knew the procedure, but cut corners	
			3) Did not input Draft and Air Draft data into the ECDIS	② Human beings are sometimes careless, ③ Human beings sometimes forget	
			As a result, although some warnings were detected by the route check function of ECDIS, as the vessel's Draft and Air Draft had not been input, the warning for Óshima Bridge showed up as "Unconfirmed" and was thus overlooked.	While it may be easy to use convenient software for ordering charts, if ECDIS is not used correctly then it will return incorrect results	・When normalcy bias and peer pressure are combined, a deviation from what was the standard occurs. Then, as a result, and in no time at all, this then becomes the new standard.
16 Oct. approx	When moored at Qingdao	Master E	The next Master E took over from the previous Master		
			・The previous Master had checked and signed the Passage Plan document for Qingdao under his command. He only checked a summary of the Passage Plan between Qingdao–Onsan, and Onsan–Etajima, and did not sign for it.	⑩ Human beings are sometimes lazy: Neglected to take over properly	Normalcy bias Human beings have the characteristic to underestimate or ignore information regarding him or herself.
			・Master E believed that the previous Master had confirmed this because the Passage Plan had already been created.	⑨ Human beings sometimes make assumptions: It was assumed that the previous Master had approved the Passage Plan up until completion of voyage discharge	Social loafing There is the psychological tendency to cut corners in the belief that someone else will take care of it
20 Oct. approx	When moored at the port of Onsan	Master E	The Master E checked the Passage Plan between Onsan–Etajima with 2/O E using the ECDIS. However, this was not carried out in detail.	⑨ Human beings sometimes make assumptions: Based on the above, he assumed that the Passage Plan had been entered into the ECDIS correctly	
				⑩ Human beings are sometimes lazy: Knew the procedure, but cut corners	
21 Oct.					
08:30	Departed the port of Onsan.			No specific problem	No specific problem
22:00	The west of Heigun Island	Master E	Manned the bridge in preparation for navigating the narrow channel		
22 Oct.					

Date and time	Movement	Who?	Behaviour	Human characteristics	Psychology
00:00	Ōshima (west of Yashiro Island)	2/O E	Duty take over from 3/O E		Confirmation bias There is the psychological tendency to underestimate something People are unconsciously prone to believe only "what they want to believe" and "information that supports what they believe" rather than purposefully seeking information to the contrary. When investigating two conflicting opinions, there is a tendency to set a high value on affirmative information, disvalue or even take no notice of negative information.
		Master E	As Master E felt uneasy about the height of the bridge, he ordered 2/O E to confirm it.	② Human beings are sometimes careless: Master E could not reconfirm in advance.	
				④ Human beings sometimes do not notice, ③ Human beings sometimes forget At the time of approving the Passage Plan, it was believed that preparation for navigating the narrow channel had been carried out, thus no double check was conducted	
		2/O E	2/O E tried in vain to ascertain information regarding the height of the bridge beam using pilot directions	⑪ Human beings sometimes panic Had he remained calm, he may have been able to have confirmed it, but instead panicked	Panick It is said that self-induced panic tends to occur when there are high levels of mental stress among the group, especially in an emergency. Unable to calmly judge the situation, this leads to the taking of drastic measures. ・When there is imminent threat to one's values or oneself. ・There was no solution Even if there were a solution, it would have only benefited a limited number of crew. (E.g. There was only one exit, or limited capacity) ・The sound of an explosion was heard.
00:09	Ōshima (north west of Yashiro Island)	2/O E	Tried to check the height of the bridge beam operating the ECDIS, but did not notice the bridge beam's height which was displayed	④ Human beings sometimes do not notice, ⑪ Human beings sometimes panic	
				Had he remained calm, he may have been able to have confirmed it, but instead panicked	
00:11	Ōshima (north west of Yashiro Island)	Master E 2/O E	Bridge manning checked for bridge lights, but were unable to see them due to it being too dark.	⑪ Human beings sometimes panic Was unable to calmly judge the situation at hand	
		Master E	Master E worried about being pressed by the westerly current. Continued to navigate to the east at half ahead	⑪ Human beings sometimes panic Abort Point: Was there a clear plan if the Passage Plan got interrupted or if there were non-returnable points? (Re-examination necessary)	
00:26	Shortly before Hakata–Ōshima Bridge	2/O E	2/O E instructed hard to starboard and the AB responded to the order.	⑪ Human beings sometimes panic Took right to manoeuvre instead of Master	
00:27	Shortly before Hakata–Ōshima Bridge	Master E	Shortly after Master E ordered midships, the 1st, 3rd and 4th cranes and the aft mast collided with the bridge in succession.	⑪ Panicked The entire bridge team panicked, and were unable to calmly judge the situation.	
00:36	East of Hakata–Ōshima Bridge	Master E	Although Master E made a call to the agency requesting them to report this to the Japan Coast Guard, the person in charge at the agency could not hear what was being explained well, thus it did not get reported		
			Master E kept navigating because it seemed that there was no appropriate point of anchor in the vicinity and it would be safe to continue to the destination		
04:00	Off the Port of Kure.	Master E	Started anchor mooring		

Attachment 17

Maritime Accident Summary of Related Facts (Collision with Ōshima Bridge)

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	13 Oct. approx.		2/O E	Created Passage Plan: Onsan – Etajima without checking the bridge beam height of Ōshima Bridge. Abort Point procedure was unclear	○		1	○
				Did not input Draft, Air Draft and Safety isobaths data into the ECDIS				
				Created Passage Plan using nautical chart ordering software and copied the data over to the ECDIS as is				
2	16 Oct.		Master E	Believed that the previous Master had checked and signed the Passage Plan both between Qingdao–Onsan and between Onsan–Etajima.	○		5	
3	20 Oct.		Master E and 2/O E	Passage Plan between Onsan–Etajima were not confirmed in detail on the ECDIS.	○		2	
4	22 Oct.	00:00	Master E	As Master E felt uneasy about the height of the Ōshima Bridge, he ordered his 2/O E to confirm it.	○		4	
5	22 Oct.	00:00	2/O E	2/O E did not confirm bridge beam height using pilot directions and the ECDIS	○		3	
6	22 Oct.	00:11	Master E	Continued navigating without confirming the height of the bridge beam	○		6	
7			Ship management company E	No intervention was taken into account whatsoever, regarding the vessel's Passage Plan	○		6	

Accident cause assessment: Prioritized according to the scale of the cause

Attachment 18

Maritime Accident Accident Cause (Unsafe Behaviour) Collision with Ōshima Bridge

Cause (Unsafe behaviour)		Man																								
		Human factor (The vessel, shipowner and ship management company)																								
		1 Psychological												2 Emotional					3 Organizational						
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Impulsive action	② Forgetful	③ Habituation behaviour	④ Personal problems	⑤ Unconscious acts	⑥ Sense of urgency and sensitivity	⑦ Mental shortcuts	⑧ Cuts corners	⑨ Judgement based on speculation	⑩ Mistakes and perceptual illusion	⑪ Habituation behaviour	⑫ Personality	① Fatigue	② Lack of sleep	③ Alcohol, medicine or disease	④ Physical ability	⑤ Ageing	① Desire and willingness	② Leadership and teamwork	③ Communication	④ Commitment (responsible intervention)
2/O E and Ship management company E																										
1	2/O E created the Passage Plan between Onsan and Etajima without confirming the height of the Ōshima Bridge						○		○			○														
②	Why was the Passage Plan created using nautical chart ordering software?			○			○	○	○	○		○														
③	What was the data copied over to the ECDIS?			○			○	○	○	○		○														
④	Why was Draft and Air Draft data not input into the ECDIS?			○					○																	
⑤	Regarding the Passage Plan, why did the management company not intervene?																									
Master E and 2/O E																										
2	Why did the Master E believe that the previous Master had signed the Passage Plan?								○	○																
②	Why was the Master E unable to take over effectively from the previous Master?	○							○	○																
③	Why did the 2/O E create the Passage Plan between Onsan and Etajima without confirming the height of the Ōshima Bridge?							○	○	○																
Master E and 2/O E																										
4	Why did the Master E continue navigating even though he felt uneasy about the height of the bridge?	○					○			○	○															
②	Why did the 2/O E not re-confirm the height of the bridge beam?																									
Master E																										
6	Why did he continue navigating regardless?	○					○	○	○	○																
②	Why was an Abort Point not arranged?		○				○																			
Total number of circled items		3	1	3		2	6	4	8	5	1	3														

Example (1/3)

Cause (Unsafe behaviour)		Man																		Machine					
																				Mechanical factors such as machinery not working properly or being out of order					
		4 Individual skills														5 Management of health and working environment		Mainly on the vessel					
		4-1 Inadequate knowledge						4-2 Inadequate skills			4-3 Poor work ethic													
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Inadequate knowledge about the work to be carried out	② Inadequate or inappropriate knowledge	③ Work content not understood or misunderstood	④ Lack of a sense of urgency and awareness	⑤ Mistakes regarding work procedure/ forgetfulness	⑥ Lacks basic knowledge of the work	① Unaccustomed to work, inexperienced, inadequate skills	② Not enough training	③ The belief that the work done is satisfactory, when objectively it is inadequate	① Not "ready" to work	② Intentionally dishonest regarding work, and breaks the rules	③ Covers up or tolerates dishonest work	④ Protective wear not worn	① Health check not implemented prior to working	② Tool box meeting was not implemented	① Design flaw in the machinery	② Defective protection against hazards	③ Lack of fundamental safety (design and ergonomic arrangement)	④ Lack of consideration regarding ergonomic factors	⑤ Lack of standardization	⑥ Lack of machinery and facility maintenance, etc.
2/O E and Ship management company E																									
①	2/O E created the Passage Plan between Onsan and Etajima without confirming the height of the Ōshima Bridge	○	○	○	○	○	○				○	○													
②	Why was the Passage Plan created using nautical chart ordering software?	○	○	○	○	○	○				○	○													
③	What was the data copied over to the ECDIS?	○	○	○	○	○	○				○	○													
④	Why was Draft and Air Draft data not input into the ECDIS?	○	○	○	○	○	○				○	○													
⑤	Regarding the Passage Plan, why did the management company not intervene?																								
Master E and 2/O E																									
2	Why did the Master E believe that the previous Master had signed the Passage Plan?				○																				
②	Why was the Master E unable to take over effectively from the previous Master?																								
③	Why did the 2/O E create the Passage Plan between Onsan and Etajima without confirming the height of the Ōshima Bridge?																								
Master E and 2/O E																									
4	Why did the Master E continue navigating even though he felt uneasy about the height of the bridge?																								
②	Why did the 2/O E not re-confirm the height of the bridge beam?	○	○	○	○	○	○				○	○													
Master E																									
6	Why did he continue navigating regardless?																								
②	Why was an Abort Point not arranged?	○	○	○	○	○	○				○	○													
Total number of circled items		6	6	6	7	6	6				6	6													

Example (2/3)

Cause (Unsafe behaviour)		Media					Management														Necessity of re-investigation
		Media connecting Man with Machinery					Management factors and organization														
		The vessel, shipowner and ship management company					On the vessel						Shipowner and Ship management company								
In ①, write down a direct cause which was investigated based on the facts After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.		① Lack of information regarding work to be carried out	② Work preparedness/inadequate working conditions	③ Inappropriate work method	④ Inadequate work space	⑤ Poor working environment conditions	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates	① Inadequate management/ organization	② Inadequate/incomplete regulations and procedure manual	③ Inadequate safety management planning	④ Lack of education and training	⑤ Inadequate layout arrangement	⑥ Inadequate supervision of his/her subordinates		
2/O E and Ship management company E																					
①	2/O E created the Passage Plan between Onsan and Etajima without confirming the height of the Ōshima Bridge			①				①	③	②		③		②	①	①					○
②	Why was the Passage Plan created using nautical chart ordering software?																				
③	What was the data copied over to the ECDIS?																				
④	Why was Draft and Air Draft data not input into the ECDIS?																				
⑤	Regarding the Passage Plan, why did the management company not intervene?													②	①	①					
Master E and 2/O E																					
2	Why did the Master E believe that the previous Master had signed the Passage Plan?																				
②	Why was the Master E unable to take over effectively from the previous Master?																				
③	Why did the 2/O E create the Passage Plan between Onsan and Etajima without confirming the height of the Ōshima Bridge?																				
Master E and 2/O E																					
4	Why did the Master E continue navigating even though he felt uneasy about the height of the bridge?																				
②	Why did the 2/O E not re-confirm the height of the bridge beam?																				
Master E																					
6	Why did he continue navigating regardless?																				
②	Why was an Abort Point not arranged?																				
Total number of circled items				1				1	1	1		1		2	2	2					1

Example (3/3)

The number in the circle applies to the number in Attachment 2-2 (Maritime Accidents 4M Classification List)

Attachment 19

Maritime Accident Analysis using 4M5E and Countermeasure List
(Unsafe behaviour) Collision with Ōshima Bridge

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/root cause)	I. 2/O E created the Passage Plan between Onsan and Etajima without confirming the bridge beam height of the Hakata-Oshima Bridge (I-③ and ⑤～⑪) 2. Regarding the Passage Plan between Onsan-Etajima, Master E did not receive details from the previous Master. (I-①, ⑧ and ⑨) 6. Continued navigating while feeling uneasy about the height of the bridge, (I-①, ⑥, ⑨ and ⑩) I. Abort Point: Was there a clear plan if the Passage Plan got interrupted or if there were non-returnable points? (Re-examination necessary) (I-①, ② and ⑥～⑨)		I. Vague setting method of ECDIS (inputting basic data) (I-③, ⑤～⑧ and ⑪)	3. Vague procedure for confirming and approving the Passage Plan (I-① and ⑦～⑨) 2. What the Master did receive from the previous Master was vague (I-①, ⑧ and ⑨)	7. No intervention was taken into account whatsoever regarding the vessel's Passage Plan (Management 2-②, 3-① and 4-①)
Education Education and training Knowledge, skills, consciousness, being given information, etc.	・Re-training for the personnel in charge of creating the Passage Plan (2/O E) ・Re-training regarding handling of Abort Point procedure ・Re-training on how to handle feeling uneasiness regarding navigation ・Re-training for Master E regarding Safety Management Code				・Formulation of continued training and education for Crew
Engineering Technology and engineering Technological countermeasures					

	Man	Machine	Media	Management	
	The vessel, shipowner and ship management company	Mainly on the vessel	The vessel, shipowner and ship management company	On the vessel	Shipowner and ship management company
Enforcement Thorough guidance and enforcement Standardization, proceduralization, alerting, reward and punishment KYT, campagnes etc.	・Re-training for taking over from previous Master ・In particular, procedure manual compliance regarding the approval procedure of Passage Plans. ・Formulation of handling method (procedure) regarding the route check function of ECDIS		・Creation of Passage Plans using ECDIS and a procedure manual on how to utilize the route function	・Thorough compliance with the revised procedure manual	・Review of SMS procedure manual regarding creation, confirmation and approval of Passage Plans. (To include basic setting method of ECDIS) ・Guidance and completeness of revised procedure manual for all ships under management ・Enforcement of internal auditing
Examples Case studies, countermeasures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.					
Environment Working environment, office internal management, on-board organization, etc.					

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