

Causes behind Maritime Accidents (4M)

1. Man	2. Machine
<ol style="list-style-type: none"> 1 Psychological factors 2 Emotional factors 3 Organizational factors 4 Individual skill factors 5 Management of health and working environment 	<ol style="list-style-type: none"> 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
<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 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

<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Man</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Human factors that cause errors</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">The vessel, shipowner and ship management company</p>	<p>1 Psychological</p> <p>Impulsive action:</p> <ul style="list-style-type: none"> 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) <p>Forgetful:</p> <ul style="list-style-type: none"> Human beings are limited in that they cannot memorize everything (Human beings sometimes forget) <p>Habituation behaviour:</p> <ul style="list-style-type: none"> Bad habit. Human beings have moments of inattention <p>Personal problems:</p> <ul style="list-style-type: none"> Relationship between strength to resist stress and stress tolerance Unconscious acts: Human beings are sometimes careless Effects of the human mind that one is unable to control (Carl Gustav Jung) <p>Sense of urgency and sensitivity:</p> <ul style="list-style-type: none"> High ability to identify differences in sensory stimuli strength, and can identify factors that impair safety or life 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) 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) <p>Judgement based on speculation: subjective decision and wishful observation (Human beings sometimes make assumptions)</p> <ul style="list-style-type: none"> Confirmation bias and experience of success or failure influence subjective judgement and wishful observation <p>Mistakes and perceptual illusions:</p> <ul style="list-style-type: none"> Visual and auditory (Human beings sometimes do not notice and occasionally make mistakes) <p>Habituation phenomenon:</p> <ul style="list-style-type: none"> 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 <p>Personality:</p> <ul style="list-style-type: none"> Unsafe behaviour caused by individual characteristics Human beings sometimes become emotional, etc.. 	<p>2 Emotional</p> <p>Fatigue</p> <p>Lack of sleep</p> <p>Alcohol, medicine or disease</p> <p>Physical ability (sight, forearm strength, muscle strength and good reflexes)</p> <p>Ageing</p>	<p>3 Organizational</p> <p>Desire and willingness</p> <p>Leadership and teamwork</p> <p>Communication</p> <p>Commitment (responsible intervention)</p> <p>Ageing</p>	<p>4 Individual skills</p> <p>4-1 Inadequate knowledge</p> <p>Inadequate or inappropriate knowledge about the work to be carried out</p> <p>Work content not understood or misunderstood</p> <p>Lack of a sense of urgency and awareness</p> <p>Mistakes regarding work procedure and forgetfulness</p> <p>Lacks basic knowledge of the work</p> <p>4-2 Inadequate skills</p> <p>Unaccustomed to work, inexperienced, inadequate skills</p> <p>Not enough training</p> <p>The belief that the work done is satisfactory, when objectively it is inadequate</p> <p>4-3 Poor work ethic</p> <p>Not "ready" to work</p> <p>Intentionally dishonest regarding work, and breaks the rules</p> <p>Covers-up or tolerates dishonest work</p> <p>Protective wear not worn</p>	<p>5 Management of health and working environment</p> <p>Health check not implemented prior to working</p> <p>Tool box meeting was not implemented</p>
			<p>Example (1/3)</p>				


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

Example (2/3)

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

Example (3/3)

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 , write down a direct cause which was investigated based on the facts After , 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.	Work preparedness/adequate working conditions	Lack of information regarding work to be carried out	Inappropriate work method	Pod working environment	Inadequate work space	Inadequate management/organization	Inadequate/incomplete regulations and procedure manual	Inadequate safety management planning	Lack of education and training	Inadequate layout arrangement	Inadequate supervision of his/her subordinates	Inadequate layout arrangement	Inadequate safety management planning	Inadequate/incomplete regulations and procedure manual	Inadequate management/organization	Inadequate supervision of his/her subordinates	
1	Why did the 2/O not notice the image captured on ARPA?																
	Why did he think he could pass starboard to starboard?																
	Why did he think that the bearing of the other vessel was changing?																
	Why did he not continue checking?																
2	Why was low visibility not reported to the Master																
	Why did he not comply with the Safety Management Code?																
5	Why did the superintendent request that the vessel navigate with only one radar?																
	Why was the radar not repaired before port departure?																
6	Why did the Master approve navigation with only one radar?																
	Why did he not request that the radar be repaired prior to port departure?																
XX																	
XX																	

 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 Inadequate or inappropriate contents in ISM Code or SMS Manual

Example (3/3)

	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)	<p>The vessel, shipowner and ship management company</p> <ol style="list-style-type: none"> Why the did 2/O not notice the image captured on ARPA? (1- , , , and 4-1-) Why was low visibility not reported to the Master? (1- , , , , 2- and 3-) Why was navigation approved using only one radar? (1- , , , , 4 - 1- , , , , 4-2- and 4-3-) <p>Shipowner and ship management company</p> <ol style="list-style-type: none"> Why was it requested that the vessel navigate with only one radar? 	<ol style="list-style-type: none"> Why was No. 1 radar left out of order? (Re-examination necessary) 		<ol style="list-style-type: none"> Why was low visibility not reported to the Master? (2- and 6-) Why was navigation approved using only one radar? (1- , 2- , 3- and -3) 	<ol style="list-style-type: none"> Why was low visibility not reported to the Master? (2- and 6-) Why was it requested that the vessel navigate with only one radar?
Education Education and training Knowledge, skills, consciousness, being given information, etc.	<ul style="list-style-type: none"> Training in behaviour psychology Learn to notice things Education to reinforce habitually that optical illusions/errors and assumptions can cause a risky behaviour 			<ul style="list-style-type: none"> Thorough compliance with work procedure 	<ul style="list-style-type: none"> Thorough compliance with work procedure
Engineering Technology and engineering Engineering counter-measure		<ul style="list-style-type: none"> 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.				<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Thoroughly clarify procedures for low visibility in the procedure manual An important nautical auxiliary instrument was also out of order
Examples Case studies, counter-measures and rules Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.	<ul style="list-style-type: none"> Gain a sense of experience using navigation simulations, for example 				<ul style="list-style-type: none"> Implementation of navigational simulation training
Environment Working environment, office internal management, on-board organization, etc.				<ul style="list-style-type: none"> Formulate a procedure for internal company reporting 	<ul style="list-style-type: none"> 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 management company	On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/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, consciousness, being given information, etc..				<ul style="list-style-type: none"> Lack of risk awareness regarding the danger of navigating with a radar left out of order Education about important nautical instruments 	<ul style="list-style-type: none"> Lack of risk awareness regarding the danger of navigating with a radar left out of order Education about important nautical instruments
Engineering Technology and engineering Engineering counter-measure		<ul style="list-style-type: none"> 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..				<ul style="list-style-type: none"> Review Safety Management Code (handling important equipment) 	<ul style="list-style-type: none">
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 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 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 Pilot A Instructed vessel to steer to port side in order to head for Kobe Rokko Island East Waterway		Ship's course <293> at a speed of 13.8 kts						
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 Pilot A Started steering to port side while heading for Kobe Rokko Island East Waterway		Ship's course <294> at a speed of 13.8 kts						
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 Pilot A Half Ah'd Instructed Hard Port		Ship's course <297> at a speed of 13.8 kts						
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.	

