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The causes and prevention of human error contributing to maritime accidents in Tanzania

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THE CAUSES, AND PREVENTION OF HUMAN ERROR CONTRIBUTING TO MARITIME ACCIDENTS IN TANZANIA.

By

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in

MARITIME SAFETY AND ENVIRONMENTAL PROTECTION

1999.

DECLARATION

I certify that all material in this dissertation that is not my own work, has been identified, and that no material is included for which a degree has previously been conferred on me.

The content of this dissertation reflects my own views and not necessarily endorsed by the university.

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ABSTRACT

Title of Dissertation: The Causes and Prevention of Human Error contributing to maritime accidents in Tanzania.

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This dissertation investigates the causes and prevention of Human Error contributing to maritime accidents in Tanzania.

Chapter 1 lays out in general the contents of the whole dissertation by identifying procedures and approach to be used in every part of the dissertation.

Chapter 2 describes in detail the meaning of human and organisational error. First of all, it defines some basics of human error, how and why human error does occur and gives some examples.

Chapter 3 gives the development of maritime industry and legal framework as well as the history of maritime accidents in Tanzania, and the relevant statistics for the period from 1990 to 1998.

Chapter 4 is the heart of this dissertation; it provides more information and analysis of the causes of human error contributing to maritime accidents in Tanzania by considering scenario type of accidents. Event and causal factor analysis is derived in each scenario type of accident. Furthermore, human and organisational error influences surrounding the events are also derived.

Chapter 5 tells about the effects of maritime accidents in Tanzania. In this part, only the fire and explosion between MV Inzi and the Single Mooring Buoy at the outer anchorage in the port of Dar-Es-salaam will be investigated in detail.

Chapter 6 describes some techniques for the prevention or reduction of human error.

Chapter 7 deals with conclusions and recommendations. The first part of it concludes the discussion from chapter four. The second part of this chapter gives recommendations, which, if implemented, would ensure that the safety of ships, seafarers and passengers is guaranteed.

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List of Abbreviations

AHFT	Annotated human factors taxonomy
MCHF	Marine casualty human factors
MV	Marine vessel
HOE	Human and organisational error
MT	Marine Tanker
MS	Marine Steam
GRT	Gross registered tonnage
VHF	Very High Frequency
TRC	Tanzania Railways Corporation
SBM	Single Buoy Mooring
DPK	Dual Purpose Kerosene
THA	Tanzania Harbours Authority
TIPER	Tanzania Italian Petroleum Refinery
HTA	Hierarchical Task Analysis
TBA	Tabular Task Analysis
HAZOP	Hazard and Operability
HRA	Human Reliability Assessment
THERP	Technique for the human error prediction
ISM	International Safety Management Code
SOLAS	Safety of Life at Sea Convention
MARPOL	Marine Pollution Prevention Convention
COLREG	Collision Regulations
STCW	Training, Certification and Watch-keeping for Seafarers Convention
URT	United Republic of Tanzania
TSB	Transportation Safety Board of Canada
OCIMF	Oil Companies International Marine Forum

"All accidents are not just a single cause but a series of many things that didn't go right"

CHAPTER 1

Introduction

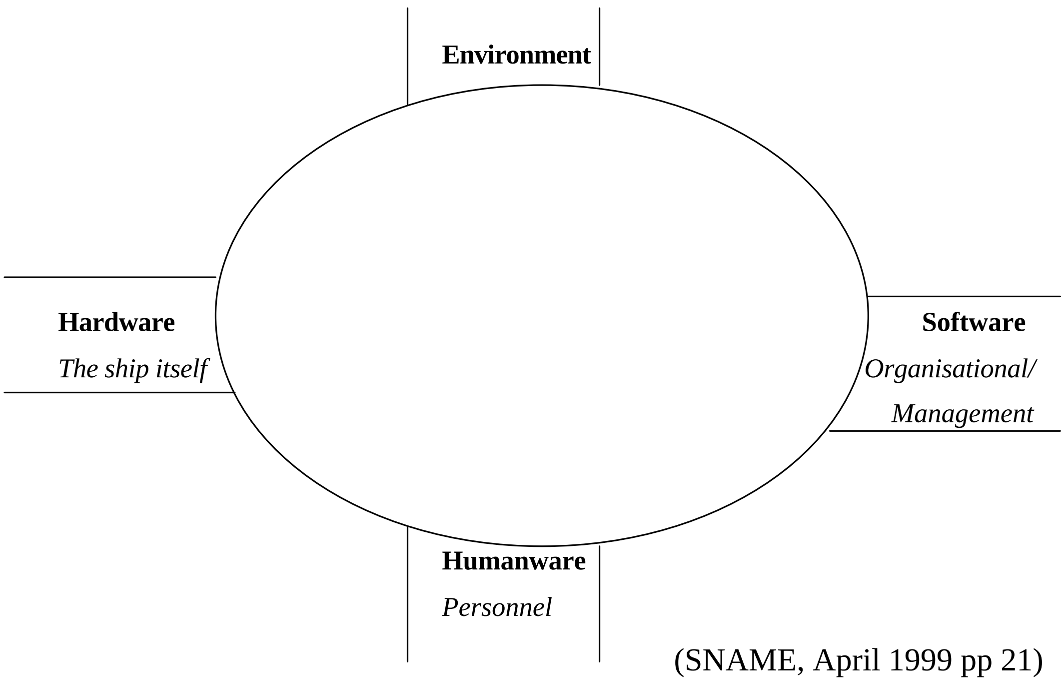
United Republic of Tanzania has a coastline of 800 kilometres, and is surrounded to the north, west and southeast with big lakes namely Lake Victoria, Lake Tanganyika and Lake Nyassa. With no or little awareness of a maritime safety or specifically ship safety (see fig.1.0), Tanzania has experienced minor and major accidents at different times. These accidents occurred from various areas such as the pressures on the seafarers to achieve fast turnaround at the berth, the authoritarian social structure that belied the interdependence and complexity of the operator interactions and the system itself, the structure of the marine insurance, the difficulties of the national and international regulations implementation, all combined to make maritime accidents in Tanzania highly probable and almost unavoidable.

This report will look deeper into three scenario type of accidents in order to identify and analyze histories of major maritime in Tanzania whose root causes were due to human error. This will include the development of a classification framework for systematically characterizing human errors.
Basically, casualties involve the individuals antecedant, and compounding events and factors. Casualties involve individuals (humans) directly involved in the activity or activities, the organizations that influence the individuals, the procedures (software, manuals of practise) that the individuals use to conduct their activities.

Historically, high consequence marine casualties have had a substantial impact upon the development of rules, regulations, and requirements for marine safety. However, the industry has generally been reactive and not proactive in developing tools necessary to ensure marine safety. Many casualties have very similar antecedents that could be either prevented or mitigated before catastrophic events occur.

The analyses of cases studies have shown that many casualties are the result of operators not complying with rules and regulations. Other case studies have shown that even with the unique circumstances surrounding their occurences, there were significant human errors contributing to maritime accidents that could either prevented or substantially mitigated. Finally, "All accidents are not just a single cause but a series of many things that didn't go just right" (BIMCO vol. 94-No 1-99 pp21).

Figure 1.0: Elements of ship safety



(SNAME, April 1999 pp 21)

CHAPTER 2

What is human and organisational error?

Human and organisational error may occur in many ways. Error is defined as all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome or simply a failure on the part of human being to carry out an intended task. In law, an intent is deliberate or knowledge with appreciation of consequence.

Any accident, not just a marine casualty, is any unintended or unexpected occurrence, which produces hurt or loss. An accident is usually the result of set a of successive human failings coinciding with other external elements at a moment of system vulnerability. It is human error, whatever that means that is the major cause of most accidents. But also, there is another term frequently used, which is called human "factors". So, why the "human factors"; what is it; and who are these humans that, in too many cases, are responsible for human tragedy or catastrophic pollution or huge expense to shipowners? Human "factors" is the study of human behaviour and performance or simply it looks on why human being cannot carry out intended task. It is often difficult to differentiate between human error, procedural and mechanical systems or ship failure when analysing a marine accident. " There is a sense in which this distinction is artificial. Most instances of ship failure are themselves the result of prior human errors, occasionally in judgements as to the design of the ship or the suitability of materials used in its construction, but more frequently in the process of planning or implementing programmes of maintenance". It is convenient to blame accidents on the people who suffer them and to see unsafe acts arising from incompetence, recklessness, carelessness or stupidity of the ship operator. Rather than being the main instigator of an accident, operators tend to be the inheritors of systems defects created by poor design, incorrect installation, faulty maintenance and bad judgement management decisions. Their part is usually that of adding the final garnish to lethal brew whose ingredients have been already long in the cooking.

Consideration of human factors is important in any elements, but particularly in hazard/low risk industries where accidents can impact upon third parties and general public: such as shipping oil, dangerous goods and passengers. In considering the human contribution to systems disasters, it is important to distinguish two kinds of error: active errors, whose effects are felt almost immediately, and latent errors whose effects may lie dormant within the system for a long time. Active errors arise from the interaction of individuals with the system that is being operated and the environment. Active errors can be seen as those actions taken by a ship's crew, immediately before and at the time of the incident.

In marine accidents, active elements relate to the decision process that leads to "unsafe acts", either in commission or by omission by those people present on the ship at the time of the accident. It is these "unsafe acts" that so often are seen as immediate cause or proximate cause, upon which issues of liability or blame may hinge. Under unsafe acts there are two actions types which are unintentional or intentional action (James Reason, 1995).

2.1. **Unintentional action**

Unintentional actions are actions that do not go as planned; these are errors in execution. Unintentional actions go with the following basic types of errors that are slip and lapse.

2.1.1. **Slip**

The failure involves attention. These are errors in execution.

2.1.2. **Lapse**

The failure involves memory. These are errors in execution.

2.2. Intentional action

Intentional actions are actions that are carried out as planned but the actions are inappropriate; these are errors in planning. Intentional actions go with the following basic types of errors that are mistake and adaptation.

2.2.1. Mistake

The failure involves no deliberation decision to act against a rule or plan. These are errors in planning.

2.2.2. Violation

Is a planning failure where a deliberate decision to act against a rule or plan has been made. Routine violation occur, as people regularly modify or do not strictly comply with work procedures, often because of poorly designed or defined work practises. In contrast, an exceptional violations tends to be a one-time breach of a work practise, such as that which occurred at the Chernobyl site where safety regulations were deliberately ignored and a safety test was carried on too far. However, the goal was not to commit a malevolent act but actually to improve system safety.

There are three performance levels on which these basic errors would occur, and they establish how was one performing at the time of failure? These performance levels are; skilled-based performance, rule-based performance, and knowledge-based performance (TSB, February 1997).

2.3. Skill based performance

Slips and lapses occur during this level whereby actions tend to be based on stored routines and there is little, if any, conscious decision-making. In this level there are two kinds of failure modes of which are inattention and over-attention. Inattention involves the failure to pay attention to an activity on progress. Over-attention is to focus all your attention to one point and fail to pay attention to other things in the action sequence. Each of the failure modes has the following specific failure modes.

Inattention

- Capture error
- Description error
- Omission following interruptions
- Reduced intentionality
- Mode error
- Perceptual confusion

Further details of these errors are given in appendix 1.

Under Over-attention the following is a list of specific failure modes.

Over-attention

- Omission
- Repetition
- Reversals

Descriptions of these errors and examples are given in Appendix 2.

2.4. **Rule based performance**

Mistakes are involved in this level where decision is based on learned procedures. This rule-based level of performance is particularly applicable when making familiar decisions; stored rules of the type "if this condition is seen" then "this action should be taken" are employed. Errors would typically be associated with either the misclassification of the "if this condition" which could lead to an incorrect "action", or just merely the use of an incorrect "action". These classes of failure modes have labelled as the Misapplication of Good Rules (Plans) and Application of Bad Rules (Plans), respectively. There has been some confusion regarding the term rule-based, in that, it has been incorrectly viewed as only pertaining to formal rule systems, such as federal/provincial laws, industrial regulations or standard operating procedures. While these are important sources of rules, the term rule-based simply means that a plan, either formal or informal, had been previously developed and then be used. To avoid such confusion, it may be more useful to think in terms of plan-based performance. Each failure mode has the following specific failure modes:

2.4.1 Misapplication of Good Rules (Plans)

- Rule strength
- General rules
- Information overload
- First exceptions
- Rigidity

Descriptions of these errors and examples are given in Appendix 3.

2.4.2. Application of Bad Rules (Plans)

- Wrong rules
- Inelegant rules
- Inadvisable rules

The descriptions of these errors are given in Appendix 4.

2.5 **Knowledge based performance**

Mistakes and violations occur during this level where decisions are based on knowledge and experiences (no set of procedures) which necessitate evaluation. This may occur also in problem solving when no rules apply to given situations; new solutions or plans must be formulated. An error that occurs during the formulation of the solutions or plans falls within knowledge-based performance. In this level there are two kinds of failure modes; bias and heuristic respectively. Each failure mode has got the following specific failure modes.

2.5.1 Bias

A bias is the tendency to apply a certain response regardless of the situation.

- Confirmation bias
- Salience bias
- Framing bias
- Overconfidence

Descriptions of these errors and examples are given in Appendix 5.

2.5.2 Heuristic

We often resort to the use of heuristics or "mental rules of thumb" that help us to diagnose problems without expending too much mental effort and thus too much time. Often, these heuristics serve us well; however, they are shortcuts and as such we may be short-changing ourselves of adequate and accurate information. Rather than processing all available information and following reasoning to its most probable and logical end, the taking of a shortcut may give us a false understanding of the actual situation. In this category we have the following kinds of errors:

- Representative heuristic
- Availability heuristic
- "As if" heuristic

Descriptions of these errors and examples are given in Appendix 6.

2.6 **Basis of human and organisational error taxonomy**

The primary basis for the human and organisational error classification is the United State Coast Guard Annotated human factors taxonomy (AHFT) and the marine casualty human factors supplement (MCHF). As shown in figure 2.0, the AHFT differentiates errors into states and actions. The states include incentives and motivation of the organisation and operating crews, the operating environment and situations, as well as information and communications. Error actions include active errors initiated by the operating crews. These active errors are lapses and slips, mistakes and violations. All active errors can be categorised as unsafe acts. The following is a presentation of the general marine operations human and organisational error classification and their descriptions. As shown in the figure 2.1, The AHFT sources lead to the error classification.

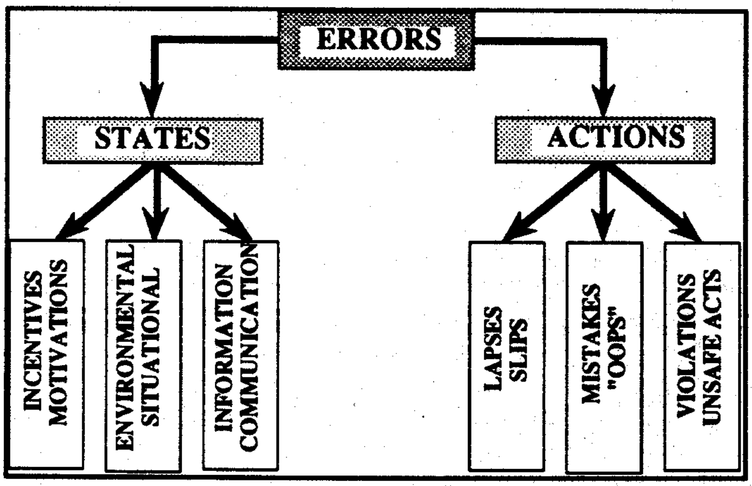


Figure 2.0 General AHFT error breakdown (Moore and Bea, HOE-1993)

2.6.1 **Commitment to safety**

The level of commitment of the available resources (money and experts) determines Commitment to safety and cognisance of potential problems to the safety of the operational system from top-level managers to front-line operating crews. Commitment to safety encompasses human, organisations and regulatory bodies. There is a distinction between commitment to safety and resources applied to the system. There can a commitment to safety, but insufficient resources, expertise and cognisance to obtain higher levels of safety, which has the effect of neutralising the commitment to safety.

2.6.2. **Resources**

Resources pertain to money and expertise used to heighten operational safety. Commitments of resources encompass human tasks and performance, organisations and regulatory bodies. There may be sufficient resources, yet little or no commitment to safety at various levels of the organisation or by front lines crews. This also has an effect of neutralising the expected commitment to safety.

2.6.3. **Human system interface**

Encompasses failures and shortcomings of human action resulting from inaccurate or insufficient response to control systems and control system display.

Human/system interface problems will be addressed particularly between the front line operators and the system during normal and crisis situations.

2.6.4. **Knowledge/experience/training**

Pertains to human or organisational failures and shortfalls resulting from insufficient or improper knowledge, experience, or training of the system under normal or extreme operating conditions. Knowledge, experience, and training are particular issues concerning the organisations, management, and front-line operating crews responsibility of ensuring sufficient job tasks and performance level during normal and crisis situations.

2.6.5. **Maintenance**

Refers to the impact on ship or platform operations as a result of improper, insufficient, or a failure to conduct adequate maintenance, which is important to the day-to-day (normal operating systems) and extreme operating environments (safety and emergency operating systems). Maintenance is regarded to be the responsibility of the operating organisation.

2.6.6. **Physical/mental lapses (including slips or mistakes)**

This pertains to mental lapses, attention failures, memory failures, and rule-based mistakes, which cause or contribute to failed or inadequately manned functions or performances under normal or extreme operating conditions. The examination of physical and mental lapses, slips, and mistakes are for front line crew whose tasks and job performance are inhibited during normal and crisis situations.

2.6.7. **Violations**

Refers to intended unsafe acts such as routine and exceptional violations or acts of sabotage. Violations are addressed with regard to the front-line operating crews, the organisations who potentially influence the decisions and actions of the crews, and the regulatory bodies, which establish the guidelines for operations policies and procedures.

2.6.8 **Morale/incentives**

Morale refers to individual behavioural attributes that decrease the willingness, commitment and thoroughness in which individuals will conduct assigned tasks and functions. Incentives pertain to the differences in goals and preferences at different levels in the organisation, which lead to inadequately manned functions or performances. This examination addresses the morale and incentives of the front-line operating crews, the organisations who potentially influence the decisions and actions of the crews, and the regulatory bodies, which establish the guidelines for operational policies and procedures.

2.6.9. **Job design**

This encompasses the inappropriate match of personnel characteristics with job, task or role requirements, or inadequate job descriptions that cause and contributes to failed or inadequately manned functions and performance. Job design applies to the inappropriate match of individuals, the operational policies or procedures leading to inappropriate of personnel, and regulatory policies, which contribute to an accident scenario.

2.6.10 **Regulating/policing**

Refers to insufficient, inaccurate regulatory and policy making system or failure of organisations and regulatory bodies in continually maintaining or monitoring integrity and reliability of the operating system. Regulating and policing addresses the insufficient active participation of the organisation or regulatory body in maintaining the safety of the operating system.

2.6.11. **Operating policy**

Pertains to the organisation policies and procedures from top level to front-line which are conducive to the implementation of the safety of the operating system.

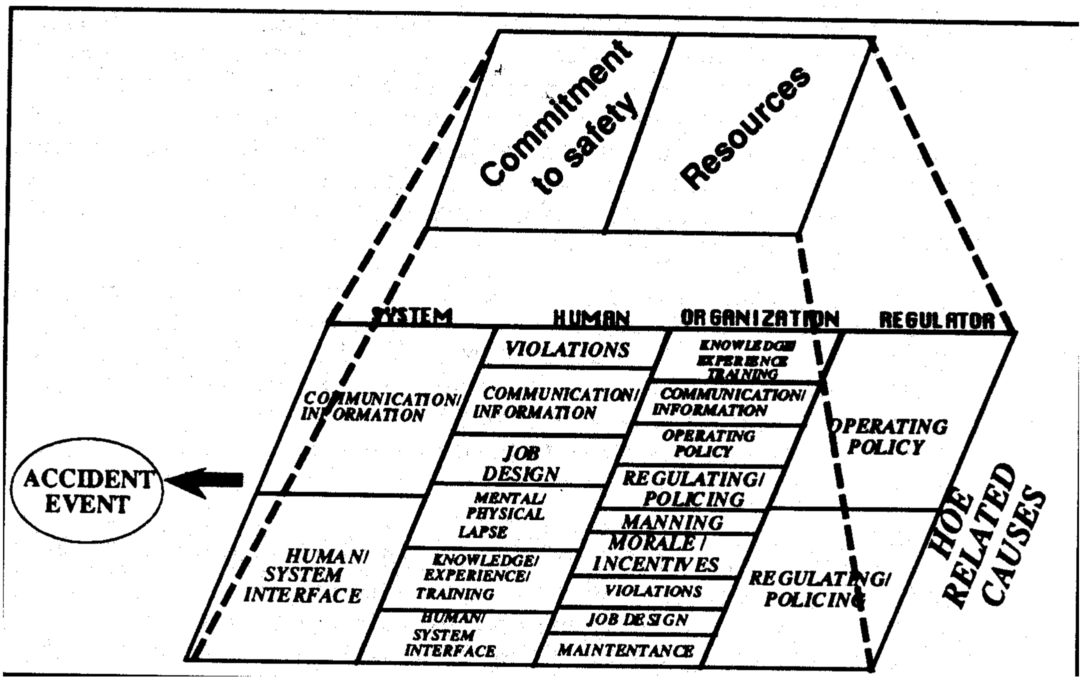
2.6.12. **Communication/information**

Refers to the incorrect, incomplete, or failure of the transfer of information between individuals, organisations, regulators and system, which inhibit the safety of the operating system. Insufficient communication and transfer of information can be between human and system, or between individuals and parties on the organisational and regulatory level (i.e. top-level management, middle management, and operators).

2.6.13**. Manning**

This embodies the inadequate manning (expertise or number of individuals) required that causes or contributes to failed or inadequately manned function or performance of the operational system. Manning decisions are maintained at the organisational and regulatory levels.

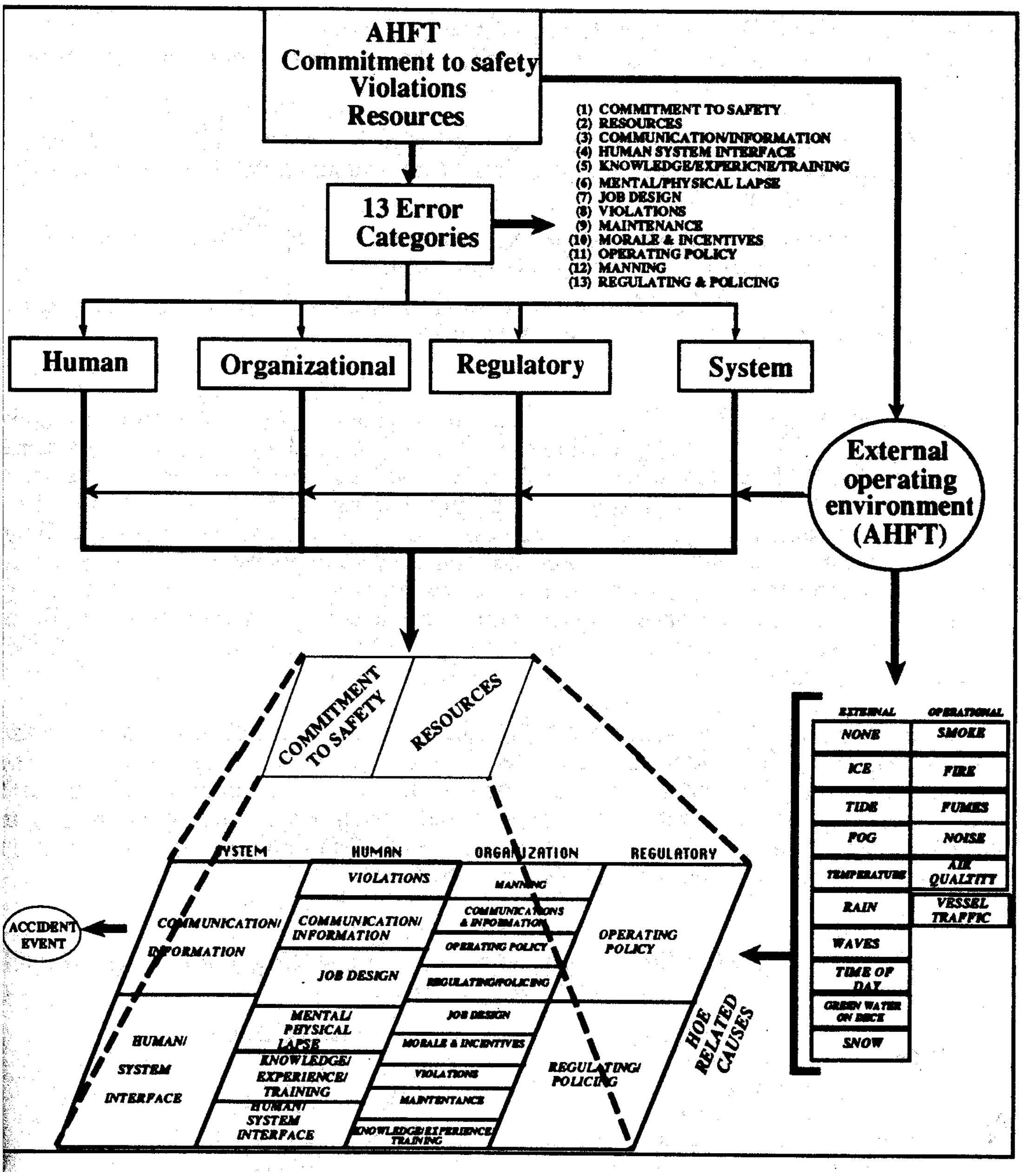
Figure 2.1- human and organisational error classification, (Moore and Bea, HOE 1993).



2.7. The external Operating Environment

AHFT makes a distinction between error states and actions (see figure 2.0) which contribute to accident scenario. As shown to figure 2.2, the HOE classification a further distinction between operating conditions (man-made or environment) and error causes. The reason for this distinction is eventually examine the effects of external operating environment on error events and causes at the various stages in an accident sequence (see figure 2.3). Table 1.0 displays the categories of the external-operating environment, which are differentiated into external and operational factors. Operational factors are specific to the operating environment. The external operating environment may contribute to event decisions, actions, or human errors. External factors pertain to the external environment (e.g. cold, snow, ice, etc).

Figure 2.2- Breakdown of AHFT taxonomy (Moore and Bea, HOE-1993)



2.8 Underlying, Direct and Compounding Errors

There are three stages of contributing causes to accident scenarios:

- **Underlying/contributing causes**

Represent latent errors in technology, organisational management, regulation, and immediate underlying causes for the specific error events.

- **Direct causes**

  Is accident initiating errors (active errors) by front-line crews, which directly effect the primary accident event?

- **Compounding causes**

  Latent errors in organisations, regulations or technological systems are those which enhance the causal factors.

2.9 Events and Causal Factors Analysis

This is another technique for analysing the accident. Events and causal factors analysis is used to:

- Organize the accident data
- Develop the investigation
- Validate findings, probable causes, and contributing factors
- Validate the accident sequence
- Organize the investigation report
- Clarify and illustrate the investigation report

2.9.1 Understanding Events and Conditions

- Provides the investigator with true a complete understanding of the accident
- Allows the investigator to identify the root cause of the accident
- Identify areas where meaningful safety recommendations may be made

2.9.1.1 **Understanding Events**

Events occur in sequential time order leading up to the accident, itself.

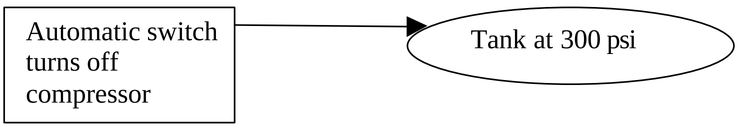
2.9.1.1.1 Criteria for Events Description

- Events should describe an occurrence, not a condition

- Events should be described with one subject and one active verb in the present tense
- An event should be precisely described (provide time, if possible)
- Events should describe only one discreet occurrence
- Events should be quantified when possible
- Events should be based on valid evidence
- Events should range from the beginning to the end of an accident sequence
- Each event should be derived from the one preceding it

2.9.1.2 Understanding Conditions

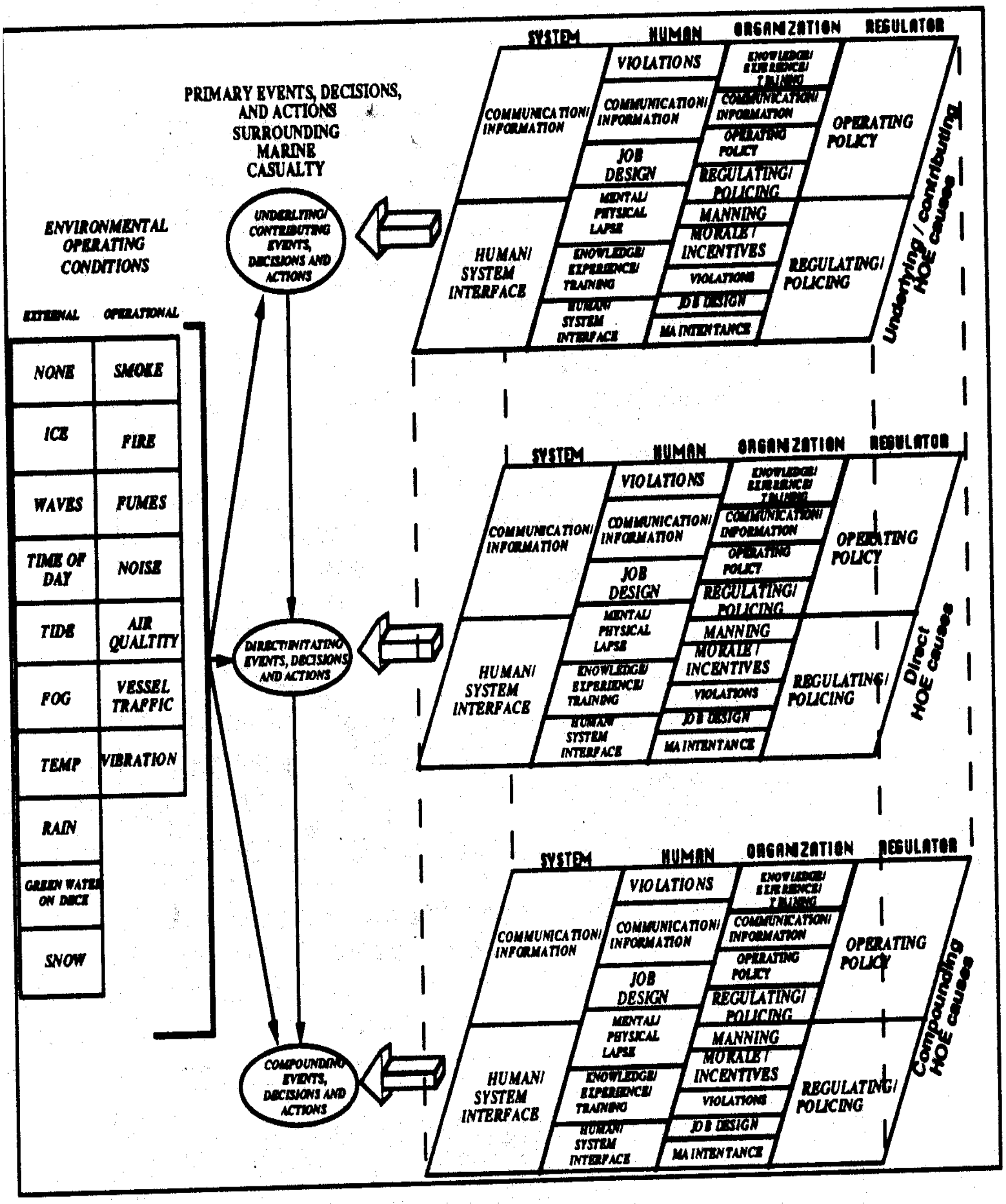
- Conditions express a state of being
- Conditions result from events



<u>Table 1.0. Classification of environmental operating conditions which contribute to HOE.</u>

External	**Operational**
Ice	Smoke
Waves	Fire
Time of day	Fumes
Tide	Noise
Fog	Air quality
Temperature	Vessel traffic
Rain	Vibration
Green water on deck	
Snow	
Wind.	

Figure 2.3- Influence of HOEs and operating environments on marine casualty events, decisions and actions.



(Moore and Bea, HOE-1993).

2.10 How does human error contribute to maritime accidents?

Accidents may be viewed as events with many causes. In case of an oil spill, it is rare that a single cause results in an oil spill or a tiny welding sparks fire develops a devastating catastrophe, which can cost millions of dollar damages. Chains of events are characteristic, with errors compounding until a spill event occurs or failure to put off fire as result of fire hoses wrongly connected from the fire mains, no water in the pipes system. As example, the oil spill has many error combinations, which combine the following contributing causes, leading to an equipment failure as an initiating event, and the absence of a mitigating factor:

a. faulty gasket not checked
b. pressure is brought up too quickly,
c. a failed gasket results,
d. scuppers have been left open

The spill result is oil leaking from the transfer line, and flowing through the scuppers into a containment boom. In this case the actual spill event (the initiating event) is the gasket failure, however a check of the gasket might have revealed the faulty or a slow build up of pressure could have revealed the leak at low pressure. Plugged scuppers would have contained the spill to the deck, instead they are open and may be considered a compounding factor. Were the vessel not boomed off (a mitigating factor), the effect and cost of the spill could be greater.

Thus spills are the product of errors. In the above example, absence of contributing causes "a or b" would not have resulted in a spill, and presence of the mitigating factor "c" would have limited this event to a deck spill. A conventional, engineering-oriented investigation would reveal the faulty gasket and list it as the spill cause. This is incorrect: the faulty gasket is only a contributing cause. The three preceding events could have human and organisational error roots. The scuppers may have been open for one or more of the following reasons:

- the operator forgot to plug them (human)
- because cold impaired his judgement (environment)

- a deck box was placed to block the operator's view of the single open scupper (system)
- the scupper plugs had been lost and the request for replacements delayed (organisational)
- the operator was rushed to commence the operation (organisation)

These are only hypothetical cases, but they demonstrate the range and complexity of errors that may classified as "human error". So errors which come from several sources such as environment, procedures, organisation may be reduced by increased vigilance and awareness of safety rules. Such vigilance, however, is most likely to reduce individual human error by increased attention to procedures and placing more responsibility upon individuals. Phrased differently, vigilance will reduce mistakes. Vigilance cannot address organisational error, error produced by systematic interactions between operational or organisational components. Organisational error is also more complex than individual sources of error, making it harder to correct if found. System errors may be foreseeable, but may be equally difficult to change. Thus there is reasonable doubt to believe that only the easiest and most obvious changes have been made, that the industry has "sucked in its gut" and tightened up operational procedures. This is not an accusation, only a reflection of the difficulty identifying and correcting system and organisational problems. Analysis of human error may identify previously unidentified problems in human, organisational, and system areas.

CHAPTER 3

Tanzania Maritime Industry background

Tanzania has a coastline of about 850 kilometres. The coast is mainly unsheltered and exposed to the Indian Ocean. In addition to the off-lying islands of Pemba, Zanzibar, and Mafia, there are hundreds of coral reefs and smaller islands scattered along Tanzania coast. The country also has inland waterways, the largest of these is Lake Victoria, which is the size of Belgium, and Lake Tanganyika and Lake Nyassa are the two other major inland waterways.

For thousands of years, Tanzania has come about because of the necessity for transport both along the coast and the lakes. However, the Indian and Arabian cargo-carrying dhows have also contributed to a seafaring tradition along the Tanzania coast and this is still apparent today. The bigger, engine powered, cargo and passenger vessels calling at Tanzania ports were all operated and owned by foreign companies.

3.1 Smaller crafts of the Tanzanian fleet

The present Tanzania fleet consists of a large of traditional smaller craft. There are about 3500 fishing vessels along the coast, whilst about 14500 such vessels harvest the resources of the inland lakes. 113 dhows are used in passenger and cargo transport in the coast. In addition to these craft, there are a number of smaller ferries, harbour and naval vessels that constitute an important part of Tanzanian seaborne activities.

3.2 Bigger vessels of the Tanzania fleets

The vessels of above 50 gross tons represent the main contributors in maritime accidents. There are at present about 100 ships with tonnage of 50 registered tons or more in the Tanzania fleet. The total tonnage of this fleet is 42870 tons with an average size of 429. The total tonnage of Tanzania fleet is decreasing compared to the total tonnage in the 1980s when 55,738 tons with average vessel size of 743 tons were registered. The reasons for this development among other things, were poor economy of the country, but most shipping company ran into severe economic problems, and as a result ships were sold or grounded indefinitely.

3.3 **Legal Framework**

In 1967, the United Republic of Tanzania put into place the Merchant Shipping Act that was derived from the then East African Merchant Shipping Act of 1966 which was derived from the British Merchant Shipping Act. This gave authority to the Minister of Transport and the power of General Superintendent on all matters relating to merchant shipping in the country. In the early 1970, the Minister of Transport appointed the Director of Shipping for the purpose of exercising or discharging the powers, authority or duties conferred or imposed upon the Directory by or under the Merchant Shipping Act of 1967. The functions of the Director of Shipping were:

1. General superintendence and co-ordination
2. Registrations of ships and related functions
3. Surveys, inspections and certification of ships
4. Inspections and detention of ships.
5. The conducting of examinations leading to, and issuance of appropriate certificate of competence and/or proficiency to various seafaring personnel.
6. Conducting of inquiries/investigations into shipping causalities.
7. Dealing with matters pertaining to prevention/control/combat of marine pollution.
8. Dealing with manning with ships.
9. Dealing with crew matters and
10. Any other duties delegated to him by the Minister responsible for the Transport.

Besides the Merchant Shipping Act, there are laws, which are closely related to Maritime activities such as:

1. East African Inland water Transport Act of 1959.
2. The ferries ordinances Cap of 1929
3. Administrative matters related to ferries.
4. The Inland Waters Transport Ordinance Cap 172 of 1938, which covers Great Lakes and rivers.
5. The Zanzibar laws

3.4. **Short descriptions of Maritime Accidents in Tanzania**

Existing maritime accident statistics in Tanzania that occurred in the period between 1990 to 1998 present the effects of marine causalities (loss of life, discharge of hydrocarbons, economic loss, etc). These accidents present information on active errors that may have immediately caused those accidents. The following are summaries of maritime accidents of Tanzanian vessels in the period between 1990 to 1998:

1. Tanker vessel M.T Uhuru and passenger vessel MS Mtwara collided on 30th June 1990 west of Tumbatu Island, Zanzibar. As result of the collision, the MS Mtwara sank shortly afterwards in some 60 metres of water with loss of 12 lives.
2. The wagon ferry M.V.Umoja ran aground on 19th October 1991 at the east of Chererenche Island in Lake Victoria. The vessel sustained severe damages on her stern and fore bottom plating.
3. On 15th May 1993, a car with passengers plunged into the sea after overshooting the ferry on Kigamboni side of the harbour channel in Dar-Es-salaam. In that incident four people died.
4. On 25th December 1996, soon after 0930 hours, the tugboat MV Inzi and Single Buoy Mooring caught fire at Mjimwema, Dar-Es-salaam. Following to these four people died.
5. On 26th May 1992, a native vessel MV Saffnat Khairiya sank in Kenyan waters. There were scores of people known to have been drowned but their number is unknown.

6. The vessel MV Umoja on 31th March, 1998, when manoeuvring at Mwanza north port for fuelling, hit the pier and sustained damages at the bow.
7. The passenger vessel Ses 1 Kitmeer on 16th April 1997 collided with a native vessel MV Imani at the port of Dar-Es-salaam.
8. The passenger vessel MV Flying Horse on 4th September 1996 grounded after striking an object at the entrance of the port of Dar-Es-salaam.
9. On 21st May 1996 at around 0730 hours while the passenger ship was approaching Mwanza from Bukoba via Kemondo bay, she capsized and later sank completely at 1550 hours. It was estimated that more than 600 people died.

3.5 Maritime accidents statistics from 1990 to 1998

The following are details on occurrences and vessels involved.

In table 02, Collision was reported to be a major type of accident from 1990 to 1998 that accounted about four compared to grounding which accounted three.

The followings are the definitions of terms to be used in the table:

1. Marine occurence means any accident or incident associated with the operation on a ship.
2. Collision is an impact between two or more vessels underway.
3. Capsizing is to turn over.
4. Foundering is to fill from above the waterline and sinking.
5. Sinking is to become submerged from water intake below the waterline and settle to the bottom.
6. Fire is the first event reported.
7. Explosion is the first event reported.
8. Striking is a hard impact with a stationary object or a vessel not underway.
9. Other that is a car falling overboard from ferry.

Table 2.0 Shipping Accidents of Tanzanian Registered Vessels

Accidents by type of:

Accident by Type	'90	'91	'92	'93	'94	'95	'96	'97	'98	Total
Collision	2	0	0	0	0	0	0	2	0	4
Capsizing	0	0	0	0	0	0	1	0	0	1
Foundering	0	0	1	0	0	0	0	0	0	1
Grounding	0	1	0	0	0	0	0	1	1	3
Striking	0	0	0	0	0	0	1	0	1	2
Fire	0	0	0	0	0	0	1	0	0	1
Other	0	0	0	1	0	0	0	0	0	1
										13

"He who is pregnant with errors, conceives trouble which gives birth to disaster".

The author

CHAPTER 4

Causes of Human Error in Tanzania

The sources of a majority of marine accidents in Tanzania can be attributed to compound human and organisational errors. Human errors originate from factors such as inattention or carelessness, inadequate training and testing (knowledge), wishful thinking, negligence, forgetfulness, and physical limitations (e.g. fatigue, seasickness). These errors are magnified and compounded in times of stress and panic. They can also be exacerbated by poor engineering structures, which invites errors.

Operational failures occur as a result of the willingness of an organisational or individual to take a calculated risk. Failures also occur as result of errors or bad decisions, most of which can be traced back to organisational malfunctions. For example, the goals set by the organisation lead rational individuals to make decisions and perform actions in a manner that the corporate management would not approve if they were aware of their implications for reliability. Similarly, corporate management, under pressure to reduce cost and maintain schedules, may not provide the necessary resources required safe operations. The decision-making ability of an organisation affects its reliability and ability to operate safely. Generally, two classes of problems face an organisation in making collective decisions that result from sequences of individual decisions. Information problems (who knows what? And when?), and incentive problems (how are individuals rewarded, what decision criteria do they use, how do these criteria fit the overall objectives of the organisation?).

In order to identify the causes of human error in Tanzania, we have to study three scenarios type of accidents which are:

- Collision.
- Capsize.
- Fire/or Explosion.

4.1 Collision between Tanker vessel MT UHURU and Passenger vessel MS MTWARA

On the 30th June 1990 at approximately 0050 GMT the passenger cargo vessel ”MTWARA”, proceeding from the port of Tanga, and the Tanker ”UHURU” proceeding from Zanzibar to the Port of Wesha, Pemba, collided at an approximate position of latitude 5° 48.1' south, longitude 39° 10.9' East

(Approximately 1.5 nautical miles West of Tumbatu Island, Zanzibar). As result of the collision, the MS MTWARA sank shortly afterwards in some 60 metres of water with the loss of 12 lives.

4.1.1 Description of voyage of MT UHURU

On 29.06.1990, MT Uhuru was proceeding from Oil Terminal at Mtoni to the Oil Terminal at Wesha, Chakechake, Pemba, with metric tonnes of product, which included 203 metric tonnes of Premium motor spirit. A crew of 18 persons was on board. She sailed from Mtoni Oil Terminal on 29.6.1990 at 2230 EAT and proceeded on a course of 348° to Mangapwani Light house.

Immediately after the ship left Zanzibar, the captain went to rest to his cabin, and left the bridge under the command of the apprentice who had no certificate of competency. The Radio officer was at the radio the moment after the ship left the port but he also went to rest to his cabin. Soon after that a lookout spotted a white light in front of the ship, he reported the matter to the apprentice who was on the bridge. The apprentice on watch altered the course to 5° to port. Five minutes later he altered a further 20° to portside and collided with MS Mtwara.

4.1.2 Description of voyage of MS Mtwara

The ship was proceeding to Zanzibar from the port of Tanga with amixed cargo of cement, containers and motor vehicles. She sailed from Tanga at 1730 EAT on 29.06.1990 and arrived off Mwana wa Mwana Lighthouse, Zanzibar at approximately 0020 EAT on 30.06.1990. When the ship was sailing from Tanga, the captain was on the bridge until after passing through the channel when he handed over duty to the chief officer. The captain gave instructions both oraly and in writing that he should be awakening when Mwana wa Mwana Lighthouse was abeam.

At 2000 EAT, the chief officer handed over to an apprentice who had no certificate of competency. He too was given instructions that he should wake up the captain when the ship reached Mwana wa Mwana Lighthouse.

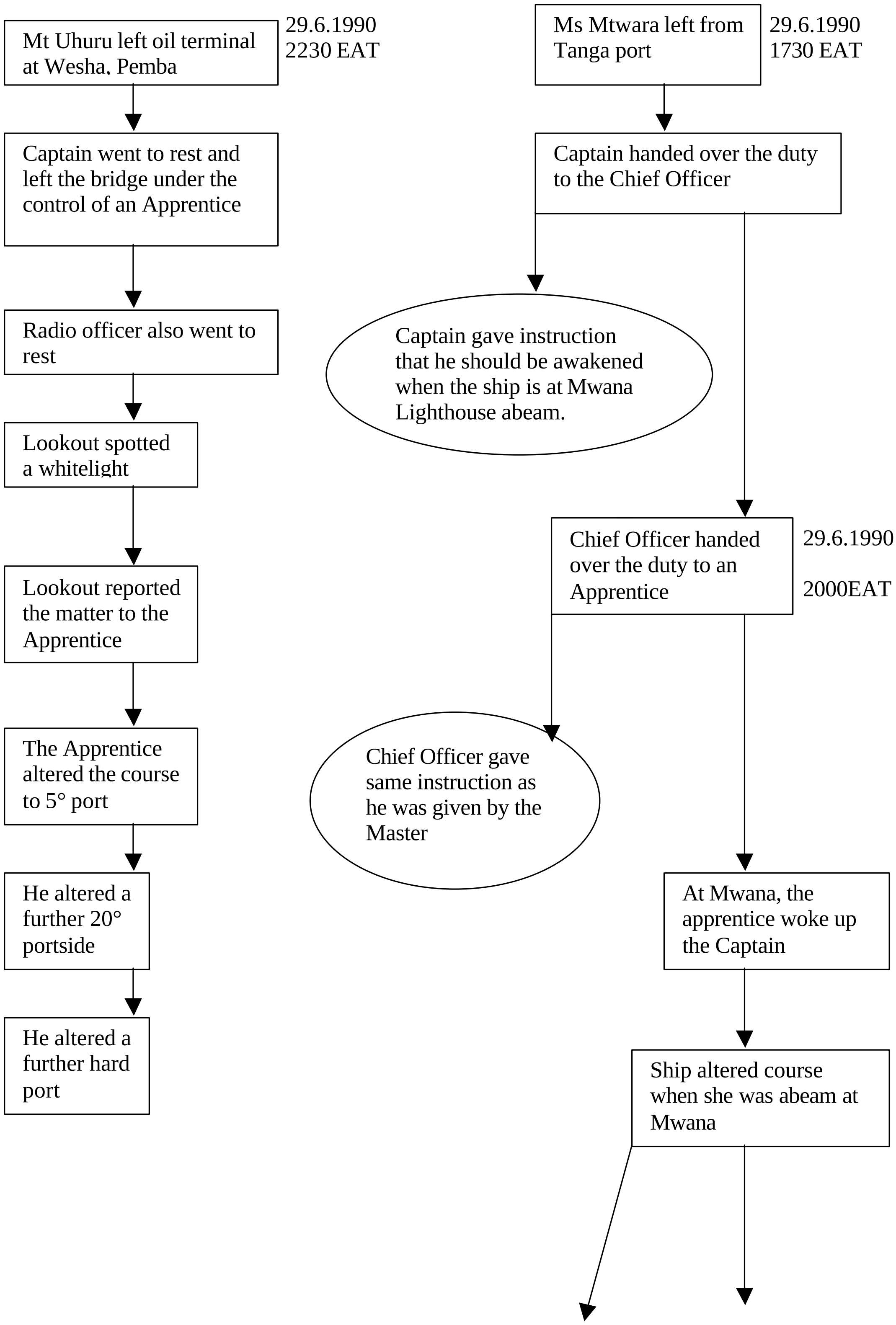
When the ship reached Mwana wa Mwana Lighthouse, an apprentice woke the captain. The captain took command of the ship and the apprentice was assisting him. The ship altered course when she was abeam of Mwana wa Mwana Lighthouse. She was on the autopilot. When the captain took position, he discerned that the Mwana wa Mwana Lighthouse was about one and a half miles off. He altered course 190°(Gyro). The Captain talked to signal station at 0025 EAT Zanzibar to tell them that MS Mtwara was approaching the Zanzibar channel from the north. The ship was going ahead at full speed of 8 to 9 knots. The signal station failed to mention that MT Uhuru had left Mtoni Terminal Zanzibar for Pemba at 2230 EAT.

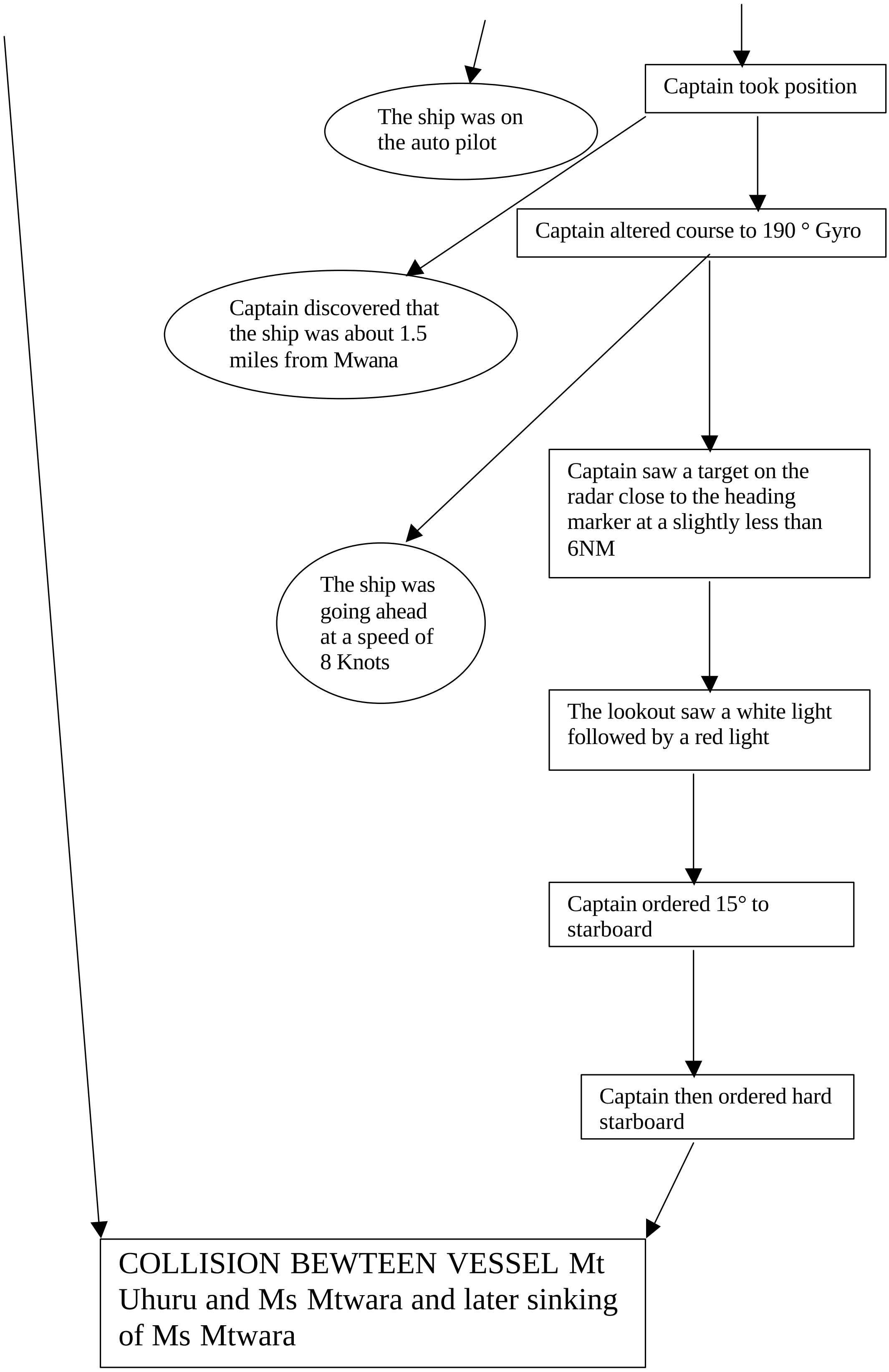
After the captain changed the course, he saw a target on the radar close to the heading marker at a range slightly less than 6 nautical miles. Soon afterwards, the lookout saw a white light followed by a red light. This was interpreted to be a dangerous cargo carrier ahead. Then the captain ordered a 15° to starboard. After a few minutes the captain ordered hard starboard.

4.1.3. The accident

Just before collision both captains discovered that the collision was unavoidable. MT Uhuru turned hard to port and MS Mtwara turned hard to starboard, with the intention of avoiding a collision. Both ships ended up on the west side of their intended courses. The MT Uhuru hit the MS Mtwara just aft of the portside door at the tween deck level. A few minutes later MT Uhuru substantial damage but did not sink.

(Chart 1.0) Events and Causal Factors Analysis of the collision between tanker vessel Mt Uhuru and Passenger vessel Ms Mtwara





The ship was on the auto pilot
Captain took position
Captain altered course to 190 ° Gyro
Captain discovered that the ship was about 1.5 miles from Mwana
Captain saw a target on the radar close to the heading marker at a slightly less than 6NM
The ship was going ahead at a speed of 8 Knots
The lookout saw a white light followed by a red light
Captain ordered 15° to starboard
Captain then ordered hard starboard
COLLISION BEWTEEN VESSEL Mt Uhuru and Ms Mtwara and later sinking of Ms Mtwara

4.1.4. Human and Organisational error influences on the events surrounding the collision

The following are the influence of causes and conditions upon the events surrounding the collision. The primary set of accident events in the collisions between MT Uhuru and MS Mtwara and their related causes are summarised as follows.

4.1.4.1. Underlying or Contributing factors

Events

The master left the bridge in the command of an apprentice and went to rest to his cabin.

Causes

It was very bad practise by Master to leave the bridge under the command of an apprentice. Although this was normal practice done by any master in each voyage. So the management did not have proper checking of how they recruiting the seafarers.

Conditions Normal

4.1.4.2 Direct factors

Event

The apprentice on watch on the vessel MT Uhuru altered the course 5 degrees to port. A few minutes later he altered a further 20 degrees to port, which he collided with MS Mtwara.

Causes

The signal station failed to mention that MT Uhuru had left Zanzibar. The apprentice was unable to determine the location of the vessel MS Mtwara just before the collision. His lack of knowledge, training, and experience in commanding a vessel prevented him from making proper judgement in altering to port instead to starboard in accordance to COLREG 1972.

Conditions

The time was approximately midnight at the height of changes of watch.

4.2. The Capsizing of Passenger Vessel MV BUKOBA

On 21st May 1996 at around 0730 EAT while M.V Bukoba was approaching Mwanza from Bukoba via Kemondo Bay on reaching position latitude 2°27'7" South and longitude 32°50' East and eventually sank completely at 15.05 EAT. The location of the accident was about 3.5 nautical miles from Mwanza.

At the time of the accident the vessel was carrying approximately 637 manifested passengers, 37 crew and 20 tonnes of manifested cargo. It is also believed that the vessel was carrying unmanifested passengers and cargo.

It has been determined that MV Bukoba capsized due to stability deficiency.

4.2.1 Main Particular of the Vessel

Name of the vessel	=	MV Bukoba
Year of built	=	1979
Building yard	=	Fulton Marine N.V, 2658 Ruisbroek Antwerp
Builders	=	Belgian Shipbuilders Co.
GRT	=	800 (Not measured)
Length overall	=	59.50 m
Length between Perpendiculars	=	54.75 m
Breadth moulded	=	9.00 m
Breadth overall	=	9.60 m
Depth moulded Main deck	=	3.50 m
Draft loaded	=	2.50 m
Propulsion	=	Single screw
Output	=	1035 HP
Auxiliary Engine	=	2 X 92 kV, 3x380 v, 50 HZ
Crew capacity	=	36

Passenger capacity	=	400
Cargo capacity	=	200 t

4.2.2. Description of the vessel ill-fated voyage

The vessel departed from Bukoba on 20th May, 1996 at 21.30 EAT. She arrived Kemondo Bay at 22.30 EAT and left at 23.45 EAT. From Bukoba the vessel was loaded with 501 passengers, 8.891t of cargo including one landrover, 136 more passengers boarded at Kemondo Bay and 11.14t of cargo were loaded on deck.

The Mwanza-Kemondo Bay-Bukoba route was not a normal route for MV Bukoba. The normal trading routes were Mwanza-Port Bell-Mwanza and Mwanza-Kisumu-Mwanza. On this occasion MV Bukoba was covering the route of M.V.Victoria due to the latter being under maintenance.

At Bukoba Pier, during boarding of the passengers the gangway was abnormally steep making it difficult for passengers to board without assistance showing that the vessel was lighter than normal at the commencement of boarding. The vessel listed to portside after boarding. On arrival at Kemondo Bay, passengers were already at the pier waiting to board contrary to normal practise by which passengers are allowed onto the pier after arrival of the vessel. Due to that there was no proper control of passengers to board the vessel. After boarding and loading of cargo, the vessel developed a heavy list to portside. After unmooring all lines, when reversing (astern) the vessel listed further to port. When going ahead the heavy list changed from port to starboard. The list then reduced to a slight starboard list, which was maintained throughout the voyage until the accident.

4.2.2.1. The accident

On 21st May, at around 07.30 EAT the captain of MV Bukoba communicated with Mwanza Control office indicating his estimated time of arrival at Mwanza North Port as 0830 EAT. At around 0730 EAT the vessel listed heavily to starboard side causing passengers on deck to move from starboard side to port. At about this time the master states that he was disturbed by some noises from the wheelhouse and went there to see what was happening. He found a number of crew there including the chief engineer, chief officer, two quarters-masters, two cadets and one sailor, as though engaged in a meeting or some argument. They stopped what they were doing and greeted him. He noticed the ship was heading towards Bwiru and was to the Northeast of her usual course line. But before he had time to comment the chief officer ordered starboard. The ship began to turn, and as she did so she rolled violently to port. The master ordered stop engine and he tried to get to the VHF set to raise the alarm, but he and others in the wheelhouse were thrown across it and neither intention could carried out. The chief engineer recalls that the movement of items disturbed him in his cabin. The ship listed to starboard and as he went out to the boat deck he saw people rushing to the port side. He went to the wheelhouse by the starboard door. The master entered at the same time. Of the only two other men in the wheelhouse who survived, one said he had gone there as was usually when approaching port and also to make coffee, but the other said he had gone to find out why the ship was behaving strangely. After two minutes the ship capsized.

The position of the accident was latitude 2°25'7" South and longitude 32°50' about 3.5 nautical miles from Mwanza. There was no distress given by the vessel. The first communication the accident was received from a fisherman who reported to the passenger agent at Mwanza north port at about 08.15 EAT. Later on about 08.15 EAT further communication was received from MV Butiama, which was on her way to Mwanza from, port Bell. The captain of MV Butiama had sighted the capsized vessel by using binoculars.

Before the ship capsized she was cruising at a speed of about 11 knots and the weather was fairly calm with occasional squalls.

4.2.2.2. Rescue Operation

Soon after the accident some passengers and crew managed to get hold of some life saving appliances which were on board, others managed to swim to private boats and canoes which were near the scene, and others were kept afloat by holding on floating banana bunches until they were rescued. Others managed to cling to the capsized the vessel and eventually climbed on top of the bottom of the hull. The majority of the people were however trapped in the vessel and could not be rescued.

Tanzania Railways Corporation (TRC) rescuers were compelled to cut a hole on the ill-fated vessel in order to rescue trapped people who were knocking the hull of the vessel for help: one hole of about one square foot was successfully cut and one person was rescued. Attempts to cut a second hole could not materialise because just after piercing a small hole pressurised air gushed out and extinguished the flame of the torch. Thereafter the vessel started to sink faster, and in the process two people came out from unknown exit of the vessel and were saved. The vessel sank completely at 15.05 EAT, approximately 7.5 hours after she capsized and rested at a depth of 30 metres. Piercing a hole was a very bad practise because it destroyed reserve buoyancy. This reserve buoyancy usually sustains the vessel from sinking. So the vessel would have taken longer to sink.

4.2.2.3 Stability

It was generally observed that MV Bukoba was listing slightly to port or starboard during her lifetime. Although the cause of list was not investigated on board the vessel, it is evident that it was either due to poor design or construction or both. Basically, TRC acquired a faulty ship from Belgium Shipbuilders Corporation (BSC) whose defects could not be detected for sometime until Danish expert came on the scene three years later. This problem originated from the contract itself which was drawn by the ship builders, and was heavily skewed in favour of the shipbuilders. The belgian party was adamantly reluctant to vary any of the terms in the contract inspite of numerous appeals from the Government of Tanzania. Due to the special circumstances prevailing at the time, especially the transportation crisis with the Government's financial weakness, the Tanzania Government apparently felt itself to have no option but to accept the unequal terms of the contract. Here are some of the contract articles which had serious anomalies:

- Article V and VI set out delivery terms obliging the purchaser to take delivery of the ship parts in Belgium and transport them to Dar-es-salaam and on to Mwanza at his cost, while article IV stipulated that all expenses for trials and adjustments once the ship was reassembled in Mwanza would be borne by the purchaser.
- Article XII gives a guarantee period of six months from the date of delivery within which any defect due to bad workmanship or use of defective materials needed to be notified one month from its discovery, failing which the contractor would not accept any responsibility.
- Article XV provides that in case of dispute or disagreement, Belgium law would be applicable in arbitration proceedings.

These terms were highly disadvantageous to the Tanzania and that the latter felt forced to accept them because of the crisis which had arisen at that material time. The mode of delivery and transfer of property were unfavourable to the purchaser, passing responsibility to the purchaser too early, even before the reassembling of the ship in Mwanza and before trials to ascertain stability and seaworthiness.

The six month guarantee given was too short in which to be able to discover defects arising from bad workmanship and use of defect materials to manifest themselves within short period of time.

Finally, requiring disputes and disagreements to be settled according to the Belgium law was designed to favour the Belgians because the two countries use radically differing legal systems.

Once the defects discovered by the Danish experts, these became the suject of a protracted and fruitless correspondence with the builders, until the Belgium Government intervened with an undertaking to provide funds for the rectification of the stability problem and improvement of carrying capacity. Even this undertaking was never implemented until the ship met her fateful accident.

In 1985, the Danish Maritime Institute recommended measures to be undertaken in order to improve stability. Also in 1994, the Embassy of Belgium in Tanzania recommended yet another solution for the improvement of the stability. Two engineers from Belgium (Naval Department, the University of Liege) visited Mwanza for the stability test which was done on May 1996. Unfortunately, the preliminary results were not submitted soon after the test. The results were expected in July 1996.

4.2.2.4 Evidence from witnesses

1. MV Bukoba had a common tendency of listing to the portside or the starboard side.
2. The vessel had two shore communication systems both in good condition but internal communication between engine room and bridge was defective.
3. It was common practise to overload the vessel.
4. There was no stability booklet onboard.
5. Most of the senior officers onboard had no knowledge of ballasting conditions requiring permanent ballasting.
6. One auxiliary engine was out of order on 20th May 1996.
7. Engine room alarm was out of order on 20th May 1996.
8. The captain was not on watch at the time of accident, he was only alerted by noise on the bridge just before the accident.
9. Cutting of the holes was authorised by the Marine Divisional Manager.
10. There was general laxity and lacking in direction in the management of the TRC.
11. There is no proper planning and monitoring system to ensure implementation of operational marine and shipping rules and regulations.
12. Most of the sailors were not well trained.
13. Applicable productivity oriented incentive encourages overloading of vessels.
14. MV Bukoba planned to go for service on 30th April 1996 but did not and resumed service on 12th May 1996.
15. Valid seaworthiness certificate expired on May 1994, and from June 1994 to the date of accident the vessel was sailing without a valid seaworthiness

certificate. The certificate dated 1st March 1996 was delivered on 28th May 1996.

16. No safety drills were being conducted on board and the muster list was not posted as required.

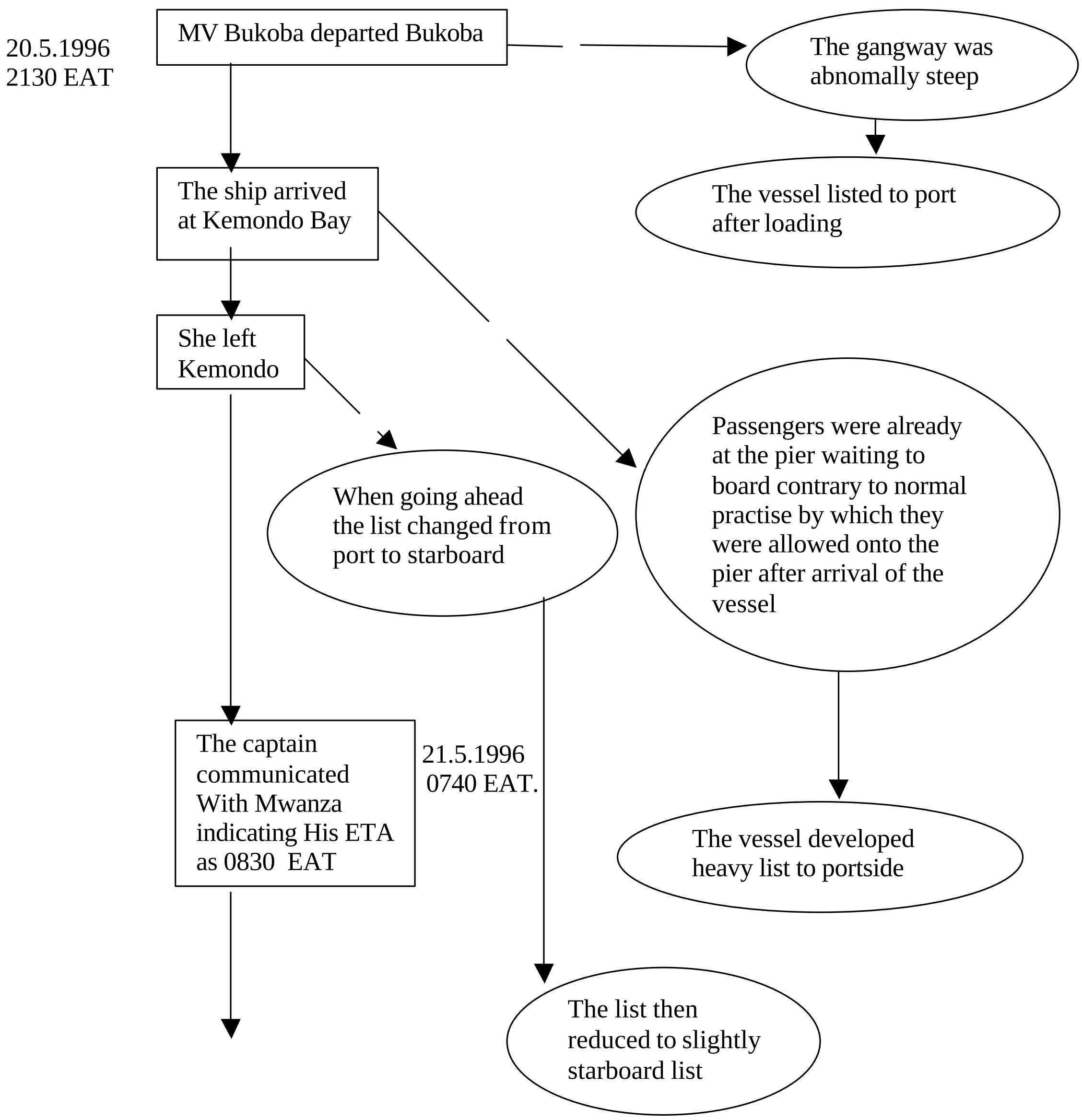
17. It was observed that most life saving appliances were kept under lock.

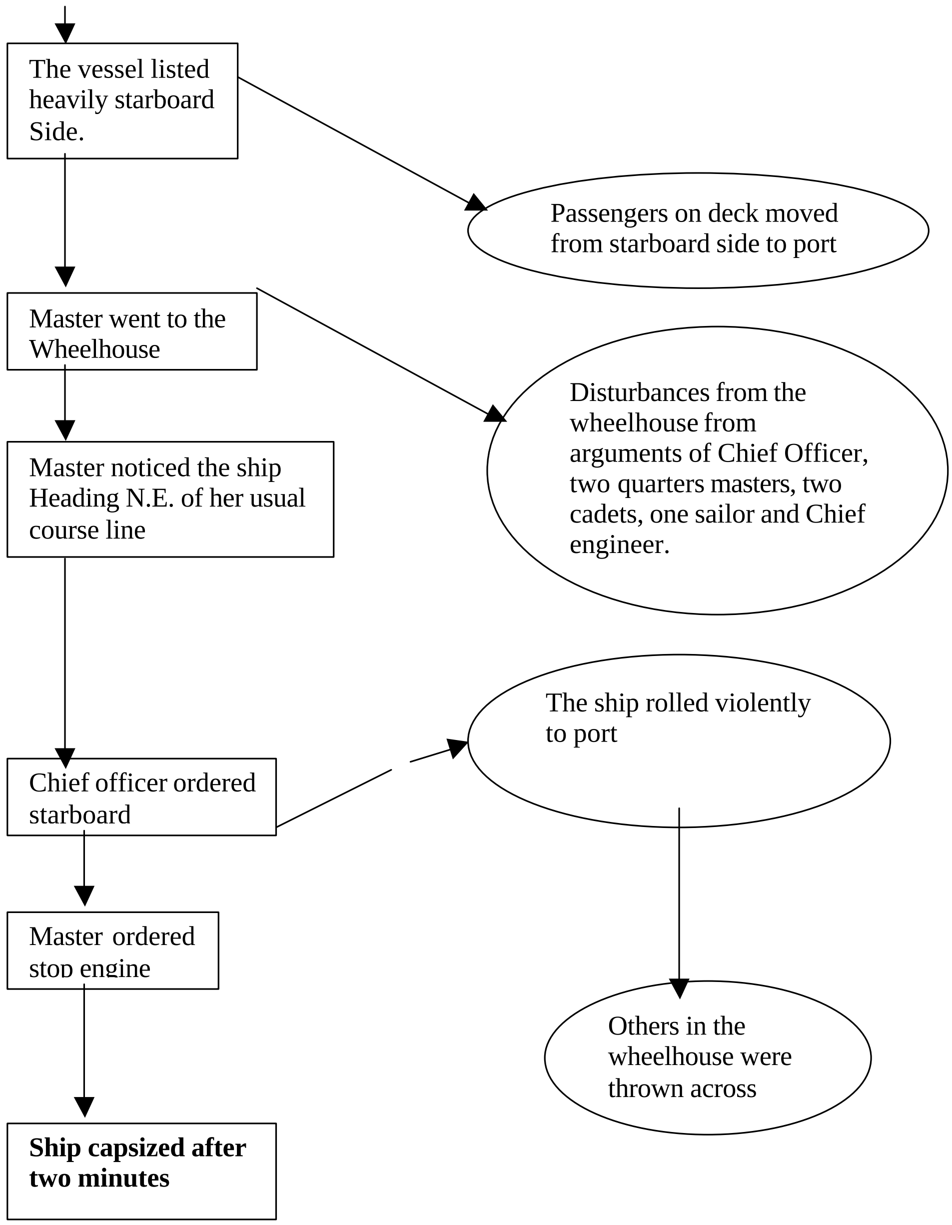
18. Excess of 200 passengers and excess of 15.03 tonnes of cargo overloaded the vessel.

19. Ships log books and other documents were not being filled.

20. The vessel had steering problems after the stability test due to increased freeboard.

(Chart 2.0) Events and causal Factors Analysis of the Capsize of MV Bukoba




The vessel listed heavily starboard Side.
Passengers on deck moved from starboard side to port
Master went to the Wheelhouse
Disturbances from the wheelhouse from arguments of Chief Officer, two quarters masters, two cadets, one sailor and Chief engineer.
Master noticed the ship Heading N.E. of her usual course line
The ship rolled violently to port
Chief officer ordered starboard
Master ordered stop engine
Others in the wheelhouse were thrown across
Ship capsized after two minutes

4.2.3 Human and organisational behaviour that influences the capsize of MV Bukoba.

4.2.3.1. Underlying or contributing factors

Event

MV Bukoba listed to starboard from Kemondo Bay, and was maintained throughout the voyage until the accident. The ballast tanks were not operative for long time.

Causes

At Bukoba pier, the vessel listed to port after the passengers boarded the vessel. Later also at Kemondo bay, the vessel listed further to portside after more passengers boarded the vessel. When the ship was set for sailing to Mwanza, she listed to starboard. In short, the vessel was overloaded. This was common practise and it has existed for a quite long time. So there was a general laxity and gross negligence in the part of the management for letting the vessel to be overloaded.

4.2.3.2 Direct factors

Event

The chief officer ordered a quartermaster to turn the ship to starboard. The ship rolled violently to port. After few minutes the ship capsized. She remained floating because she had reserve buoyancy.

Causes

The ship had a problem of listing to port or starboard. When the ship was coming from Kemondo Bay, she was listed to starboard throughout the voyage until the accident. From Kemondo bay the ship was sailing under " angle of loll" until the ship was about 12 nautical miles from Mwanza when the chief officer ordered starboard. When the chief officer starboard, passengers moved to the portside. Then the ship rolled violently to port responding to the passenger’s movements. The passengers, after seen the likelihood of ship capsizing to portside, moved quickly to starboard, and that is when the centre of buoyancy could not move out far enough to get vertically under G, the ship capsized.

Furthermore the ballast tanks were not functioning for quite a long time. The ship centre of gravity was moving up when she was sailing from Kemondo bay until her fate. This was due to the fact that the fuel was being consumed during the voyage. Master ignored the extraordinary listing from the fact that they were used with it.

Condition

The time was approximately early morning of sunrise.

4.2.3.3. Compound factors

Event

TRC rescuers cut a hole to the vessel as authorised by the Marine Divisional Manager (Picture 1).

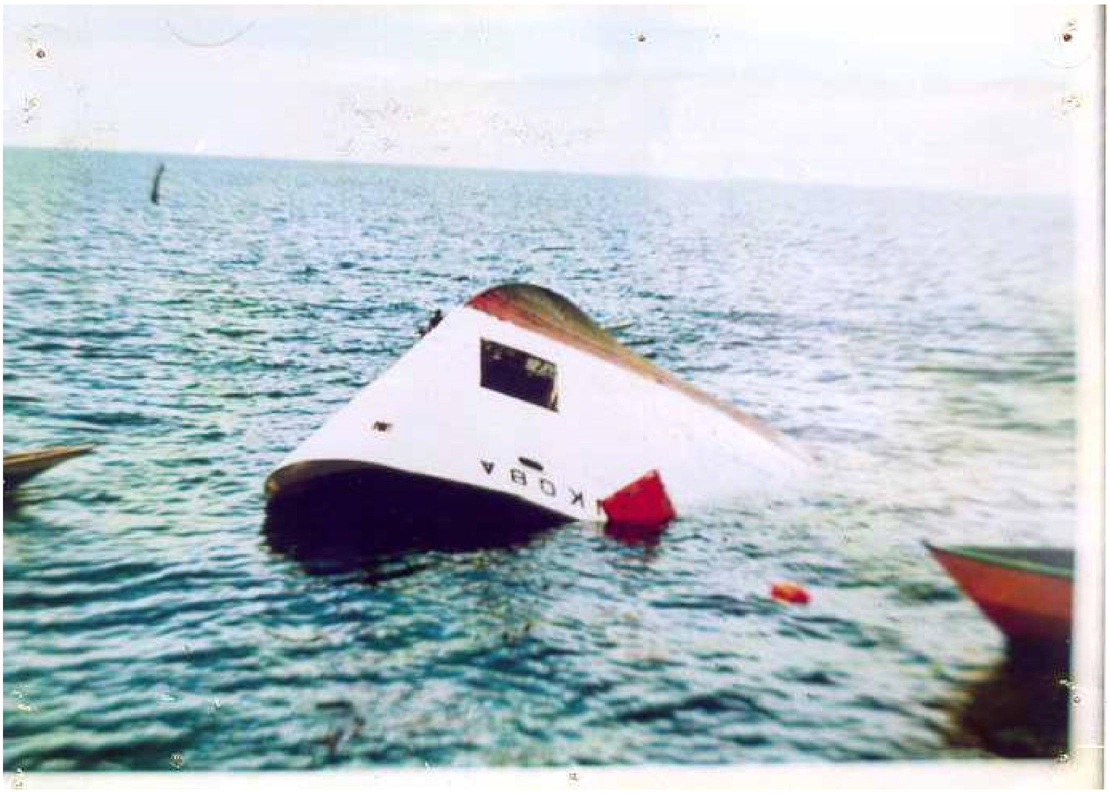
Causes

Piercing a hole was a very bad practise, which resulted for the vessel to sink completely after 7.5 hours of floating. The Marine Divisional Manager was supposed to authorise to tow the vessel to the shallow water, and the rescue operation would have continued. Piercing a hole removed reserve buoyancy, which sustains the vessel from sinking faster.

Condition

The time was approximately 15.05 EAT with clear sky.

Picture 1.0: A hole cut by the TRC rescuers at the starboard bow



(A photo of MV BUKOBA taken by armature camera)

4.3 The Fire/Explosion involving the boat MV INZI and SBM (Single Buoy Mooring)

On 25th December 1996, soon after 0930 EAT, the boat MV INZI and SBM caught fire at Mjimwema, Dar-Es-salaam. The boat drifted to the shore. There was loss of life. Five people died and four survivors.

4.3.1 Background

On 5th December 1996

Mooring Master went on leave from 1st December 1996 until 30th December 1996. On 1st December 1996 he handed over his duties verbally to the Assistant Mooring Master on front of Harbour Master and Senior Harbour Master. The Mooring Master left the following assignment to be done on the SBM that is to repair the damaged and worn out floating hose, which was losing ability to float (Figure 3.0).

On 5th December 1996

The SBM maintenance team headed by the acting mooring master took off to SBM to remove the damaged and worn out floating hose and to replace with another floating hose.

On 10th December 1996

The maintenance team went back to the SBM to check whether the floating hose they replaced on 5th December 1996 is able to float, and they found that it could not float at all. They came back and reported the matter to the acting senior harbour master.

On 21st December 1996

They went back to the SBM under the instruction of mooring master to remove the floating hose. This day the mooring master was not among them. The instructions were to remove the floating hose and then put the blind disc to the flange. The technicians closed first the valves at the top part of the buoy. Then divers went down and unfasten the bolts and nuts at the flanges where the floating hose was supposed to be removed. In due course the oil started leaking (Figure 3.1) and immediately the tug master reported the leakage to the mooring master. The mooring master told them to let to let the oil to leak out until the next day whereby perhaps the remaining oil in the buoy will be finished. The team left SBM while oil was still leaking.

On 22nd December 1996

The team returned to the SBM and found oil spillage all over the place. The divers initiated their way down to close the Cameroun valve or emergence valves (Figure 3.2). When they were closing it, the lock pin of the handle was broken. It must be noted that it takes 20 to 30 minutes for three people to close that valve when working on the land surface. While in the water it takes more time to close it. They decided to take the handle of the valve for repair at the dockyard and reported the matter to the acting-mooring master.

On 23rd December 1996

The Mooring master who badly enough acted as a senior harbour master and also the harbour master informed the matter of oil spillage to the chief marine officer. The

Chief Marine Officer and the maintenance team took off to the SBM. They found the place clear of oil spillage. They removed the floating hose, unfasten the remaining 8 bolts and nuts, and covered the flange with a blind disc. The blind disc was left loosely fastened in full knowledge of chief marine officer and acting mooring master.

24th December 1996

The team did not go to the SBM.

25th December 1996

The day of fire accident of the boat MV INZI and SBM

The team assembled at the senior harbour master's office. It comprised nine people. They left for the SBM with their boat MV INZI at 0730 EAT. They left with no dispersants, foam compounds or any other fire fighting equipment to face the oil spillage problem in case it would reoccur. The boat had no life saving appliance or fire fighting equipment. They arrived at the SBM at 0845 EAT.

The main objective of the trip was to close properly the blind disc and to open the Cameroun valve. That task was part of their preparation to offload the expected marine tanker ”Athenian Beauty”. Upon arrival at the SBM, the team was divided into three groups. The first group of three divers went straight to the seabed to open the Cameroon valve. The second group of four peoples that is the boat technician; coaxwain, a sailor and the buoy technician remained on boat. The last group of two peoples that is the tug master and his tug mate was at the top part of the buoy.

According to the one diver, when they were still opening the Cameroun valve, they heard four knocks signs from the top of the buoy. That is a sign used by people on top of the buoy to summon divers. Then one among the three divers decided to come up to respond to that call. While on the way up, he noticed that there was a big cloud floating on the water surface. That situation led him to suspect that there was a big spill of oil and he went back to instruct his co-divers to close the valve. Some few minutes later (while closing the valve) there was another four knocks.

The team of divers decided to come up to see what was going on while they are satisfied that the cameroun valve is properly closed. While on their way out, the leader spotted a big cloud of smoke above the water. He instructed his co-divers to dive back into the water to save their lives. They decided to swim underneath water away from that area of the buoy before re-emerging and see what was going on at the buoy.

At that time they realised that there was a fire accident and the SBM was on fire. The marine vessel MV INZI was nowhere to be seen and nobody was around to rescue them. Once again the leader diver instructed his colleague to take off their breathing cylinders and they swam fast for their safety. Fishermen rescued them and together they started searching for the tug mate who was shouting desperately for help.

According to the tug mate who was standing on top of the SBM with the tug master they witnessed a big spill of oil accompanied with fumes coming out of the loosely closed flange at high pressure. Oil fumes from the loosely closed flange were flowing directly to the boat and other oil splash wetted the tug-master. The tug master was standing on top of the buoy close to the elbow and the tug mate was standing far away from the tug master.

When the tug master saw the oil and petroleum fumes leaking from the flange and flowing direct into the boat through the engine room sky doors, he instructed the boat technician to start up the engine in order to take the boat to be away from the incoming fumes.

Upon starting of the engine, there was a big roaring sound accompanied with the big explosion. The fireball went up in the sky. The tug master was engulfed by fire from the boat and the tug mate threw himself into the water. The tug mate managed to swim to safety while shouting desperately for help until fishermen rescued him.

At around 1045 EAT, the duty officer at the signal station spotted a big cloud of smoke from the SBM. Without any delay he relayed the information to the acting senior harbour master who was at the same time the acting mooring master and acting harbour master. The acting mooring master informed the fire officer who was on duty with motor-tug ”Simba” spraying foam compound to the oil spill within the inner port area.

4.3.2 The possible cause of fire

The team, which investigated this scenario, indicated that the possible source of fire was the starter motor. The starter motor has a tendency of producing sparks. The sparks produced are quite enough to ignite highly flammable vapours. These flammable vapours entered into the engine room at high pressure. These flammable vapours consisted of mogas, light crude oil, gas oil and DPK (dual-purpose kerosene). The spiked crude oil was at a high vapour pressure and with low flash point contents (the flash point of gasolines is below 0 degree centigrade). In the presence of naked flame (starter sparks) there was a high possibility to cause a sudden explosion.

It must be noted that the spiked crude oil with heavy fumes entered direct to the engine room through skydoors. The led to the formation of a closed combustible gas chamber. Therefore, upon starting the engine, the combustible gas chamber was ignited by the starter sparks. It was revealed that the boat was not using the formal procedure for starting the engine. Instead, she were being started by short circuiting or putting metal material at the both ends of the battery (i.e. negative and positive poles) and join metals to provide the current to pass through. This technique always produces a sparks. These sparks are quite enough to ignite combustible highly flammable vapours, as it was the case of this scenario.

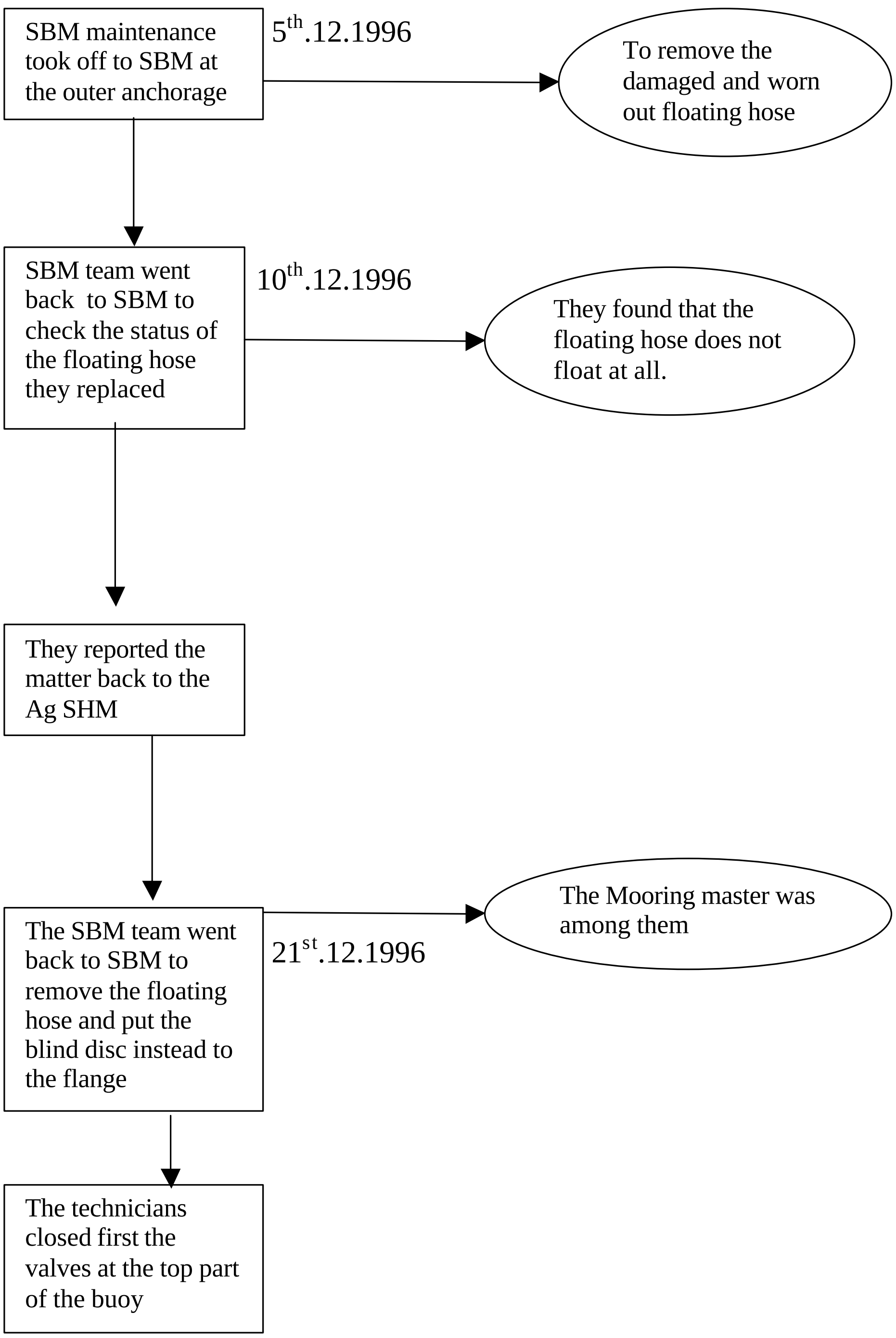
4.3.3 Observation and Comments

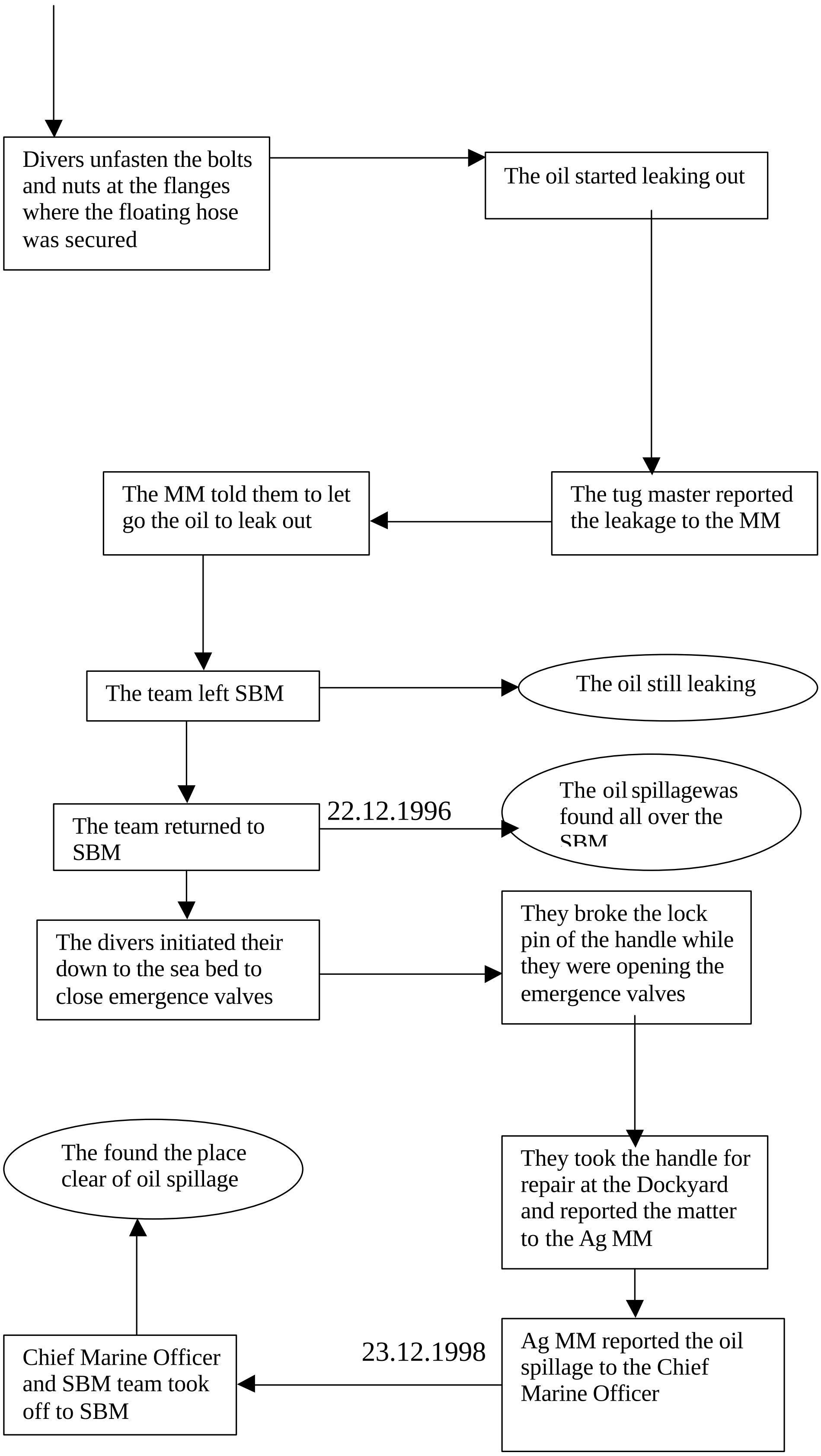
The boat had no safety equipment i.e. fire fighting appliances, life saving appliances, communications equipment and oil detergents.

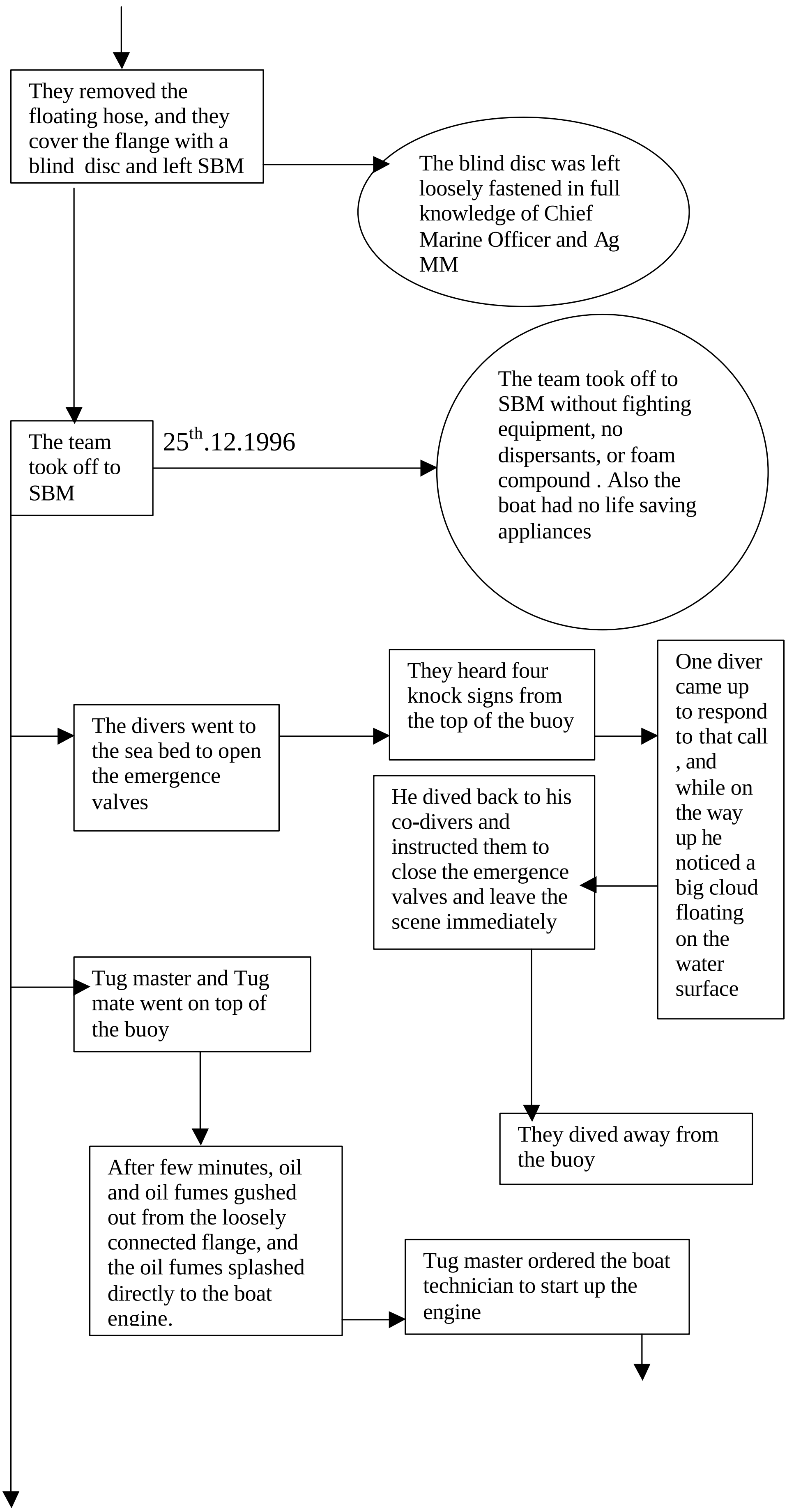
The teams which went there for repairing the SBM and the crew of the boat were not knowledgeable on the kind of oil products and had no training in the fire fighting and the fire fighting techniques, rescue operations or oil spills technique etc.

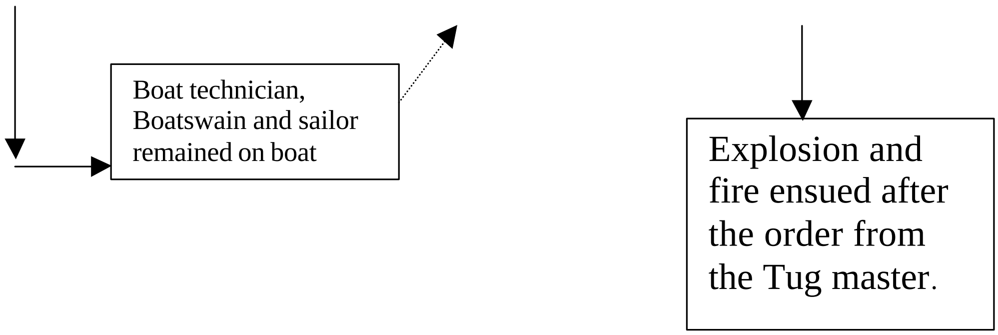
The boat herself was not fit for that kind of job and not even recommended by the IOCMF which deals with oil safety precautions at oil terminals and was operating the SBM without complying IOCMF regulations for about more than 10 years. The Tanzania Harbours Authority (THA) management is largely accountable for what has happened and contributed a lot to this fire accident.

(Chart 3) Events and Causal Factors Analysis of the Fire/Explosion involving Mv INZI and SBM (Single Buoy Mooring)




Divers unfasten the bolts and nuts at the flanges where the floating hose was secured
The oil started leaking out
The tug master reported the leakage to the MM
The MM told them to let go the oil to leak out
The team left SBM
The oil still leaking
The team returned to SBM
22.12.1996
The oil spillagewas found all over the SBM
The divers initiated their down to the sea bed to close emergence valves
They broke the lock pin of the handle while they were opening the emergence valves
They took the handle for repair at the Dockyard and reported the matter to the Ag MM
Ag MM reported the oil spillage to the Chief Marine Officer
23.12.1998
Chief Marine Officer and SBM team took off to SBM
The found the place clear of oil spillage


They removed the floating hose, and they cover the flange with a blind disc and left SBM
The blind disc was left loosely fastened in full knowledge of Chief Marine Officer and Ag MM
The team took off to SBM
25th.12.1996
The team took off to SBM without fighting equipment, no dispersants, or foam compound . Also the boat had no life saving appliances
The divers went to the sea bed to open the emergence valves
They heard four knock signs from the top of the buoy
One diver came up to respond to that call , and while on the way up he noticed a big cloud floating on the water surface
He dived back to his co-divers and instructed them to close the emergence valves and leave the scene immediately
Tug master and Tug mate went on top of the buoy
They dived away from the buoy
After few minutes, oil and oil fumes gushed out from the loosely connected flange, and the oil fumes splashed directly to the boat engine.
Tug master ordered the boat technician to start up the engine



4.3.4 **Human and Organisational error influences on the events surrounding the Fire**

The following are set of accident events in the fire\or explosion involving the boat MV INZI and SBM (Single Buoy Mooring).

4.3.4.1.Underlying or contributing factors

Event

The divers unfastened the flange and immediately the oil started leaking out. The tug master reported the matter to the mooring master who told them to let go the oil until next day perhaps thinking the oil in the pipeline would have been finished by then.

The second event took place in 23rd December 96 when divers removed the loating hose after unfastening the remaining 8 bolts and nuts, and covered the flange loosely with the blind disc with the full knowledge of Chief Marine Officer and Acting Mooring Master.

Cause

The pipeline was almost full of oil, which was discharged by the previous vessel. So the team did not check whether the line had oil and at what pressure. The valves at the top of the SBM were not operational, the possibilities that the team could not remove gas vapours or to determine if the line had fuel oil.

Condition

The time was 0900 EAT in the morning.

4.3.4.2. Direct factors

Event

The tugmaster instructed the boat technician to start up the engine in order to take the boat away from the incoming fumes.

Causes

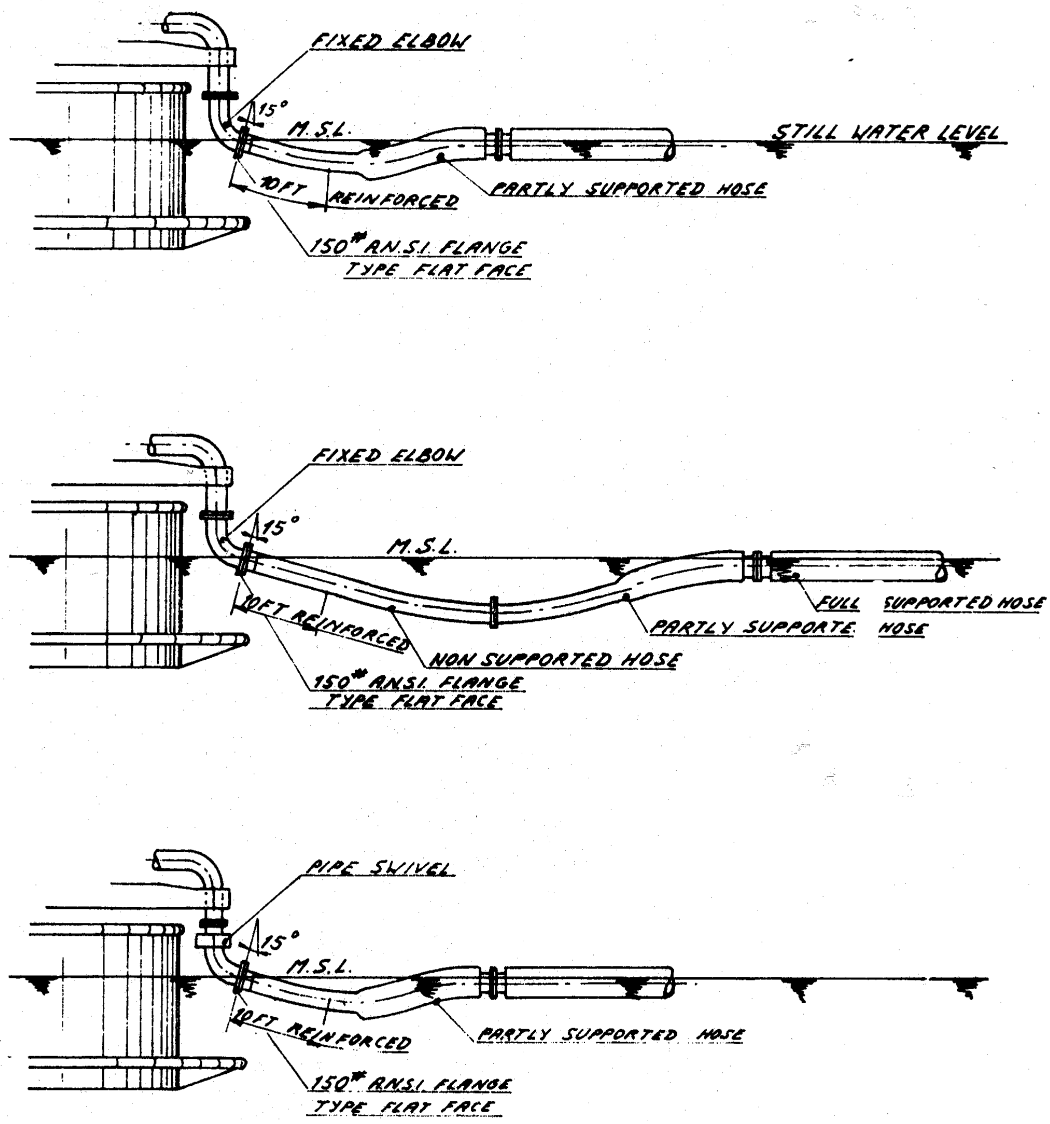
On 25th December 96, the team went to the SBM for the purpose of properly closing the blind disc which was left loosely in the previous day, and later open the Cameron valve which are located at the bottom of the seabed.

Divers made the mistake that instead of closing tight the blind disc they opened the Cameroun valves and that is where the oil fumes at high pressures flew directly to the boat which was alongside the SBM. These oil fumes entered into the engine room through skydoors. This led to the formation of a closed combustible gas chamber. Therefore, upon starting the engine, the combustible gas chamber was ignited by the starter sparks. The vessel was not using the formal starting procedure but instead short-circuiting or putting metal at both ends of the battery was starting her. This technique always produces a spark. These sparks are quite enough to ignite the combustible highly flammable vapours, as it was in this scenario.

Condition

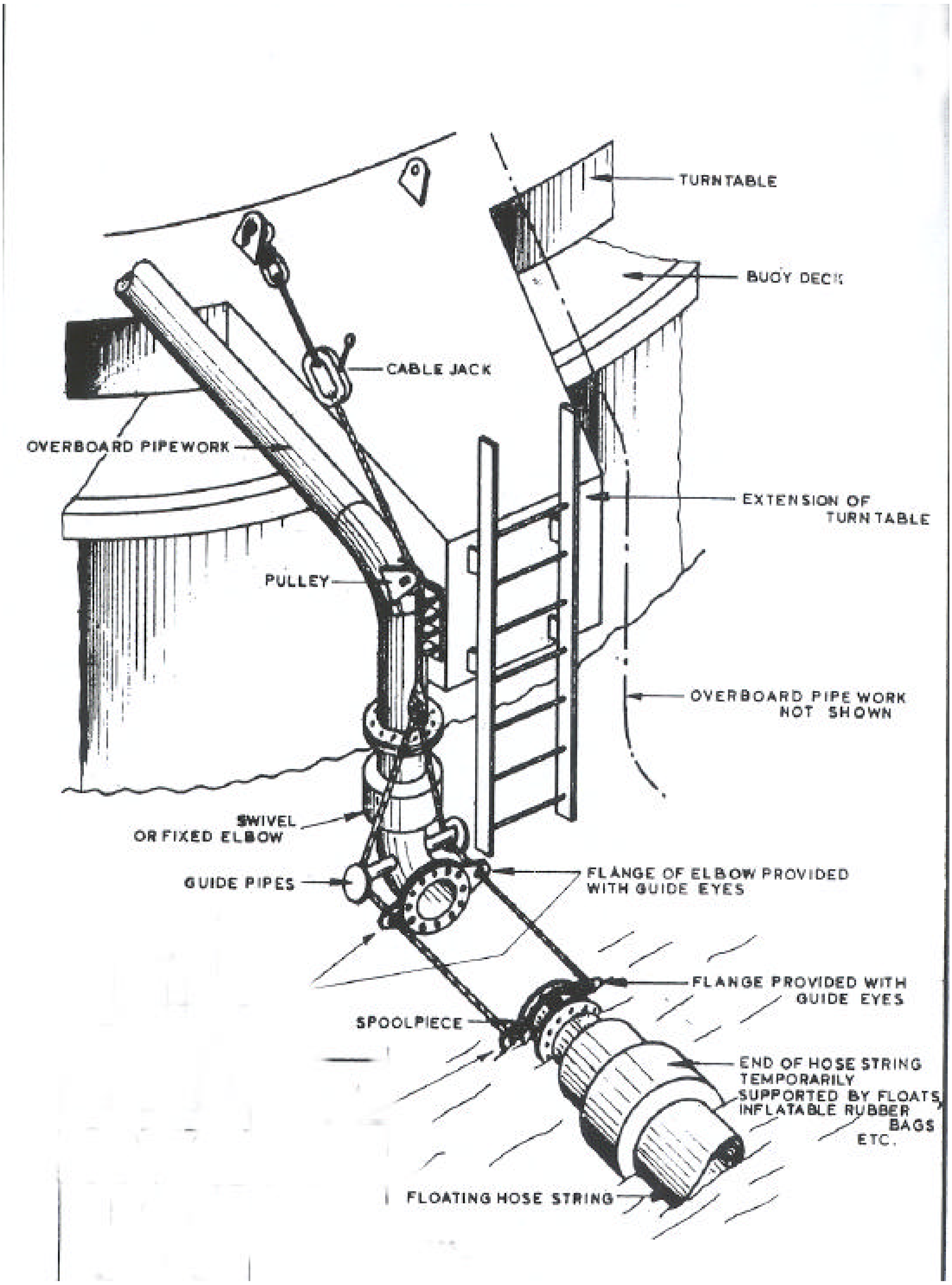
The time was 1045 EAT.

Figure 3.0 Different arrangements of floating hose



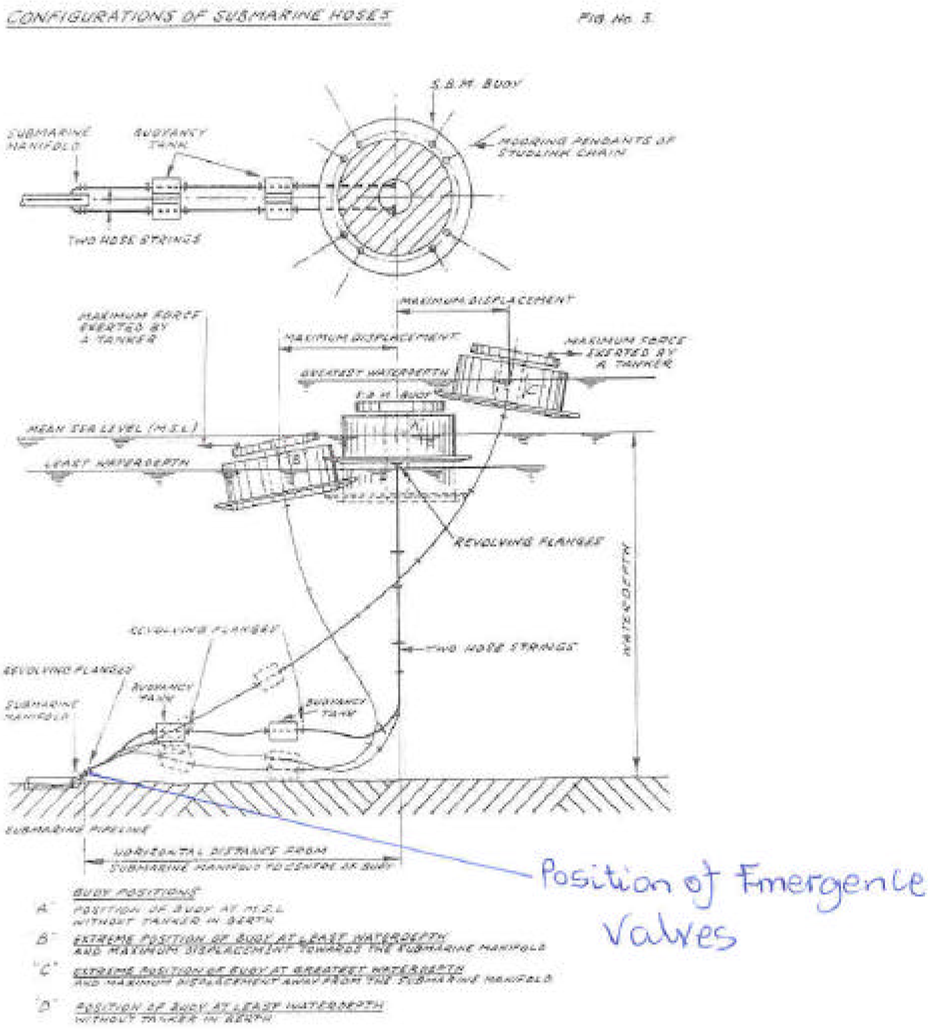
(OCIMF- Commentary, 1975 pp17)

Figure 3.1 Flange where oil started leaking out



(OCIMF- Commentary, 1975 pp15)

Figure 3.2 Position of Emergence valves



(OCIMF -Commentary , 1975 pp 15)

CHAPTER 5

Effects of Maritime accidents in Tanzania

Any casualty has got tremendous damage to the environment, social, and political to the country where the casualty took place, and also to the shipowner, seafarers and passengers at large.

Let us now take take one scenario type of accident and identify the damage caused to the parties mentioned above.

5.1 Fire and Explosion between MV Inzi and Single Buoy Mooring at the Outer Anchorage in the port of Dar-es-salaam on 25th December 1996

In this casualty, five workers lost their lives and four survived. Another damage and loss was caused to the buoy and the tug. The buoy was very old and long overdue for removal. The same applies to the boat MV Inzi which was unseaworthy.

The model used to establish the loss caused by the casualty depended very much on the following elements:

5.1.1 Loss in the production time at TIPER (Tanzanian and Italian Petroleum Refinery).

5.1.2 Demurrage charges for the tanker waiting at the outer anchorage.

5.1.3 Importation of emergency cargo to fill the shortage of petroleum products in the market and cost of the unplanned rehabilitation of SBM.

Due to this casualty the Government of Tanzania had to remit funds to import petroleum products at the spot market prices in order to bridge the gap caused by the shutdown at Tanzanian and Italian Petroleum Refinery (TIPER).

Another area which generated loss to the Government is related to the waiting charges of the vessel MT Athenian Beauty. The demurrage charges for keeping the Marine Tanker waiting was in the tune of US Dollar 18,000 per day. So far, it took almost more than four weeks for the SBM to resume service. The Authority also acquired new special boat to be used at the SBM at the cost of 1.3 million USD which was constructed in Italy.

Another cost related model was with contracting of a foreign company to rehabilitate the SBM at short notice. The authority was forced to incur more cost to get the right contractor in a right time. The consequence of that process was the increase of operation cost which in turn reduced the shareholders profit or stimulate the increase in wharfage rates.

5.2 Impact of oil spill on the environmet

The SBM oil spill keeps the estimates, from an experience point of view**,** at a higher price. In 1981, a major oil spill took place at the SBM and another casualty took place in 1986, destroyed the coral reefs, seagrass beds and mangrooves along the Kivukoni-Mjimwema shore/beach.

The oil spill which was seen on 21st to 25th December 1996 by the witnesses, descibed to have seen fishes and other sea living organisms floating dead in large numbers. Of course as it is widely known that should damage occur to any of the sensitive components of the marine ecosystem, recovery will be long time. The damage to the marine ecosystem would lead to beach erosion, decrease in fish harvets, shift of birds and other animals which depends on sea living organisms. The following ismore detailed information on the impact of oil on marine environment:

5.2.1. **Physical contamination**

When oil is spilled on a calm water surface, only soluble components in the oil affect organisms in the underlying water. Most of waters however, are not calm and waves and currents mix oil into the underlying water. The growth of the marine organisms depends basically on the quantity and quality of the primary production of phytoplankton (algae). Apart from the toxic effects of oil, marine microfauna can experience indirect food effects since algal production can changed after an oil spill.

5.2.2. **Tainting and recovery of fish and crustaceans**

Fish, crustances and molluscs under prolonged exposure to concentrations of oil may acquire an objectionable, oily odour or flavour, thus losing their market value in extreme cases they are inedible.

5.2.3. **Coral reefs**

Coral reefs are important in supporting coastal fisheries, protecting tropical coastlines from wave action and erosion and providing a basis for tourism and recreation.

Platforms of fringing reefs form extensive shallow habitats covered with algae, seagrasses and invertebrates. After a few days exposure to an oil spill at low tides a band of substratum 1 to 3m wide at the reef edge becomes nearly barren of the normal assemblage of sessile inverbrates and algae, which contributess to cover abundances of organisms oil spills cause substantial mortality among fish and invertebratess (including lobsters, crabs, gastropods, bivales, octopus, sea urchins, seastars and sea cucumbers) in intertidal areas, on the surfaces and margins of coastal fringing reef platforms, aand in adjacent shallow subtidal areas.

5.2.4. **Mangroves**

Of the four mangrove species the red mangrove is the most seaward in occurrence and makes up nearly all of the fringing forest. The labyrinthine prop roots of red mangroves serve as a firm substrate that support a number of plants and animals. After a spill, the mangrove trees in oiled areas become defoliated and the leaves yellow. This is particularly so in areas where the trees are rooted in a berm of intertidal sediments. In most places, the berm apparently intercepts and partially absorbs the oil into the forest. The trees of the inner fringe that are rooted in the subtidal sediments suffer less defoliation. The trees that are rooted in supralittoral sediments of the oiled region suffer less defoliation than the trees rooted at lower levels. If mortality follows stress and defoliation of the red mangroves, the impact may be much wider than loss of the trees themselves. The thickets of prop rots of this species serve as breeding and nursing areas for marine species and as a substrate and shelter for a diverse group of others, including economically important species of fish, molluscs and crustaceans. Sediments retained by the root masses could be released, if the roots decompose, which is a potential threat to nearby corals and other organisms that are intolerant to siltation.

"People are not only part of the cause of most of accidents but they are also the best means of prevention"

(Mitropoulos, E.E., June 1977)

CHAPTER 6

Prevention or reduction of human error

The importance of human error in the causation of marine accidents is self-evident. It is clear that significant improvement can be made by the application of the basic human factor principles and, where necessary, systematic studies to further reduce the potential for human error.

People, by their very nature make errors. The cognitive processes, which enable people to take decisions, make judgements, and develop plans of actions, are the very processes, which can fail and lead to errors. Usually, however, errors do not occur solely due to cognitive failings (so-called psychological error mechanisms such as misinterpretation, incorrect assumption). More often the potential for the error is increased by the failure to take account the human factors issues in the design of man-machine interfaces, in the operation and management of ships, for example training needs; design of procedures and checklists; and job organisation to optimise workload and minimise fatigue.

It is clear that attention to detail in applying such principles should be undertaken in all aspects of human performance. Below are some techniques that minimise potential for human errors:

6.1 **Human Factors Audits**

These provide straightforward questions (requiring either yes or no responses); addressing particular principles associated with various human factors issues. For example, task design and job organisation is characterised by issues such as:

- ensuring required choices of behaviour are clear and unambiguous,
- assisting with high or multiple workloads,
- optimising levels of activity,
- providing clear allocation of responsibility,
- meeting personal needs and values (job satisfactions),
- Learning lessons by reviewing up the incidents and near misses reporting.
- Audit questions are then provided to examine each of these issues and to identify any shortcomings. These audit questions may be reflected in a marine context such as:
- ”Are crew members expected to resolve conflicts between productivity and safety?” This should be avoided wherever possible, but if required to do so, the crew must be given clear guidance on such conflicts and the required priorities.
- If by consequence a crew failing to detect an abnormal state (to take appropriate action) is high, he will attempt to reduce the potential for such errors, thus increasing the probability of false alarms. False alarms have to be accepted as indications that the crews are trying to reduce the potential for important missed signals and the consequence hazards which might arise.

The use of audit questions, such as those given above, across all human factors areas discussed, enables the analyst to identify critical human factors issues where improvements could be made, and so the potential for human error is reduced. The adoption of sound human factors principles, such as designing controls and displays in accordance with ergonomics standards or the use of human factors audits, may not be sufficient by itself, however. The design of the interfaces, procedures, training programmes and task organisation should also take into account the specific tasks to be carried out, the capabilities, and the limitations of the crew designed to perform them (IMAS, May 1995 pp173).

6.2 Task Analysis

Task analysis is the study of what an operator is required to do in terms of actions and cognitive processes to achieve a system goal. Task analysis in global term for a variety of specific techniques which collect information about tasks, organise it and use to make various judgements and design decisions. The primary purpose of task analysis is to compare the demands of the system with the capabilities of the human operator, and, if necessary, to change those demands to reduce the potential for error and improve human performance. It is a process of data collection, representation, analysis and sometimes simulation (IMAS, May 1995 pp174).

6.2.1 Hierarchical Task Analysis

This is best known task analysis technique. It is used to present the relationship between tasks and subtasks, recording system requirements or functions, and how these are to be achieved. Plans are also developed, along with hierarchical structure operations, which enable the technique to record the order in which the tasks and subtasks are to be performed.

HTA is often used to develop a framework within which other task analysis techniques are applied. For instance, within the process of carrying out an HTA there frequently requirements to identify when operations must be done, how quickly they must be done or what sort of difficulties may be incurred. These may be identified by discussion with a task expert, or by simple observation, but it may also be beneficial to adopt another complementary task analysis approach, which may be suited to such data collection.

HTA is a general method, which can be applied in all of the application areas discussed above (6.2). It is, perhaps, best developed in collaboration between the task analyst and people involved in actual operations, including managers, engineers and other operations staff. It is collaboration, which often provides the strength of the analysis, by ensuring the adequacy and completeness of the information gathered. It is this very same attribute which has led to the Hazard and Operability (HAZOP) study technique being recognised and adopted internationally as one of the most powerful hazard identification techniques (IMAS, May 1995 pp174).

6.2.2 **Task Decomposition (Tabular Task Analysis)**

Task decomposition is used to expand upon a basic description of the activities, which make up each task element. As such, it requires a set of basic task descriptions, most usually developed from an HTA, previously described. It is often referred to by the term tabular task analysis, which reflects the presentation of the information gathered in the task decomposition process.

The choice of decomposition categories depends entirely upon the purpose of the analysis and the information requirements of the analyst. Often, the information gathered in a task decomposition process is used to determine control and information requirements or to assess the adequacy of control and information provisions. It can, however, be used to meet organisation-specific requirements, for example by identifying relevant codes of practise or standards applicable to any task, or by identifying the safety classification of equipment used.

The information can also form the fundamental basis for design decision and provide detailed background information for discussion of particular issues. The method provides a structured framework for the gathering of information, whilst remaining flexible in enabling the analyst to develop the information required to address particular issues in as much detail as necessary (IMAS, May 1995 pp174).

6.2.3 Benefits of Task Analysis

The benefits of carrying a task analysis are dependent upon the goal of the study, or the particular human factors issue addressed. The main generic benefits from a safety and quality perceptive are, however:

- it allows mismatches between a design engineer’s view of a system and human capabilities needed to operate the system to be resolved and the potential for error to reduced (e.g. by the removal of error production conditions):

- It provides a formal, structured and documented assessment of the human contribution to system performance; upon which to base subsequent design decisions.

6.3 Human Error Assessment

In addition to systematically addressing human factors principles and analysing task requirements to optimise human performance, industries where a safety case regime exists have also been assessing, where required, reliability of human operators. More recently, the offshore industries, the contribution of the human element to the risks arising from their operations has been assessed as part of the safety case development. This has typically included both qualitative and quantitative assessments.

Qualitative studies include identification of potential human errors and their consequences, as well as other human factors studies in support of the safety case, e.g. modelling of human behaviour during emergencies in support of escape, evacuation and rescue analysis.

Before any attempt to assess potential human errors (or to quantify human reliability) is made, it is essential that a task analysis be carried as discussed earlier. The task analysis identifies what the human should be doing, how he should be doing it, when he should act, what controls and displays he should use, and what other factors might influence his performance. It is an essential precursor to any human error or reliability analysis.

Potential human errors are identified using a checklist approach, related to potential error types. This identifies the errors in terms of the way they are revealed (the external error modes). Typical error modes include, for example: action omitted:

action too early or too late: wrong information obtained: or check omitted.
Now at this stage we may consider the consequences of the potential errors identified, in line with general process of hazard analysis. At this stage, errors may be investigated from detailed consideration, for example if the consequences of errors are insignificant, then the potential for recovery is to be judged very high, and also if the probability of the error occurring is judged to be so remote as to be considered incredible. In any case, the qualitative assessment of the consequences of potential for errors which have been identified, may well point the way to critical issues where the potential for error should be reduced, without the need for detailed quantification of error probabilities and assessment of the associated risks.

6.4 Human Reliability Assessment

It is often said that 90% of the benefits of a goal-setting, risk assessment-based approach come without quantification. The same is true of human error and human reliability assessment (HRA). It is the systematic process of assessment, which is more important than the ”numbers” generated. Indeed, the accuracy of quantification of human reliability is only good as the qualitative assessment of human tasks and errors: i.e. the task analysis and human error analysis must be accurate representations of what is actually done and the potential errors which may arise.

HRA techniques fall primary into two categories:

- Data-based approaches or
- Expert judgement-based approaches.

Database approaches include technique for the human error rate prediction (THERP) and the human error assessment and reduction technique.

The choice of HRA technique depends upon such factors as: the nature of human errors to be assessed, the perceived validity of the methods in the scenarios of concern, the equivalent risk modelling of equipment failures, and the sources available to the analyst. As well as providing a balanced consideration of the risk

arising from one’s operations (i.e. human as well as equipment failure), HRA may also lead to the identification of additional error reduction mechanisms and strategies which should reasonable be adopted in line with the ALARP principle.
The benefit of HRA over solely qualitative studies is that it allows direct comparison of the risk reduction, which may be achieved through various design options, and therefore facilitates the process of cost-benefit analysis.

6.5 Training:

The U.S. Coast Guard has introduced the team approach to reduce human error accidents. They applied human factor research to improve upon Bridge Resource Management principles. The Coast Guard as a regulatory agency Advocates Bridge Resource Management as an effective tool to combat human errors in ship navigation. This concept develops skills, which are universally applicable to operational teams performing complex tasks in a highly dynamic environment.

Introduction of Bridge Resource Management came after Coast Guard failed to prevent marine accidents even when they had instituted several controls, including periodic examinations for its deck watch officers and a rigorous seamanship refresher school for prospective Commanding officers and executive officers. Basically, the team training was given at the unit and involved lecture, classroom discussion, exercises, and case studies. The training was designed to facilitate open discussion between different ranks. Training included: structured decision-making and risk management: methods to detect and eliminate poor judgement claims: ways to recognise a person’s loss of situational awareness and how to regain it: methods to enhance team communication: recognition of hazardous attitudes: and ways to recognise and control stress.

The training for individuals covered mission briefing, promoting assertive communications, challenging perceptions to maintain situational awareness, error recognition, decision-making, work delegation and monitoring crew performance.

6.6 ISM CODE

The International Maritime Organisation (IMO) has developed and adopted the International Management Code for the Safe Operations of Ships and for Pollution Prevention (A.741 (18)) as Chapter of the Safety of Life at sea (SOLAS) Convention. Though it has historically been a requirement for the vessel crews to be properly certified before going to sea, the owners or operators have not been subject to requirements that certify their ability to manage safely the operations of these vessels. The ISM Code is the IMO's first step in a number of initiatives to address the human element in marine safety. As a part of ISM Code, teamwork can be further developed on board ships in order to minimise marine accidents, and of course, will increase a safety culture in the following ways:

6.6.1. Establishment of a team culture and accepted working practises

Sometimes organisations decide to embrace a new culture, which requires the whole organisation committed in a team approach. In these cases it requires fundamental changes of attitude and behaviour for the workforce. It is unfortunate that there have been many instances where such initiatives have also gone hand-in-hand with other efficiency drives such as downsizing and relocation. Naturally when this happens the reaction to team working has been less enthusiastic. But important characteristics of successful implementation include commitment from the top, inspirational leadership, clarity of direction and mission, a willingness to involve seafarers and responsibility down the lower rank, clear communication and demonstrable improvements which show behavioural commitment to change at all levels.

6.6.2. Coaching individual members in a team

Coaching involves developing the abilities of seafarers to produce what is required and then promoting awareness to recognise the situation and the responsibility to act appropriately. Also coaching involves one-to-one techniques as coaching a football team. As a coach has to spend time to know seafarers and likewise seafarers get to know a Coach. This is an exceptional valuable investment because it enables team members to work through their emotions and concerns - issues such as am I good enough? `, What ‘s going on? `And so on - and this end up for them being able to offer each other their strengths and weaknesses. A coach should try to unlock what’s already there and encourage creativity and innovations among the team members. The key which unlocks the team members potential is effective questioning. This technique should help to raise the team members' awareness of what is happening and this should encourage them to take responsibility, both individually and as a team, for achieving success. Unfortunately, people tend only to praise performance. This can be de-motivating if the team or its members are not achieving what is being expected of them. And, while people concentrate on judging performance, they can fail to recognise ideas and the actual activity. The key to coaching team successfully is establishment of personal relationship, develop trust, respect and common understanding despite language and culture barriers between team members, passion and a belief in people. For example, the coach onboard ship may be either a Captain or Chief Engineer.

6.6.3. The Rip-Free Team

The shipping companies should be ready to assess their readiness for implementing new methods of team working. As the shipping business seek to become more efficient they cannot overlook the advantages offered by flexible, self-disciplined, multi-skilled work team. Workers, meanwhile, also recognise the benefits to learn different job skills and feel as valuable and respected members of their organisation. The team concept must fit into the larger shipping company culture and be compatible with the company’s overall maritime safety proactive objectives. Making the investment decision to establish teams includes assessing the organisation’s long- term safety needs and define role and importance of team, within the larger maritime safety proactive context. It is important to determine if the shipping company's vision and values are sufficiently clear and compatible to enable an empowered team to operate. For example, safety is an overriding value onboard ship. Any team member can shut down a generator if safety thought to be compromised. Of course, this is an expensive decision for the crew to make, but the company looks to team working to achieve its fundamental safety proactive objectives and is prepared to empower its workers to that level.

6.6.4. Change of people's attitudes and behaviours

Achieving change within team working onboard ships is one of the most challenging issues facing any master chief engineer. The drive for change is often the respond to technical demands. The focus is frequently to review operational procedures, maintenance schedules and team working strategies. However, successfully change only comes when seafarers attitudes and behaviour, not just processes are changed. Seafarer attitudes and behaviour can develop to create the concept of one operation, one Team. In order to develop these, issues like communication and trust are important to develop a cohesive team. This may be attained by providing a non-threating arena where seafarers could evaluate individual behaviour and the team dynamics, whilst building a team identity and commitment.

6.6.5. Trust & Team Leader

6.6.5.1. How to destroy trust?

First raise expectation; then fail to deliver. Here a leader has failed to deliver what is expected of him in the first place when he joined the company. As a matter of fact he has destroyed trust from him by the team members.

6.6.5.2. How to build trust?

1. Tell your Team the score i.e. demonstrate your commitment to openness.
2. Identify your Team concerns. That is to say, spend time with each Team member doing their work along side with them.
3. Ask a lot of questions and do a lot of listening.

4. Lead decisively. To involve all Team members in decisions which affect them. Of course, as deems fit, to take decision oneself on fundamental issues like dismissing a Team member who is no longer willing or able to contribute?
5. Act consistently. Consistently with beliefs and values, and consistently with the promises, you have made. People should rely on the leader, and reliability is the cornerstone of the trust.

6.7 To think the unthinkable

Most companies don't factor in the possibility of catastrophes or their Potential costs when making decisions. This is classic 'qualitative' oversight by management and results in insufficient resources being allocated to managing safety. Once this critical step is taken, it paves the way for other initiatives, which dramatically reduce the risk of catastrophes. These initiatives coincidentally have a great deal in common with standard quality management practises. They include:

1. Giving those closest to a problem decision making power to respond.
2. Improving internal communication, and especially encouraging employees to come forward with bad news.
3. Not overworking employees.
4. Providing special training to alert workers to potential dangers.
5. Making sure that sophisticated technology does not diminish a worker's ability to assess a situation.

"We sometimes forget that regulations can only be effective if they're properly implemented. And this can only be done by skilled people"

(William O'Neil, Secretary-General of IMO)

CHAPTER 7

Conclusion and Recommendation

This dissertation has discussed human errors and prevention on maritime accidents in Tanzania. Three maritime accident scenarios were reviewed and causes of accidents were established, and to the end prevention techniques were discussed which are available to reduce the potential risks arising from human errrors on board ships.

In the preceding chapters, we discussed three scenario type of accidents, Collision, Capsize and Fire or Explosion. But among of these three scenario type of accident, only one scenario whereby the shipbuilder was involved by delivering a faulty ship to the purchaser who were Tanzania Railways Corporation. The ship which was involved in the casualty was MV Bukoba which capsized on 21st May 1996.

So, now we can categorize the causes of human error in Tanzania according to the these three scenario type accidents which are:

7.1 **Collision**

In this scenario the following were the causes of accident:

- Master left the bridge to the command of the unqualified personnel
- Management did not have proper procedure for the employment of seafarers

All these causes were the result of severe violation of rules, regulations or procedures at all level i.e management ashore or management on board ship.

7.2 Capsizing

In this scenario the following were the causes of accident:

- A ship builder delivered a faulty ship and this was caused by skilled based performance on the part of the builder.
- The ship was overloaded and this resulted in the heavy list. This was basically a severe violation of rules, regulations or procedure in the part of the management ashore and management onboard ship.

7.3 Fire or explosion

In this scenario the following were the causes of accident:

- The team did not check whether the pipeline had oil and at what pressure
- The divers unfasten the flange and immediately the oil started leaking out and they were told to let go the oil until the next day thinking perhaps the oil in the pipeline would have been finished.
- The tugmaster ordered the boat technician to start the engine in order the boat to be taken away from the incoming fumes

All these above were also serious violations of rules, regulations or procedures of operations in those areas.
We have seen that most of accidents in Tanzania are the result of severe violations Of rules, regulations or procedures which also include

- Lack of experience
- Service condition exceeded
- Preventive maintenance not done
- Inadequate firefighting equipment
- Inadequate statutory regulation requirements
- Inadequate owner-operator safety program
- Improper safety precautions
- Failure to use radio telephone
- Inadequate lifesaving equipment.

In order for Tanzania, to achieve measures for prevention or mitigation of marine accidents, must make sure shaping its future shaping its future of maritime safety. This will involve ratification of major IMO conventions which are not yet ratified by the Government of Tanzania as MARPOL, SOLASS, COLREG. This to ensure that Port State Control inspections are conducted according to well established International , IMO agreed criteria and procedures. Other recommendations to the government of Tanzania are as follows:

- It is recommended that the subject of Human error should form a part of the courses in the Maritime Institute. With introduction of Human error subject into the Maritime Education and Training Institutions world wide, through the STCW 95, hopefully, it will be common knowledge soon to every seafarer.

- The adoption of appropriate task analysis techniques to assess and document formally the process of designing tasks, procedures, job aids, training programmes, etc, so that the jobs allocated to crew members are within their capabilities and limitations and the potential for errors is minimised. For example, task analysis could be used to ensure that the reductions in manning levels are only carried out where it is safe to do so, and that the potential for error is not increased as a result.

- The audit of existing vessels against the standards and guidance identified such as operating and maintenance procedures, task organisation and job design and training requirements, methods and evaluation, to identify any particular short comings in these areas. This would enable the typically limited resources available to be targeted where they are needed most.

- The identification of critical human tasks in relation to the safety of a vessels operation, and , for these tasks, the performance of a systematic human error assessment. In the future this might include a quantified human reliability assessment, possibly in conjunction with an Formal Safety Assessment of the vessel.

- A successful implementation of these recommendations will contribute greatly towards establishing the desired safety culture in shipping. The role of education must be pivotal in this process in that a change in attitude must come first.

"Prevention begins with understanding"

(BIMCO vol.94.No 1-99 pp 25)

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Appendix 1

Description and examples of Inattention as a specific failure mode under skilled based performance

(TSB, February 1997)

1. Capture Error

Definition: This error occur when a sequence being performed is similar to a more familiar sequence, and stronger plan of the familiar sequence "captures" control of the action. The outcome generally, is a strong habit intrusion.

Common example: In January, people often incorrectly place the previous year in the date slot on cheques.

Summary: The defining characteristic of a Capture Error is that a strong habit interferes with the performance of the intended action.

2. Description Error

Definition: This slip may result when our internal description of the intended action is not sufficiently precise. A description error usually results in performing the correct action on the wrong object. The more the wrong and right objects have in common (especially approximate physical location), the more likely the error is to occur. Also, being distracted, bored, preoccupied, under stress, and not inclined to pay full attention to the task can lead to description errors.

Common example: In the kitchen after peeling potatoes, a person may throw the potatoes in the garbage and place the peelings in the pot of boiling water.

Summary: The defining characteristic of a Description Error is that ambiguity and/or distractions interfere with performance of the intended action. Usually the correct action is performed on the wrong object.

3. Omission following Interruption

Definition: The required attention check is interrupted by some external event; the original action sequence continues but with parts of it omitted as a result of the interruption. Indeed, the interruption may even become part of the original sequence.

Common example: While monitoring the cooking of food on a barbecue, your planned check on the food status and adjustment of the heat at the 5-minute mark may be interrupted by a telephone call. When you return shortly to the barbecue, you check the food but do not adjust the heat level. Later when you check the food status at the 10-minute mark, you find the food has been singed.

Summary: The defining characteristics of an Omission following Interruption error are,

3.1. An interruption disrupts an attention check; and

3.2. An omission in the original action sequence results from the interruption.

4. Reduced Intentionality

Definition: If there is a delay between the formulation of an intended action and the time it is carried out, and the appropriate attention checks are not made, the intended action will become overlaid by other demands.

Common example: Quite frequently, a person entering a room, such as the kitchen at home, will wonder why he/she had intended to end up there. What has likely happened is that while en route to the kitchen, the individual's thoughts became focused on matters other than the reason for going to this room. Often, an individual will need to backtrack in thought, and sometimes-physical location, to remember the original intention, such as getting a glass of water for someone.

Summary: The defining characteristics of a Reduced Intentionality error are

4.1. There is a delay between planning and execution an action.

4.2. The appropriate attention checks are not made; and

4.3. Actions stemming from other demands replace the intended action.

5. **Mode Error**

Definition: A mode Error can occur when a situation is falsely classified, and the resulting actions are inappropriate. The misclassification is termed a Mode Error when equipment is designed to have more actions than it has controls or displays, so the controls are required to do more than one action.

When the equipment does not make the mode in which it is operating visible (for example, "on/off"), the information provided to the operator is ambiguous and mode are likely.

Common example: On many small battery-powered radios, the "on/off" control is often also the volume control. If the volume is turned down in order to attend to other information, the radio can be inadvertently left on for long periods of time and battery power drained.

Summary: The defining characteristics of a Mode Error are:

5.1. The equipment in use provides ambiguous information regarding control functions;

5.2. The user unsure of the mode status of the equipment and chooses inappropriate actions

6. **Perceptual Confusion**

Definition: During highly routine tasks, one object is accepted as a match for the intended object because it looks like the intended object, is in the expected location, and/or it does a similar job.

Common example: In the shower, hair conditioner is applied before shampoo. The tube of hair conditioner is accepted as a match for the tube of shampoo because the two tubes look alike, the tube of hair conditioner is in the expected location of the tube of shampoo, and the two have similar functions.

Summary: The defining characteristics of Perceptual Confusion slips are:

6.1. The task is highly routine;

6.2. A rough approximation is accepted for the real object;

6.3. The rough approximation looks like, is in the location, and/or does similar job as the real object.

Appendix 2

Description and examples of Overattention as a specific failure mode under skilled based performance

(TSB, February 1997)

1. Omission

Definition: Attending to the progress of an action sequence at the wrong time can result in the assessment that the process is further along than it actually is, and as a consequence, some necessary step in the sequence can be omitted.

Common example: In the process of preparing a pot of tea while waiting for the water to boil, a person may check the status of the boiling water too late and forget to place a tea bag in the pot.

Summary: The defining characteristics of an Omission error are:

1.1. There is an inappropriate-timed check of an action sequence;

1.2. The assessment is that the action sequence is further along than it really is; and

1.3. A segment of the action sequence is omitted.

2. Repetition

Definition: Attending to the progress of an action sequence at the wrong time can result in the assessment that the process is not at the point where in fact it actually is, and an action already done is repeated.

Common example: In the process of preparing a pot of tea while waiting for the water to boil, a person may check the status of the boiling water too early and place a tea bag in the pot. A second check may be made a short time later and another tea bag inadvertently added to the teapot.

Summary: The defining characteristics of a Repetition error are:

2.1. There is an inappropriately-timed check of an action sequence; and

2.2. The assessment is that the action sequence is not as far as along as it really is; and

2.3. A segment of the action sequence is repeated.

3. Reversals

Definition: Mistimed checks can cause an action sequence to double back on itself.

Common example: After a checklist sequence is interrupted, the checklist is resumed at the wrong place and previously set switch reset. Often people, rather than consciously turning a system on, move the selector from where it is to "where it is not".

Summary: The defining characteristics of a Reversals error are:

3.1. There is an inappropriately-timed check of a bi-directional action sequence (note: the "bi-directional action sequence" refers to the opportunity for the action to take one of two alternate paths); and

3.2. The action sequence is reversed.

Appendix 3

Description of misapplication good rules as a specific failure mode under ruled based performance

(TSB, February 1997)

1. Rule Strength

Definition: Strength of a rule depends on the number of times the rule has achieved a successful outcome. The more successful the rule, the stronger the rule becomes. In turn the stronger the rule, the more likely it will be chosen, even when the match between the situation and rule are less than perfect.

Common example: In the city of Dar-Es-salaam, a driver may turn right on a red light signal after bringing the vehicle to a complete stop and if the roadway is clear. When travelling in another city for the first time where this is not permitted, such as Mwanza, Dar-Es-salaam driver may incorrectly apply this rule.

Summary: The defining characteristic of a Rule Strength error is that an incorrect rule for the situation is chosen because it has been used successfully frequently in the past.

2. General Rules

Definition: General rules are stronger than specific rules simply because they are encountered more frequently in the world.

Common example: Generally in North America, the flicking of a wall switch to the "up" position activates room lights. This movement stereotype of the "up" position being associated with the "on" position has become a general rule used by North American designers in the development of a variety of machines, tools and appliances. However, equipment built in other parts of the world, such as Europe and Africa, use the reverse of this rule. For the Canadian user of foreign equipment, the general rule of "up" equal to "on" would result in an incorrect control action.

Summary: The defining characteristic of a General Rule error is that an incorrect rule for the situation is chosen because of its greater frequency of occurrence.

3. **Information Overload**

Definition: The amount of information confronting the decision-maker is so abundant that it exceeds the capacity of the cognitive system to capture and process all indications of the local situation. Without specific information about the true local situation, people may revert to other "Misapplication of Good Rules" errors, such as Rule Strength or a General Rule; i.e. they would be inappropriate for this particular local situation.

Common example: When driving a rented car which is very different from your own personal vehicle, locating and activating the real window defrost switch during a severe storm may be difficult. While attending to the numerous and varied cues in the external environment, the driver must first search for the location of the correct control switch and then decide upon the correct control action. For both of these activities, it is understandable that in stressful situations the driver may resort to strong or general rules derived from previous experiences in his personal vehicle.

Summary: The defining characteristic of an Informational Overload is that an incorrect rule for the situation is chosen because of an overwhelming amount of information confronting the decision-maker.

4. First Exceptions

Definition: The first time a person encounters a significant exception to a general rule, that general rule, particularly if it has been very reliable in the past, will continue to "rule" or govern.

Common example: Every morning an individual catches the intercity train at Platform #1 to take him to work. On one particular morning, he notices that a number of fellow commuters are waiting at Platform #2. H e disregards this cue that there has been a change in the waiting area on this morning and mistakenly continues to wait at Platform #1 for his train.

Summary: The defining characteristic of a First Exceptions error is that an incorrect general rule for the situation is chosen because the decision-maker finds difficult to make the first-time choice of the correct alternative.

5. Rigidity

Definition: If a rule has been successfully used in the past, there is an overwhelming tendency (almost stubbornness) to use it again even when the circumstances do not warrant its uses. So strong are such rules, that we will apply familiar but cumbersome solutions even when simpler and more elegant solutions are readily available.

Common example: "To every person with a hammer, every problem looks like a nail". In industry if a successful Workplace Hazardous Materials Information System (WHMIS) program has been introduced, a safety officer may demand that WHMIS-specific training be used to resolve all accidents involving hazardous materials. In some cases, actual redesign may be more appropriate rather than the hazardous material awareness training.

Summary: The defining characteristic of a Rigidity error is that an incorrect rule is chosen because the decision-maker strongly believes in its "correctness", despite the presence of more appropriate options.

Appendix 4

Description and examples of Bad rules (Plans) as a specific failure mode under Rule-based performance

(TSB, February 1997)

1. Wrong Rules

Definition: The "wrongness" in this type of error stems from a defect or weakness in the strategy of the rule itself.

Common example: Increasing speed and advancing through an intersection whenever an amber traffic light is encountered is a common driving behaviour. However, the amber traffic light is a cautionary and it is bad logic to assume one always has a clear path.

Summary: Th defining characteristic of a Wrong Rule is that a rule choice is deemed incorrect because the plan or structure of the rule is flawed.

2. **Inelegant or Clumsy Rules**

Definition: Without the benefit of expert instruction or because one is operating in a forgiving environment, we may employ solutions that are clumsy, circuitous or even bizarre, but they work and may even become established as part of our rule-based procedures.

Common example: The striking of a "sticky" valve handle, with a hammer or heavy screw driver, in order to loosen the valve so it can be adjusted, is bad work practise that can become an "unofficial" procedure passed from worker to worker.

Summary: The defining characteristic of an Inelegant or Clumsy Rule is that an inefficient rule is permitted to flourish because checks within the operating environment do not exist or have not functioned properly.

3. Inadvisable Rules

Definition: Although this type of rule may be perfectly adequate to achieve its immediate goal most of the time, continuing to use it in the long run is advisable because it can lead to avoidable accidents. Typically, this type of rule violates established codes or operating procedures, and, in the long run, such activity can result in an accident.

Common example: It is a common practise for workers not to wear mandatory eye protection when performing hammering tasks so as not to obscure their vision while performing these tasks. For the most part, this rule works. However at some point, it will be necessary to hammer overhead or in other positions where there is a greater danger that something (e.g. metal/wood splinter or dust) could fall into one's eyes.

Summary: The defining characteristics of an Inadvisable Rule are:

3.1. Although the rule works, there is high accident risk associated with its use; and

3.2. The rule breaches established procedures, standards, etc.

Appendix 5

Description and examples of Bias as a specific failure mode under Knowledge based performance

(TSB, February 1997)

1. **Confirmation Bias**.

Definition: This is the tendency to seek information that will confirm what we already believe to be true. Information that is inconsistent with the chosen hypothesis is then ignored or discounted.

Common example: In the news media, we are often informed of a transgression or crime that may have been committed by a celebrity. Based on the initial account, we decide whether the person is guilty. Then as further information is revealed we tend to only look for and except those bits of data which confirm our initial assessment of the individual's guilty.

Summary: The defining characteristic of a Confirmation Bias error is that attention is only given to information that supports a previously chosen hypothesis.

2. **Salience Bias**.

Definition: This is the tendency to focus on physically important characteristics or evidence (e.g. loud, bright, recent, centrally visible, easy to interpret) and ignore critical cues that might provide diagnostic information about the nature of a problem. Salience bias results from the fact that decision-makers do not necessary process all information available to them, particularly under times of tress. This bias is known as "selectivity" due to the selective processing of information that is engaged by a decision-maker.

Common example: In searching for a car engine faulty, a mechanic may limit his focus to those physically salient symptoms (such as noise, heat, and smell, and ignore other critical cues, such as a driver input or diagnostic instrument tests), that might shed more light on the true nature of the faulty.

Summary: The defining characteristic of a Salience Bias error is that attention is either given to the wrong characteristics or given to the right characteristics.

3. Framing Bias.

Definition: In risky decision-making, there is tendency to frame the problem as choice between gains or between losses. With respect to losses, people are biased to choose the risky loss which is less probable although more disastrous, rather than the certain loss.

Common example: When returning to Tanzania from a visit to a Germany, many people choose not to declare certain items requiring the payment of duty. If initially claimed, there will a known cost (certain loss). If one is caught without claiming the items, the unknown cost (risky loss) could be much greater, but is considered less likely to occur.

Summary: The defining characteristics of a Framing error are:

3.1. Are alternatives are rated in terms of losses (or gains); and

3.2. Given the choice between a sure loss versus an uncertain probability of disaster of disaster, people are biased towards the risky choice.

4. Overconfidence Bias.

Definition: There is a tendency for people to overestimate the correctness of their knowledge of the situation and its outcome. The result is that attention is placed only on information that supports their choice and ignores contradictory evidence.

Common example: Inexperienced staff who have just received preliminary job-related training can sometimes fall prey to this bias when attempting to apply their newly attained knowledge. Without the tempering afforded by on-the-job experiences, an individual may overate the utility of "classroom" theory versus the more "work-shop"-oriented knowledge used by peers.

Summary: The defining characteristic of an Overconfidence error is that attention is given to certain information because an individual overrates his/her knowledge of the situation.

Appendix 6

Description and examples of Heuristic as a specific failure mode under Knowledge based performance.

(TSB, February 1997)

1. Representative Heuristic.

Definition: This is the tendency to match cues drawn from a current situation to those that form a mental representation of a particular situation that already exists in long-term memory. Simply stated, a comparison is made between perceived information and what exists in memory. If it is decided that the cues of the current situation match those of a particular situation stored in memory, then the conclusion drawn is that the situations are similar or the same. In turn, it follows that the decision-maker may conclude the actions taken previously are appropriate again. However if the cues perceived from the current situation were not complete or were ambiguous, an incorrect match could occur. Should the pattern of cues in long-term memory not be a good indicator of the current situation, then the person's judgement and decision-making could be faulty. Once a match has been established, people tend to cling to that interpretation, often not changing it despite evidence to the contrary.

Common example: When receiving directions on how to find a specific location of a city that you have visited on a few occasions, your attention may focus on only those street names and landmarks that sound familiar to you. A mental map of your route would be recalled from memory. Since you did not consider the other directional cues, your mental map was probably incorrect for this situation, which most likely resulted in your getting lost.

Summary: The defining characteristics of a Representative Heuristic error include:

1.1. Perceived information is incorrectly matched with specific patterns stored in memory; and

1.2. Current actions taken are incorrect because they are based on the wrong interpretations of the current situation.

2. Availability Heuristic

Definition: This is the tendency to diagnose a situation using the hypothesis most available in memory, i.e. giving undue weight to facts that come readily to mind. The most available hypothesis may not be the most probable, but simply the recently experienced or less complicated one.

Common example: In the "Human Factors in Investigations" course a Professor showed a slide, which had a pattern of lines and asked the course participants to guess what the pattern was or represented. After a short while, he informed us the pattern of lines were of another map. As it turned out, the pattern was of a cow's head.

Summary: The defining characteristic of an Availability Heuristic error is that an inappropriate hypothesis is selected because of its inconvenience.

3. "As if " Heuristic.

Definition: This is the tendency to treat all information sources "as if" they were of equal reliability. Information that is at best marginal is given same degree of reliability as that which is very reliable.

Common example: A simple method to measure one's heart or pulse rate is to press lightly with two fingers on a blood vessel located near the skin's surface, such as at the wrist or throat, and count the pulses (i.e. surges of blood as the heart pumps). The reliability of this method can be significantly lower than that found with other methods, such as listening for the beating sound with a stethoscope at the chest level or use of an electrocardiogram machine to measure the electrical activity of the heart. For a general description of the heart function, the wrist or throat palpation may be given similar weighting of reliability to provide adequate information. However in critical situations, the output of an electrocardiogram should be used as measure of heart function.

Summary: The defining characteristic of an "As if" Heuristic error is that all perceived information is incorrectly given the same weighting of reliability.