# A COMPREHENSIVE ANALYSIS OF HAZARD MITIGATION THROUGH SYSTEM THEORY – A CASE STUDY OF THE MV MORNING BIRD FERRY ACCIDENT

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department of Civil Engineering

Sonargaon University

147/I, Green Road, Dhaka-1215, Bangladesh

Section: 20A

Semester Year: 2023

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# MORNING BIRD FERRY ACCIDENT

BY


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# DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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***Dedicated***

*to*

*"Our Beloved Parents"*

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# ABSTRACT

Inland waterway is a natural and relatively cheaper mode of transportation in Bangladesh. It carries a significant portion of total arterial freight traffic and passenger traffic in Bangladesh, thereby, contributing significantly to the national GDP. However, every year many people die, get injured and are reported missing due to inland water transport accidents. The most significant fact is that accidents involving the passenger ships share most of the fatality of overall maritime accidents in Bangladesh. However, there have been very limited studies to address this vital issue. Most of the studies conducted on the passenger vessel safety are based on simple statistical approach due to lack of adequate accident data. Therefore, the underlying causal factors behind the accidents had never come into the observation of researchers and stakeholders. The present study attempts to perform a hazard analysis of MV Morning Bird Ferry Accident-2020 by applying the Casual Analysis of System Theory (CAST) method. This method can identify the causal factors and hazardous scenarios, particularly those related to system design, human behavior.

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# INTRODUCTION

## 1.1 Background

Being a riverine country, the inland water transportation carries above 50% of the total arterial traffic and one-fourth of total passenger traffic in Bangladesh. Therefore, the inland water transport sector has a significant contribution to the national GDP (0.71%) of Bangladesh (Bangladesh Bureau of Statistics, 2018). Different types of watercrafts like Passenger vessels, cargo vessels, container ships, oil tankers, tugboats, dumb barges, trawlers and country boats etc. ply in the inland waterways of Bangladesh. The number of unregistered vessels in Bangladesh is approximately more than three times than the registered ones. Huge numbers of bulkheads move during day and night creating a high risk for other types of vessels. In particular, the risk is higher for the passenger vessels which mostly operate during night. Most of the water vessel in Bangladesh are not properly maintained in physical condition. There is a shortage of skilled workers and properly educated people. Large and small ships are plying simultaneously in inland waterways. Complex flow patterns also occur between them and mixed traffic. Most of them do not have separate routes specified. In case of a waterway accident has been loss minimum 40 life. So, it’s just to need a proper safety guideline.

## 1.2 Problem Statement

The research addresses the critical issue of maritime safety in Bangladesh's waterways, highlighted by the MV Morning Bird ferry accident resulting in a substantial loss of lives. The identified challenges include the movement of unregistered and unfit vessels.

## 1.3 Motivation

The MV Morning Bird ferry accident, extensively covered by news portals and media, serves as a tragic reminder of the profound consequences of maritime accidents. The motivation for this study is driven by several factors.

The loss of a minimum of 40 lives in the MV Morning Bird accident highlights a significant humanitarian concern. Understanding the root causes and contributing factors is crucial for preventing such tragedies in the future and ensuring the safety of individuals using waterway transportation.

The MV Morning Bird accident brings attention to potential gaps in existing policies and regulations governing waterway safety. By analyzing this incident, the study seeks to provide insights that can influence the development and enhancement of safety regulations in the maritime sector.

Learning from the MV Morning Bird accident can offer valuable lessons for preventing similar incidents. By investigating the contributing factors and recommending improvements, the study aims to contribute to a safer maritime environment.

The study is motivated by a broader goal of contributing to safety science and accident analysis methodologies. By applying the CAST methodology, the research seeks to advance the understanding of complex systems involved in accidents and improve safety assessment practices.

Overall, the motivation behind this study lies in its potential to make a meaningful impact on public safety, regulatory frameworks, and the advancement of safety science in the context of waterway transportation in Bangladesh.

## 1.4 Objectives

The objectives of this thesis are-

1. to build a safety control structure at waterway domain for hazard free environment in Bangladesh by applying the hazard analysis technique named Casual Analysis of Systematic Theory (CAST),
2. to assemble basic information, and
3. to analyze each component in loss and create improvement program also identify control structure flaws.

## 1.5 Organization of The Thesis

**Chapter 1: Introduction.** Brief dicustion of backgrouund of study and motivation of study. Highlight objective of this thesis and problem statement.

**Chapter 2: Literature Review.** Surveys existing accident models and safety methodologies. Explores relevant literature on ferry accidents and causal analysis. Discusses the limitations of traditional accident models.

**Chapter 3: Methodology.** Details the application of the CAST methodology to the MV Morning Bird accident. Describes the systematic analysis of data, system boundaries, and modeling of the accident scenario. Discusses the holistic examination of technical, organizational, and human aspects.

**Chapter 4: Data Collection.** Outline the sources of data, including accident reports, witness testimonies, and expert analyses. Newspaper cutting and online news porta.

**Chapter 5: Data Analysis.** Analyzes the MV morning bird accident at the maritime transportation system level, using the CAST and provides the recommendations and CAST summary.

**Chapter 6: Conclusion and Recommendations**. Summarizes major findings from the study. Reflects on the significance of applying CAST in maritime safety analysis. Concludes with implications for future research and safety practices.

# LITERATURE REVIEW

### 2.1 Introduction

Most of the research papers accompanied by different accidental analysis models demonstrated that Safety Control Structure needed to be ensured to improve a hazard free environment in waterway system. One of the accidental tools called CAST Model which derived from the STAMP (Systems-Theoretic Accident Model and Process), is used to model the multifactorial cause of adverse incidents. Typically, this thesis is conducted by applying this model.

## 2.2 Systems-Theoretic Accident Model and Process (STAMP)

The method is grounded in the hypothesis that accidents result from 'external disturbances, component failures, or dysfunctional interactions among system components (Leveson, 2004) that are not adequately constrained or controlled by the system.

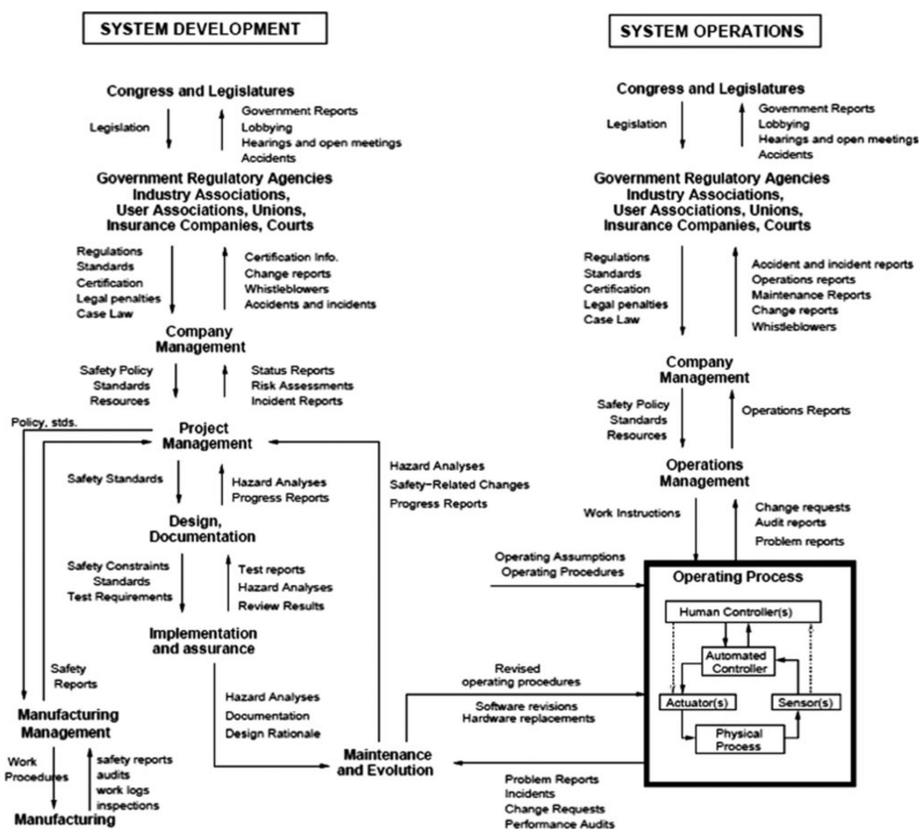


Figure 2-1. Generic Control Structure Model (Leveson, 2004)

**Advantages of STAMP**

1. Leveson (2004) argues that the STAMP control flaws classification scheme provides a few different levels of analysis which can explore accident causation at a few stages of abstraction.
2. The method allows for the exploration of relationships between factors, including non-linear relationships (Leveson, 2004).
3. Leveson (2004) posits that the method can be used for accident analysis, hazard analysis and in the development of accident prevention, safety and risk assessment techniques.
4. The comprehensive nature of the technique enables causality to be identified across numerous systemic levels (Leveson, 2004).
5. The method can, and has been, utilized in numerous domains.
6. STAMP includes both a taxonomy of possible failures and a control structure template to guide the analyst in the identification of causal factors.

**Disadvantages of STAMP**

1. The analysis is resource-intensive, especially with respect to time (Braband, Evers and Stefano, 2003).
2. A significant amount of detailed data is required to conduct the comprehensive method.
3. Previous research has highlighted the need to increase the level of guidance within the STAMP method (Almeida and Johnson, 2007; Qureshi, 2007).
4. Previous research by Almeida and Johnson (2007) has also highlighted the inability of STAMP to fully explore the reasoning behind actions within the accident scenario.

## 2.3 Heinrich's Domino Model

Heinrich's Domino Model was developed in 1931 as one of the first general accident models which explains accidents as a series of events or "Dominos." In this model, there is comfort in believing that finding and addressing the root causes can prevent accidents. For the better understanding of the causes of accidents and improving ways to prevent the accidents, Dr. Leveson suggests in her book: Engineering a Safer World (2011): Systems Thinking Applied to Safety, **an approach using systems theory and systems thinking**, which is known as Systems-Theoretic Accident Model and Processes (STAMP) (Nancy G., 2011).

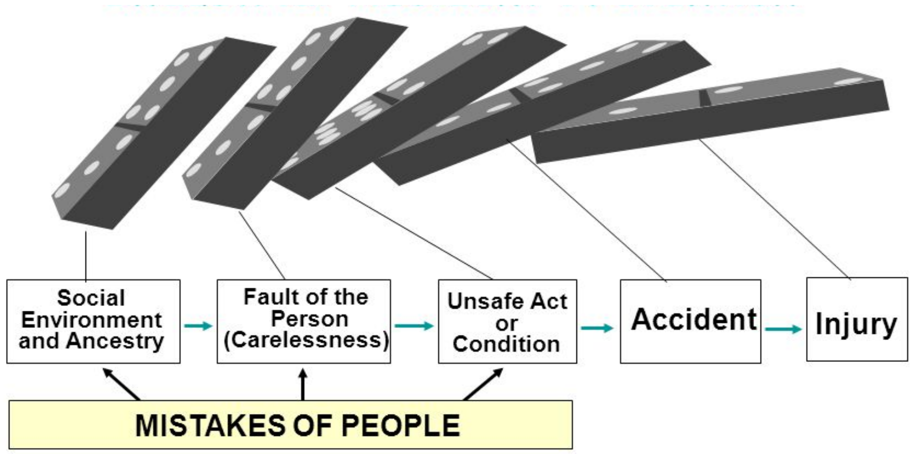


Figure 2-2. Domino Theory of Accident Causation

## 2.4 Accident Causation Models

In addition, Lehto and Salvendy (1991) identified three main classes of **Accident Causation Models**: **(i)** generic accident process models; **(ii)** human error and dangerous behavior models; and **(iii)** human lesions mechanism models.

| | | |
|---|---|---|
| *Human error and dangerous behavior models* | | |
| Behavioral models | Individual human characteristics may contribute for accidents | Discredited |
| Human decision process models | Understanding and predicting human decisions in accidents | No complete explanation of accidents |
| Human information processing models | Describing basic error mechanisms and document the knowledge required to perform tasks safely | No complete explanation of accidents |
| Error taxonomy models | Relation of multiple factors which must be considered for analyzing human error | No complete explanation of accidents |
| *Human lesions mechanism models* | | |
| Cumulative stress models | Relates physical stressors with cumulative damage to people | Fails to directly evaluate causation |
| Immediate lesions modes models | Relates physical stressors with immediate damage to people | Fails to directly evaluate causation |
| Epidemiological models | A framework for analyzing existing accidents | Entirely descriptive and fails to directly evaluate causation |
| Energy transfer models | A set of generic countermeasures strategies | Neglects categories of accidents |
| System models | Performance evaluation and insight into accident causation | Accidents considered as a control problem |

Figure 2-3. Classes of Accident Causation Model

## 2.5 Accident Root Causes Tracing Model (ARCTM)

Besides, Abdelhamid and Everett (2000) developed the Accident Root Causes Tracing Model (ARCTM), aimed at supporting the investigation of the causes of accidents considering three classes of sources: (i) failure to identify unsafe conditions previous to the task starting; (ii) decision to proceed with the task despite identifying unsafe conditions; and (iii) decision to perform a dangerous action, independently of the initial occupational safety and health conditions in the workplace.

## 2.6 Constraints-Response Model

Suraji et al. (2001) developed a model which can be called as "constraints-response" model, considers that the factors explaining accidents can be classified as proximal or distal. Proximal factors are those directly related to accidents while the distal factors are the underlying reasons for the proximal factors.

## 2.7 Human Error Template (HET)

HET (Human Error Template) (Marshall et al., 2003) technique was developed by the ErrorPred consortium specifically for use in the certification of civil flight-deck technology. Along with a distinct shortage of HEI techniques developed specifically for the civil aviation domain, the impetus for HET came from a US Federal Aviation Administration (FAA) report entitled Report on the Interfaces between Flightcrews and Modern Flight Deck Systems (Federal Aviation Administration, 1996), which identified many major design deficiencies and shortcomings in the design process of modern commercial airliner flight decks.

**Advantages of HET**

1. The HET methodology is quick, simple to learn and use and requires very little training.
2. It utilizes a comprehensive error mode taxonomy based upon existing HEI EEM taxonomies, actual pilot error incidence data and pilot error case studies.
3. It is easily auditable as it comes in the form of an error pro-forma.
4. The HET taxonomy prompts the analyst for potential errors.
5. The HFT methodology has encouraging reliability and validity data (Marshall et al., 2003; Salmon et al., 2002; Stanton et al., 2006a).
6. Although the error modes in the HET EEM taxonomy were developed specifically for the aviation domain, they are generic, ensuring that the HET technique can potentially be used in a wide range of different domains, such as command and control, ATC and nuclear reprocessing.
7. It is a useful tool for HF certification (Stanton et al., 2006b).

8. Li et al. (2009) argue that the method enables the design of a user-friendly interface that can improve task performance and increase task effectiveness.

**Disadvantages of HET**

1. For large, complex tasks, an HET analysis may become tedious and time-consuming.
2. Extra work is involved if an HTA is not already available.
3. It does not deal with the cognitive component of errors.
4. It only considers errors at the sharp end of system operation and does not consider system or organizational errors.
5. Stanton et al. (2006b) pointed out that the method was originally developed for use in aviation and application outside of this domain would require adaptation of the method.
6. It is best applied by an analyst with domain relevant knowledge (Stanton et al., 2006b).

## 2.8 Technique for the Retrospective and Predictive Analysis of Cognitive Errors

TRACEr (Technique for the Retrospective and Predictive Analysis of Cognitive Errors) (Shorrock and Kirwan, 2002) is an HFI technique that was developed specifically for use in the ATC domain as part of the human error in European air traffic management project (Isaac, Shorrock and Kirwan, 2002).

**Advantages of TRACEr**

1. The TRACEr technique appears to be a very comprehensive approach to error prediction and error analysis, including IEM, PEM, EEM and PSF analysis.
2. It is based upon sound scientific theory, integrating Wickens' (1992) model of information processing into its model of ATC.
3. In a prototype study (Shorrock, 1997; cited in Shorrock and Kirwan, 2002), a participant questionnaire highlighted comprehensiveness, structure, acceptability of results and usability as strong points of the technique.
4. It has proved successful in analyzing errors from AIRPROX (air proximity) reports and providing error reduction strategies.
5. It has been developed specifically for ATC, based upon previous ATC incidents and interviews with ATC controllers.
6. It considers PSFs within the system that may have contributed to the errors identified.

**Disadvantages of TRACEr**

1. The TRACEr technique appears unnecessarily overcomplicated. A prototype study (Shorrock, 1997; cited in Shorrock and Kirwan, 2002) highlighted a few areas of confusion in participant use of the different categories. Much more simple error analysis techniques exist, such as SHERPA and HET.
2. There is no validation evidence or studies using TRACEr.
3. For complex tasks, a TRACEr analysis may become laborious and unwieldy.
4. A TRACEr analysis typically incurs high resource usage. In a participant questionnaire used in the prototype study, resource usage (time and expertise) was the most reported area of concern (Shorrock and Kirwan, 2002).
5. Training time would be extremely high for such a technique and a sound understanding of psychology would be required to use the technique effectively.
6. Extra work is involved if an HTA not already available.
7. Existing techniques using similar EEM taxonomies appear to be far simpler and much quicker to apply (SHERPA. HET, etc.).

From above all, there is an inadequacy that no researcher worked on CAST model as accidental tool applied on waterway accident for safety control structure in Bangladesh previously. So we want to work on safety control structure in the waterway system.

# METHODOLOGY

## 3.1 Introduction

As discussed in the previous chapter, CAST is a relatively new accident causation model on systems theory. Casual Analysis based systems theory on (CAST) is the hazard analysis technique based on the STAMP model. This chapter will give a brief overview on the fundamental steps that are needed to perform the hazard analysis based.

## 3.2 CAST Analysis

CAST (Causal Analysis Based on Systems Theory) is a structured technique to analyze accident causality from a systems perspective.CAST is an analysis method, not an investigation technique. But performing the CAST analysis as the investigation proceeds will assist in identifying what questions need to be answered and what information needs to be gathered during the investigation to create a comprehensive explanation as to why the loss occurred and to help formulate recommendations to prevent related accidents in the future. Because the cause of an accident is defined in STAMP to be a safety control structure that did not prevent the loss, then the goal of the accident investigation is to identify why the safety control structure was unable to enforce the safety constraint that was violated and to determine what changes in the control structure are required to prevent a related loss in the future. In most cases, investigators will find that there was inadequate control provided at all levels of the safety control structure, not just the lower levels.

To enhance safety using the CAST Analysis Model, follow these steps:

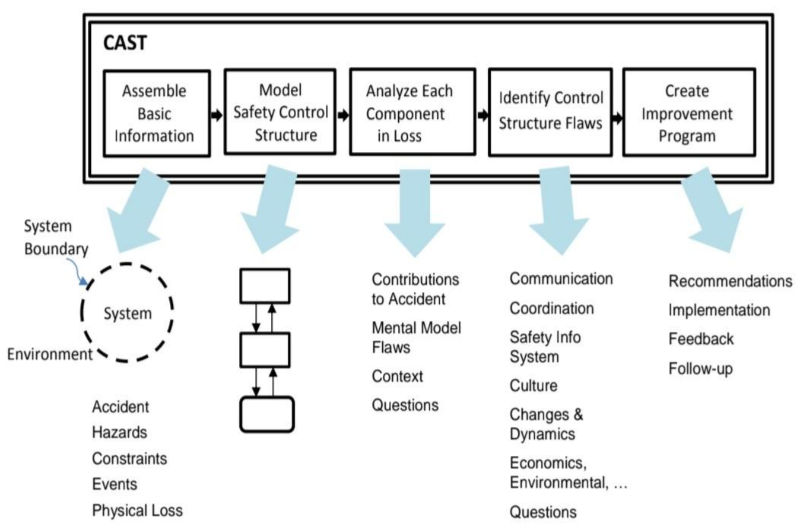


Figure 3-1. CAST Analysis Model

1. **Assemble Basic Information:**

 - Gather comprehensive data about the accident, including events leading up to it, contributing factors, and system characteristics.

2. **Model Safety Control Structure:**

 - Construct a detailed representation of the safety control structure involved, highlighting the interconnected components and their intended functions.

3. **Analyze Each Component in Loss:**

 - Examine each element of the safety control structure to identify weaknesses, failures, or deviations from their intended roles during the accident.

4. **Create Improvement Program:**

 - Develop a structured program to address identified issues, incorporating corrective actions, system enhancements, and procedural improvements.

5. **Identify Control Structure Flaws:**

Focus on uncovering underlying flaws in the control structure, emphasizing systemic issues that hindered the effectiveness of safety measures.

By systematically following these CAST Analysis steps, we aim to shift the focus from isolated failures to understanding why preventive measures fell short, paving the way for targeted improvements to reduce accidents.

# DATA COLLECTION

## 4.1 Introduction

In our country, there is a prevailing tendency to attribute the main responsibility for transportation accidents solely to the driver, absolving others of their share of responsibility. This approach, while seemingly providing a sense of justice by placing blame on the driver, has proven to be fundamentally flawed. Consequently, we find ourselves stuck in a recurring cycle of accidents, with our failure to take effective action perpetuating the issue.

The primary objective of this research is to shed light on waterway accidents, specifically identifying practical factors contributing to these incidents. By scrutinizing the entire infrastructure involved, we aim to pinpoint areas where modifications can be made to prevent such accidents from occurring in the future.

Utilizing the Causal Analysis based on System Theory (CAST) model, our research seeks to challenge the notion that assigning responsibility solely to the driver is sufficient in preventing accidents. Instead, we argue that a comprehensive understanding of the accident's systemic elements, including infrastructure and human behavior, is essential for devising effective preventive measures. This research endeavors to pave the way for a paradigm shift, emphasizing the significance of a sound infrastructure in mitigating transportation accidents.

## 4.2 Summary of ML Morning Bird Ferry Accident 2020

On June 29, 2020, the MV Morning Bird, a ferry navigating the Buriganga River in Dhaka, Bangladesh, tragically sank following a collision with the launch Mayur-2, resulting in the loss of at least 34 lives among the 50 passengers on board. The incident occurred around 9:30 am local time near the Shyambazar area.

The Morning Bird was en route from Munshiganj to the Port of Dhaka, Sadarghat. According to the Bangladesh Inland Water Transport Authority (BIWT) report (Appendix- Picture:1), the Morning Bird departed from Munshiganj's Kathpatti at approximately 7:30 am with 60/70 passengers. The launch was expected to have seven sailors but had only five on board.

The collision took place as the Mayur-2, arriving from Chandpur, was picking up passengers at Lalkuti Ghat. The Morning Bird, without a voyage declaration, sounded a warning whistle, but Mayur-2 failed to respond or take evasive action. Mayur-2 collided with the Morning Bird's rear left side, causing it to turn 90 degrees to the left and eventually sinking. Unfortunately, 34 individuals lost their lives, and several passengers sustained injuries.

Witness accounts revealed that the Morning Bird almost collided with another vessel earlier in its journey. Mayur-2, while leaving Bogdadiya dock upstream, approached the Morning Bird from behind, accelerating excessively. Despite a warning whistle from Morning Bird, Mayur-2 failed to avoid the collision. After the accident, Mayur-2 retreated to Lal Kuthi Ghat and later anchored at the Ultiganj idle berthing ghat.

Meteorological reports on the day of the incident showed no warning messages or fog in the Dhaka region at 9:00 am. The hydrographic chart indicated a water depth of approximately 14 meters at the accident site. The circumstances surrounding the accident underscore the need for a thorough investigation into safety measures, navigation protocols, and response mechanisms to prevent similar tragedies in the future.

# DATA ANALYSIS

## 5.1 Introduction

This chapter mainly intends to accomplish the research objectives by performing a statistical analysis of ML Morning Bird ferry accident 2020 and CAST hazard analysis. Before performing such analysis, the drawbacks of current maritime accident data collection and record-keeping system of Bangladesh will be discussed. The casual analysis is performed to reveal a detailed representation of the safety control structure involved, highlighting the interconnected components and their intended functions. This will reveal Develop a structured program to address identified issues, incorporating corrective actions, system enhancements, and procedural improvements. However, a few important conclusions can be drawn from the casual analysis that is helpful to demonstrate the steps of the CAST analysis for safety of inland passenger ship operation in Bangladesh.

## 5.2 Steps of CAST Analysis

### 5.2.1 CAST Step 1: Identify the System(s) and Hazard(s) Involved in the Loss

ML Morning Bird Ferry Accident was involved a system in two relevant processes being controlled as:

**System 1:** Safe operations of the ferry

**System 2:** Rescue operations of people on the distressed ferry

The system hazards related to the ML Morning Bird Ferry Accident are the following:

**Hazards:**

**1. Navigational Hazards:**

- Haphazard movement of country boats across the river.
- Mix traffic different size of vessels.
- Lack of proper traffic control on the waterway.

**2. Technical Hazards:**

- Movement of a huge number of unregistered vessels;
- Movement of unfit vessels;
- Improper time schedule;

**3. Human-Related Hazards:**

- Lack of trained masters and skilled crew members.
- overtaking and unnecessary competition tendency in driving culture.

**Identify the System Safety Constraints:**

**1. Navigational Safety Constraints:**

- Adequate visibility and awareness of navigational hazards.
- Adherence to established navigation routes and regulations.
- Real-time monitoring of weather conditions.

**2. Technical Safety Constraints:**

- Regular maintenance and inspection of technical components.
- Functioning and reliability of navigation instruments and propulsion systems.
- Emergency response mechanisms for technical failures.

**3. Human-Related Safety Constraints:**

- Crew training and competency in handling emergency situations.
- Adequate rest periods to mitigate fatigue and maintain crew alertness.
- Effective communication and coordination protocols among the crew members.

**4. Organizational Safety Constraints:**

- Clear and comprehensive safety policies and procedures.
- Regular safety audits and assessments.
- Adequate staffing levels to ensure operational safety.

### 5.2.2 CAST Step 2: Document the Safety Control Structure in place to control the hazard and enforce the safety constraints.

A high-level system safety control structure is created to capture the primary controllers, the control actions and feedback. As shown in Fig. 5-1, the system safety control structure is highly simplified and idealized to capture a generalized Maritime Transportation System. As indicated in the high-level safety control structure shown in Fig. 5-2 and 5-3, the CAST analysis has been carried out separately with each system boundary defined for the two processes to include the following:

1. ML Morning Bird Ferry Operations, Maritime Accident Investigation committee, Department of Shipping acting upon the ferry as the controlled process as shown in Fig. 5 -2 (pink area).

2. ML Morning Bird Ferry Operations, Bangladesh Inland Water Transport Authority, and Inland River port Authority controlled process as shown in Fig. 5-3 (green area).

The high-level ML Morning Bird Ferry Operations, Maritime Accident Investigation committee, Department of Shipping, Bangladesh Inland Water Transport Authority, and Inland River port Authority include a number of lower-level controllers as shown in the subsequent control diagrams of the two processes, "Safe operations of the ferry" and "Rescue operations of people on the distressed ferry."

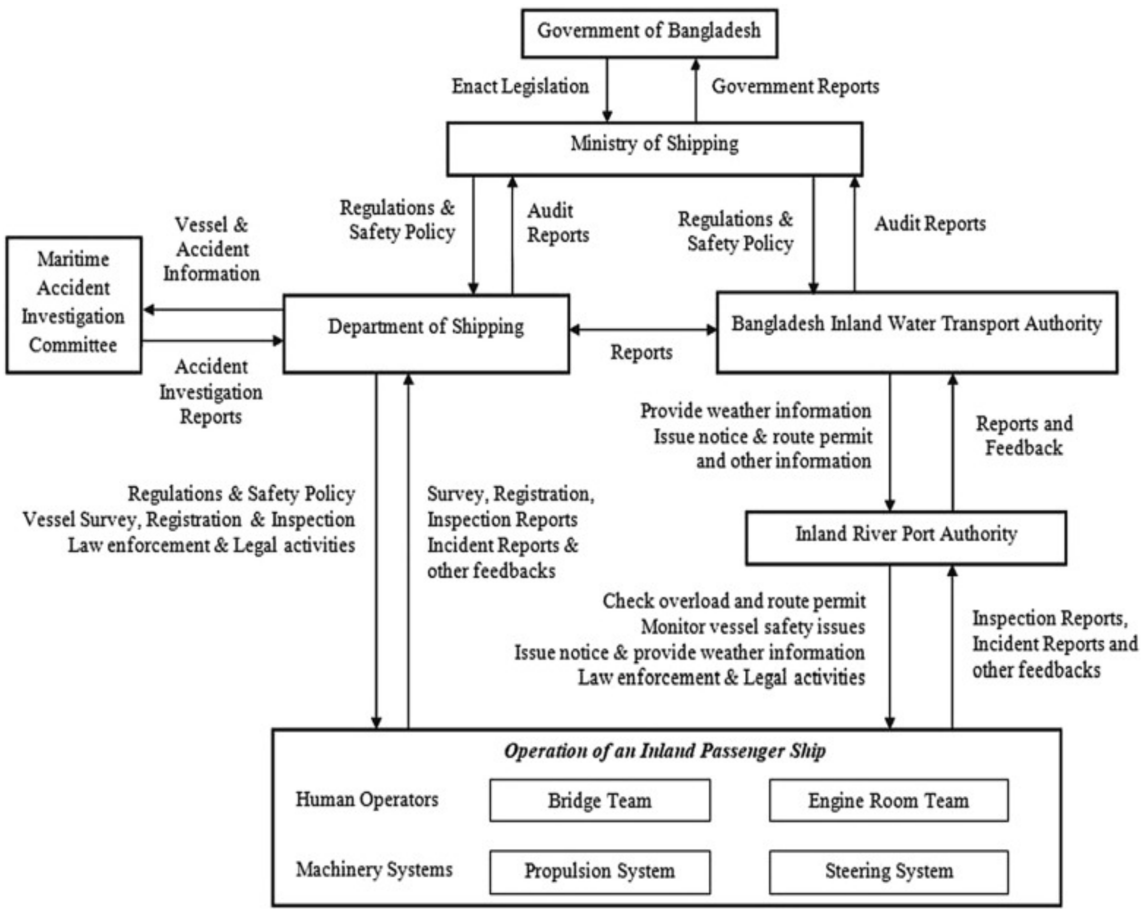


Figure 5-1. The Control Actions and Feedback

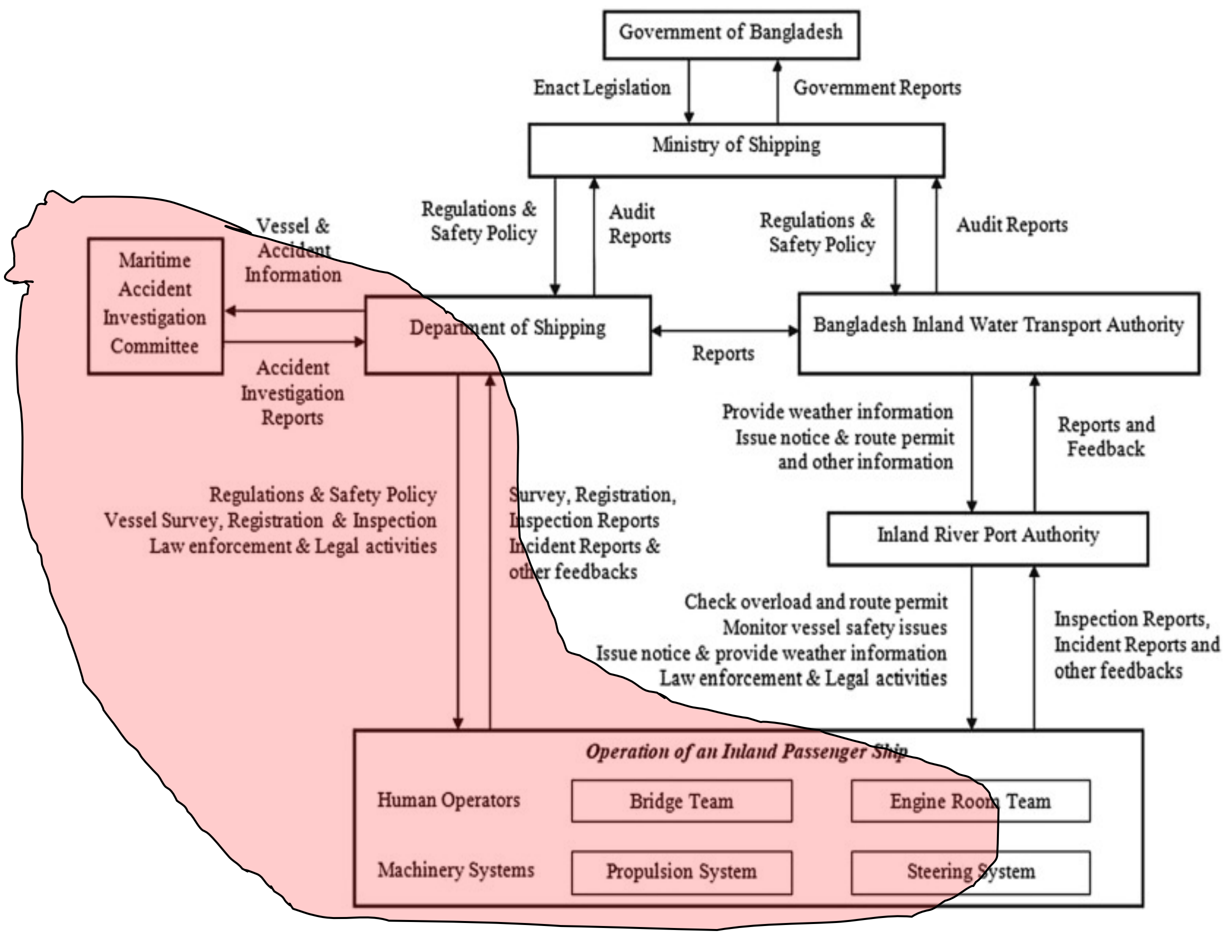


Figure 5-2. The Ferry as the Safety Controlled Process

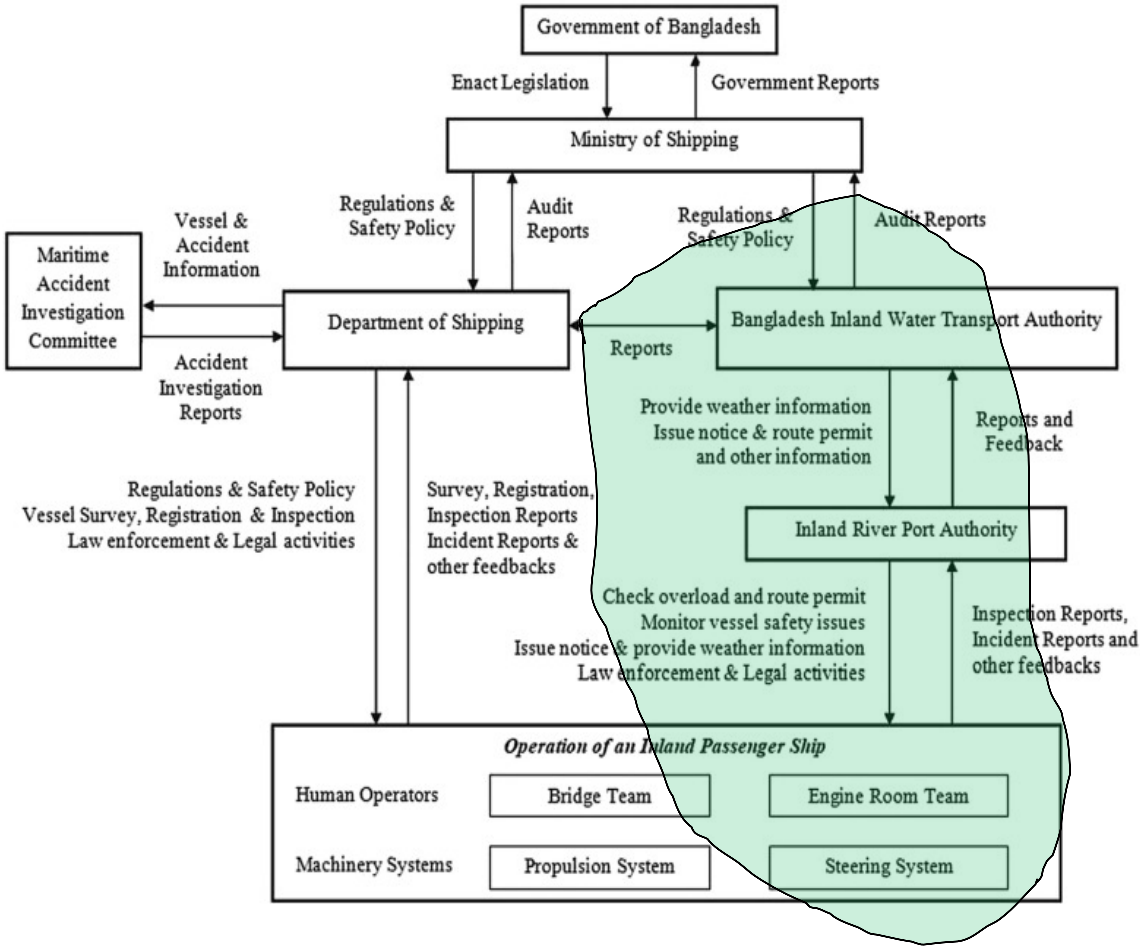


Figure 5-3. Rescue Operations of People Process

### 5.2.3 <u>CAST Step 3:</u> Determine the proximate events leading to the loss.

**Process 1: Safe operations of the ferry**

June 29, 2020

**Time 04:30**- Mayur-2, while leaving Bogdadiya dock upstream,

**Time 07:00**- It seems there is uncertainty about the exact number of passengers on the Morning Bird ferry from Kathpatty. The estimates vary, with some suggesting around 90 to 95 passengers and others mentioning 120 to 125 passengers. Without a voice declaration and the BIWTA supervisor not present, it becomes challenging to determine the accurate count.

**Time 08:30**- ML Morning Bird Launch crossed the Postgola Bridge.

**Time 09:00** (around)- According to the weather forecast at 9 am, there were no warning messages, and there was no fog in the Dhaka region. According to the hydrograph, the water depth at the accident site was 14 meters.

**Time 09:00-** The Mayur-2 launch was seen leaving the dock on the opposite side of Sadarghat.

**Time 09:05**(around)- The Morning Bird launch overtook the Mayur-2 launch.

**Time 09:10**(around)- When the Mayur-2 launch accelerated and passed the left side of the Morning Bird launch and turned its head more to the right, the Morning Bird launch started whistling repeatedly while remaining 8-10 feet away.

**Time 09:13**(around)- Mayur-2 collided with the Morning Bird's rear left side, causing it to turn 90 degrees to the left and eventually sinking. Unfortunately, 34 individuals lost their lives, and several passengers sustained injuries.

**Process 2: Rescue operations of people on the distressed ferry**

June 29, 2020

**Time 09:15-** Upon witnessing the incident, people in the vicinity move forward to help with boats.

**Time 09:14-** The ML Morning Bird Launch sinks in just 21 seconds.

**Time 09:15 (approximately)-** The Mayur-2 launch retreats to the rear.

**Time 09:30-** Some passengers, having swum to safety, begin seeking refuge on a rescue boat.

**Time 09:55-** A total of 150 divers, including senior officers and personnel from other agencies, persist in the ongoing rescue operation.

**Time 17:00 (approximately)**- Around 30 bodies are successfully recovered.

June 30, 2020

**Time 14:30-** The rescue team concluded the rescue operation after finding no body or survivors around the sunken Morning Bird launch.

### 5.2.4 CAST Step 4: Improvement Program for ML Morning Bird Ferry Accident (2020):

1. Enhanced Crew Training:
   Implement comprehensive training programs for the ferry crew, focusing on navigation skills, emergency response procedures, and effective communication protocols.

2. Upgraded Equipment:
   Invest in the latest navigation and communication technology to ensure the ferry is equipped with state-of-the-art systems that enhance operational safety.

3. Safety Protocol Implementation:
   Develop and enforce stringent safety protocols, including regular safety drills and inspections, to ensure compliance and readiness for emergency situations.

4. Mandatory Certification:
   Introduce mandatory certification programs for crew members, verifying their competence in handling the ferry and responding to potential emergencies.

5. Real-time Monitoring Systems:
   Install real-time monitoring systems to track the ferry's location, speed, and overall condition. This data can be used to identify potential risks and take proactive measures.

6. Weather Monitoring and Alerts:
   Integrate advanced weather monitoring systems with real-time alerts to provide the crew with timely information about adverse weather conditions, enabling informed decision-making.

**7.** Enhanced Communication Protocols:
Establish clear communication protocols for both routine operations and emergency situations. This includes improved communication between the crew, passengers, and relevant authorities.

**8.** Regular Safety Audits:
Conduct regular safety audits, involving external experts, if necessary, to assess the overall safety culture, identify potential vulnerabilities, and ensure continuous improvement.

**9.** Incident Reporting and Analysis:
Implement a robust incident reporting system to encourage the crew to report any safety concerns or near misses. Analyze reported incidents to proactively address potential risks.

**10.** Collaboration with Regulatory Bodies:
Collaborate closely with maritime regulatory bodies to stay updated on industry best practices and ensure compliance with safety standards.

**11.** Community Awareness Programs:
Conduct community awareness programs to educate passengers about safety procedures and emergency protocols, fostering a sense of shared responsibility for safety.

**12.** Emergency Response Team Training:
Train a dedicated emergency response team on board, equipped to handle various crisis scenarios efficiently.

### 5.2.5 CAST Step 5: Analyze the Loss at the Physical System Level

**1.** Remove the lazy bearding 7/8 km downstream from Sadarghat and 3/4 km upstream. Anchored boats cannot be kept in this area without a pontoon. Shipyards and dockyards should be relocated.

**2.** Prohibit the placement of Kheyaghat around Sadarghat terminal; shift Kheyaghat upstream of Wiseghat.

**3.** Install CCTV cameras in front, back, master bridge, easy room, and deck. Ensure the use of the back camera for the master's convenience. Introduce a periodic walkie-talkie system on the launch.

**4.** Make the submission of Voyage Declaration at the wharf mandatory before leaving the launch/ship ghat. Include information on the number of passengers, deckside and engine workers in the Voyage Declaration.

**5.** Cease operation of unfit launches. Mandate life-saving life jackets and buoys on every launch.

6. Determine speed limits for different boats on all rivers. Install towers and CCTV cameras at Sadarghat to control speed.
7. Install towers and CCTV cameras to control speed.
8. Initiate Electrohydraulic Steering instead of Mechanical Steering on launches. Phase out 28/30 sunken deck launches; strictly control their movement in wide and busy rivers.
9. Prohibit boat operation without a dispensation certificate; cancel the practice of dispensation certificates.
10. Establish gangways/bridges for passenger safety, especially for children, women, and the elderly.
11. Increase the number of pontoons at Sadarghat.
12. Strengthen inspection activities of inspectors for safety equipment and vessel matters between surveys. Increase the activities of Executive Magistrates and Mobile Courts.
13. Stop the sale of excess capacity tickets on every launch, including during festivals. Prohibit passengers from boarding without showing a ticket. Arrange online ticket sales by determining the number of cabins and deck passengers to prevent over-carrying.
14. Take initiatives to amend laws, adapting the period of punishment and fines for maritime law violations.
15. Enhance BIWTA's role in effective training for naval personnel. The Department of Shipping should play a stringent role in ship fitness and qualification certificates for naval personnel. Increase the number of surveyors and logistical facilities in the Survey Certification Body of the Department of Shipping.

## 5.3 Findings

The Mayur-2 launch arrived at the Lalkuthi (Sadarghat) ghat at least one and a half hours before the scheduled arrival time at the ghat. Traffic mismanagement, narrowing the traffic path by tying launches across the Sadarghat, small and big launches in the same river may cause this incident.

# CONCLUSION AND RECOMMENDATIONS

## 6.1 General

The main objectives of this research are to apply CAST hazard analysis to find out the unsafe activities that are responsible for the occurrence of accidents in "ML Morning Bird Ferry Accident 2020" and to find possible safety requirements that can mitigate those unsafe acts. This chapter presents some key findings of the study, some recommendations based on those findings and some suggestions for future research works to be carried out in this field.

## 6.2 Conclusion

The studies were unable to perform the detailed causal analysis of the unsafe actions related to the Ferry Operation System. Some of the studies performed a general statistical analysis and put forward a few general and common recommendations that are being suggested for a long time. Some other studies focused only on a specific area like collision of ships, mitigation of overloading problem, mitigation of stability failure related accident, improvement of ship design and stability etc. However, there was no study that considered the human behaviour through extensive analysis. In this regard, the present study has extensively analysed the unsafe actions involved in the overall operation of an inland passenger vessels.

## 6.3 Recommendations

**System Requirements:**

1. **Navigational System Requirements:**
   - **i.** Advanced navigation equipment for real-time tracking.
   - **ii.** Weather forecasting systems to anticipate and plan for adverse conditions.
   - **iii.** Emergency response protocols for navigational hazards.

2. **Technical System Requirements:**
    - **i.** Regular maintenance schedules and adherence to industry standards.
    - **ii.** Backup systems for critical technical components.
    - **iii.** Continuous monitoring of the vessel's technical health.
3. **Human-Related System Requirements:**
    - **i.** Comprehensive crew training programs covering emergency response.
    - **ii.** Communication systems supporting effective information exchange.
    - **iii.** Procedures for managing crew fatigue and workload.
4. **Organizational System Requirements**
    - **i.** Robust safety management systems and protocols.
    - **ii.** Continuous improvement processes based on incident analysis.
    - **iii.** Efficient communication channels within the organizational hierarchy.

Identifying these system safety constraints and requirements provides a foundation for evaluating the adequacy of existing safety measures and formulating recommendations for improvements to prevent similar accidents in the future.

## 6.4 Relation with Civil Engineering Work

The thesis work you've described appears to be closely related to the field of civil engineering, particularly within the sector of transportation engineering and infrastructure

1. **Transportation Engineering:** The focus on waterway accidents, specifically the Morning Bird Ferry Accident, implies a connection to transportation engineering. This field involves the planning, design, operation, and maintenance of transportation systems, including waterways. Understanding the causes of accidents and proposing preventive measures aligns with the goals of transportation engineering.

2. **Infrastructure:** The thesis emphasizes the significance of a sound infrastructure in mitigating transportation accidents. Infrastructure in civil engineering includes the physical and organizational structures necessary for the operation of a society, and in this case, it specifically relates to waterway infrastructure. This involves aspects such as docks, berthing

facilities, navigational aids, and safety protocols.

**3. System Theory and CAST:** The application of the Causal Analysis based on System Theory (CAST) model suggests a systems engineering perspective. Civil engineering often involves complex systems, and system theory provides a framework to analyze interactions and dependencies within these systems.

**4. Preventive Measures and Paradigm Shift:** The emphasis on identifying practical factors, scrutinizing the entire infrastructure, and proposing modifications to prevent accidents reflects a proactive approach, which is common in civil engineering practices. The call for a paradigm shift underscores the broader impact of the research on the design and management of transportation systems.

In summary, the thesis work is related to civil engineering, specifically in the sector of transportation engineering and infrastructure. It addresses issues related to waterway transportation, safety, and the systemic elements that contribute to accidents, providing insights for improvements in design, operation, and safety protocols within this sector.

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# APPENDIX

**Picture: 1**


**Picture: 2**


**Picture: 3**