Risk Assessment on the Sabine – Neches Waterway


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Risk Definition

- The Department of Defense Standard Practice for System Safety, MIL-STD-882D defines risk as:

  *An expression of the impact and possibility of a mishap in terms of potential mishap severity and probability of occurrence*

- The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) defines risk in ISO/IEC Guide 73:

  *A combination of the probability of an event and its consequences*
Security Risk

- Security related risk can be assessed by identifying internal and external threat scenarios linked with a particular event and negative consequences caused by that event.

Security Risk = [Threat (T) * Vulnerability (V)] * Consequence (C)
Security Improvement Process

1. Identify Risks
2. Prioritize Risks
3. Allocate Resources
4. Design risk mitigation strategies
5. Implement Risk mitigation strategies
**Maritime Risk Categories**

Total Risk: \[ \text{Total Risk} = \sum_{k=1}^{n} T_K \times V_K \times C_K \]

- \( n \) = Number of Events
- \( T_K \) = Threat associated with \( k \)th “Event”
- \( V_K \) = Vulnerability associated with \( k \)th “Event”
- \( C_K \) = Consequences associated with \( k \)th “Event”

**Events Causing Maritime Risks**

- **Natural Disasters**
  - Hurricane
  - Tropical Storm
  - Bad Weather
    - Fog
    - Tornado

- **Man–made Events**
  - Intentional
    - Terrorism
    - Sabotage
  - Unintentional (Errors/Failures)
    - Human Errors
      - Lapse
      - Procedure
    - Mechanical Failure
      - Engine Breakdown
Delphi Technique

- Structured method of gathering expert opinion

Used when:
- Limited or no data exist
- Analytical models do not exist

- Diverse Group of Experts
- Anonymous Responses
- Structured Surveys and Feedback of Summary Data
Delphi Technique Flowchart

Start

Define Project Objectives

Identify and Enlist Experts

Prepare First Round Survey

Obtain Information, Analyze and Provide Feedback

Enough Info Gathered?

Prepare and Distribute Subsequent Survey Rounds

Use Results to Improve Decision Making

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The Delphi Project Panel of Experts

Experts from Maritime Domain

Affiliation

Public Ports

USCG

Delphi Project on Maritime Domain

Law Enforcement

Private Ports/Docks

Shipping Industry

Expert’s Knowledge

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List of “Events” (based on Maritime Risk Categories) generated for the Delphi Survey

1. Major vessel accident causing waterway closure or disruption of vessel traffic for more than Twenty four hours. (Unintentional, Human Error)
2. Major oil spill / leakage affecting the Sabine – Neches Waterway. (Unintentional)
3. Port facility infrastructure breakdown (Unintentional)
4. Damage to port facility, due to a vessel equipment failure / malfunction (Unintentional, Navigational)
5. Terror threat (hoax) – Causing shutdown of port facilities or parts of the Sabine – Neches waterways.
6. Damage to or destruction of a large vessel or tanker with the help of a small vessel approaching it with explosives on board. (USS Cole type Terrorist act)
7. Disruption of port facilities and/or operations by destroying key assets or infrastructure such as cranes, electrical power systems, etc (Intentional, Terrorists’ acts)
8. Introduction into the United States of a weapon of mass destruction via the Sabine – Neches waterway. (Intentional, Terrorists’ acts)
9. Dense fog, coastal storms, hurricanes up to Category II and other similar weather conditions. (Natural disaster)
10. Category III, IV, or V hurricanes. (Natural disaster)
## Delphi Study Analysis (Ranking Approach)

### Survey Round 2 Analysis

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
<th>Average</th>
<th>Lowest</th>
<th>Highest</th>
<th>Rg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event 1</td>
<td>(Major vessel accident)</td>
<td>1.6</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Event 9</td>
<td>(Dense fog, storms, hurricanes up to Category II)</td>
<td>2.2</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Event 2</td>
<td>(Major oil spill / leakage)</td>
<td>2.7</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Event 4</td>
<td>(Port facility damage due to vessel equipment failure)</td>
<td>3.7</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Event 3</td>
<td>(Port facility infrastructure breakdown)</td>
<td>5.3</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Event 10</td>
<td>(Category III, IV, or V hurricanes)</td>
<td>6.2</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Event 5</td>
<td>(Terror threat (hoax))</td>
<td>6.5</td>
<td>9</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Event 6</td>
<td>(USS Cole type terrorist act)</td>
<td>8.2</td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Event 7</td>
<td>(Disruption of port facility by conducting terrorists acts)</td>
<td>8.2</td>
<td>9</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Event 8</td>
<td>(WMD type terrorist act)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>
Level of Convergence - Rankings

St. Dev. Analysis (SR1 & 2)

Event 1  Event 2  Event 3  Event 4  Event 5  Event 6  Event 7  Event 8  Event 9  Event 10

St. Dev. of Value (Rank)

SR1 St. Dev
SR2 St. Dev

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## Delphi Study Analysis (Probability Approach)

<table>
<thead>
<tr>
<th>Survey Round 4 Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses for the probabilities (1-100%), 100%= The Most Probable Event to Occur in a Calendar Year</td>
</tr>
<tr>
<td>Event 9, (Dense fog, storms, hurricanes up to Category II)</td>
</tr>
<tr>
<td>Event 1, (Major vessel accident)</td>
</tr>
<tr>
<td>Event 2, (Major oil spill / leakage)</td>
</tr>
<tr>
<td>Event 5, (Terror threat (hoax))</td>
</tr>
<tr>
<td>Event 3, (Port facility infrastructure breakdown)</td>
</tr>
<tr>
<td>Event 4, (Port facility damage due to vessel equipment failure)</td>
</tr>
<tr>
<td>Event 10, (Category III, IV, or V hurricanes)</td>
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<tr>
<td>Event 7, (Disruption of port facility by conducting terrorists acts)</td>
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<td>Event 6, (USS Cole type terrorist act)</td>
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<tr>
<td>Event 8, (WMD type terrorist act)</td>
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</tbody>
</table>
Level of Convergence - Probabilities

Standard Deviation Analysis (SR 3 & 4)

Events

<table>
<thead>
<tr>
<th>Event</th>
<th>SR3 St. Dev</th>
<th>SR4 St. Dev</th>
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</thead>
<tbody>
<tr>
<td>Event 1</td>
<td>28.5</td>
<td>35.5</td>
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<tr>
<td>Event 2</td>
<td>25.2</td>
<td>12.34</td>
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<td>Event 3</td>
<td>20.2</td>
<td>25.2</td>
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<tr>
<td>Event 4</td>
<td>19.9</td>
<td>16.2</td>
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<tr>
<td>Event 5</td>
<td>18.7</td>
<td>16.3</td>
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<tr>
<td>Event 6</td>
<td>19.4</td>
<td>17</td>
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<td>Event 7</td>
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<td>16.8</td>
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<tr>
<td>Event 8</td>
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<td>16.8</td>
</tr>
<tr>
<td>Event 9</td>
<td>18.7</td>
<td>16.8</td>
</tr>
<tr>
<td>Event 10</td>
<td>20.2</td>
<td>25.2</td>
</tr>
</tbody>
</table>

Standard Deviation of value (Probability %)
Conclusions

- The analysis of round 1 and 2 questionnaire suggest that the consensus was reached on identifying and prioritizing the events which could cause the closure of the S-N Waterway for Twenty four hours or more. However the consensus was not reached on round 3 and 4 questionnaire on estimating the probabilities for the events to occur on the S-N Waterway.

- Events from the Man-made Events “Unintentional” category: Unintentional (human errors, mechanical failures), and Natural Disasters category scored high on the likelihood scale. The least likely events were from the Intentional (terrorists’ acts) category.
Conclusions Continued

• The findings of Delphi Research indicated that subjective judgment on a collective basis can be used to provide multidisciplinary expertise which can be utilized for the comprehensive security risk assessment of the maritime domain.

• Since natural disasters, accidents, failures are ranked so much higher than terrorists acts. Efforts and funds expended on detailed recovery plans should reflect these relative likelihoods.
Questions ?