Safety in Maritime Industry – Meeting Tomorrows Challenges

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In the search for better effectiveness and efficiency to manage and enhance safety in marine industry many ways and means are being contemplated, developed and tried out by various international and national bodies. Most of these approaches refer to the generic concept of 'Risk Analysis' which is a widely used in most of the other hazardous industries. In this presentation a new proactive and comprehensive approach named 'vulnerability analysis' towards assessing and enhancing maritime safety is introduced. This presentation provides an introduction to the concept of vulnerability, an approach to vulnerability analysis and a comparison with 'Risk Analysis' and then brings out the potential advantages and appropriateness of the 'Vulnerability Analysis' towards managing and improving maritime safety.

KEY WORDS
Safety, Reliability, Vulnerability, Risk, Robustness

INTRODUCTION:

Today, many of the maritime system e.g. ships, ports, offshore platform etc. are complex entities with multiple physical and virtual relationship and multiple internal and external interfaces. As regards to safety, many maritime systems are vulnerable because of lack of awareness of all the threats the system is exposed to. High demands are put on the quality of services and service regularity. Whether the system is to be a part of a more complex system, the system is expected to be available for the demand of service and safe to use during all its life phases. In the search for better effectiveness and efficiency, the systems are sometimes engineered with delicate and sophisticated concepts / technology and made more specialized and dependent with less tolerance for failure.

Vulnerability is a rather new concept that may be used to characterize a system's lack of robustness.

A system approach is described using input / output model in the basis for vulnerability analysis. Then how the concepts of Robustness, Resilience, Damage tolerance, Threat and Risk are connected to vulnerability is described.

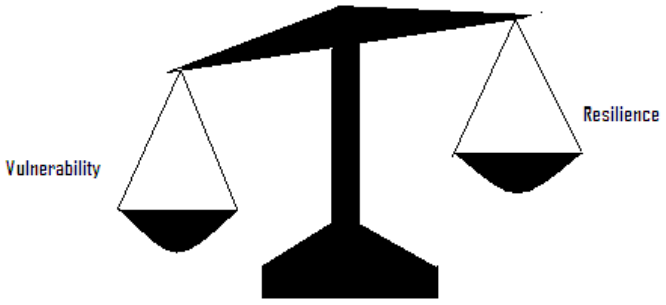
CONCEPT OF VULNERABILITY:

Vulnerability may be viewed as properties of a maritime system; its modes and nodes; structure, equipment, including its human resources and all its software, hardware and net-ware, that may weaken or limit its ability to endure threats and survive accidental events that originate both within and outside the system boundaries.

Table-1:

Related Concepts	Opposite Concepts
• *Threat:* A stable, latent, adverse factor which may manifest itself in an accidental event	• *Robustness:* A systems ability to resist shock and return to do its intended mission and gain the same position as it had before shock
• *Risk :* Combination of the frequency or probability of occurrence and the consequences of a specified hazardous event	• *Resilience:* A systems ability to absorb change without catastrophic failure, i.e. its ability to return to a stable state.
• *Threat → Vulnerability* • *Hazard → Risk*	• *Damage tolerance:* A measure of a systems robustness w.r.t. a specific damage i.e. the reduction in reliability of a system that has specific damage but has not failed

'*Resilience*' can be considered as the counterweight to '*Vulnerability*'.



Properties of Resilience are '*Robustness to withstand*' (as mentioned in the table-1 above) and '*Flexibility to adapt*' *i.e.* regain stability, but adapted to the new situation, it can have the following dimensions:

- system characteristics
- environment
- time and timing
- operational
- physical

VULNERABILITY AND MISSION OF THE MARITIME SYSTEM:

The focus of vulnerability is dependent on the mission of the maritime system.

- The MISSION of a maritime logistic system may be: Its ability to support the safety of life, properly and environment in delivering the products to the intended destination, in a given amount, with predefined contractual obligations and at given times and places. Also, to make good performance in ideal situation as well as preparing for the adverse condition. The mission is to address the system's vulnerability towards survival and the disruption of the larger entity or network (environment, supply chain, activity / production network) due to the performance of the specific system.

The length of the disruption time is very important -

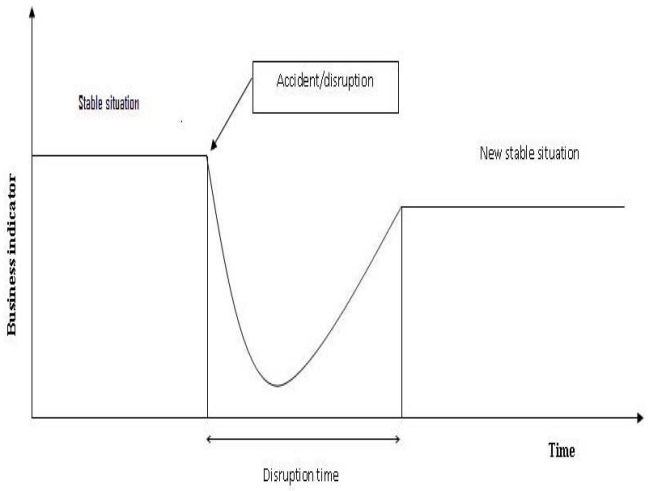


Fig-1: Mission time

MODEL OF THE MARINE LOGISTIC SYSTEM:

A marine logistic system may be perceived as an input / output model – Fig:2

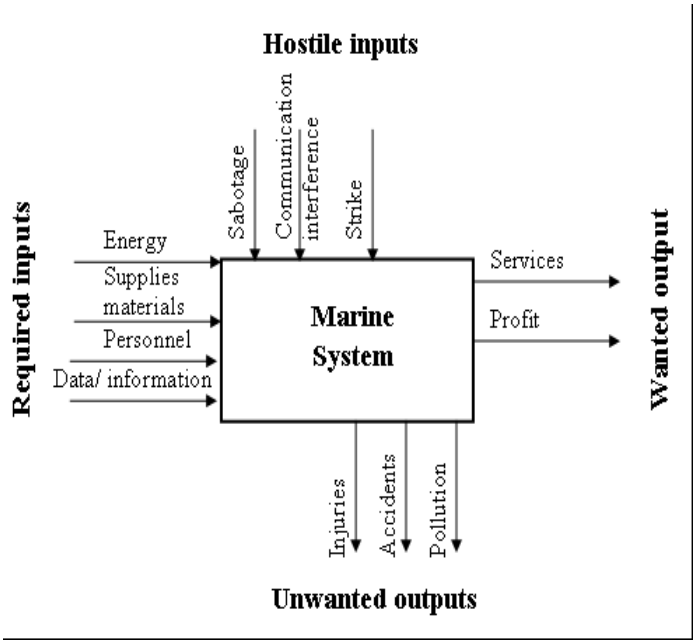


Fig2: Marine Logistic system

Input

- Required
  - Necessary input factors to operate the system
- Adverse
  - Un-wanted inputs that in an active or latent way may disrupt the system mission

Output

- Wanted
  - The goods / services that are the basis of the systems existence
- Unwanted
  - Accidental output due to the system itself or input / output related - 'Adverse' inputs

FACTORS / THREATS CONTRIBUTING TO RISK / VULNERABILITY:

The factors which contribute to the occurrence of Accidental event or disruption may be categorized into two groups – 'Internal' and 'External' – See Fig-3

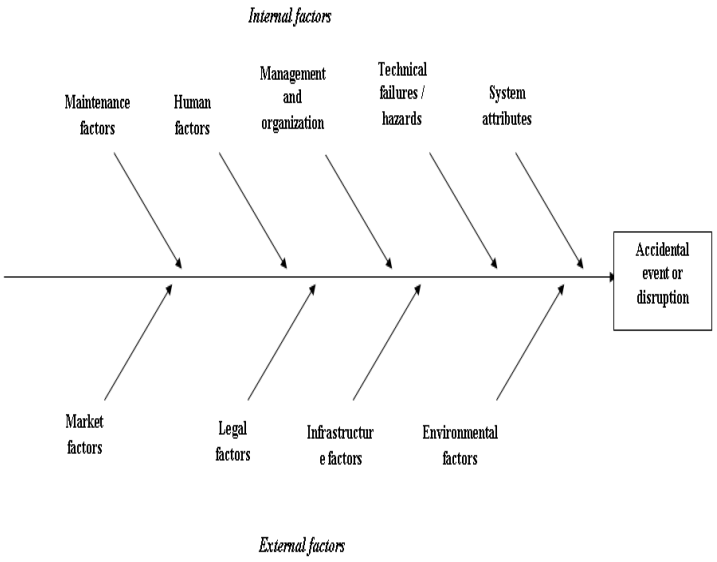


Fig-3: Internal and External factors contributing to Risk

Internal: Maintenance, Human factors, Management and organizational, Technical failures/hazards, System attributes etc.

External: Environmental, Infrastructure factors , Legal factors etc.

VULNERABILITY ANALYSIS VIS-À-VIS RISK ANALYSIS, W.R.T. SCOPE AND END-RESULT:

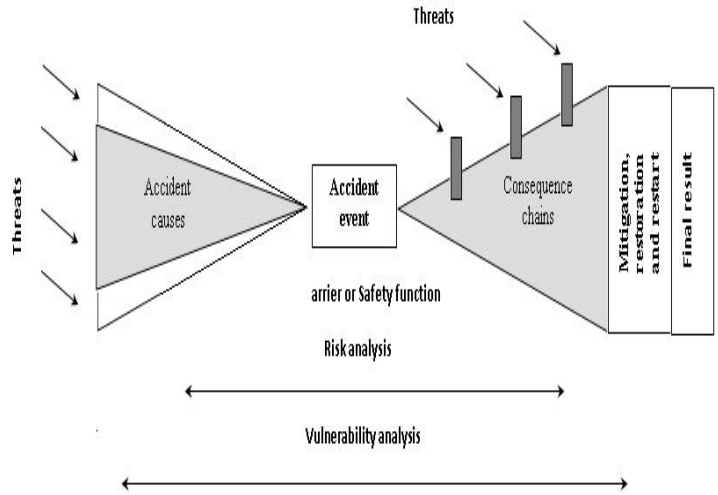


Fig-4: Vulnerability Analysis vis-à-vis- Risk Analysis

Table 2: Risk Analysis and Vulnerability Analysis

Risk Analysis	Vulnerability Analysis
❑ Focus: - Human , environmental and property impacts	❑ Focus: - Survivability of system
❑ What can go wrong?	❑ Threats and Consequences
❑ How likely is it to happen?	❑ Adequate resources to mitigate and bring the system back to new stability
❑ What are the consequences?	❑ When will new stability be reached?

SEQUENCE OF VULNERABILITY ANALYSIS:

Vulnerability analysis for a marine logistic systems can be done in two parts (steps) based on scenarios

- ❑ The first part;
  - gives an overview of potential scenarios and their likelihood
  - potential immediate effects, and
  - resources , systems and plans for mitigation, restoration, rebuilding etc.

- ❑ The second part; is a quantitative analysis to establish an internal ranking of the scenarios, ranked on how critical they are (emergency to attend to).

A scenario is a sequence of possible events, where the events may be separated in time and space and where barriers to prevent the sequence are part of the scenario.

Based on the vulnerability factors (threats) the first part establishes scenarios and their attributes.
The sequence of the analysis follows a potential route of an accident.

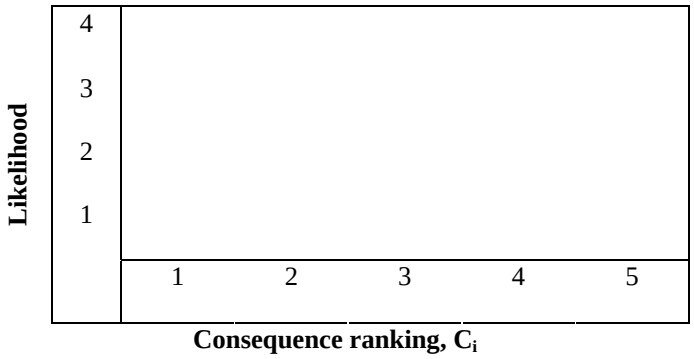
- Identify threats and describe scenario
- Rule out those scenarios which are not likely to occur
- Identify and describe potential immediate effects
- Establish which internal and external resources, systems and plans are present to mitigate, restore or rebuild after an accident.

The result may be a list of scenarios that gives a rough, overall picture of the vulnerability situation of the system.

The second part is a quantitative assessment of the scenario criticality.

- A quantitative analysis to establish a criticality ranking of the scenarios may follow:
    - Give each input a weight (the lower the better).
    - The ranking of the scenarios are based on the sum (Total), or by matching likelihood and consequence to resources to mitigate, rebuild and restore.
    - Selective analysis can be performed by e.g. adding a factor to selective inputs.
- Time is an important factor w.r.t. all consequences.
- The result is a list of critical scenarios that may be used 'backwards' to guide actions.

Criticality of scenarios may be illustrated in a consequence likelihood matrix.



CONLCUSION:

Coping with Risk in Maritime Logistics:

Managing vulnerability, risk and resilience in maritime logistics –

Ability to -

- Understand and manage the risks that origin when shipowners extend their responsibility in cargo-owners' value chains from port-to-port to door-to-door operations.
- Specific sub-goals may be developed and documented:
    - Assess vulnerability
    - Assess and measure resilience in the system,
    - Assess impact of and contributions from maritime rules and regulation,
    - Principles, Methods and Tools for analysis of risk, vulnerability and resilience in maritime system,
    - Proactive approach to the treatment of risk and resilience improvement strategies.

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