ASET JOURNAL OF MANAGEMENT SCIENCE
A Bi-Monthly Peer Reviewed Journal

Aset Journal Of Management Science
Volume 2/ Issue 2/ pg:38 - 51

# A Study on Factors Influencing Environment With Respect to Transportation of Dangerous and Hazardous Goods by Sea

Dr. A. Shameem[1],Mr.S.Arunkumar[2], Nikhil Singh[3]

*[1]Professor, [2]Assistant Professor , [3]Second Year MBA Student*

## Abstract

The UN Dangerous Goods list can help you determine if the items in your shipment qualify as dangerous goods and is a reference point for packing and correctly labeling the shipments. However, your shipping vendor may also have specific requirements regarding what can and cannot be shipped and how the shipment must be packaged, so seek confirmation from them, as well.

**Key words:** Explosives, Gasses, Flammable liquids

## Introduction

Dangerous goods include any item or material that poses an unreasonable short or long-term risk to health, safety, or property and, consequently, requires proper identification, packaging, or protocol during shipping or handling.

A fairly comprehensive (but not exhaustive) list of Dangerous Goods would include items that are:

- Explosives
- Gasses
- Flammable liquids
- Flammable solids
- Oxidizing agents
- Toxins and infectious substances
- Radioactive material
- Corrosives
- Miscellaneous regulated materials

So, you may correctly assume that shipping radio active material is a no-go and therefore decide not to carry uranium in your online marketplace. Still, even something as seemingly innocuous as a smoke detector contains low levels of radioactive material and requires appropriate labeling.

**Rules and Regulations Regarding Dangerous Goods**

There are national and international laws and regulations that apply to shipping, handling, and declaring dangerous goods.

The transportation of dangerous goods is regulated by the United Nations using a system known as the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS) to establish uniformity in defining, classifying, and appropriately identifying hazardous materials and to create homogeneity among labels and safety data sheets.

The International Carriage of Dangerous Goods by Road (ADR) is another agreement that legislates transport. The most up-to-date legislation and regulations about transporting dangerous goods can be found on the UNECE website.

Some carriers allow merchants to send dangerous goods in Limited Quantities (LQ), with the maximum size determined by the ADR for each substance. All dangerous goods must be marked and labeled in accordance with ADR regulations and require pre-authorization from DHL Parcel.

Some prohibited items cannot be shipped at all, either due to restrictions imposed by your shipping carrier or because they are banned goods that will be seized at customs. Carriers will not ship dangerous goods that contain one or more hazard labels because those items are not covered by the Limited Quantity regulations under the ADR; they also have a list of items that cannot be shipped due to safety reasons.

**Scope of the Study**

The project aims at studying the factors influencing the environment by transportation of dangerous and hazardous goods by sea.

The project aims at studying various factors like physical properties, chemical properties, packing, form of transportation, quantities, storage, handling, segregation, consignment procedure, land personnel qualification, crew qualification, transportation, environment, weather

condition, sea state, terrorism.

This study gives us an idea about the safe transportation of dangerous and hazardous goods from one location to another by sea and the procedures to carry out or handle the dangerous cargo which would not affect the environment.

**Research Design**

A research design is known as a blueprint of research.

The respondents in this study of the "Factors Influencing Environment with Respect to Transportation of Dangerous and Hazardous Goods by Sea" are the people who work in the organization.

Quantitative research methodology is adapted for this study. Both primary and secondary data was collected.

The primary data was collected through questionnaires in the organization, with around 60 respondents having responded.

The secondary data was collected through magazines, articles, journals, books andresearch.

**Research Objectives**

To analyze the dangerous cargo parameters such as physical properties, chemical properties, packing, form of transportation and quantity affects the environment whilecarried through sea.

To analyze the supply chain sources which affect the environment while carrying the dangerous cargo such as storage, handling, segregation, consignment procedure, land personnel qualification, crew qualification and transportation.

To analyze external factors such as environment, weather condition, sea state, and terrorism which affects the environment externally by carrying the dangerous goods by sea.

**Limitations of the Study**

Taking appointments of the respondents became a little difficult.

The analysis is completely based on the information provided by the employees and hence could be biased.

Due to confidential information, most of the data is collected by means of secondarysources.

Certain areas are restricted so a detailed study is not possible.

Employees were busy with their work so they could not give more information.

## Research Methodology

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic. In a research paper, the methodology section allows the reader to critically evaluate a study's overall validity and reliability.

This chapter aims to understand the research methodology establishing a framework of evaluation and revaluation of primary and secondary research. The techniques and concepts used during primary research in order to arrive at findings; which are also dealt with and lead to a logical deduction towards the analysis and results.

## Research Objectives

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To analyze supply chain sources which affects the environment while carrying the dangerous cargo such as storage, handling, segregation, consignment procedure, land personnel qualification, crew qualification and transportation.

To analyze the external factors such as environment, weather conditions, sea state, and terrorism which affects the environment externally by carrying the dangerous goods by sea.

## Sampling Method

The sampling technique used here to study the necessary information is probabilitysampling.

## Probability Sampling

Probability sampling means that every member of the population has a chance of being selected. It is mainly used in quantitative research.

## Sample Size

A sample of **60** respondents are selected for the study.

## Sampling Framework

Primary and Secondary data collected for the completion of the research work is presented in Pie chart.

## Research Tool

Percentage Analysis research tool was

used in the study.

**Data Analytics Tool**

Both primary and secondary data was collected. The questionnaires are developed and the respondents responded to the questionnaires, the respondents are the people who work in the organization for the collection of the primary data. The secondary data was collected through the internet for information such as magazines, journals, books and research.

**Data Interpretation of Primary Data**

**Table.1 showing cargo parameters and transportation;**

| CARGO PARAMETERS | RESPONDENTS | PERCENTAGE |
|---|---|---|
| Physical Properties | 7 | 11.66 |
| Chemical Properties | 10 | 16.66 |
| Packing | 30 | 50 |
| Form of Transportation | 5 | 8.33 |
| Quantities | 8 | 13.33 |
| Total | 60 | 100 |

**INFERENCE**

It can be inferred from the above pie chart, the packaging in the dangerous and hazardous cargo is high. Around 50% of the respondents have responded that the packaging in the hazardous and dangerous cargo causes the environment problems which leads to impact on the environment. If the packaging of dangerous goods has not been done properly, it leads to damage in the cargo, ship and the environment itself. So packaging should be done with certain procedures so that the dangerous goods should not be exposed to the environment. Physical and chemical properties play an important role in influencing the environment. The chemical properties should be indicated in the container or the shipment properly so that the handling procedures can be done without any damage

**Table 2 showing supply chain sources;**

| SUPPLY CHAIN | RESPONDENTS | PERCENTAGE |
|---|---|---|
| Storage | 7 | 11.66 |
| Handling | 15 | 25 |
| Segregation | 10 | 16.66 |
| Consignment Procedure | 8 | 13.33 |
| Land personnel Qualification | 5 | 8.88 |
| Crew Qualification | 7 | 11.66 |
| Transportation | 8 | 13.33 |
| TOTAL | 60 | 100 |

**INTERPRETATION**

It can be inferred from the above pie chart, the handling of the dangerous and hazardous cargo are high when compared to other parameters like storage, consignment procedures, land personnel qualification segregation and crew qualification. The handling of the hazardous cargo is so difficult that it

cannot be handled like other cargo. The hazardous cargo must be handled with care that is if it is exposed it may damage the environment and cause difficulty in the shipment handling The other factors like segregation should be done with the proper procedure that the hazardous cargo must be segregated under the nine different classes of the dangerous goods

**Table.3 showing external factors;**

| EXTERNAL FACTORS | RESPONDENTS | PERCENTAGE |
|---|---|---|
| Environment | 20 | 33 |
| Weather Condition | 25 | 41.66 |
| Sea state | 10 | 16.66 |
| Terrorism | 5 | 8.33 |
| Total | 60 | 100 |

**INFERENCE**

It can be inferred from the above pie chart, the weather condition plays an important role in the carriage of the dangerous goods through sea. If the weather condition during the shipment was bad it may affect the arrival time and the delay in the shipment. The hazardous and the dangerous goods should be carried through certain weather conditions, if the weather condition was not favorable to the dangerous it may cause damage to the container, cargo, other shipments and even the ship itself. For example, if the dangerous goods such as lithium ion battery was carried from Chennai to Madagascar through sea shipment in a container, the sea temperature may increase during sailing which heats the container and the cargo within, so when the battery gets its odd temperature it explodes and causes damage to the cargo, crew and ship. So the hazardous cargo must be carried and planned in a right timing and should be sailed in the good weather condition

**Table 4 main factors that influence the environmental impact of transporting dangerous goods by sea**

| CONTENTS | PERCENTAGE |
|---|---|
| Improper Handling and Packaging | 30 |
| Accidents and Incidents | 25 |
| Environmental Sensitivity | 20 |
| Lack of Risk Assessment and Preparedness | 25 |

**Inference**

1. Improper Handling and Packaging: This factor accounts for 30% of the environmental impact. It includes issues such as inadequate packaging, improper stowage, and insufficient training of personnel. These factors can lead to leaks, spills, and accidents during transportation, resulting in environmental harm.

2. Accidents and Incidents: This factor

contributes to 25% of the environmental impact. It encompasses collisions, groundings, fires, explosions, equipment failures, and human errors. Such incidents can lead to spills, leaks, and other environmental hazards, causing damage to marine ecosystems and wildlife.

3. Environmental Sensitivity: This factor represents 20% of the environmental impact. It refers to the transport of dangerous goods through environmentally sensitive areas, including protected habitats or marine sanctuaries. The potential harm to marine life and contamination of water bodies is a significant concern.

4. Lack of Risk Assessment and Preparedness: This factor also accounts for 25% of the environmental impact. It highlights the importance of conducting thorough risk assessments and implementing adequate emergency response plans. Insufficient assessment and preparedness can lead to delays in mitigating environmental consequences during incidents or accidents.

**Table.5 Who do you think should be responsible for ensuring the environmental safety of transporting dangerous and hazardous goods by sea**

| CONTENTS | PERCENTAGE |
|---|---|
| Shipping companies | 35 |
| Regulatory authorities | 30 |
| International organizations | 15 |
| Port authorities | 20 |

**Inference**

It appears that there is a relatively even distribution of opinions, with shipping companies and regulatory authorities being seen as primary responsible parties. This suggests that there is recognition of the shared responsibility between the industry and regulatory bodies in ensuring environmental safety during the transportation of dangerous and hazardous goods by sea. Port authorities and international organizations also hold some level of responsibility according to a portion of the respondents. It is important to note that these percentages are based on the responses provided and may not represent a comprehensive view on the topic

**Table 6 How would you rate the level of environmental concern associated with this type of transportation**

| CONTENT | PERCENTAGE |
|---|---|
| Low concern | 10 |
| Moderate concern | 15 |
| High concern | 30 |
| Very high concern | 45 |

**Inference**

Based on the responses received, it can be inferred that:

10% of the participants have a low level of environmental concern associated with the transportation of dangerous and hazardous goods by sea.

15% of the participants have a moderate level of environmental concern.

30% of the participants have a high level of environmental concern.

45% of the participants have a very high level of environmental concern.

This indicates that a significant majority of the participants (75%) express moderate to very high levels of environmental concern regarding the transportation of dangerous and hazardous goods by sea.

**Secondary Data**

Carriage of goods by sea is the most important form of transport in the world. In 2015, it accounted for more than 80% of global freight. The volume of transportation of goods by sea is an indicator of the global economy. Marine industry is characterized by consistent growth of port facilities and increasing transportation volume, including dangerous goods .

Dangerous goods transportation is growing in regard to the number of chemicals and the total volume of goods. Nowadays, the number of different dangerous goods and compounds is quoted in thousands. Maritime transport of these goods is done in bulk and in packed form.

International Convention for the Safety of Life at Sea, (SOLAS, 1974) defined dangerous goods as follows: "Dangerous goods means substances, materials and articles covered by the International Maritime Dangerous Good Code". The term "dangerous goods" includes any empty unclean packaging such as tank – containers, receptacles, intermediate bulk containers (IBC's), bulk packaging, portable tanks or tank vehicles which previously contained dangerous goods, (unless the packaging has been sufficiently cleaned of residue of the dangerous cargoes and purged of vapors to nullify any hazard) or has been filled withsubstances not classified as being dangerous.

Dangerous goods are transported on a regular basis by sea and include many widely-usedcommodities such as;

- Fertilizers,
- Paints,
- Fuels,

- Alcohols,
- perfume products,
- Pesticides,
- Aerosols
- Refrigeration gasses

Transport of dangerous goods is generally associated with significant levels of risk which may depend on a variety of factors. Safety is the one of the main concerns in all activities related to the transport of dangerous goods. Catastrophic consequences of a possible accident include: fatalities, injures, emergency evacuations, property damages and environmental damage. Maritime safety during transport of dangerous goods depends on the factors associated with technology and the organization of the transport and crew preparation for the task resulting from the specific working conditions. Some of the dangerous chemicals are characterized by the environmental impact if released into the water or air. Dangerous goods and materials transportation may be associated with accidents causing environmental damage through the whole course of carriage such as loading, unloading and storage .Potential accident effects: fires, explosions, toxic gas release, leakage of dangerous substances. Every accident is associated with several types of costs:

- Social cost (deaths, wounded or lost people);
- Expenses incurred from restoration of ships and equipment;
- Economic losses due to interrupted or slowed down volume of transported cargo;
- Losses caused by environmental pollution, including damage restoration;
- Loss of reputation of shipping company.

The environmental damage accounted for more than half of the total cost .The cost on the environment is the cost due to damage restoration of infrastructure and costly techniques used to recover the ecosystem. In recent years, the cost of environmental damage has increased significantly. Although

various research has been conducted since the increase in trend, no analysis has definitively clarified the cause for this increase. One potential reason for that is increased sea transportation of hazardous and harmful products around the world over the last decades. The evolution of shipping transport, which was affected by new cargoes and new carriage methods, introduced new, not well-understood hazards. It may be noted that high numbers of dangerous cargoes are increasingly using containers for transport. IMO regulations determine the conditions of the transport and assists in highlighting dangerous cargoes that require special care, however, some new cargoes are not covered. Therefore, a new type of environmental and economic risk appears, which presents new challenges for maritime transport. Information is the most important factor in the carriage of dangerous goods. The goal of this paper is to develop categories of the chemical and physical factors and processes which have an impact on the environment during sea transportation of dangerous goods

**Findings and Suggestion**

The results of the employee perception towards the cargo parameters for the dangerous

Goods, shows that among the other parameters, packaging causes more impact to the environment. The packaging of the dangerous cargo should be done with the given certain parameters by the nation or the government. The packaging should be done in a manner that the dangerous goods should not get exposed to the environment. There are certain regulations that need to be followed while packing the dangerous cargo. There are different types of dangerous cargo available which come under the nine classes of the dangerous goods. According to the proper class of the goods the packing method should be followed. The physical and chemical properties are another major problem in the dangerous cargo. The chemical properties of the goods should be specified before the shipment itself and it has to be handled with the proper documentation which was given by the director general of

foreign trade. The physical properties need to be within the cargo limit, if not it has to be carried in another or special type of container.

The results of the employee towards the supply chain sources for dangerous goods shows that the handling of the dangerous goods are more difficult than other parameters such as storage, crew qualification, land personnel qualification and segregation. The handling of dangerous cargo is not as easy as handling normal or other cargoes. The dangerous cargo must be handled with persons who are qualified for handling the dangerous cargo. The dangerous cargo must be specified about its nature, packaging, and quantity so it can be easy for the forwarder to handle the dangerous cargo. The danger cannot be stored or put on the inventory for a long time, as the name indicates it can get damaged or damage the other goods in the inventory.

The results of the employee towards the external factors that influence the environment during the carriage of the dangerous cargo by sea show that the weather condition and environment plays an important role in defining the dangerous cargo towards the shipping by sea. If the weather condition was not prior to the condition of the dangerous goods which are traveling sea, the goods inside the container may get damaged which can damage the container, other goods and containers and even the ship. It should be carried in a perfect condition so that it can't get damaged, if the damage occurs it leads to the loss of cargo and the investment. It is the responsibility of the captain or the ship owner to indicate the safe travel of dangerous goods in certain weather conditions.

## CONCLUSION

In the carriage of goods by sea, the most common type of damage or loss is loss of or damage to goods. However, there are cases where the carrier suffers loss or damage as a result of the shipment of goods. In this regard, the law relating to "dangerous goods" occupies an important, although often overlooked, aspect of maritime law. The carriage of dangerous goods involves an inherent risk of danger to those

concerned with its care. The best way to eliminate the risk would be either to prohibit altogether the carriage of dangerous goods by sea or to impose such measures as would render their carriage impractical. Either way would be unacceptable, hence policy-makers have searched for a middle path, an "acceptable risk", which lies in between. Regulations have been enacted to reflect the level of "acceptable risk" which translates into practical measures of risk containment. As Part I demonstrates, there are special regulations for all types of dangerous goods. These regulations contain technical and detailed operational procedures. Dangerous goods regulations firstly seek to prescribe rules to ensure the safe carriage of certain goods. Failure to comply with the regulations renders the offending party liable to sanctions in the form of a fine or imprisonment. Dangerous goods regulations differ in technical details; however, they all have a common aim in providing for risk containment. Firstly, there is a system of documentation which is designed to inform the carrier as to the classification and characteristics of the dangerous goods. Secondly, there are provisions for the proper transmission, and due appreciation, of information relating to the dangerous goods to all concerned. Thirdly, they contain provisions which ensure the proper handling, stowage and carriage of such goods. Additionally, with regard to packaged goods, there must be proper containment of the substance in packages, tanks or receptacles which are sufficient to withstand the ordinary risk of handling and transport by sea with regard to the properties of the goods. In the light of these operational regulations, the actions or conduct of the carrier or shipper may amount to breach of contract. In this regard, operational regulations complement a liability regime. Operational regulations are particularly relevant to the issues of which goods are dangerous, whether adequate notice of the dangerous goods has been given, whether the packaging or container is sufficient and to what extent the carrier knows about the dangerous characteristics of the goods.

**BIBLIOGRAPHY REFERENCES**

UNCTAD 2017 Review of Maritime

Transport Geneva .

Häkkinen J M, 2014 Review of Maritime Accidents Involving Chemicals –Special Focus on the Baltic Sea the International Journal on Maritime Navigation and Safety of Sea Transportation 8 295-304 .

IMO 2014 International Convention for the Safety of Life at Sea 1974London.

Ellis J, 2010 Undeclared Dangerous Goods-Risk Implications for Maritime Transport WMU Journal of Maritime Affairs 95-27 .

Leung Y, Li R, Ji N, 2017 Application of extended Dempster – Shafer theory of evidence in accident probability estimation of dangerous goods transportation J. Georg Syst 19 249-271.

Oluwoye J O, 2000 Transport of dangerous goods and environment: A conceptual framework of the planning for classification procedure of dangerous goods. Proc. South African Transport Conference (Pretoria:South Africa) 1-7.

Othani H, Kobayashi M, 2005 Statistical analysis of dangerous goods accidents in Japan Safety Science 43 287-297.

Kelman J B, 2008 Hazards in the Maritime Transport of Bulk Materials and Containerized Products IChem Symposium Series No 154 1-15.

Ellis J, 2011 Analysis of accidents and incidents occurring during transport of packaged dangerous by sea Safety Science 49 1231-1237 .

Pinatric Z N, 2007 Assessment of the consequence of accident scenarios involving dangerous goods Trans IchemE Part B Process Safety and Environmental Protection85(B1) 23-38.

Charlier R H, 2001 Hazardous Goods and their Environmental Impact Intern. J. Environ. Studies 58 271-285.

Guner-Ozbek Meltem D, 2008 the carriage of dangerous goods by sea Hamburg Studies on Maritime Affairs 12 (Berlin: Springer-Verlag).

Bocas G, Saliot A, 2002 Sea transport of animal and vegetable oils and its environmental consequence Marine Pollution Bulletin 44 1388-1396.

Luhtala H, 2010 Maritime Transport of Chemical in the

Baltic Sea (Finland: University of Turku).

IMO 2016 International Maritime Dangerous Goods Code London.

Myrberg K, Lappàranta M, 2006 The physics, state and future of the Baltic sea In Finnish Helsinki Finland.

Klopott M, 2016 The Baltic Sea as a model region for green ports andmaritime transport Gdynia.

Bogalecka M, 2009 How safe is Baltic Transport Journal 28 37-37.

Eurostat 2017 Maritime Transport –Database. European Commision [available at ec.europa.eu/eurostat/web/transport/data/database] last accessed 23.03.2018.

]HELCOM 2012 Annual report on shipping accidents in the Baltic Sea in 2012 Helsinki.

Bogalecka M, Kołowrocki K, Soszyńska –Budny J, Ledóchowski M, Reszka M, 2016 Shipping critical infrastructure network Journal of Polisk Safety and Reliability Asociacion 7 43-52