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STAKEHOLDERS' ANALYSIS IN LNG BUNKERING: AN INTEGRAL PART OF RISK MANAGEMENT PROCESS

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ABSTRACT: The interest to use LNG as a maritime fuel is increasing significantly due to IMO's regulations. However, LNG's use as a shipping fuel faces important challenges, mainly due to the lack of infrastructure, facilities, and important uncertainties/challenges regarding the adoption by the shipping industry. Risk Management is an appropriate method to take into consideration uncertainty and support the relevant decisions. The current paper proposes a stakeholders' approach for managing risks, that includes a structured way for identifying and analyzing their interests, needs and expectations for the development of an LNG bunkering facility, and thus their potential influence on its objectives. The paper also presents the use of the Social Network Analysis (SNA) for assisting the modelling and analysis of stakeholders' interests, interactions, and activities to allow a justified evaluation of their power and their potential to create threats and opportunities for the implementation of the facility.

KEYWORDS: Risk Management, Maritime systems, Maritime logistics, Environment, Stakeholders' analysis, Social Network Analysis (SNA)

1 INTRODUCTION

In recent years, Liquefied Natural Gas (LNG) has been proposed as an alternative fuel in the transport sector since it is a more environmentally friendly solution than conventional fuels. Discussion about the use of LNG as a maritime fuel is increasing significantly mainly due to the introduction of stricter legislation by the International Maritime Organization (IMO) and European Commission (e.g. Directive 2012/33/EU) regarding the emissions of exhaust gases to environment from ships. In particular, the Agency claims that, on and after 1 January 2020, ship fuel should not contain more than 0.50% m/m (mass by mass) sulfur, against the current limit of 3.50%, which has been in effect since 1 January 2012 (IMO, 2016a; MEPC, 2008).

Although LNG has been considered as a preferable low emission solution (IMO, 2016b), data for 2012 regarding maritime fuels show that LNG consumption is still far behind Heavy Fuel Oil (HFO) and Marine Gas Oil (MGO) (Faber et al., 2016).

To consider LNG as an alternative marine fuel, a stable and efficient supply chain must be established in which several organizations (LNG Receiving vessels, LNG bunker vessels, bunker terminals, port authorities etc.) should collaborate. Each organization in this supply chain has its mission, vision, and objectives either in the same direction with the others or conflicting.

Important challenges in this supply chain are due to the lack of infrastructure and bunkering facilities, creating

important uncertainties regarding the adoption of LNG by shipping industry.

Risk management is an appropriate management method to consider the effect of uncertainty for the establishment and operation of such a supply chain.

Risk should be considered in all phases of an LNG installation lifecycle and throughout the LNG supply chain and not only related to accidental events, but in general as a positive or negative deviations from the expected outcomes and desired results at strategic and operational level.

Each organization in the LNG supply chain should be able to develop a risk management framework, which clearly defines its external and internal environment and objectives. Moreover, it should be able to efficiently communicate and consult with all relevant interested parties (stakeholders) to achieve an in depth understanding of its business environment dynamics, opportunities, and threats. Crucial role among these organizations has the organization which will implement the LNG bunkering facility, especially the design phase.

The current paper includes an approach for systematic analysis of stakeholders, their needs, and expectations, as a part of a framework to manage risks related to the design of an LNG bunkering facility. The proposed approach utilizes the Social Network Analysis (SNA) methodology to model and analyze the stakeholders' interests, interactions and activities related to the organization's objectives.

2 LITERATURE REVIEW

2.1 Risk and Interested Parties

A significant number of bibliographic references, standards and technical specifications demonstrate that uncertainty is an important issue for LNG bunkering installations. However, research is mainly oriented towards the analysis of events (occurrence or change of a particular set of circumstances) that could have as consequences technical failure or accident, and therefore threats that could result in negative impact on human health and environment. The special focus given by the scientific community and engineers to this category of risk (i.e. technical failures and accidents) is reflected in the definition of the term "risk" for this industry. Indicatively:

- ELOT EN 1473:2016 defines risk as a “combination of the consequence and the frequency of a specific hazard occurring within a specified period under specified circumstances” (ISO, 2016)
- ISO/TS 16901 defines risk as a “combination of the probability of occurrence of harm and the severity of that harm” where harm is a physical injury or damage to the health of people or damage to property or the environment (ISO, 2015a)
- ISO/TC 8 ISO 20519 defines risk “...As a result, personnel involved in the transfer shall devise procedures to minimize the risks when a safety zone, or a monitoring and security area, in their provisions are violated”. (ISO, 2017a)
- EMSA defines risk as a multiple of Hazard Consequence (expressed in terms of its negative impact) and Likelihood of its occurrence (European Maritime Safety Agency, 2017).

Risk management in LNG bunkering, is mainly implemented by event driven risk analysis methods for assessing the probability and the severity of consequences of accidental events. Popular risk analysis methods implemented in the field are:

-Qualitative methods such as Preliminary Risk Analysis, What-if Analysis, Hazard and Operability Analysis (HAZOP) etc.

- Semi-quantitative Risk Analysis such as Tree-based techniques; Fault Tree Analysis (FTA), Event Tree Analysis (ETA) Bow-tie method, Barrier-Systematic Cause Analysis Technique (BSCAT), Layers of Protection Analysis (LOPA) etc.

-Quantitative Risk Analysis (QRA) (Mokhatab et al., 2013).

However, if an organization participated in the LNG supply chain attempts to take into consideration uncertainties in the decision making, then the scope of risk management should be extended to cover also other important objectives, related for example, to the market share, supply chain stability, conformance to legislation, sustainability etc. This approach is in line with the ISO

31000 standard, which defines risk as “the effect of uncertainty on objectives” and highlights the importance of the continuous and systematic communication and consultation with interested parties/stakeholders in all steps of the risk management process.

Stakeholder or interested party constitutes one of the common terms and core definitions for ISO management system standards given in Annex SL of the Consolidated ISO Supplement to the ISO/IEC Directives, Part 1.

More specifically in ISO 31000 a stakeholder (or interested party) is defined as a “person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity”. The standard recommends that continuous and systematic communication and consultation with all stakeholders is a cornerstone at all steps of the risk management process, as decisions and reasons for taking action become clearer (ISO, 2018). Appropriate and timely involvement of stakeholders enables their knowledge, views and perceptions to be considered. This results in improved awareness and informed risk management. Therefore, to conduct risk management, the stakeholders must be analyzed at all steps of the risk management process, considering the set goals of the organization.

ISO 9000, shares the definition with ISO 31000 and stipulates that the relevant interested parties may cause significant risk to organizational sustainability if their needs and expectations are not met. (ISO, 2015b)

In the field of an organization’s social responsibility, an interested party is defined in ISO 26000 as "individual or group that has an interest in any decision or activity of an organization". According to the standard a stakeholder has one or more interests that can be affected by the decisions and activities of an organization. This interest gives the party a “stake” in the organization that creates a relationship with the organization, which need not be formal or even acknowledged by the stakeholder or the organization (ISO, 2010).

ISO 21500 which provides guidance on project management states that for a project to be successful, the stakeholders must be described in detail, while the roles and responsibilities of the stakeholders must be defined and communicated based on the goals of the organization and the project (ISO, 2012a). ISO 21500 defines stakeholders as “a person, a group or an organization that has interests or may influence, be influenced or perceived to be affected from any aspect of the project”.

In ISO 22313, which gives guidance and recommendations for applying the requirements of the business continuity management system (BCMS) given in ISO 22301, the interested party is defined differently than in the other standards. The concept of stakeholder is presented with a broader definition than other standards.

Clause 3.19 states that the party concerned is “a person or group of people who hold an opinion which may affect the organization” (ISO, 2012b).

2.2 Stakeholder’s Analysis

Analysis of stakeholders is becoming increasingly popular in a wide range of organizations, in many different areas. Stakeholder analysis is an approach for generating knowledge and data regarding interested parties, by understanding their behavior, interests, needs and expectations (Varvasovszky & Brugha, 2000). Understanding those stakeholders from an organization's point of view leads to an assessment of the influence and resources they convey connected on decision-making or implementation method (Brugha & Varvasovszky, 2000; Varvasovszky & Brugha, 2000). In project management the aim of stakeholder analysis is to increase the chances of a successful decision making which leads to the projects’ success. (Varvasovszky & Brugha, 2000)



Figure 1:Stakeholders Analysis Process

The stakeholder analysis process (Figure 1) includes the following steps:

- Identification of stakeholders; identifying who has a stake in aspects of the system under study, and who thinks he is affected (Brugha & Varvasovszky, 2000; Prell et al., 2009; Varvasovszky & Brugha, 2000).
- Stakeholders Categorization
- Investigating relationships and interactions between stakeholders (Reed et al., 2009).
- Collecting, recording and analysis information, in order to define interest, needs expectations, power (Prell et al., 2009; Varvasovszky & Brugha, 2000).
- Prioritization of stakeholders: Power and influence are analyzed and then stakeholders are evaluated according to their involvement in decisions about aspects of the system in relation with the objectives of the organization (Brugha & Varvasovszky, 2000; Prell et al., 2009; Varvasovszky & Brugha, 2000).
- Monitoring and review: Stakeholders analysis is a dynamic and recurring situation, due to the many data and relationships that are discovered during its conduct

Various tools have been developed to assist in the implementation of this process, such as analysis of the value chain and the related legislative framework market analysis, interviews with stakeholders, social media analysis etc. (ISO, 2017b). The Social Network Analysis is a popular method for the investigation of relationships between stakeholders as presented in paragraph 2.3 (Buckingham et al., 2018; Reed et al., 2009; Zedan & Miller, 2017).

2.3 Social Network Analysis (SNA)

Social Network Analysis is used to identify the role and influence of different stakeholders and categories of stakeholder and their relationships. Stakeholders are part of a social whole that is permeated by the most important element of a society, which is their relationship. These relationships determine the impact of the stakeholders on the achievement or not of the objectives of an organization or the implementation of a project.

Social Network Analysis (SNA) is based on the identification of relationships/interactions among the stakeholders. The basic elements of a social network are the "nodes" and the "links". "Nodes" represent the stakeholders under analysis, while "Links" represent the relations among the stakeholders (Buckingham et al., 2018; Hanneman & Riddle, 2005; Research to Action, 2012).

Following the identification of the stakeholders and the relationships among them, it is possible to calculate important indices to evaluate the role of each stakeholder in the network. Main indices of the method are:

- Density: which is calculated as the ratio of the sum of existing links by the number of possible links (Ding & Liu, 2011; Hanneman & Riddle, 2005).
- Degree: The degree of a node reflects the number of connections to other nodes. Degree is the sum of in-degree and out-degree, of each node. In-degree value, calculate how many connections enter the node, and Out-degree value, calculate how many connections come out of a node (Hanneman & Riddle, 2005).
- Closeness centrality: It is calculated by the sum of the lengths of all the shortest paths between all linked nodes (Ding & Liu, 2011; Hanneman & Riddle, 2005).
- Betweenness centrality: It reflects how often an interested party interrupts the shortest routes between two other interested parties (Ding & Liu, 2011; Hanneman & Riddle, 2005).
- Eigenvector: It reflects the indirect influence of a node in a network, according to the connectivity of its neighboring nodes (Hanneman & Riddle, 2005).
- Alliances-modularity: The modularity calculation allows the identification of stakeholders’ communities and potential alliances (Ding & Liu, 2011).

3 METHODOLOGY

In this section, the Social Network Analysis Methodology is applied to describe and analyze the interactions between stakeholders during the design and construction phase of an LNG bunkering installation. LNG facilities are either onshore or offshore.

The proposed methodology presents an approach for systematic analysis of stakeholders, their needs, and expectations, as a part of a framework to manage risks. The systematic proposed approach utilizes tools and processes to model and analyze the stakeholders' interests, interactions and activities and thus serve the establishment of the risk management framework and process which extends ISO 31000 approach.

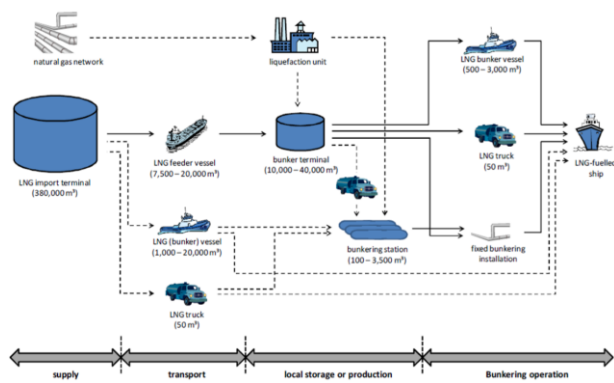


Figure 2: LNG supply chain

In Greece, Liquefied Natural Gas arrives from upstream suppliers and is temporarily stored at Revithoussa LNG import terminal which is operated by the Hellenic Gas Transmission System Operator, DESFA S.A. Ships' bunkering can be achieved through three possible alternative supply options which are: LNG bunker ships, LNG trucks or onshore installations. Onshore installations can be supplied either by LNG bunker ships or LNG trucks. Several National Ports are considering options for LNG ship bunkering. In the port of Patras an onshore installation is considered. For the port of Piraeus, a solution of banker vessels is examined. In other ports (e.g. port of Volos) a solution of LNG trucks seems more feasible.

Several organizations, both from public and private sector, are directly or indirectly involved in the design and operation of LNG bunkering facilities.

The proposed method identifies stakeholders and also analyses all possible interactions and relationships among them to better understand their interests, needs and expectations. The following types (Table 1) of interactions and relationships are examined:

R1. Stipulated by the legislation	R7. Alliance
R2. Customer requirements	R8. Cooperation
R3. Funding / financial flow	R9. Material flow

R4. Exercise of authority	R10. Competition
R5. Guidelines from standard	R11. Information exchange
R6. Exercise of influence or pressure	

Table 1: Types of stakeholders' interactions/relationships

Such relationships are due to material (LNG) flow, information exchange, funding and financial flows, synergies, influence, and others. Many of these relationships are stipulated by the existing legal framework or the structure of the value chain.

All interactions involve decisions to be taken by the stakeholders. These decisions are taken under uncertainties which lead to threats and opportunities, with different levels of probability of realization and impact, that is, with different risk.

3.1 Stakeholders Identification

Based on the analysis of the legislative framework, the value chain and the national LNG market the following main stakeholders are involved in the design of an LNG bunkering facility (Table 2).

Banks	Citizens
Citizens' protest groups	Committee for determining the boundaries of the seashore
Competent authorities for environmental impact assessment	Competition Commission
Engineer	Environmental organizations
European Commission	Fire Service
General Chemical State Laboratory	General Secretariat for Civil Protection
General Secretariat of Ports, Port Policy and Maritime Investments	Government
Greek State	Hellenic Coast Guard
Hellenic Gas Operator	Investors
Labor Inspectorate	LNG Suppliers
Media	Ministry of Culture and Sports
Ministry of Development & Investments	Ministry of Environment and Energy
Ministry of Finance	Ministry of Health
Ministry of Infrastructure and Transport	Ministry of Labor and Social Affairs
Ministry of Maritime Affairs & Insular Policy	Ministry of National Defense
Ministry of Rural Development and Food	Ministry of Tourism
Municipality	Opposition Political Parties

Other Neighboring Facility	Prefecture
Port Authority	Port Design and Development Committee
Organization implementing the project	Regulatory Authority for Energy
Regulatory Authority for Ports	

Table 2: Main stakeholders involved in the design of an LNG bunkering facility

3.2 Development of stakeholders' network

During this step the Social Network was developed in which the stakeholders presented in Table 2, were depicted as “nodes” of the diagram while the identified relationships between them as “links”.

For the determination of these relationships, a detailed analysis of the value chain and the relative legislative framework was performed. Moreover, an extensive research on social media and other online sources took place to facilitate the identification of existing informal relations among the interested parties.

The diagram was developed with the use of a specialized software tool, called Gephi-The Open Graph Viz Platform (*Gephi-The Open Graph Viz Platform*, n.d.). The tool allows the graphical representation of stakeholders and their interrelations using a network diagram of nodes and edges.

The diagram (Figure 3) presents the 42 identified stakeholders and a total of 302 relationships existing in the design phase of an LNG bunkering facility.

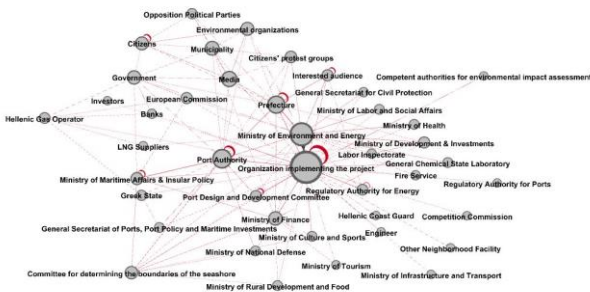


Figure 3: Social Network Graph

3.3 Network analysis results

In this paragraph the basic results of the Social Network analysis are presented.

Density: The density of the network is 0.096. This means that only 9.6% of all the potential connections between nodes are present. This low value of the network density indicates that the stakeholders act on a rather independent way and the interactions are mainly triggered by the legislation.

Average degree: The average degree of the network is 3.9. This means that a stakeholder interacts with others with 3.9 connections on average.

Node degree: As mentioned earlier, the degree of a node reflects the number of connections to other nodes. Figure 4 shows that the stakeholder with the most connections during the design phase is the Organization implementing the project, having 51 links to or from other entities. Other highly connected stakeholders are the Ministry of Environment and Energy (32 connections), the Port Authority (23 connections) and the Prefecture (20 connections). Other less connected stakeholders (10 – 20 connections) are the media, the municipality, the government, the Ministry of Finance, the municipality, the government, the Ministry of Finance, environmental organizations, the citizens, the commission for determining the boundaries of the seashore and the Ministry of Maritime Affairs & Insular Policy. In Figure 3 the size of the node of each stakeholder represents its degree.

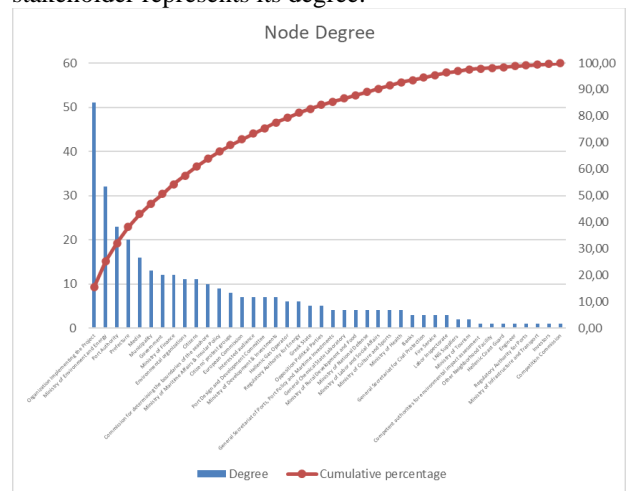


Figure 4: Node degree frequencies (pareto diagram)

Centrality: The Organization implementing the project has the greatest value of **closeness centrality** (73.58%) and he/she could be considered as the more influential stakeholder in the network during this phased along with the Ministry of Environment and Energy with 59.09%.

Similarly, the Organization implementing the project and the Ministry of Environment and Energy have also the greatest values of **betweenness centrality**, which are 814.6 and 257.6 respectively.

Finally, the **eigenvector centrality** values show that the Organization implementing the project and the Port Authority have greater independence in relation to the overall structure of the network.

Alliances – modularity. The analysis identifies four (4) communities in the network, which are groups of stakeholders that could potentially act coordinated to control or strengthen their position on the project. These communities are (see Figure 5):

- The construction related community (Group 1)
- Stakeholders associated with LNG (Group 2)
- Interested Parties associated with the local community (Group 3)
- The port-related community (Group 4)

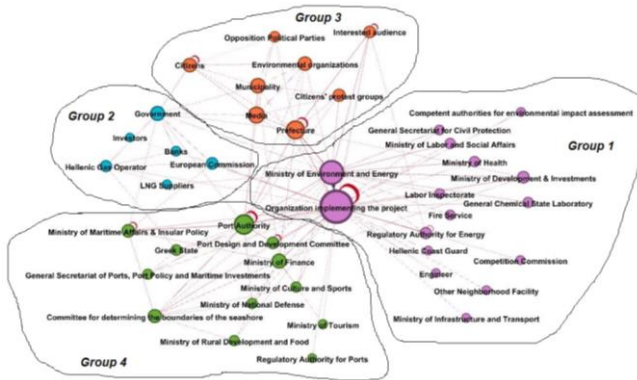


Figure 5: Social Network Graph presenting the four communities

Important connections: Analyzing the interactions it is noticed that strong relations exist between the following stakeholders:

- The Ministry of Environment and Energy and the Organization implementing the project.
- The Prefecture and the Ministry of Environment and Energy
- The Ministry of Maritime Affairs & Insular Policy and the Port Authority
- The Organization implementing the project and the Energy Regulatory Authority

DISCUSSION

The analysis of the network showed that many stakeholders are involved in the design phase of an LNG bunkering facility. The increased legislative requirements in this phase (i.e. related to permitting) mainly determine the relationships among the stakeholders. It has been also demonstrated that the Organization implementing the project, the Ministry of Environment and Energy and the Port Authority are the key stakeholders.

The interactions seen on the network are related to activities which aim to realize needs (i.e. explicitly defined requirements) and expectations (i.e. desired requirements) and thus the related decisions may influence the project objectives set by the Organization implementing the project, positively or negatively.

Therefore, the Organization implementing the project should take into consideration that decisions taken from stakeholders which have strong interactions may have important impact and that the related risks should be managed.

Ministry of Environment and Energy, Port Authority and the local Prefecture appear to have strong interactions with the Organization implementing the project thus uncertainty related to their decision should be taken into consideration and related risks should be managed.

Impacts of these risks would delay or accelerate the permitting procedure and the design of the LNG facility.

Interested parties with high node degree value (i.e. larger nodes circles in the network) are related to decisions which may probably have important impact during the design phase of the LNG facility and therefore should be closely monitored.

Interested parties with low node degree value (i.e. smaller nodes circles) whose decisions may not probably have important impact during the design phase of the LNG facility should be simply monitored.

CONCLUSIONS

Discussion about use of LNG as a fuel is increasing significantly in the shipping sector, mainly due to the introduction of legislation by the International Maritime Organization (IMO) regarding the emissions of exhaust gases to environment from ships.

LNG has been considered as a preferable low emission solution (IMO, 2016b). However, LNG's use as a shipping fuel faces important challenges, mainly due to the lack of infrastructure, facilities, and important uncertainties/challenges regarding the adoption by the shipping industry. Risk Management is an appropriate method to take into consideration uncertainty and support the relevant decisions.

For an effective risk management, an Organization implementing the design and construction of an LNG bunkering facility should deeply understand its business environment dynamics, opportunities, and threats.

The current paper proposes a stakeholders' approach for managing risks, that includes a structured way for identifying and analyzing their interests, needs and expectations for the development of the project, and thus their potential influence on its objectives. The exploration of the relations and interactions among the stakeholders at various levels (e.g. strategic, operational, and legislative) would allow a justified evaluation of their power/ influence and their potential to create risks for the project.

Social Network Analysis (SNA) appears to be a promising method for assisting the modeling and analysis of the stakeholders' interests, interactions, and activities as part of a holistic risk management framework.

The current paper presented the application of this method for implementing stakeholders' analysis for the design of an LNG bunkering facility. It demonstrated the relative importance of the various interested parties, taking into account the extent of their involvement into important activities of this phase of the project, such as the permitting activities, the engineering studies, the

funding etc. The research will further examine the development of a methodology for considering the relative importance of these interactions for achieving the project's objectives.

The proposed approach for implementing risk management taking into account the stakeholders interactions and their potential to cause risks for a project or organization, is highly differentiated from existing popular event driven risk analysis methods as it focuses to the actors' interactions and decisions rather than to predicting of unexpected accidental conditions. The authors believe that this approach could serve risk management in general and not only the LNG bunkering operations.

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