Available online at www.sciencedirect.com
ScienceDirect
Journal of Hazardous Materials 154 (2008) 901–913
Journal of Hazardous Materials
www.elsevier.com/locate/jhazmat

SWOT analysis for safer carriage of bulk liquid chemicals in tankers

Ozcan Arslan [a,*], Ismail Deha Er [b]

[a] *Maritime Transportation and Management Engineering Department, ITU Maritime Faculty, 34940 Tuzla, Istanbul, Turkey*
[b] *Marine Engineering Department, ITU Maritime Faculty, 34940 Tuzla, Istanbul, Turkey*

Received 26 June 2007; received in revised form 31 October 2007; accepted 31 October 2007
Available online 21 February 2008

Abstract

The application of strengths, weaknesses, opportunities and threats (SWOT) analysis to formulation of strategy concerned with the safe carriage of bulk liquid chemicals in maritime tankers was examined in this study. A qualitative investigation using SWOT analysis has been implemented successfully for ships that are designed to carry liquid chemicals in bulk. The originality of this study lies in the use of SWOT analysis as a management tool to formulate strategic action plans for ship management companies, ship masters and officers for the carriage of dangerous goods in bulk. With this transportation-based SWOT analysis, efforts were made to explore the ways and means of converting possible threats into opportunities, and changing weaknesses into strengths; and strategic plans of action were developed for safer tanker operation.

Keywords: SWOT analysis; AHP; Maritime; Chemical tankers; Safety

1. Introduction

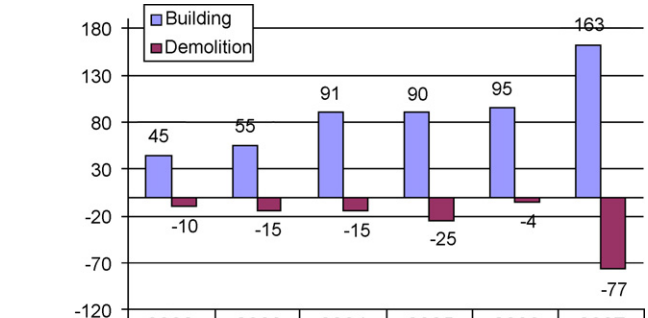
Many sections of the worldwide chemical industry depend on the transport of large quantities of liquid chemicals by maritime tankers. Chemical cargoes have different properties, and many of them represent health and safety hazards, which is a critical issue for the tanker industry [1]. Ocean shipping is the dominant transport mode in chemical logistics, as large volumes of liquid chemicals require transportation between continents. At present, 65–85% of international trade is via sea transport, and this is expected to increase with the growing world economy [2]. The present rate of construction of chemical tankers exceeds the rate of demolition and, thus, the world chemical fleet is growing, as illustrated by Fig. 1 [3].

Chemical tankers are complex vessels that are designed to carry different types of chemical cargo. Some cargoes need heating, some need refrigerating/freezing, some must be kept under inert conditions, some need to be carried in stainless steel tanks, and some are flammable, explosive or give off noxious vapor [4], and these properties require careful consideration during the planning process and loading. Checks need to be made regarding the chemical ship type, tank coating compatibility, compatibility with other cargo, and the environmental controls required during transport. In addition, the venting requirements, monitoring equipment, vapor detection, compatible fire protection medium, and density limitations of the product in relation to the holding tank construction, and pumping requirements are important considerations [3].

Every type of chemical liquid that is carried by chemical tankers needs specific carriage and loading/discharging conditions, and specific operational and safety-related precautions. This study used strengths, weaknesses, opportunities and threats (SWOT) analysis to identify and develop safer carriage of liquid chemicals. Section 2 describes the hazards; Section 3 describes the SWOT analysis used in this study; and Section 4 is a discussion of the strengths, weaknesses, opportunities and threats for the carriage of liquid chemicals in bulk. Section 5 describes the strategies suggested for safer carriage of bulk chemicals in tankers and in Section 6, an incident investigation case study has done by utilizing analytic hierarchy process (AHP) with SWOT analysis method.

* Corresponding author. Tel.: +90 5057134754; fax: +90 2163954500.
E-mail addresses: arslano@itu.edu.tr (O. Arslan), erde@itu.edu.tr (I.D. Er).

0304-3894/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.jhazmat.2007.10.113



	2002	2003	2004	2005	2006	2007
Building	45	55	91	90	95	163
Demolition	-10	-15	-15	-25	-4	-77

Fig. 1. Chemical tanker deliveries and demolition per year (>5000 DWT).

2. Hazards associated with the transport of bulk chemicals

2.1. Fire hazards

Flashpoint, boiling point, flammability limit and autoignition temperature vary between different liquid chemicals, which therefore have different fire characteristics. For example, methanol, which is carried commonly by chemical tankers, has a flashpoint of 16 °C, is extremely flammable when mixed with air, and may be explosive when such mixtures are in a confined space [5].

2.2. Health hazards

Many chemicals have an irritant or toxic effect on the skin or on the mucous membranes of the eyes, nose, throat, and lungs in the gas or vapor state. Acrylonitrile, which is carried in bulk by chemical tankers, is highly flammable and toxic, and it undergoes explosive polymerization. The burning material releases fumes of hydrogen cyanide and oxides of nitrogen, and acrylonitrile is classified as a possible human carcinogen. The carriage of acrylonitrile needs special precautions for personnel safety [6].

2.3. Pollution hazards

Water pollution hazards are defined in terms of human toxicity, water solubility, volatility, odor or taste, and relative density. The air pollution hazards of chemicals are defined by the emergency exposure limit (EEL); vapor pressure; solubility in water; relative density of liquid and vapor density. The reactivity hazard of a chemical is defined by reactivity with other products including water; and with the product itself (including polymerization). Marine pollution hazards are defined by bioaccumulation with attendant risk to aquatic life, tainting of seafood, damage to living resources and hazard to human health [7].

3. Method

The SWOT analysis method was used in this study to analyze the current situation concerning the carriage of chemical liquids in maritime tankers, and to formulate strategy for reducing human error and, thus, maritime casualties. SWOT is an acronym for strengths, weaknesses, opportunities and threats. SWOT analysis, is a strategic planning tool used to evaluate the strengths, weaknesses, opportunities, and threats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective. The technique is credited to Albert Humphrey, who led a research project at Stanford University in the 1960s and 1970s using data from Fortune 500 companies. Every program, including the operational process, the management plan and development characteristics, has its strengths and weaknesses, opportunities and threats. Consideration of the processes involved in the carriage of chemicals in tankers can lead to improved safety. SWOT analysis is intended to maximize strengths and opportunities, minimize external threats, transform weaknesses into strengths, and to take advantage of opportunities along with minimizing both internal weaknesses and external threats [8]. SWOT analysis is designed to be used in the preliminary stages of decision-making on one hand, and as a precursor to strategic management planning on the other, and should be performed by individual users and by groups. Groupwise analysis is particularly effective in providing clarity, and identifying factors and major objectives and, therefore, focuses discussions about strategy formulation regarding any proposed organization aboard chemical tankers to improve safety [9].

In the SWOT analysis, available resources and their potential utilization are studied from the viewpoints of economic, ecological and social sustainability. However, its main purpose in the planning process is to obtain decision support that is to be utilized in the choice of strategy to be followed. In a decision-theoretic study, a decision is considered as a choice between two or more alternative measures. Generally, rational decision makers choose the alternative that maximizes the utility, determined on the basis of information available on the decision alternatives. In decision support, information is produced on the decision situation, and on alternative choices of action and the consequences. A complete decision model constitutes the basis for the decision support. The alternatives available, information about the consequences associated with these alternatives and the preferences among these consequences are the three criteria to be considered in making the decision [10]. Each aspect of the information must be sound, so that the best alternative can be selected. SWOT can be used for the analysis of internal and external environments in order to attain a systematic approach and support for decision-making and, if used correctly, it can provide a good basis for successful strategy formulation. It was intended that the SWOT analysis would provide: a framework for analyzing a situation and developing suitable strategies and tactics; a basis for assessing core capabilities and competences; and the evidence for and the key to change and success; and a stimulus to participate in a group experience [11].