
ROAD TRANSPORT OF DANGEROUS GOODS AND IMPLEMENTATION OF THE ADR AGREEMENT IN GREECE

V.Manousaridou ^a, F.Karazois ^a, D. Folinas ^a, D.Aidonis ^a,
D.Triantafyllou^a, S. Drogalas ^a

^a Logistics Department, TEI of Central Macedonia, Greece

Abstract: *In the present study focus is placed on road transportation of dangerous goods and on the respective implementation of the existed institutional framework, for the particular case of Greece. The aim of the study is 1) to conduct a thorough literature review of the terms dangerous goods, road transportation, legislative framework and ADR Agreement; 2) to properly reflect the conditions of DG transportation in Greece; 3) to assess whether the implementation of ADR Agreement by carriers is satisfactory and 4) to test the sufficiency of the control process by the responsible control authorities. The study was conducted into two levels, namely in a secondary and a primary survey.*

Keywords: *Road Transportation, Dangerous Goods, Fuel, ADR Agreement.*

1. INTRODUCTION

Dangerous Goods (DG) consist of materials that pose a risk to the environment, society, life, health of human beings and animals and to public safety. The most commonly used and transported DG include: flammable liquids (gasoline, oil), flammable pressurized gases (LPG, medical gases), oxidizing and corrosive substances, toxic substances (pesticides), explosives and infectious waste (hospital). The majority of DG (more than 70%) transported to Greece and to other European countries is held via roads. In case of a transportation accident where DG are involved the leakage of the transported product leads to consequences disproportionately destructive and irreversible. Thus the road transportation of DG has been extensively studied by the graduate program of the Logistics Department (TEI of Central Macedonia, Greece) with an emphasis placed on capturing the conditions of DG transportation in Greece. A thorough review of the efficiency and the implementation of the ADR agreement has been conducted. Data provided by the a) Hellenic Statistical Authority (HSA); b) European Statistics (EUROSTAT); c) Ministry of Infrastructure, Transport and Networks; d) Union of Hellenic Chambers and e) General Commercial Registry, have been used for assessing the statistics of DG transportation in EU with a particular interest on Greece case. These data provide useful insights on the number of vehicles eligible for DG transportation, the percentages of driver training certificates and on the number of companies involved in DG transportation. For further analysis questionnaires regarding DG transportation were designed and distributed to people involved. For control and implementation of the ADR agreement, the survey focused on the Transportation and Communication Departments of the Regional Units of Greece. To that end the main focus of that research is placed on: 1) Definition of the terms: DG, road transportation, Legislative framework and ADR Agreement, 2) Identification of EU and Greek transport conditions, and 3) Assessment of ADR implementation and of control mechanisms efficiency. Though previous studies deal with DG transportation in a national level (i.e. Greece), the implementation of the respective legislation framework has not been investigated yet. Instead focus was placed on the

relationship between road safety and the infrastructure. This study is organized as follows: Section 1 describes the significance of road transportation; potential consequences of DG accidents while the conceptual approach the aim and the hypotheses used in the study are clearly stated. A thorough literature review where the relationship between road transportation and the efficient administration of supply chains and logistics are analyzed is conducted in Section 2. Additionally the research objectives and questions are presented. Section 3 deals with the methodology developed. Collection of real data and their analysis took place in order to capture the Greek reality for DG road transportation. Empirical data collection was carried out using structured questionnaires with closed-ended questions sent to transport and communication services to DG transportation companies. Section 4 discusses the results drawn from this research and finally in Section 5 conclusions and suggestions for future work are presented.

2. LITERATURE REVIEW

Supply chain is defined as a link between production and distribution and includes all the necessary processes such as the purchase, supply, transport and storage of natural products (Papadimitriou and Shinas, 2004). In Greece, the supply chain is estimated at about 10% of GDP, and there is much scope for further growth in the sector as the country's dynamics has not been fully exploited due to its geographical location (the smallest distance between Europe and the Suez Canal). The development of the logistics sector can play an important role in the recovery of the Greek economy, as the reduction in import and export costs can have a positive effect on domestic GDP due to the overall growth of the sector. On the other hand the attempt to group the fragmented domestic Economies will bring about an improvement in economies of scale and productivity. According to David A. Taylor, the supply chain consists of set of facilities linked to transport channels. Facilities based on their primary function are distinguished in production and storage facilities. Transport channels are categorized according to the selected mode of transportations, which may be terrestrial (road, rail), waterborne, sea, air or pipeline (Taylor, 2004). Road freight transport (RFT) is a subsystem of the transport system. In that respect the national transport system is a subsystem of the global transport system, influenced by international developments (Naniopoulos, 1988). RFTs occupy the first place in all inland transport operations in EU and especially in Greece where their share exceeds 95% of total land freight traffic. Based on the conditions that RFTs take place, three conclusions can be drawn: 1) According to EUROSTAT data, by the end of 2012, 1659 km of motorway, 9299 km of main national network, 30864 km of sub-network and 75600 km of other roads were delivered to Greece, 2) Trucks in Greece can be divided into two categories according to the use of the vehicle in a) private trucks (PT), which operate to meet the transport needs of the company to which they belong and in b) public transport trucks (PPT) which offer transport services to third parties, and 3) Approximately 50% of the goods transported worldwide can be categorized as dangerous goods. The hazards that DG pose are attributed to their nature and their properties. DG can be transported at any phase, either as a gas, as a liquid or as solid. The phase of the transported goods is significant due to the risks that may arise. For example, powders could enter the respiratory system and contact with liquids may damage the skin (Kouloheris, 2013). Transporting DG, even in small quantities, may cause serious accidents. The necessity of transporting goods leads in many cases to routes through public and crowded areas such as motorways and railway stations. Accidents with DG can be also seen as an unforeseeable and undesirable leakage of the transported material during transportation, loading and / or temporary storage (Abkowitz and List, 1987). Accidents involving DG evolve in a specific way and potential ramifications are: 1) Liquid leakage or DG gas dispersion. In the case of leakage of large amounts of toxic gas, toxic fog can be formed which, depending on the prevailing conditions, such as weather and soil morphology, can be transferred affecting a wider area. In case of liquid leakage, a jet is created and a pond is formed on the ground. Typical examples of

toxic gases are chlorine and ammonia, 2) Fire. Possible causes are road accidents, short circuits, smoking, static electricity, mechanical stress, strong electromagnetic emissions. Even the material itself poses risk of fire due to chemical instability and high reactivity. Fire can be distinguished in: a) gas flame which is generated by the combustion of a flammable gas cloud with very low flame transmission rates and thermal radiation; b) Fire spheres: this type is usually associated with liquefied gases and is usually manifested after a tank explosion under pressure. In this case, the explosion can be done with or without fire; c) Lake fires are created by burning the lake of a flammable liquid with constant flame propagation. Liquid lake fire usually occurs when a flammable liquid leaks to the ground and ignites and (d) Torch fires: Torch fires are created by burning a flammable gas during gas leakage under pressure. This type of fire occurs when a flammable gas under pressure exiting a pipe or other opening, ignites to form a flame in the form of a beam (Poulios et al., 2007), and 3) Explosion. Generally, explosions are considered to have a destruction potential greater than that of fire, but less than that of the leakage of toxic chemicals. Possible types of explosions include explosion of gaseous cloud and explosion of effervescent liquid expanding gas. Explosion of gaseous cloud is created by the burning of a flammable gas cloud with very high velocities of flame transmission and overpressure. Explosion of effervescent liquid expanding gas is created during the complete bursting and loss of the flammable liquid content of a tank exposed to flames and flammable liquid (Vayokas, 2010). EU countries keep a record not only on the amount but also on the type of DG transported. Figure 1 displays the type of DG transported during 2014. As expected the category that exceeds half of the total DG transported is that of flammable liquids. Gases followed by corrosives consist 14% and 10% respectively. The methodology used for the collection of the data varies for different countries, a fact that increases uncertainties regarding the absolute values and the distribution of the data. However, for the majority of the countries the percentage of the flammable liquids and gases exceeds ~70%. Though DG accidents occurring in RFMs consist a small proportion of total road accidents, they result in devastating and often irreversible consequences. Apart from their primary consequences such as fatal injuries, they may result in secondary ramifications such as soil contamination, threatening and affecting the flora and fauna. DG RFMs taking place in Europe are regulated by the European Agreement on International Road Transport DG, known as "ADR", the acronym of the French name "Accord Dangereux Routier". The agreement regulates DG terrestrial transportation and entered into force for the first time in 1957 in Geneva under the aegis of the United Nations Economic Commission for Europe. Freight transport of Dangerous Goods is subject to registration at European level due to the increased risk involved. This record is kept and maintained by EUROSTAT and is updated on an annual basis (Eurostat, 2016). For most countries, the proportion of DG migrants fluctuated around 4%. All major economies recorded rates between 4% and 8%, except for Poland, the second largest transport industry in Europe, which had a lower rate (3.5%). Cyprus has the highest percentage of DG transport (27.3%), while Slovakia, the Netherlands, Lithuania, and Latvia ranged only between 1% to 2%. Greece range is slightly above 5%. Variation on the records are caused by the lack of data and therefore post processing of data does not cover the total DG transported units.

3. METHODOLOGY DEVELOPED

The present study addresses the following research questions: 1. What is the current situation for DG road freight transportation in Greece? 2. In what extent is the ADR agreement implemented by DG carriers? 3. How adequate are the controls of the transported DG? These questions are answered respectively. Primary and secondary surveys for the collection of statistics were conducted. In particular primary surveys consist of data collection from the following three categories of questionnaires; a) Dangerous Goods carriers b) companies whose activities are related to Dangerous Goods and c) the DPEs of the Regional Units. Statistics provided by the Hellenic Ministry of Infrastructure, Transport and Networks and from the Union

of Hellenic Chambers were used for the secondary survey, respectively. Addressing the second question includes a primary survey that aims to DG carriers and DG-related companies. The third question was addressed by employing a primary survey on Transport and Communications Services. The study of the current situation in DG road transport started with the implementation of quantitative research. The main objective was to extract specific measures based on statistically reliable data. The necessity of addressing the three questions within a questionnaire format emerged the use of telephone and e-mail communications. Both types provide coverage in both urban and remote areas and facilitate the accommodation of larger participation sample. To that end it was concluded that the distribution of questionnaires to workers of DG RFT field, DG production and logistics companies would be more efficient. The majority of participants showed a willingness on contributing to the research. Carriers, contact details provided by their association and internet research participated to a satisfactory degree. In that sense the participants were categorized into three groups: DG Carriers (drivers and companies), Companies involved in any of the following field: production; process; distribution; extraction; generation of DG and Transport and Communication Authorities. Assessing the research objectives required data collection from all of the three groups. Difficulties encountered included the separation of DG carriers and companies, due to the format of the official authorities. The sample of companies was randomly selected.

4. DISCUSSION ON THE RESULTS

Fuels (liquids and gases) consists more than 80% of DG road transport. To that end studying the movement of fuels provides approximately a global picture of DG traffic. According to secondary research data from EUROSTAT, the total volume of transported liquid fuels of the last five years (years of financial crisis) was at the level of 43943.1 thousand tonnes of oil. Considering that the latter number corresponds to 80% of the total DG transported we estimate the total volume of DG (57536.8 thousand tons of oil). From the results it was also shown that the first type of liquid fuel transported is oil (more than 50%), followed by gasoline, while other types have a negligible contribution to the total amount. By comparing the transported quantities of fuel in Greece with the corresponding countries with similar populations, it was observed that only Belgium demonstrates similar behavior with Greece regarding fuels transportation. As far as gaseous fuels are concerned, the fluctuations in LPG were steadily rising even during financial crisis, while natural gas was on a downward path. In particular, over the course of the financial crisis years (2010-2014) the total volume of transported liquid fuels was approximately 43943.1 thousand tons of oil while the respective total volume in the period before the crisis (2004-2008) was 62,264.7 thousand tons. The drop of in the transported quantities of liquid fuels is significant (30%). In Greece the number of registered and active companies trading DG is 1084. Statistics of these companies were provided by the Union of Hellenic Chambers. The majority of these companies (54%) operates in the field of petroleum transport that are carried via tanker vehicles, followed by companies involved in production of petroleum products, bitumen and asphalt. Two hundred and sixty (216) companies are active in the collection, processing and disposal of Dangerous Waste, most of them licensed after 2013. Companies active in the production of weapons, ammunition, bombs, missiles, gunpowder and various munitions amount to seventy (70) , a number considered extremely high for a country with the population of Greece. The geospatial distribution of companies operating in the DG sector denotes a preference on large size cities. In particular, the headquarters and facilities of these companies are located in the ten largest cities of Greece, with more than half locating in the two major urban centers namely, Athens and Thessaloniki. Most of the DG transportation is held by entrusted transport companies. In total, fifty (50) transport companies responded to the survey. Given the number of companies active in DG transportation in Greece, this sample is considered representative to provide valuable information. From the answers given, the following outcomes can be drawn:

- Approximately 90% of the responding companies have legal form of individual enterprises. They own one to three vehicles and employ one to three people in DG transport driver posts. In that sense the size of these companies is small, a fact that represents the major trend of self-employment in Greece. Despite the guidelines and strategic planning of the government, carriers are denying effective co-operation with each other in any form of companies and hence this sector is still fragmented.
- All transport companies are engaged only in transport and do not provide other logistics services. As mentioned the majority of the transported products belongs in liquid fuels category, while other DG phases consist less than 10% of the total DG products carried. As a result, the largest volume of transport is carried out by tanker vehicles.
- Financial crisis has affected DG transport companies in the period 2010-2015. About three-quarters of the companies show a drop of more than 20%. The same applies for distances traveled. Only one out of ten companies is able to increase the distance traveled dropping the amount transferred simultaneously. According to companies involved in DG transport 80% records a decrease in the distance traveled and 10% increase of the distance traveled over the last 5 years. There is also correlation between the distance traveled and the amount of DG transported. In particular, an increase on the distance traveled is correlated to a slight decrease on the amount transported.
- Regarding the existence of a tracking system in vehicles, two-thirds of the companies asserted that they use a tracking system. Concerning the employment or cooperation of DG transport companies with the DG Transport Safety Advisor (DGTSA), less than half responded that they either employ or cooperate with DGTSA.
- DG transport companies pay particular attention on road safety issues. All drivers hold a certificate on professional training A.D.R with three-quarters of them undergoing medical examinations more often than prescribed by law (five years). 30% of the companies also stated that they provide their drivers with additional DG transport training and all without exception have taken measures to deal with a possible leakage or accident. In the key question about the history of company vehicles in terms of accidents and leaks, only 6% of companies claimed either an accident or a leakage, a percentage considered satisfactory. Additionally, it was concluded that oil companies impose rules stricter than those imposed by legislation.

Analysis of the statistics provided by the Ministry of Infrastructure, Transport and Networks lead to the following outcomes: 1) The number of drivers licensed by the ADR agreement exceeds 101,00, and 2) The majority of drivers holds an ADR license that falls into the category "Basic education and tracks". DG carriers' opinion on ADR license realization can be summarized as: 1) The majority of companies (98%) asserts that legislation for DG transport is not extremely strict, while only 2% believes that it is extremely strict, 2) Realization of the ADR agreement is considered absolutely satisfactory according to 75% of the drivers, with the rest of the sample asserting that the agreement is merely realized, 3) DG transport and distribution companies, impose stricter internal legislation for safety purposes, and 4) Potential reasons for not complying with the agreement for some drivers include the high cost and the combination of other minor reasons (ignorance, indifference, lack of control, complexity of the legal framework). Conflicting views regarding the implementation of the ADR agreement were reported by the Directorates of Transport and Communications (DTC). Twenty-six out of fifty-one of the DTCs consider the ADR Agreement to be applied by road carriers "not at all" to "moderate" while the rest of them believe that the ADR applies "very" and "fully". The percentage of DTCs that chose extreme values namely "no" or "full" was limited. Likert scale was used for the questionnaires design. The adequacy of DG transport controls by Transport and Communications Divisions of the Regional Units was assessed by designing questionnaires targeted on these Services. According to the questionnaires analysis the following results can be drawn: 1) Employees of DTCs licensed to control DG transport vehicles consist approximately 50% of the total employees, 2) The lack of control mechanisms is highlighted by the fact that

only 70% of DTCs provide this service. Additionally 30% of DTCs control mechanisms consist totally of Roadside Inspections, while only 10% provides Roadworthiness Test Centre (MOT Test) services. Finally, 30% of DTCs provide all the legislated control mechanisms, and 3) Information regarding the control of the ADR Agreement shows a lack of qualified staff, followed by a lack of financial resources.

5. CONCLUSIONS AND RECOMMENDATIONS

From the analysis conducted it is suggested that attention should be paid to DG road freight transport. The first concern regards a new legislative framework that should be in harmony with European law. This framework should take into account the social and economic conditions of the country as well as the needs of the industry and it should be also accompanied by the introduction of new administrative sanctions. It is also proposed to upgrade and modernize DG transport vehicles, co-financed by the European Union if possible. The driver of a DG transport vehicle is an important factor in road safety and therefore it is crucial to provide high-level education covering the provisions of the ADR Agreement. All the responsibilities of the Transport and Communications Directorates related to the ADR Agreement are proposed to be coordinated and controlled by the Ministry of the Environment and the Directorate-General for Road Safety. Finally, databases development that would allow record of DG traffic at a national level is highly recommended. Future work would include comparisons of the current situation in Greece and other European countries. It is also possible to compare the control mechanisms of Greece with those of the EU countries in terms of constitution, operation and effectiveness. This would serve to identify the appropriate actions by the central administration to improve any deficiencies. In any case, the use of tools other than questionnaires (such as unstructured interviews with open-ended questions to those involved in the movement of dangerous goods) would give greater credibility to the survey, and it would depict a clear picture of the reality. Lastly, the impact of financial crisis on Greece would be interesting to assess. Therefore, should the financial situation in Greece being balanced, a comparative analysis between the pre and post crisis DG transport conditions will be conducted.

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