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TÍTULO: Factores de riesgo en la transportación de materiales peligrosos.

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RESUMEN: El presente estudio aborda los factores de riesgo en el transporte por carretera de materiales m peligrosos en Irán. La presente investigación se realiza en dos secciones teóricas y prácticas. En la parte teórica, se recopiló la información necesaria utilizando la biblioteca y el método de documentación, y en la sección práctica, en el método de la encuesta, se recopiló la información necesaria a través de entrevistas con expertos y revisores. Al analizar el contenido de estas entrevistas, se identificaron los factores de riesgo. Luego, utilizando estos factores e indicadores, un cuestionario fue desarrollado por conductores de camiones que transportaban materiales peligrosos. Los resultados de la investigación indican que el tipo de material transportado, las condiciones ambientales, las condiciones humanas, las condiciones del tráfico y las condiciones del vehículo son factores de riesgo para el transporte por carretera en Irán.

PALABRAS CLAVES: factores de riesgo, transporte por carretera, materiales peligrosos.

TITLE: Risk factors in transportation of hazardous materials in Iran.

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ABSTRACT: The present study addresses the risk factors in road transport of hazardous materials in Iran. The present research is conducted in two theoretical and practical sections. In the theoretical part, the necessary information was collected using the library and documentation method, and in the practical section, in the survey method, the necessary information was collected through interviews with experts and reviewers. By analyzing the content of these interviews, risk factors have been identified. Then, using these factors and indicators, a questionnaire was developed by drivers of trucks carrying hazardous materials. Research findings indicate that the type of material being carried, environmental conditions, human conditions, traffic conditions, and vehicle conditions are risk factors for road transport in Iran.

KEY WORDS: risk factors, road transport, hazardous materials.

INTRODUCTION.

Statement of Problem.

Transportation of hazardous materials is a field which, despite the high safety record, is very much considered due to the high potential of accidents.

In order to further develop manufacturing industries that will lead to an ever-increasing economic boom, there is a need to expand infrastructure in various sectors, including the transportation industry and the road. Obviously, the broader the network of distribution and distribution in a wider and more efficient country, it will be easier to advance development objectives. Our country, Iran, was not excluded from this, and with regard to the dramatic growth of oil and chemical industries, the issue of the transportation and transfer of these materials has become one of the main issues in this section (Jabari and others, 2014: 30).

Such materials, classified as hazardous, always have their own special sensibilities, because in the event of any incident involving the carriers of such goods, the dimensions of the potential consequences will be greatly damaged. The risks of such displacements are so significant that the managers of this sector have been compelled to make a decision to reduce the risk posed by such

materials by making decisions. Although these decisions are rigorous and costly, management will have to apply them (Hajarzadeh, 1394: 50). Therefore, the adoption of a proper procedure, as well as being aware of the aspects and all possible risks in the case of the carriage of such commodities, can lead to a reduction in possible costs and the choice of the best option. Therefore, managers and decision-makers in this field are always seeking to find out how much the actual risk of carrying such commodities is from a specific route, by checking the extent of this risk by providing the necessary control measures, or by adopting other methods reduce the risk of this displacement (Abdullah Zadeh, 1393: 12).

In Iran, millions of tons of dangerous cargo are transported annually through roads. The high volume of road transport of hazardous materials, on the one hand, along with non-compliance with loading and unloading standards, causes many disasters annually. The most important dilemma in the transportation of hazardous materials is the lack of centralized management of accidents and the impossibility of communicating rapidly and simultaneously between the devices involved in responding to and responding to relevant incidents (Ghorbanzadeh, 1396: 4).

Part of the road transport of goods is the transportation of hazardous materials. As an example, 18% of road freight transport in Italy is related to the transport of hazardous materials. This road transport accident has also led to accidents, many of which are associated with severe human casualties and the environment has been accompanied by the destruction of national resources and resources. Control and reduction of accidents caused by road transport of hazardous materials is important and necessary. This requires identifying the drivers of road accidents hazardous materials. The next step is to assess the risk of road transport hazardous materials. This risk assessment helps to decide on the design of transport of hazardous materials. Since many factors, such as road conditions, weather conditions, driver's condition and hazardous materials conditions, affect the risk, then the design of transportation of materials hazard requires risk assessment based on these factors (Jabali, 1395: 17).

In the same vein, the present study has identified: firstly, the identification and classification of hazardous substances, and secondly, identifying and prioritizing the risk factors in road transport of hazardous materials in Iran.

Hazardous materials such as explosives, flammable, toxic and infectious substances are substances that, because of their chemical and physical properties, impose a significant risk to the health and safety of people, the environment and property (facilities and facilities), transport and the transportation of hazardous materials is an indispensable necessity for the development of industrialized countries, which must be carried out in accordance with specific measures.

Risk analysis, facility location and routing and timing are among the most important issues in the transportation of hazardous materials. In the issue of routing, route selection or how to allocate hazardous vehicles according to safety and economic considerations (competing and contradictory goals) is due to the increasing production and diversification of hazardous materials and goods; the safety of transportation of these materials is very important in terms of risk management (Haddadin, 1959: 5). The statistics show that about 800,000 dangerous goods are transported daily in the United States (Glickman, 2015: 62). In Iran, 270 million tons of cargo is carried annually in the road section, more than a third of which is hazardous material (Haddadin, 1959: 5). What has highlighted the importance of transporting hazardous materials is the extent to which incidents are threatening the lives of people and the environment on the one hand, and security issues on the other. Security issues make it important to increase the shipping risk of these materials due to the use of terrorist means to transport hazardous materials. In this research, we tried to study the risk of transportation of dangerous materials in the road section, relying on the concept of transportation risk.

DEVELOPMENT.

Research objectives.

The research objectives are defined as Identification of road hazardous materials, and Identification of risk factors in transportation of hazardous materials in Iran.

Questions or research hypotheses.

There are two questions or research hypotheses determined as:

1. What are the dangerous shipments of Iran?

2. What are the risk factors in road transport of hazardous materials in Iran?

Conceptual definition and Operations.

Conceptual definition. Hazardous substances such as explosives, flammable, toxic and infectious substances are substances, that due to their chemical and physical properties, have a significant risk to the health and safety of people, the environment and property (Jabbari, 1393: 31).

Operational definition. The substance of the hazardous materials in this study is the materials that experts refer to. These hazardous materials are: 1. Gases, 2. Flammable liquids, 3. Flammable solids, self-reactive substances and explosive solids, 4. Flammable gases in contact with water, 5. Oxidizing substances, 6. Toxic substances, 7. Radioactive materials, 8. Corrosive materials, and 9. Other hazardous materials.

Research literature (background and theoretical basis).

Background.

Ghorbanzadeh (1396) has introduced "Assessing the Road Network Performance Based on the Risk of Transportation of Hazardous Materials". Among the criteria used to assess the risk of transport due to the transport and handling of hazardous materials, Risk index based on the method presented in this paper, we can determine the risk of passing hazardous predictions based on vulnerable elements such as population and environment for network arcs. The correct determination of this index can be a good tool for decision makers to estimate network risk and evaluate its performance and decide on doing things like routing these materials to improve the network status (Risk index) (Gorbanzadeh, 1396: 93).

Oroui and others (1393) conducted a study entitled "Analysis of road accidents caused by the transport of toxic gases in the city of Hassan Abad located on the transit route of Tehran-Bandar

Abbas". This paper assesses the effects of toxic gases leakage. To simulate the effect area, a Gaussian model or heavy gases in which the effects of velocity, wind direction and atmospheric conditions are considered are used. In this article, according to the location of the incident in Hassan Abad, the population at risk of death is calculated and amounted to 386 people for ammonia gas.

Rahimov (2016), assessing the safety of transportation of hazardous materials in the railway and road transport of the Azerbaijani Republic, wrote: "Today, the reduction of financial and human damages, increasing the reliability and safety of transportation systems, has attracted many industrialists, including the road and rail. Among the important concerns in rail and road transport is the safe transportation of hazardous materials, which will result in the least significant neglect of the extremely dangerous environmental and human consequences. Studies in this area suggest that risk assessment is a suitable method for achieving these goals (quoted by Ghorbanzadeh, 1396: 23).

Theoretical Foundations.

According to the definition given by American Occupational Safety and Health Administration, the risk is a factor that makes it difficult for humans or equipment to be present in the two potential and actual ways around us. What is mainly related to the transport of hazardous materials is the potential danger that it is unlikely that they will occur in the event of non-compliance with the transport regulations and standards. Of course, appropriate warning signs can be used to reduce the incidence of accidents. These terms are called alert tags and have dimensions of 10 cm × 10 cm. Alert tags are signs that quickly guide the user to the concept of existing dangers and have certain meanings, so that they are used for a particular group of materials (Azar and other: 1394: 3).

Hazardous materials are divided into different categories based on their inherent characteristics and their effects. Each of these categories is also divided into specific subcategories. For example, a gas may be toxic, flammable or non-flammable. Users of hazardous materials must be familiar with all warning labels and have full awareness of their implications in order to be in the best position to deal with risk when in risk situations (Giummarra, 2013: 4).

Hazardous Materials are classified in:

1. Gases.

These materials are combined individually or separately at a temperature of 50 ℃ with a vapor pressure of more than 300 kPa, and at a temperature of 20 °C, and a pressure of 101.3 kPa. They are completely gas-shaped. Gases are divided into three flammable, non-toxic and toxic groups, and fire, explosion, poisoning and suffocation are considered as harmful to the group.

2. Flammable liquids.

Flammable liquids are those substances that have a steam pressure of less than 300 kPa at 50 °C and do not have a gaseous state at a temperature of 20 °C and a standard pressure of 101.3 kPa, and their ignition point is less than 61 °C Celsius. Gasoline, Acetone, Benzene, Adhesives containing flammable materials, and Printer ink are in this group.

3. Flammable solids, self-reactive substances and explosive solids.

They are Aluminum Powder, Phosphorus, Tianium Powder, and Flammable combustion materials: Carbon, Sodium sulfide, White phosphorus and yellow phosphorus (Faribraud and others, 1385: 7).

4. Materials that produce flammable gases in contact with water are barium, calcium, lithium, sodium phosphide.

5. Oxidizing materials.

These materials do not burn themselves, but by releasing oxygen, the flame of other materials becomes obsolete. The production of fire-fighting gases in the vicinity of water, the production of toxic gases during fire and toxicity and corrosion are dangers.

Great Peroxides, such as peroxide steel, and benzyl steel peroxide can cause skin corrosion in the event of ignition.

6. Toxic substances.

In case of ingestion or contact with this substance, the health of a person is at risk and causes human death. Arsenic, Mercury Nitrate, Mercury Sulfate, Nicotine, Potassium and others are examples of

toxic substances. Microbial substances are substances that transmit pathogenic agents such as bacteria, viruses, fungi, and others, causing infectious diseases in humans and animals.

7. Radioactive material.

Substances, which by their radiation, endanger the health of the environment as a whole, and are divided into three groups of white, yellow, and yellow with special conditions. These include uranium.

8. Corrosive materials.

Substances threaten chemical reactions, skin or mucous membranes. These materials, when leaked and treated with water or gas, are corrosive, such as sulfuric acid, phosphoric acid, formic acid, perchloric acid, hydroxide, and others.

9. Miscellaneous hazardous materials.

This group includes various materials including flammable vapor, lithium battery, solids and environmental pollutants, organisms and microorganisms modified by genetic modification, and solids and liquids associated with temperature rise (Hajarzadeh, 1394: 51).

Hazards from road transport hazardous materials:

1. Material type.

The type of material carrying one of the most important risk factors in road transport is hazardous substances. Radioactive contamination is a hazardous substance. Explosives are in the next stages.

2. Environmental conditions.

The path factor is analyzed as an uncontrollable variable in terms of geometric design and land and climate conditions. The defect is any defect in the procedure, markings, shields, and vertical marks indicating the deviation and inaccuracy of the driver's decision, directly causing the incident or facilitating the occurrence of the accident. Lighting, pavement and roadway are among the environmental conditions that affect road transport. In some parts of the country, such as mountainous, desert and forest areas, we see nonstandard roads that have hosted many cars throughout the day in the same way, style, and engineering.

Rural roads also have similar situations and in many axes there is a need for leveling and sand blasting, refurbishing and re-pavement.

On some roads, with some rainfall and fogging, driving has many difficulties and limitations, and along with these, there should be insufficient lighting in some axes that increase the visibility of the driver to a very limited extent (Azarodiangan, 1394: 4).

3. Human conditions.

Human factors are associated with road accidents in two general categories: factors that are dependent on the human neurobiological function outside of the control and management of the driving person, and factors that are related to the personality traits of individuals and act in complex interaction. A cumulative of several factors can usually be seen in a person, and can be divided; for example, the driver's refinements, caries, maneuverability, etc., and are part of the second group of factors.

Abdullah Zadeh's research (1393) between any of the dimensions of the urological aspects (low experience of drivers and young people, cognitive, motor and sensory-perceptual defects in persons, diseases and disabilities and age), individual and psychological factors such as Alcohol, high speed, drowsiness, overcrowding, disregard for warning and warning boards, long drive without rest, seat belts, no inspection, experience and previous accident history, driving self-confidence, stress, and lack of precise equipment review. Transport and dimensions of short-term capabilities such as overeating, cigarette smoking, the use of mobile phones and even talk with passengers) with the intensity of road accidents in the 95% confidence that there are.

4. Conditions of the vehicle.

To carry hazardous road materials, both the technical condition of the vehicle and its safety conditions must be met. Road transport companies and companies are required to install a panel with a bold lettering in red and a special mark for hazardous solvent materials in 50 x 50 cm sections on the four sides of the vehicle. There are some aspects to take into consideration:

1. Companies and road transportation agencies are required to install a system to deal with the risks of carrying hazardous substances approved by competent authorities in a vehicle carrying hazardous materials.

2. Vehicles carrying hazardous materials must have only three red electric lights, and the use of fireworks such as lanterns and the like is prohibited as warning signs.

3. Road companies and road transport companies should load and secure the vehicle's loads so that there is no risk of falling, dripping, opening or spreading of loads in the air.

4. Drivers of motor vehicles carrying hazardous materials at the intersection of the railway, if there is no sign, stop completely, and after ensuring that they are safe, cross the intersection. However, they are not allowed to change gear when crossing the rails.

5. When the driver of a hazardous substance is compelled to stop, it must stop the vehicle even to the right of the road, in an open area away from stairs and tunnels and road maintenance.

6. At intermediate stops and emergency stops, one person from the driver, driver's assistance, representative of the company or transportation agency must always be present and take care of the vehicle or the surrounding area.

7. Regarding refueling of vehicles carrying hazardous materials, the following points are required:

(A) Refueling can be done at offshore pumps or at low population levels.

(B) The vehicle is not in front or rear of the vehicle carrying hazardous material, refueling or waiting.

C) The transport vehicle transporting dangerous substances should be off.

D) Do not drive, driver, or representative of the transportation agency from the vehicle (Ghorbanzadeh 1396: 58-57).

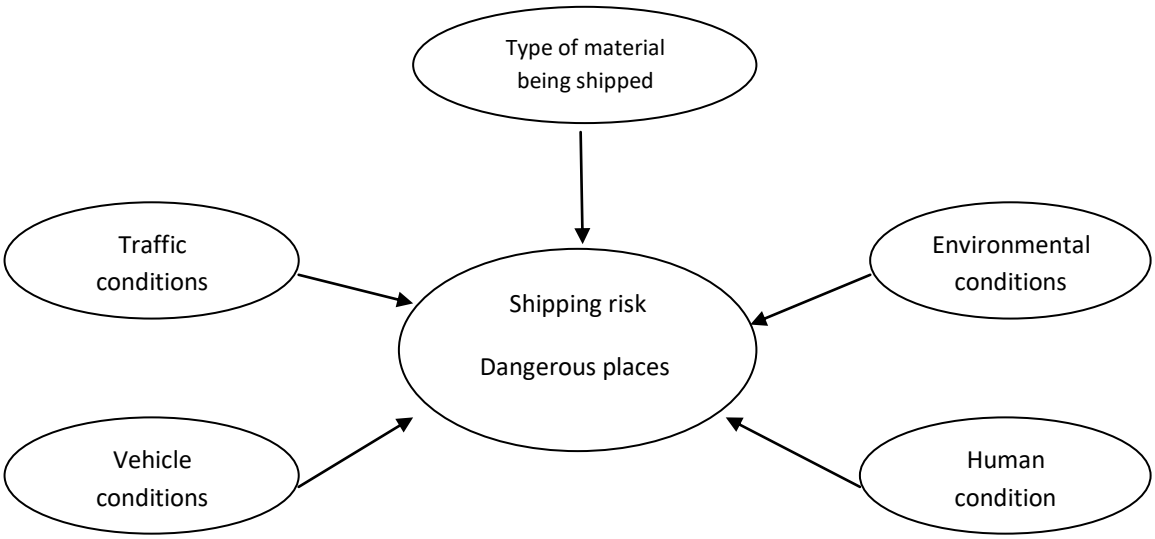
Research Method.

The research is based on the purpose of the applied type and according to the method of collecting data from the survey group.

The present research is conducted in two theoretical and practical sections. In the theoretical part, the necessary information was collected using the library and documentation method, and in the practical section, in the survey method, the necessary information was collected through interviews with experts and reviewers.

By analyzing the content of these interviews, risk factors have been identified. Then, using these factors and indicators, a questionnaire was developed by drivers of trucks carrying hazardous materials.

Considering the theoretical foundations of the research, the backgrounds and the analysis of the content of experts, 'and experts' opinions, several factors were identified as hazardous factors in road transport of hazardous materials in Iran, which are shown in the following model:



Research hypotheses were using the above model:

--Type of material is one of the risk factors in transporting hazardous materials in Iran.

--Environmental conditions are one of the risk factors in transporting hazardous materials in Iran.

--Human conditions are one of the risk factors in transporting hazardous materials in Iran.

--Traffic conditions are one of the risk factors in transporting hazardous materials in Iran.

--The conditions of the vehicle are one of the risk factors in road transport of hazardous materials in Iran.

Statistical population, sampling method and sample size.

The statistical population of this study is university professors in civil, road, traffic, chemistry, geography and urban planning, and drivers selected through purposeful sampling to saturation sampling and compilation. The number of these people is in the table below:

Table 1 - Table of Experts Sample Size

Plenty of examples	field	Row
7	Civilization - Road	1
4	Civil traffic	2
7	chemistry	3
7	Geography	4
25	**Total**	

After identifying factors and their indicators, a questionnaire was designed. This questionnaire was distributed among 68 drivers of hazardous road transport vehicles in Zahedan and its results were analyzed for entering the SPSS software.

Methods and tools for data collection.

The method is both library and fieldwork. In the real environment, a survey was conducted using interviews and questionnaires.

Data collection tool: Theoretical basis, Library, Quantitative data collection, Semi-structured interview, Researcher-made questionnaire.

- *Information Analysis Method:*

Data analysis was done using SPSS software and T and Friedman tests.

Findings.

Table 2. Testing of hypotheses using T test

Number of shadows	The significance level	Test coefficient	Test title	Hypothesis title
68	0.021	0. 76	T test	The first hypothesis
68	0.029	0. 69	T test	The second hypothesis
68	0.027	0. 79	T test	The third hypothesis
68	0.031	0.68	T test	Fourth hypothesis
68	0.026	0.75	T test	The fifth hypothesis

According to Table 2, the significance level of T test in all hypotheses is less than 0.50, so all the hypotheses are accepted, that means:

- Type of material is one of the risk factors in transporting hazardous materials in Iran.
- Environmental conditions are one of the risk factors in transporting hazardous materials in Iran.
- Human conditions are one of the risk factors in transporting hazardous materials in Iran.
- Traffic conditions are one of the risk factors in transporting hazardous materials in Iran.
- The conditions of the vehicle are one of the risk factors in road transport of hazardous materials in Iran.

Ranking factors (Friedman test).

Table 3. Ranking of solutions

Number of shadows	**The significance level**	**K-square**
68	0.028	81.389

According to Table 3, the output of the Friedman test is because of the significance level of the test 0.028, less than standard level 0.50, so it can be concluded that: these factors are not ranked the same. The following is presented below to determine the exact ranking of the Friedman table below:

Table 4. Precise ranking of solutions

The significance level	K-square	Factors
0.024	80.532	Human condition
0.027	80.992	Type of material being shipped
0.029	81.459	Vehicle conditions
0.032	81.763	Environmental conditions
0.034	81.931	Traffic conditions

As indicated in table 4, the human factor has been identified as one of the most important factors among the risk factors in transporting hazardous materials in Iran. The type of material being carried, vehicle conditions, environmental conditions and traffic conditions are ranked.

CONCLUSIONS.

The type of material being carried, environmental conditions, human conditions, traffic conditions and vehicle conditions are among the risk factors for transporting dangerous materials in Iran. Among these risk factors in road transport of hazardous materials in Iran, the human factor has been introduced as the most important factor, and the type of material being carried, vehicle conditions, environmental conditions and traffic conditions are in the next ranks.

Suggestions.

According to the results of the research it is suggested that for the improvement of the human condition, the special drivers of these trucks will be disadvantaged and trained. These people are better off looking at mental health, physical health, especially vision and ethics such as non-addiction, examinations and precautions, etc.

Vehicle conditions are always subject to technical control and maintenance, and these trucks will not be used for more than 5 years in this area.

There are special lines for moving these trucks on the road.

The roads are equipped with driving signals, speed control, and control of the load.

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