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Balan Sundarakani

University of Wollongong in Dubai, balan@uow.edu.au

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Study of Safety Aspects in Handling Hazardous Material Transportation in the Middle East

Balan Sundarakani

Associate Professor, Faculty of Business
University of Wollongong in Dubai
Block 15, Knowledge Village
United Arab Emirates. PO Box 20183
E-mail: balansundarakani@uowdubai.ac.ae
Tel: +97146372466

Abstract

Purpose of this paper

The transportation of hazardous materials exposes to major risk aspects not only for the personnel involved in transportation but for the environment as well. In view of this, the research aimed to identify various categorical risks that are to be identified, analysed and mitigated accordingly. As for the safety of the material and the transport, such factors as the flow, structure and volume of the material need to be examined continuously (Verma, 2009). The evaluation of the risk factors is thus essential for the safety of hazardous materials and its transportations.

Design/methodology/approach

The proposed methodology follows with a comprehensive literature review of identifying the various hazardous materials and their degree of hazard-ness and then analysing the safety measures through an industry focused case study approach.

Findings

The research develops an initial framework as well as measures of safety aspects in handling hazardous material transportations. The research identified some gaps in following safety aspects while Transporting Hazardous Materials in developing countries mainly from the Gulf Cooperation Council (GCC) countries logistical operations.

Research limitations/implications (if applicable)

The research is therefore limited to the GCC region. Further, an in-depth understanding of safety aspects in handling hazardous material would help the logistics industry, in providing better proactive safety mechanism among the Logistics Service Providers (LSPs).

Practical implications (if applicable):

The transportation of hazardous materials has always been existing as a critical business because of the magnitude of any mismanagement and operations. This can be attributed to the fact that it not only affects the environment but also the driver's /employees life at risk. In view of this the research contributes to both the theory and practice of material handling, transportation and logistics.

Paper Type: Research paper

Keywords: *Logistics Service Providers, Hazardous materials; Gulf Cooperation Council*

1. Introduction

The collection, transport and disposal of waste material and other dangerous goods have today become a complex and crucial issue that requires be controlling and monitoring by rules governing the same. The problem is very complex so much so that many industrialized nations have framed specific rules and regulations and medical institutions have complied, irrespective of the fact whether they are a part of the public or private sector (Diaz et al., 2005). Management of biomedical waste is a special situation wherein exposure to risks and hazards are not limited to just the waste generators and operators, but will also extend to the entire community (Sandhu & Singh, 2003). Therefore, the collection, segregation and disposal of waste in a manner that is scientific and proper is of vital importance as it has the potential to mitigate the risks posed to health in people both in a direct and indirect manner, thereby reducing damage to the environment, flora and fauna (Centers for Disease Control and Prevention, 2003). Workers in healthcare sector stand exposed to blood and other body fluids daily, due to the nature of their routine functions and responsibilities at such healthcare facilities. Due to this, workers in healthcare sector stand exposed to the risk of infection as a result of pathogens borne by blood or other liquid.

A program that is effective and efficient for the management of waste generated by healthcare is a crucial aspect of the infection control program of the facility and as a result, plays a vital role in the qualitative care and occupational health of all staff employed at the facility. Management of waste has now manifested into a crucial issue since it poses serious potential health risks and environmental damage, occupying a focal place in national health policy and a lot of significant international interest has been focused on it.

2. Literature Review

A comprehensive manual on environmental management and various procedures was conceived and compiled by SHELL egypt in (1992). All the aspects of management encompassing policy and objectives including audit were covered in the manual. A chapter in the context of this paper, titled "Operational Techniques" took into consideration various elements of management of waste (i.e. environmental management system, identification, characterization, inventorization, waste management hierarchy, treatment and disposal, handling and records, and plan integration). The chapter comprised a list which classified waste products according to their source of generation, apart from inclusion of brief descriptions of particular techniques of waste treatment.

The problem of medical waste is increasing and it is projected that in the near future it will become more and more complex. The enforcement of strict environmental regulations has led to a situation wherein the expenses towards disposal of medical waste will increase manifold, resulting in increased cost of providing healthcare. And in all probability, these costs will be borne by the patient. An appropriate management plan for disposal of medical waste should ideally follow a cradle-to-grave approach (Meany & Pual, 1989). This would include the adoption of a standard operating procedure to focus on issues like as waste generation, segregation of waste, handling, storage, transportation, treatment and finally disposal. All the factors need to be included under regulations so as to be assured that there is no impact on either the occupational or environmental health. Additionally, the framework for management of medical waste needs to incorporate components like extending training modules to

individuals handling the waste in various stages from generation till final disposal. Table 1 classifies the various goods and their degrees of hazardous tendencies.

Table 1. Classification of Hazardous materials

UN Class	Dangerous Goods	Division(s)	Classification
1	Explosives	1.1 – 1.6	Explosive
2	Gases	2.1	Flammable gas
		2.2	Non-flammable, non-toxic gas
		2.3	Toxic gas
3	Flammable liquid		Flammable liquid
4	Flammable solids	4.1	Flammable solid
		4.2	Spontaneously combustible substance
		4.3	Substance which in contact with water emits flammable gas
5	Oxidising substances	5.1	Oxidising substance
		5.2	Organic peroxide
6	Toxic substances	6.1	Toxic substance
		6.2	Infectious substance
7	Radioactive material		Radioactive material
8	Corrosive substances		Corrosive substance
9	Miscellaneous dangerous goods		Miscellaneous dangerous goods

In early 2001, An assessment of management of medical waste in the UAE was evaluated through surveys and on-site visits to many major hospitals in the nation. The results of the survey went through a process of updation later so as to reflect the present situation. The primary purpose of the survey was to assess the procedures in practice for the management of waste, and to identify additional scope for improving methods and processes of waste collection, handling and its disposal. The study's findings revealed that the average rate of medical waste that was generated at hospitals in the UAE is 1.95 kg/bed/d, and that had high variations (i.e. 0.2 to 4.5 kg/bed/d) among the hospitals that were surveyed. It is pertinent to note that though the total quantity of medical waste that was generated at hospitals in the UAE was established, almost all the hospitals surveyed had no clue regarding the estimated quantity of different types of medical waste that were generated.

Moreover, procedures need to be followed for storage and segregation of dangerous goods. The separation between any two different categories of hazardous materials is identified with the point of intersection mentioned in the table below. Codes are provided for each category such as A, B and C. Code A states that the distance between materials should be at a minimum of 3 metres, Code B states that the distance between materials should be at least 5 metres and Code C states that the minimum distance between the materials should be at least 10 metres (Dubai Municipality, 1997).

All the hospitals that were surveyed put in practice procedures for segregation for pathological, infectious, and sharp waste, but the segregation of chemical, pharmaceutical and pressurized containers was not practiced by the hospitals. The colour coding that was followed was that hospitals located in the Emirate of Abu Dhabi utilised red bags for the disposal of medical waste, whereas hospitals in other emirates utilised yellow bags. But, all the hospitals did not practice marking of the bags and containers that were disposed. Most of the

hospitals in the UAE had a separate storage room on-site for storing medical waste. Similarly, the on-site transportation of medical waste for the purpose of incineration was carried out through specialised vehicles or trolleys. Likewise, the off-site transportation of waste for treatment or for disposal is carried out through specialised vehicles. However, all the hospitals do not employ a system of tracking the waste (Al-Dahiri et al., 2008).

2.1 Safety aspects in Transporting Hazardous Materials

Welles *et al.* (2004) indicated in their paper that around 21% of accidents related to chemicals occur during transport while the other reasons for accidents are - 39% due to failure of equipment and 33% due to human error. Fabiano *et al.* (2005) pointed out the major areas where there is higher probability for accidents to occur during transportation by road. They are; tunnels bend radii, slope, height gradient, traffic frequency of tank truck, dangerous goods trucks and other critical areas. Duan *et al.* (2011) discussed in their presentation regarding the reasons and environmental issues of accidents related to various chemicals of hazardous nature in China between the year 2000 and 2006. A vast majority of the accidents during this period were related to petroleum and chemical explosives.

In light of higher probability of accidents that involve vehicles used for the transport of hazardous chemicals, there is room for improvements in vehicle quality, drivers, and infrastructure such as condition of roads, highways and the basic amenities available for members of the crew. Wei *et al.* (2004) has averred that a majority of the accidents occur as a result of human error and failure of equipment. The improper release of goods or material that are explosive, inflammable and toxic, tend to be hazardous in routine life. In the event of an accident, intimation requires to be sent immediately to the concerned authorities which includes, the environmental protection agencies, police, fire departments, poison control centres, hospitals, local media, and personnel who are earmarked for rescue operations. Yang *et al.* (2010) observed that travel at high speeds on roads and the presences of densely populated residential areas adjoining the roads are a form of dangerous environment that result in accidents during the transport of hazardous chemicals.

The provisions of Central Motor Vehicle (CMV) rule 131 of India, stipulates that, it is the responsibility of the consigner to obtain the appropriate permit for the transportation of hazardous materials and to ensure that the driver or owner or the transporter is provided with complete and sufficient information regarding the hazardous materials that are being transported. Additionally, as per the provisions of CMV rule 132 which states that it is the responsibility of the owner or transporter to ensure that, apart from a valid registration and permit; the vehicle that transports such hazardous materials is safe and furnished with the necessary safety equipments and devices. It is also his responsibility to ensure that the driver who is detailed for the particular duty is trained in the handing and transport of hazardous materials and that he has been provided with sufficient and accurate information, in order to enable him to be in compliance with the different safety rules and regulations that are prescribed (Palanisamy et al., 2015).

Transportation by road or rail of hazardous material has many varied issues associated with it. The obstacles that need to be sorted out are many. One of the main issues relates to the transportation of large quantities through major cities of hazardous chemicals that are classified as "toxic by inhalation". Even without dispensing the consideration of public policy of permitting the transfer of risk from citizens of one category to another, routing decisions involve a great

degree of risk and safety issues. Increasing exposure will result in compromise of safety. For instance, choice of a different route for the transportation may result in additional distance to be travelled and that additional distance may have infrastructure that is inappropriate to handle transport of hazardous materials. The alternative routes that have been chosen may not have the necessary emergency response capability and may lack sufficient expertise in the handling of commodities that are dangerous in nature. The transfer of such hazardous materials from road transport to rail transport places a requirement on the rail industry to be more technologically advanced and competitive with a willingness to honour their obligations as a carrier to handle hazmat movements which are distinct from routine material movements. The dearth of accurate data on hazmat movement by road is particularly challenging. Hazmat movements places mandatory requirements such as sharing of information to permit proper preplanning and prioritization. This will result in an improved economic impact analysis and justification of mode movement. Developments on this aspect can potentially increase productivity and better utilisation of prevailing rail capacity (Spraggins, 2010).

More recently, Chia-Hsun Chang et al. (2015) The paper has assessed the various risks of container shipping operation across the range of products by using a case study methodology, thus classified a total of 35 risk factors according to their impact. The research warrants further research need that focus on exploring appropriate factors analysis to evaluating their relative performance in managing container shipping operations. This research aims to fill the research gap partly by identifying those factors and assessing their impact on driver's satisfaction.

3. Research Objectives

Since it is an ongoing research project, the current aim of this paper is to *"identify the factors which are associated with overall satisfaction in relation to safety when transporting hazardous materials in the GCC region"*.

4. Theoretical Framework

The research is therefore developing the conceptual framework as the initial model conceived by identifying the various independent variables (IVs) and dependent variable (DV) as depicted in Figure 1. Driving policy, In-vehicle monitoring system, driver's fitness and alertness, warning labels according to the product classification and site management for safe warehousing and disposal are the major identified factors or drivers (IVs) impacting to the overall satisfaction of the safe transportation (DV).

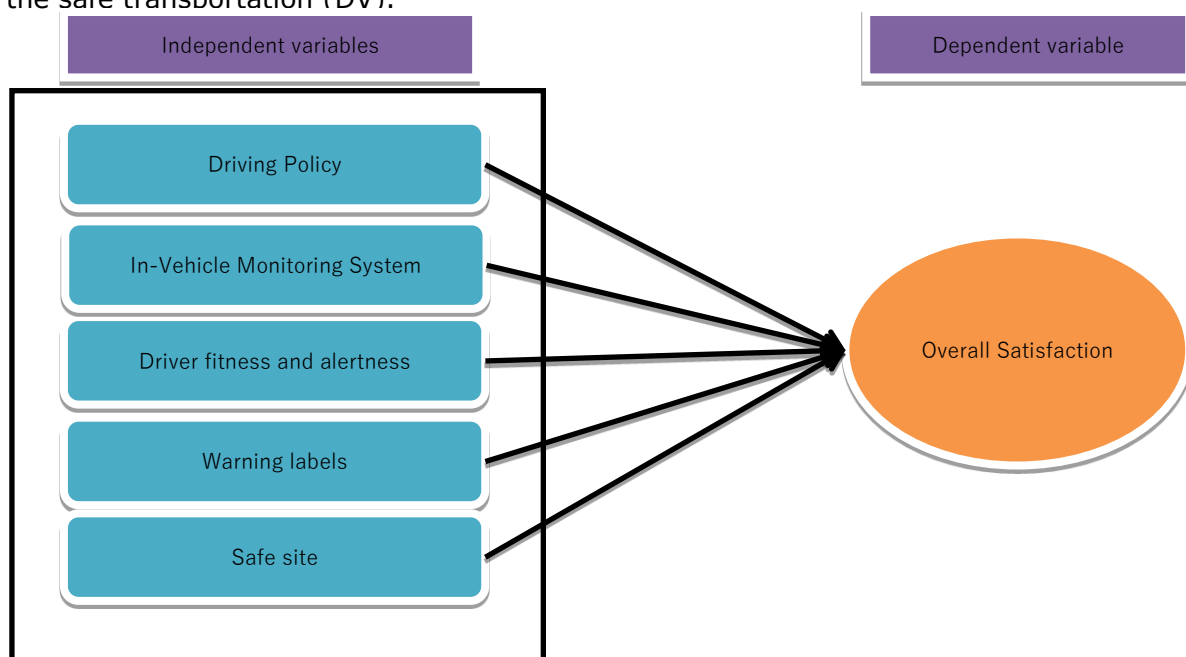


Figure 1. Conceptual research model with identified IV and DV

Therefore, the following hypotheses are developed according to the IV and DV relationship in order to identify root cause, and to have further analysis as a proactive approach and is suitable for anyone involved in accident / incident investigations.

Hypothesis 1: Driving policy has a significant positive influence on the overall satisfaction when transporting hazardous materials

Hypothesis 2: Vehicle monitoring systems has a significant positive influence the overall satisfaction when transporting hazardous materials

Hypothesis 3: Driver fitness and alertness has a significant positive influence the overall satisfaction when transporting hazardous materials

Hypothesis 5: Warning labels has a significant positive influence the overall satisfaction when transporting hazardous materials

Hypothesis 6: Safe Site has a significant positive influence the overall satisfaction when transporting hazardous materials.

5. Research Methodology

Realistic deductive methods of research have been deployed in the present study. According to Bryman (2012) existing theories and frameworks are reassessed to arrive at relevant research questions and hypotheses. By such a reassessment a deductive research approach will be adopted. It is through this approach a theoretical framework will be created. It will be analysed to arrive at specific answers to the research questions as well. Since a deductive approach involves the analysis of the safety measures of transporting handling hazardous goods in UAE, it is the best suited approach for this study. The cause and effect of accidents happening in UAE can also be investigated through this approach.

The research methods, sampling strategies and techniques involved in data analysis are the major components in the study which will be determined by research strategy (Bailey, 1994). In this research a survey based questionnaire will be conducted in order to identify those factors and their interrelationships. In terms of measuring the types, frequencies, effect and cost incurred because of accidents survey will be the most appropriate method. It will also imply suggestions for improving the safety in such hazardous transportation (Elo et al., 2014)

6. Conclusion

Transportation of hazardous materials is a dangerous activity wherein the need of observation is absolutely imperative. This can be attributed to the fact that it not only the environment that is affected but also the drivers/employees life at stake. In view of this, the present research develops a framework by secondary data and a focused case study. As for the types of materials that are being transported are identified that the company does not transport explosives, but transports gases, flammable liquids, flammable solids, oxidising substances,

toxic substances, radioactive material, corrosive substances and other dangerous goods. The research is thus an ongoing research which is limited to the GCC region.

References

- Absal, R. (2009). Hazardous materials can be managed, says environment expert. *Gulf News*. [Online]. 4th April 2017. Available from: <http://gulfnews.com/news/uae/environment/hazardous-materials-can-be-managed-says-environment-expert-1.62609>.
- Al-Dahiri, M.A., Maraqa, M.A. & Kanbour, F. (2008). Medical waste management in the UAE. In: *Kuwait Waste Management Conference*. 2008, pp. 1–14.
- Alumur, S. & Kara, B.Y. (2007). A new model for the hazardous waste location-routing problem. *Computers and Operations Research*. Vol. 34 (5). pp. 1406–1423.
- Bailey, K.D. (1994). *Methods of Social Research*. New York: Free Press. USA
- Branko Milovanović (2012). Methodology for establishing the routes for transportation of dangerous goods on the basis of the risk level - Case study: City of Belgrade. *Scientific Research and Essays*. Vol. 7 (1). pp. 38–50.
- Bryman, A. & Bell, E. (2007). *Business research methods* 3rd ed. Oxford: Oxford University Press. UK
- Bryman, A. (2004). *Research methods and organization studies*. 2nd Ed. Unwin Hyman Ltd.
- CCOHS (2016). Needlestick Injuries, Canadian Center for Occupational Health and Safety. Canadian Centre for Occupational Health & Safety. Available from: http://www.ccohs.ca/oshanswers/diseases/needlestick_injuries.html. [Accessed: 22 April 2017].
- Centers for Disease Control and Prevention (2003). Healthcare Infection Control Practices Advisory Committee (HICPAC): Guidelines for Environmental Infection Control in Health-Care Facilities. [Online]. Atlanta, GA. Available from: http://www.cdc.gov/hicpac/pdf/guidelines/eic_in_hcf_03.pdf.
- Chia-Hsun Chang, Jingjing Xu, Dong-Ping Song, (2015) "Risk analysis for container shipping: from a logistics perspective", *The International Journal of Logistics Management*, Vol. 26 Issue: 1, pp.147-17
- Creswell, J.W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 4th Ed. Thousand Oaks: SAGE Publications.
- Dadkar, Y., Jones, D. & Nozick, L. (2008). Identifying geographically diverse routes for the transportation of hazardous materials. *Transportation Research Part E: Logistics and Transportation Review*. Vol. 44 (3). pp. 333–349.
- Devetak, I., Glažar, S.A. & Vogrinc, J. (2010). The Role of Qualitative Research in Science Education. *Eurasia Journal of Mathematics, Science & Technology Education*. 6 (1). pp. 77–84.
- Diaz, L.F., Savage, G.M. & Eggerth, L.L. (2005). Alternatives for the treatment and disposal of healthcare wastes in developing countries. *Waste Management*. Vol 25 (6). pp. 626–637.
- Duan, W., Chen, G., Ye, Q. & Chen, Q. (2011). The situation of hazardous chemical accidents in China between 2000 and 2006. *Journal of Hazardous Materials*. Vol.186 (2-3). pp. 1489–1494.
- Dubai Municipality (1997). Code of Practice for the Management of Dangerous Goods in the Emirate of Dubai. [Online]. Dubai, UAE. Available from: http://www.gefahrgut-foren.de/ubbthreads/files//15744-DM_CodeOfPracticeForTheManagementOfDangerousGoods_1997.pdf.
- Elo, S., Kaariainen, M., Kanste, O., Polkki, T., Utriainen, K. & Kyngas, H. (2014). Qualitative Content Analysis: A Focus on Trustworthiness. *SAGE Open*. Vol. 4 (1). pp. 1–10.

- Emek, E. & Kara, B.Y. (2007). Hazardous waste management problem: The case for incineration. *Computers & Operations Research*. Vol. 34 (5). pp. 1424–1441.
- Environment Agency (2011). Standard Operating Procedure for Permitting of Traders of Hazardous Materials. Abu Dhabi, UAE
- European Communities (2004). Statistical analysis of socio-economic costs of accidents at work in the European Union. Working papers and studies. [Online]. Luxembourg. Available from: <http://www.uni-mannheim.de/edz/pdf/eurostat/04/KS-CC-04-006-EN.pdf>.
- Fabiano, B., Currò, F., Reverberi, A.P. & Pastorino, R. (2005). Dangerous good transportation by road: from risk analysis to emergency planning. *Journal of Loss Prevention in the Process Industries*. Vol.18, Issue. 6. pp. 403–413.
- FMCSA (2016). Large Trucks in Crashes by Hazardous Materials (HM) Cargo Type, HM Release, and Crash Severity, Department of Transportation, USA.
- Gupta, A. & Upadhyay, D. (2012). Impact of Occupational Health Safety on Employee Satisfaction. *International Journal of Scientific Research*. 1 (7). pp. 118–120.
- Homan, R. (1991). The ethics of social research. California, United States: Longman.
- IOGP (2016). Land transportation safety recommended practice. [Online]. Available from: <http://www.ogp.org.uk/pubs/365-6.pdf>.
- Jovanović, V.D., Tica, S., Milovanović, B. & P., Ž. (2009). Researching and analyzing the features of oil and demand for transporting oil derivatives in the area of Belgrade. *Transport*. 24 (3). p.pp. 249–256.
- McNeill, P. & Chapman, S. (2005). Research Methods. 3rd Ed. London: Routledge.
- Meany, J. & Pual, N. (1989). Medical wastes strategy. *Pollution Engineering*. 21 (11). pp. 92–107.
- NaSH (2007). The National Surveillance System for Hospital Care Workers. [Online]. Available from: <http://www.cdc.gov/nhsn/pdfs/nash/nash-report-6-2011.pdf>.
- Palanisamy, S., Sebastian, J. & Venkatesan, S. (2015). Safety analysis on hazardous chemicals transportation by Indian roads. *Scientific Research and Essays*, Vol. 10 (2). pp. 53–57.
- Puro, V., Carli, G. De, Petrosillo, N. & Ippolito, G. (2001). Risk of Exposure to Bloodborne Infection for Italian Healthcare Workers, by Job Category and Work Area. *Infection Control and Hospital Epidemiology*. Vol. 22 (4). p.pp. 206–210.
- Sandhu, T.S. & Singh, N. (2003). A hazard going unnoticed – biological waste is a threat to the community at large. *The Tribune*.
- Shell International (1995) Classifying Waste, Health, Safety and Environmental Committee. Hague, Netherlands.
- Shell International (1996) Waste Management Guideline, Health, Safety and Environmental Committee. Hague, Netherlands.
- Spraggins, B. (2010). The case for rail transportation of hazardous materials. *Journal of Management and Marketing Research*. Vol 3 (1). pp. 1–8.
- Van Manen, M. (1997). Researching lived experience: Human science for an action sensitive pedagogy. Canada: The Althouse Press.
- Verma, M. (2009), A cost and expected consequence approach to planning and managing railroad transportation of hazardous materials, *Transportation Research Part D: Transport and Environment*, Vol.14 (5), pp. 300–308
- Wei, C., Rogers, W.J. & Mannan, M.S. (2004). Application of screening tools in the prevention of reactive chemical incidents. *Journal of Loss Prevention in the Process Industries*. 17 (4). pp. 261–269.
- Welles, W.L., Wilburn, R.E., Ehrlich, J.K. & Florida, C.M. (2004). New York hazardous substances emergency events surveillance: Learning from hazardous substances releases to improve safety. *Journal of Hazardous Materials*. 2004, pp. 39–49.

- Wyman, M.M. & Kuby, M. (1995). Proactive optimization of toxic waste transportation, location and technology. *Location Science*. Vol 3 (3). pp. 167-185.
- Yang, J., Li, F., Zhou, J., Zhang, L., Huang, L. & Bi, J. (2010). A survey on hazardous materials accidents during road transport in China from 2000 to 2008. *Journal of Hazardous Materials*. Vol. 184 (1-3). pp. 647-653.
- Yu, H. & Solvang, W.D. (2012). Route planning of municipal solid waste management: A methodology and literature review. *International Journal of Energy, Environment and Economics*. Vol.23 (1). pp. 1-22.