



# 2021

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# World Safety Journal

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by E.M. Choueiri

Hazardous Drug Wipe Sampling in Healthcare Facilities  
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## Cover Photo

On Tuesday 4th August 2020, at 6:09 p.m. local time, a large explosion occurred at a warehouse in the Port of Beirut, Lebanon, which resulted not only in the destruction of buildings and infrastructure in a large section of Beirut, but also devastated the lives of many people who were just going about their daily lives, leaving some 200 deaths, 6,000 injured, 300,000 people homeless and an unknown number unaccounted for in its wake. Reconstruction cost of the various buildings and infrastructure is currently estimated at some \$15 billion, whereas the rebuilding of the lives of many people in Beirut and beyond will take much more than just money. Lebanon cannot do this on its own, as it is highly in debt and its finances are nearly depleted – the country itself is on the brink of collapse. Assistance from the international community and financial institutions is very much needed, in order to aid this country in its endeavors to pick up the rubble, dust down the pieces and start rebuilding the various buildings and infrastructure, as well as the lives and livelihoods of its people – so that there may be hope for both Lebanon and its people!

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## Article Submission

The World Safety Journal (WSJ) is a quarterly refereed journal (ISSN: 1015-5589) that includes original full length papers, review articles and case studies on the most recent outcomes of advanced research in any occupational safety and health fields.

All articles shall be written in concise English and typed with a minimum font size of 12 point. Articles should have an abstract of not more than 300 words. Articles shall be submitted as Times New Roman print and presented in the form the writer wants published. On a separate page, the author should supply the author's name, contact details, professional qualifications, current employment position, a brief bio, and a photo of the author. This should be submitted with the article.

Writers should include all references and acknowledgments. Authors are responsible for ensuring that their works do not infringe on any copyright. Failure to do so can result in the writer being accountable for breach of copyright. The accuracy of the references is the author's responsibility.

## References

Articles should be referenced according to the Publication Manual of the American Psychological Association, 7<sup>th</sup> ed.

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### Submissions should be mailed to:

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Articles, wherever possible, must be up-to-date and relevant to the Safety Industry. ***All articles are Blind Peer Reviewed by at least two referees before being accepted for publication***

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## EDITORIAL

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**From the Editor-in-Chief:**  
A tribute to the outgoing editor, and a note for prospective authors

I am honored to have been given this opportunity to serve as Editor-in-Chief of the World Safety Journal (WSJ). Thanks to the outstanding work of outgoing Editor, Dr. Janis Jansz, I inherit a publication well-positioned for continued development and success in occupational safety and health fields.

By all means, Dr. Jansz has devoted an enormous amount of time and effort to producing a journal that is scientifically rigorous and relevant to safety; a difficult balance to strike. I thank her from the bottom of my heart for her immensely valuable contribution to WSJ, and am delighted that she will remain on the WSJ Editorial Board, as Associate Editor, to provide ongoing guidance!

I am grateful for the trust placed in me by Dr. Jansz and the WSO management. In collaboration with Dr. Jansz and the Editorial team, I will continue to work to make WSJ a scientifically sound, academically useful and safety-applicable journal that one looks forward to reading every quarter.

When it comes to increasing the number of submissions any journal receives, regardless of its stage in publication, focusing on publishing and promoting path-breaking research is paramount. Therefore, I would like to ask WSO members to continue to submit quality papers; from my side, I will work hard to attract papers from leading academics, in order to show that WSJ is at the forefront of its discipline.

Since the journal is peer-reviewed, the following represent the range of possible outcomes of the review process: (1) **Accept without any changes (acceptance)**: WSJ will publish the paper in its original form. This type of decision outcome is rare. (2) **Accept with minor revisions (acceptance)**: WSJ will publish the paper and asks the author to make small corrections. This is typically the best outcome that authors should hope for. (3) **Accept after major revisions (conditional acceptance)**: WSJ will publish the paper provided the authors make the changes suggested by the reviewers and/or editors. (4) **Revise and resubmit (conditional rejection)**: WSJ is willing to reconsider the paper in another round of decision making after the authors make major changes. (5) **Reject the paper (outright rejection)**: WSJ will not publish the paper or reconsider it even if the authors make major revisions.

On a final note, I would like to express my heartfelt thanks to Ms. Zahra Etemadi for the help she had provided over the years to Dr. Janis Jansz in compiling and setting up the previous issues of the World Safety Journal.

**Respectfully,**

*Elias M. Choueiri*

**Prof. Dr. Elias M. Choueiri**  
Editor-in-Chief

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## World Safety Journal

A peer-reviewed journal,  
published by the World Safety Organization



### Traffic Congestion in Beirut, Lebanon:

#### *Environmental Impact, Financial Consequences, and Possible Solutions!*

Elias M. Choueiri<sup>(\*)</sup>

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#### Keywords

Traffic Congestion  
Public Transport System  
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Beirut  
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#### Abstract

In the Greater Beirut Area (GBA), Lebanon, there is a high dependency on private car use that has seriously exacerbated road traffic congestion with traffic literally coming to a complete standstill for hours, turning the daily commute to/from the city center of Beirut into an ordeal for many people. Studies to implement an efficient public transport system to alleviate this problem are underway – however, the dire political, humanitarian, economic and financial crisis Lebanon is currently facing, in combination with the corona virus (Covid-19) pandemic, has been slowing down progress in this respect.

#### Introduction

This article was partially written before Tuesday the 4th of August 2020 when, at 6:09 p.m. local time, a large explosion occurred at a warehouse in the Port of Beirut, Lebanon. This resulted not only in the destruction of buildings and infrastructure in a large section of Beirut, but also devastated the lives of many people who were just going about their daily lives, leaving some 200 deaths, 6,000 injured, 300,000 people homeless and an unknown number unaccounted for in its wake. With Lebanon already suffering from a serious economic and financial downward spiral since the autumn of 2019, which has led to a sharp devaluation of its national currency against the US Dollar, sky rocketing prices for food and other basic necessities, high unemployment rates, poverty, famine and fear, shortages of medical supplies and medicines, as well as having to cope with the spreading of the corona virus (Covid-19) pandemic, this was literally a blow that the country did not need nor deserve.

Reconstruction cost of the various buildings and infrastructure is currently estimated at some \$15 billion, whereas the rebuilding of the lives of many people in Beirut and beyond will take much more than just money. Lebanon cannot do this on its own, as it is highly in debt and its finances are nearly depleted. The country itself is on the brink of collapse. Assistance from the international community and financial institutions is very much needed, in order to aid this country in its endeavours to pick up

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the rubble, dust down the pieces and start rebuilding the various buildings and infrastructure, as well as the lives and livelihoods of its people – so that there may be hope for both Lebanon and its people!

### **Public Transport Virtually Lacking**

Lebanon used to have one of the most advanced public transport systems in the Middle East, with trams, buses and trains providing efficient services. However, the fraternal infighting that ripped through the material and social fabric of the country during the civil war (1975-1990), unfortunately, also laid waste to its sophisticated public transport network. Since the civil war, there has not been an efficient public transport infrastructure in place due to a lack of funds and, therefore, there is a high dependency on private car use.

### **High dependency on private car use**

The high dependency on private car use has seriously exacerbated road traffic congestion in Lebanon, especially in the Greater Beirut Area (GBA), turning the daily commute to/from the city center of Beirut into an ordeal for many people (see Figure 1).



**Figure 1.** The daily commute to/from the city center of Beirut

The situation has also worsened over recent years, due to the influx of some 1.5 million refugees from neighboring Syria, who now make up roughly 25% of the resident population in Lebanon – this has led to an increase in road traffic levels of about 15-25% (with some 50% of the households in Lebanon owning one car, and about 25% owning at least two, there is almost one car for every two persons in the country (BLOMINVEST, 2015)). Further, road traffic congestion is also exacerbated by the fact that many roads are in a poor state of repair.

### **Public transport infrastructure and facilities virtually non-existent**

Whatever public transport there is comes in the form of taxi, minibus and bus services. The bus services are provided either by OCFTC (Office for Railways and Public Transport), a public entity that comes under the tutelage of the Ministry of Public Works & Transport, or by a number of private bus



operators. OCFTC receives a subsidy to assist in its provision of the bus services, whilst the private operators exist without any subsidy.

The minibuses operate either as communal taxis on popular routes or on a roaming basis, as do taxis – these and the bus services are not facilitated with a proper infrastructure to make them easily accessible to the public, and also lack facilities (e.g. bus stations, dedicated taxi-spots [taxi ranks] and proper scheduling) to provide an efficient and reliable public transport system – ultimately leading people to use the only reliable option: the private car.

Furthermore, the existing public transport (taxi, minibus and bus) services are not only unreliable but, in most cases, also unevenly distributed over the market. The city of Beirut, for instance, is over-served as compared to the demand, resulting in severe competition among operators, whereas other cities have a shortage of public transport services. In fact, the number of taxis and minibuses in the city of Beirut is increasing rapidly, giving rise for concern, as it has become clear that these also contribute significantly to road traffic congestion.

In a report published in 2015 (BLOMINVEST, 2015), it was noted that the number of daily motorized trips within the Greater Beirut Area (GBA), which has a population of over 2 million people, reached some 5,000,000, with about 68% of these journeys made by private car, with an occupancy rate of 1.6 persons/car (see Table 1).

**Table 1.** Daily motorized trips in GBA – share per transport mode (BLOMINVEST, 2015)

Greater Beirut Area (GBA)	
Population	> 2,000,000
Daily number of motorized trips	5,000,000
Share of daily number of motorized trips per transport mode	
Taxis & Minibuses	15%
Private Sector Buses	14%
OCFTC Buses	3%
Private Cars	68%

### Mobility cost

Mobility cost in Lebanon is estimated to be around USD 50 cents/vehicle km or USD 42 cents/passenger km. Furthermore, the road transport sector in Lebanon is one of the largest energy consumers (27.42% of the national energy consumption). This reflects the economic burden that the road transport sector has not just on the people, but also on the national economy.

Implementation of a properly managed and efficient public transport system could address three components of mobility cost, i.e. through:

- reducing air pollution levels;
- lowering fuel consumption, resulting from a decrease in private car use; and
- reducing car ownership costs.

As regards the latter (reducing car ownership costs), of the annual household expenditure in Lebanon, transportation cost represents the third largest share (13.11% of total expenditure), after expenditure on housing (28.36%) and food (20%) – the latter may not be quite the case at this moment in time as, besides having to deal with the currently prevailing corona virus (Covid-19) pandemic, Lebanon is also faced by a very serious economic and financial crisis that has seen a sharp fall in the exchange rate of the Lebanese Pound against the US Dollar, and a sharp rise in the prices for food and other goods and necessities, leaving many people destitute and on the verge of famine. Further, daily power outages and increased levels of unemployment are pushing the country to the verge of total collapse – a very dire situation indeed!

## High Private Car Use: Road Traffic Congestion, Environment and Economy

The high private car use results in serious road traffic congestion, especially during the peak-hour periods, and also has a high impact on the environment, as well as financial consequences for the economy of Lebanon, Choueiri (2015) and Choueiri (2020).

### Road traffic congestion

The World Bank estimates that some 650,000 road vehicles enter the Greater Beirut Area (GBA) on a daily basis, with 300,000 accessing the city via the northern approach from the Jounieh-Beirut highway, 200,000 via the southern approach, and 150,000 via the eastern highway – not counting the vehicles already circulating in Beirut (Rahhal, 2019).

During the morning peak-hour period (between 6:45 a.m. and 11:00 a.m.) and the evening peak-hour period (between 4:00 p.m. and 7:00 p.m.), road traffic speeds are usually very low, ranging from 30 km/h on main roads to less than 10 km/h on secondary roads, with traffic literally coming to a complete standstill for hours, which seriously increases journey times. During peak-hour periods, traffic on the northern approach to the city center alone may reach an hourly high of 7,000 vehicles; these vehicles often spend hours jammed on this north-south artery that runs along the full length of the Mediterranean coast line, connecting Beirut to the cities of Jounieh and Tripoli in the north, and Sidon and Tyre in the south.

### Environmental impact

The high dependency on private car use not only causes road traffic congestion, but also has an environmental impact as regards:

- **noise:** the road traffic congestion situation is accompanied with unacceptable levels of noise, due to the high traffic density, old vehicle engines and also an excessive use of the claxon. On the main roads of the Greater Beirut Area (GBA), noise levels reaching 90-95 dB have been measured, whereas the standard level is 72 dB. The measured noise levels fall into the category that cause irritation and may well also lead to health problems.
- **air pollution:** with 25% of CO<sub>2</sub> emissions in the Greater Beirut Area (GBA) coming from the land transport sector, which is estimated to consume about 45% of all imported fuel, the contribution of road traffic to air pollution is very significant. The proliferation of the use of badly-run engines on taxi services also greatly contributes to this. The high levels of air pollution in the Greater Beirut Area (GBA), which has also become a serious deterrent to tourists to visit the city, also lead to high medical costs due to illnesses caused by the said air pollution.



## Financial consequences

The cost of the road traffic congestion situation in the Greater Beirut Area (GBA) to the economy of Lebanon is at least a substantial USD 2 billion a year (THE DAILY STAR, 2017). Further, the heavy traffic in the Greater Beirut Area (GBA) also leads to the occurrence of a high number of road traffic accidents, with high inherent costs to the country's economy.

Road traffic congestion cost is largely attributable to time wasted in traffic jams – the adage “time is money” is true in this respect, as well as excess fuel consumption, impact on economic productivity, health problems resulting from air pollution, a higher cost of rent as people tend to live closer to their jobs, and increased vehicle operating costs. As regards the latter, vehicle operating costs also increase because of poor road conditions [Lebanon's roads ranked 124 in terms of road quality among 138 countries, i.e. one of the worst, according to the 2016-2017 Global Competitiveness Index of the World Economic Forum (World Economic Forum, 2016)].

## An Efficient and Reliable Public Transport System Urgently Needed

Studies to implement an efficient public transport system to alleviate road traffic congestion in the Greater Beirut Area (GBA) are underway, as building more roads, demolishing buildings to make space for more cars, and adding more parking spaces will only exacerbate the problem. In a report for a road traffic congestion situation in the United Kingdom (LEIGH, 2016), it is noted that such measures would only provide a temporary relief until the induced demand replenishes the space available on the roads, and also that business cases to solve road traffic congestion should be developed very carefully and take into account the prevailing situation in the specific city and country in question.

In the case of Beirut, decreasing road traffic congestion by developing more roads, for instance, is not a viable option because of its urban density and terrain, with the mountains to one side, the sea to another, and a narrow coastal strip in-between. Any road development project would require either the expropriation of land or the construction of tunnels in mountains or highways over the sea, all of which would be costly options. This leaves developing an efficient public transport system as the only option.

## An efficient public transport system – the only option

According to Choueiri (2014), Choueiri (2018) and Choueiri (2020), an efficient public transport system is the only option. Among the studies into implementing an efficient public transport system in Lebanon railways are looked at. In this respect, a number of routes are under focus for possible revitalization (see Figure 2):

- **Beirut - Jounieh - Tabarja-Maameltein (- Tripoli):** in an effort to alleviate road traffic congestion in Beirut, especially on the northern approach into the city centre, studies have been conducted to see if the situation could be alleviated by implementing railway services between Beirut and Tabarja-Maameltein, and even beyond to Tripoli, using the existing coastal railway right-of-way. If sufficient funds were to become available, it has been recommended to extend the studies also to the south of Beirut, at least to the coastal town of Jiyeh, near Sidon.
- **Tripoli - Abboudiyeh:** the government has assigned the Council for Development and Reconstruction (CDR) of Lebanon to look into the possibility of revitalising the railway line between Tripoli and Abboudiyeh on the Lebanese/Syrian border, in coordination with the country's Railways & Public Transport Authority (RPTA).

For the aforementioned railway lines to become a reality, it would take quite some time. However, the dire road traffic congestion situation needs to be alleviated much sooner – a temporary solution could come in the form of the Greater Beirut Urban Transport (GBUT) project.

### The Greater Beirut Urban Transport (GBUT) project

The Greater Beirut Urban Transport (GBUT) project, by implementing a new Bus Rapid Transit (BRT) system between the densely-populated Tabarja-Maameltein/Jounieh area and Beirut, as well as feeder bus services to the trunk BRT system and within Beirut, is aimed at improving transport connectivity and mobility on the northern approach into the city center of Beirut. The project also includes the establishment of appropriate institutional entities for the management, operation and maintenance of this BRT system. Once effected, it would become Lebanon's first modern public transport system in decades.



**Figure 2.** Routes are under focus for possible revitalization

### Attracting private car users to become public transport patrons

For any public transport system to be conceptualized to accommodate a reasonable level of ridership on a given corridor, it is essential that the system specifically understands, targets and adapts itself to the current private car users. Once an objective has been established, then it can be executed through respective levels of subsidy, as well as fare and price discrimination mechanisms.

As regards implementing a public transport system, the following aspects could influence the levels of ridership:

- parking fees;
- pedestrian-only zones in the Central Business District;
- feeder bus networks;
- fare and service integration with feeder bus networks;
- park-and-ride facilities at stations;
- level of services and amenities provided.

For attracting current private car users, the majority of whom would be middle-class professionals, to patronize the public transport system, it should be recognized that one of the key variables would be the location of stations. Also, in suburban areas, the stations would need to have adequate parking facilities, as the majority of commuters would need to park their cars at the station and then use the public transport system to commute into the city.

As for stations in Beirut, it would be very important to address the issue of transport mode transfer, as well as to consider the walking distance from the station to the Central Business District or other destinations in the city. For instance, requiring a commuter to use three modes of transport to get to his/her place of work would likely diminish ridership.

Based on the levels of ridership expected, the respective public transport system could be sized, such as regards the number of vehicles required, if there is a need for a single or double-track system, etc. This will then allow the development of a rough estimate of the relative costs of the bus and railway alternatives, including both capital and ongoing operating costs. Based on the comparative costs and other characteristics, such as the ability to attract additional patronage, contribution to urban development objectives, environmental impact, and other implications of the alternative systems, a preliminary selection of the eligible technologies could then be recommended. It is important to recognize that this would remain a preliminary recommendation until further developments of the study are completed. The intent here is to provide broad system characteristics, including vehicle travel speed, capacity and frequency, which would meet the anticipated levels of ridership.

## Concluding Remarks

The high dependency on private car use in the Greater Beirut Area (GBA) has seriously exacerbated road traffic congestion, turning the daily commute to/from the city center of Beirut into an ordeal for many people. Building more roads, demolishing buildings to make space for more cars, and adding more parking spaces will only make the problem worse, whereas the development of a reliable and efficient public transport system with optimal services and facilities, once in place, could well attract the patronage of many current private car users. This would alleviate road traffic congestion, as well as noise and air pollution, in the Greater Beirut Area (GBA) – it would also enhance the mobility and quality of life of the people. It could also attract more visitors and tourists to Beirut, bringing both societal and economic benefits. However, for all this to become a reality, the financial support from external bodies (e.g. World Bank, the European Union (EU), the European Investment Bank (EIB) and the United Nations' Development Programme (UNDP)) would be very much needed.

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**Prof. Dr. Elias M. CHOUEIRI** has been very active in academic and research settings for over 35 years. He is the author/co-author of over 20 books and booklets, and hundreds of refereed publications, technical reports, conference presentations and newspaper articles. He has won more than 20 awards for his scholarship, and has held faculty and managerial positions at several public and private institutions in Lebanon and the USA. He is a member of the WSO Board of Directors, and serves as WSO Liaison Officer to the United Nations. Besides, he assumes the roles of Director of the WSO National Office for Lebanon, Chairperson of the WSO Highway Transportation Committee, and Chairperson of the WSO Transportation of Dangerous Goods Committee.





# World Safety Journal

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## Hazardous Drug Wipe Sampling in Healthcare Facilities

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### Keywords

Pharmaceutical hazards  
Antineoplastic drugs  
Wipe samples  
Industrial hygiene.

### Abstract

Hazardous drugs are associated with causing acute and chronic side effects to healthcare workers that experience occupational exposures. Antineoplastic drugs are known to cause headaches, nausea, vomiting, hair loss, mutagenic activity, spontaneous abortions, infertility, and congenital malformations. Currently, there are no acceptable thresholds for exposures to this type of hazardous drugs. The use of as low as reasonably acceptable (ALARA) is used for exposures to these types of drugs. Occupational exposure risk should be evaluated within facilities where they are used. Performing hazardous drug wipe sampling in areas that are high risk for contamination can provide information to facilities on how to protect their employees.

## Introduction and Background

Antineoplastic drugs are a workplace hazard. These drugs are known to be toxic to cells that are non-cancerous (Vyas, Yiannakis, Turner and Sewell, 2013). These types of drugs are associated with adverse side effects for employees with both acute and chronic exposures. Some of the earliest reports of these drugs posing occupational risks was in 1979 (Soteriades et al., 2020). The levels were quantifiable in the urine of nurses handling these mutagenic drugs. Previously, the worker exposures were higher levels (e.g., mg/mL) and currently the exposures are much lower. Most exposures recently are nanograms per milliliter (ng/mL) (Soteriades et al., 2020). Since the 1940's, the toxicity of cancer treatments has been known to cause side-effects to both patients and to the healthcare workers handling these drugs while performing their daily duties (Soteriades et al., 2020). Because healthcare workers handle these toxic drugs, the occupational risk should be evaluated.

The symptoms associated with occupational exposure to Antineoplastic drugs include headaches, nausea, vomiting, hair loss, hypersensitivity, mutagenic activity, spontaneous abortions, infertility, and congenital malformations (Vyas, Yiannakis, Turner and Sewell, 2013). These symptoms have been reported in healthcare workers that are being exposed to these cytotoxic drugs at much lower doses than patients (Dugheri et al, 2018). The drugs are also known to cause irritation and/or damage to the skin, eyes, and mucous membranes. In another study, it was been shown that the compounds were

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mutagenic to mammalian cells in cell cultures (Harrison, Peters, and Bing, 2006). Antineoplastics have no therapeutic relevance to individuals that do not require these types of drug therapies.

By 2020, it was expected that there will be a rise in yearly cancer diagnoses to 16 million, globally (Dugheri et al., 2018). The market for cancer treatment drugs is expected to generate approximately US \$161.3B by the end of 2021. Treatments included in the estimate are chemotherapy, hormone therapy, immunotherapy, and targeted therapy, with chemotherapy projected to be 50% of the revenue. Antineoplastic drugs are classified as hazardous chemicals by National Institute for Occupational Safety and Health (NIOSH) (Dugheri et al., 2018).

NIOSH published the Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings Alert in 2004. The list was recently updated in May 2020 to include newly approved drugs by the Food and Drug Administration (NIOSH, 2020). Of the drugs on this list from NIOSH, roughly half of them are antineoplastics. The purpose of this alert was to bring awareness to employees the risk involved with the handling of these drugs and outline protective measures they could implement for their facility (Fuller, Bain, Sperrazza, and Mazzuckelli, 2007).

Currently, there is no safe occupational threshold, such as a Permissible Exposure Limit (PEL), for hazardous drugs, however, there have been proposals for possible threshold limits for single drugs only (NIOSH, 2020). Healthcare facilities are trying to minimize the occupational exposure by utilizing the NIOSH hierarchy of controls, by implementing engineering controls, administrative controls and personal protective equipment, as well as environmental monitoring (i.e. wipe sampling) and biological monitoring (laboratory testing) as a method to identify problems and create more worker awareness (Dugheri et al., 2018).

The occupational exposure to hazardous drugs by healthcare workers is proposed to happen most commonly by dermal contact. It is not likely that healthcare workers are exposed via inhalation of the hazardous drugs. Hazardous drugs that have a low molecular weight (< 500 Daltons) are of concern because these drugs are easily absorbed through the skin, whereas some of the current hazardous drugs have a molecular weight of >40,000 Daltons (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

The larger molecular weight limits the dermal uptake from contaminated surfaces. However, nurses have a higher risk of exposure and possible dermal uptake of these higher molecular weight drugs due to constant hand-washing practices, which damages their skin and causes cracks that these drugs can penetrate through (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

Wipe sampling is one of the most common practices for hazardous drug contamination assessment (Conner and Smith, 2016; Connor, Zock and Snow, 2016). Environmental monitoring has shown that hazardous drugs can be found in the air and on work surfaces in sterile compounding rooms, manufacturing and packaging areas for the compounded sterile products and clinical administration areas (Harrison, Peters, and Bing, 2006). Performing hazardous drug wipe sampling in areas at risk for exposure can provide information for environmental monitoring on cleaning processes and handling of hazardous materials.

Environmental wipe sampling has been used for the last 20 years in healthcare facilities to evaluate contamination within the workplace. Conner, Zock and Snow (2016) stated that other reasons for surface sampling is as follows: hazard identification and evaluation, exposure assessment, facility characterization, housekeeping, selection of engineering controls, evaluation of engineering and administrative/work practice controls, evaluation of exposure pathways, selection of personal protective equipment, compliance with regulations and standards, source identification, education and training, and investigation of complaints. The samples that were collected in the facilities of were not



used for worker exposure but to look at the environmental contamination as a possibility for worker exposure (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

## Recommended Wipe Sampling Methods

Wipe sampling was originally developed to evaluate other agents such as lead, asbestos, methamphetamine, and antibiotics (Connor and Smith, 2016; Connor, Zock and Snow, 2016). This methodology was evaluated and applied to hazardous drugs. However, not all hazardous drugs can be analyzed because not all drugs have methods designed to analyze them in a laboratory. Additional methods can be developed for other drugs that do not currently have a testing method determined, as long as there are antibodies available for the drug (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

When performing hazardous wipe sampling, there is a need to have a strategy in mind for which factors are to be assessed and what variables may be present in the sampling evaluation. Some factors to consider are the types of hazardous drugs that are being used and quantities stored and used within the facility. Once a sampling plan has been completed, a certified laboratory and/or industrial hygiene professional that conducts this type of sampling should be identified. Currently, there are no standards for sampling and analysis for these drugs, therefore it is essential to identify a laboratory that is experienced with hazardous drug wipe sampling analysis (Power, Sessink, Gesy, and Charbonneau, 2014). The laboratory should have a validation process for the drugs their facility evaluates. These validation methods should include how samples are stored for stability, medium desorption efficiency, limits of detection and quantitation, calibration curves and quality control methods. Their method should give greater than 90% extraction efficiency, which is preferred, however greater than 75% extraction is acceptable (Conner & Smith, 2016).

When hazardous drug wipe sampling is performed, the sample size should be no less than 100 cm<sup>2</sup>, however if a smaller sample size is used, more samples must be taken which can increase the cost of this testing since the cost is per wipe rather than per drug being tested for. A more acceptable size would be 400 cm<sup>2</sup>, which would give a larger sampling area and reduce the cost by not needing as many samples for one location. A sampling plan should be devised so that the facility knows exactly what locations were sampled and make note of what type of activity takes place in those locations (i.e., surface of the biological safety cabinet – admixing of hazardous drugs). Common locations for hazardous drug wipe sampling would be the geometric center of the engineering controls (biological safety cabinet or compounding aseptic containment isolator), where the direct compounding area is located. The floors directly below the engineering controls, pass-throughs from the hazardous drug storage into the negative pressure hazardous drug ISO Class 7 buffer areas and the pass through from the hazardous buffer areas to the general pharmacy, equipment, counters, storage containers, door handles, high touch areas, and computer keyboards (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

Once the sampling has been completed, samples are sent overnight to a laboratory where the samples are processed and analyzed. Typical methods used for specimen recovery and analysis are gas chromatography, liquid chromatography, high-performance liquid chromatography, ultra-high-performance liquid chromatography along with mass spectrometry, tandem mass spectrometry or inductively coupled plasma mass spectrometry. These methods determine the concentration of hazardous drugs present on the wipe samples that have been collected within the healthcare facility (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

## Summary and Conclusions

Currently, no standards or regulations exist for an acceptable level of exposure to hazardous drug, and nothing is known about the synergistic effects multiple drugs could elicit in human systems. The only allowable standard for exposure is as low as reasonably achievable (ALARA). A common approach is put in place workplace controls, as well as implementation of personnel training on the handling of hazardous drugs, cleaning, deactivation and decontamination of work surfaces and surveys given to healthcare staff involved with the processes of admixture and administration of these therapies could work to lower potential contamination and the exposure of employees to these toxic drugs in the workplace (Soteriades, et al., 2020). Despite the usual healthcare protocols, workers may not be fully protected in their facilities. The overwhelming evidence is that an occupational risk persists for those handling antineoplastic drugs. The highest risk groups include pharmacists and their team that compounds antineoplastic drugs and the nursing staff that administers these drugs to patients (Vyas, Yiannakis, Turner and Sewell, 2013). Surface sampling should be used as part of an environmental monitoring program. In doing so, results will inform staff the larger picture of possible contamination and exposures on within the facility (Conner and Smith, 2016; Connor, Zock and Snow, 2016).

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## Prevalence and Determinants of Frailty:

### *A Cross-Sectional Study from Rural and Urban Communities in South Lebanon*

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## Keywords

Frailty  
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## Abstract

Frailty is a common geriatric syndrome that poses an increased risk of catastrophic declines in health and functional impairment in older adults. Frailty is a condition associated with aging that has been recognized for centuries. Despite gaining global attention, determinants of frailty have remained unmeasured in rural/urban community settings in Lebanon. This study aimed to identify this gap by assessing the prevalence and determinants of frailty in the absence of disability among the older population living in rural communities in South Lebanon. We conducted a cross-sectional population-based study of 400 older adults aged > 65 living in rural and urban communities in South Lebanon. The adults under study gave their consent to fill out a population characteristic sheet and were then screened for frailty using the "Frailty Phenotype." The population characteristic sheet entailed different risk factors known to be related to frailty. The prevalence of frailty in South Lebanon was found to be 24.5%, with a high prevalence in urban areas as compared to rural areas. The main factors that stood out in rural and urban areas were: age, female gender, number of chronic diseases, number of medications, obesity, depression, and limited access to health services. The findings shed light on poor aging in rural and urban communities in South Lebanon, as evidenced by frailty prevalence. Our findings suggest the need of frailty awareness (by policymakers and the general public), so as to avoid negative consequences. To reduce the healthcare burden, this study recommends that early screening for frailty in primary care be considered! Frailty is a common geriatric syndrome that poses an increased risk of catastrophic declines in health and functional impairment in older adults. Frailty is a condition associated with aging that has been recognized for centuries. Despite gaining global attention, determinants of frailty have remained unmeasured in rural/urban community settings in Lebanon. This study aimed to identify this gap by assessing the prevalence and determinants of frailty in the absence of disability among the older population living in rural communities in South Lebanon.

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## Introduction

Generally speaking, we are facing a wave of aging, or the so-called “Silver Tsunami”, that is expected to hit the world with 2 billion elderly people by the year 2050 (Santini et al., 2015). Lebanon is no exception, as it will be among the first countries in the Arab world to be affected by the demographic change (Sibai et al., 2004).

As a syndrome that affects the elderly, frailty is characterized by an accelerated decline in physiological, social, and/or psychological reserves. Consequently, it leads to disability, morbidity, and mortality. Frailty has always drawn the attention of scientists around the world to determine its prevalence and the associated factors (Buttery et al., 2015). A central point of attention is: "Prevention", which must be assessed and managed in order to prevent the preventable factors (Gu et al., 2009).

Frailty is a high predictor of poor aging (Pegorari & Tavares, 2014; Salem et al., 2014) and has catastrophic effects on the Lebanese government and society. There are several factors that lead to frailty, which differ between countries as well as between rural and urban areas (Moreira & Lourenço, 2013). Frailty cannot be prevented or delayed without knowing and addressing the contributing factors (Ng et al., 2014). In this respect, and to the best of our knowledge, no studies have been carried out in South Lebanon to tackle the frailty issue. Our study, therefore, aims to determine the prevalence of frailty in rural and urban areas of South Lebanon and to compare the associated factors with frailty in both communities.

## Methods

### Study Design

A quantitative approach using a descriptive population-based cross-sectional study design was carried out, in order to determine the prevalence of frailty (in percent) among elderly people living in shared apartments in South Lebanon. The study was carried out between April 2017 and August 2017.

### Sample Calculation

Lebanon is divided into 8 mohafazats (governorates), see Figure 1. Each of the mohafazats is subdivided into several cazas (districts), yielding a total of 25 cazas. A list of the elderly people living in each of the sampled districts was obtained from municipalities or the local authorities.

To investigate the prevalence of frailty in South Lebanon, a sample of 400 subjects was selected, consisting of:

- 200 subjects from the Sidon district, with 100 subjects from the city of Sidon (regarded as "urban"), and 100 subjects from the villages belonging to the Sidon district (regarded as rural);
- and
- 200 subjects from the Nabatiyeh district, with 100 subjects from the city of Nabatiyeh (regarded as "urban") and 100 subjects from the villages belonging to the Nabatiyeh district (regarded as "rural").



**Figure 1.** Map of Lebanon (Governorates)

Note that the sample was selected by means of probability cluster sampling. Further, for a population of 377,473 elderly people (UNDP, 2008), at least 400 subjects were deemed necessary to establish a 95% confidence level within 5% accuracy, see Table 1.

**Table 1.** Confidence level, margin of error, and sample size

Population Size	Confidence Level = 95%			Confidence Level = 99%		
	Margin of Error			Margin of Error		
	5%	2.5%	1%	5%	2.5%	1%
100	80	94	99	87	96	99
500	217	377	475	285	421	485
1,000	278	606	906	399	727	943
10,000	370	1,332	4,899	622	2,098	6,239
100,000	383	1,513	8,762	659	2,585	14,227
500,000	384	1,532	9,423	663	2,640	16,055
1,000,000	384	1,534	9,512	663	2,647	16,317

## Selection Criteria

The criteria for inclusion were as follows: at least 65 years old, lives at home/with relatives, and free from a terminal disease. The criteria for exclusion were as follows: under 65 years old, institutionalized, having a terminal disease, hospitalized, and having a Mini-Mental State Exam (MMSE) of less than 12 years.

## Data Collection and Measurements

Due to the possible differences between ages, in terms of educational level, we always obtained verbal consent from participants, taking into account the constant presence of two witnesses.

Information from both clinical measurements and population characteristics was collected. For clinical measurements, we used the frailty phenotype created by Fried to measure frailty. To investigate factors that might contribute to frailty, a selection of factors reported in the literature review with links to frailty was made; these constituted the so-called population characteristics. The frailty phenotype (Fried et al., 2001) is considered the gold standard model for measuring frailty (Nunes et al., 2015) and is most commonly used to assess and measure frailty (Lee et al., 2017).

## Variables

### Socio-demographic Factors

These included factors such as age, ethnicity, gender, marital status, financial support, availability of health guarantor, educational level, previous or current occupation.

### Situational Factors

These included: life events such as physical, sexual, verbal victimization, discriminatory abuse, financial abuse, neglect, physical abuse, psychological and emotional abuse, present or history of homelessness, and incarceration.

### Health-related Factors

These included: nutritional status (BMI, waist circumference), presence of chronic diseases (cardiovascular diseases, diabetes, congestive heart failure ... etc.), visual problems, hearing problems, polypharmacy (using five or more medications daily), depression (by means of the geriatric depression scale), loneliness, perception of health, cognitive impairment (according to MMSE), recent hospitalization, recent fall, functional capacity (ADL and IDAL) and urinary incontinence.

### Behavioral Factors

These included: smoking, alcohol consumption, physical exercise, and agricultural work involvement.

### Resource factors

These included: whom they live with (family, partner, or alone), and social and spiritual engagements (companies, social activities, parties ... etc.)

### Environmental factors

These included: area of residence, an area close to pollutants, hygiene and sanitation status.



## Statistical Methods and Results

Population characteristics of rural and urban areas were tested by means of a t-test for continuous variables and a Chi-squared test for categorical variables. The prevalence of frailty was analyzed by means of the Chi-square test. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 22.

About one-third of the sample consisted of elderly people aged 65 to 70 years old, out of whom 38.0% live in rural areas and 32.5% in urban areas.

The relationship between the socioeconomic factors and frailty is provided in Table 2. In urban areas, most of the non-frail elderly are males aged 65 to 70 years, are married, have median financial support and a health guarantor, and are well educated. This association is statistically significant ( $p < 0.05$ ) except for marital status and the availability of health guarantor ( $p > 0.05$ ). On the other hand, in rural areas, non-frail elderly are also males aged 65-70 years, are married, have median financial support and health guarantor, and are well educated. This association is statistically significant ( $p < 0.05$ ) except for the availability of a health guarantor ( $p > 0.05$ ).

**Table 2.** Distribution of factors by frailty and residence

Factor		Urban				Rural			
		Non-Frail	Pre-Frail	Frail	Test + Sig.	Non-Frail	Pre-Frail	Frail	Test + Sig.
		n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	
Age (in years)									
	[65-70]	23 (65.7%)	36 (33.3%)	6 (10.5%)	$\chi^2=35.54$ $p<0.0001$	30 (61.2%)	38 (34.5%)	8 (19.5%)	$\chi^2=39.34$ $p<0.0001$
	[70-75]	8 (22.9%)	34 (31.5%)	17 (29.8%)		19 (38.8%)	37 (33.6%)	11 (26.8%)	
	[75-80]	4 (11.4%)	21 (19.4%)	13 (22.8%)		0 (0.0%)	26 (23.6%)	17 (41.5%)	
	80 and above	0 (0.0%)	17 (15.7%)	21 (36.8%)		0 (0.0%)	9 (8.2%)	5 (12.2%)	
Gender									
	Male	30 (85.7%)	63 (58.3%)	14 (24.6%)	$\chi^2=34.80$ $p<0.0001$	38 (77.6%)	58 (52.7%)	15 (36.6%)	$\chi^2=15.93$ $p<0.0001$
	Female	5 (14.3%)	45 (41.7%)	43 (75.4%)		11 (22.4%)	52 (47.3%)	26 (63.4%)	
Marital Status									
	Married	28 (80.0%)	53 (49.1%)	19 (33.3%)	$\chi^2=8.78$ $p=0.187$	40 (81.6%)	71 (64.5%)	26 (63.4%)	$\chi^2=27.18$ $p<0.0001$
	Widowed	4 (11.4%)	39 (36.1%)	32 (56.1%)		8 (16.3%)	34 (30.9%)	14 (34.1%)	
	Divorced	1 (2.9%)	11 (10.2%)	1 (1.8%)		0 (0.0%)	4 (3.6%)	0 (0.0%)	
	Single	2 (5.7%)	5 (4.6%)	5 (8.8%)		1 (2.4%)	1 (0.9%)	1 (2.4%)	

**Table 2 (cont.): Distribution of factors by frailty and residence**

<b>Financial Support</b>								
<i>Unsatisfactory</i>	2 (5.7%)	5 (4.6%)	11 (19.3%)		0 (0.0%)	10 (9.1%)	10 (24.4%)	
<i>Median</i>	18 (51.4%)	57 (52.8%)	19 (33.3%)	$\chi^2=12.81$ $p=0.012$	40 (81.6%)	76 (69.1%)	21 (51.2%)	$\chi^2=16.89$ $p=0.002$
<i>Satisfactory</i>	15 (42.9%)	46 (42.6%)	27 (47.4%)		9 (18.4%)	24 (21.8%)	10 (24.4%)	
<b>Availability of Health Guarantor</b>								
<i>Yes</i>	22 (62.9%)	60 (55.6%)	26 (45.6%)	$\chi^2=2.82$ $p=0.244$	27 (55.1%)	61 (55.5%)	16 (39.0%)	$\chi^2=3.48$ $p=0.175$
<i>No</i>	13 (37.1%)	48 (44.4%)	31 (54.4%)		22 (44.9%)	49 (44.5%)	25 (61.0%)	
<b>Educational level</b>								
<i>Illiterate</i>	3 (22.9%)	16 (14.8%)	11 (19.3%)		0 (0.0%)	32 (29.1%)	10 (24.4%)	
<i>Did not complete elementary school</i>	8 (22.9%)	11 (10.2%)	11 (19.3%)		8 (16.3%)	20 (18.2%)	10 (24.4%)	
<i>Completed elementary school</i>	1 (2.9%)	22 (20.4%)	20 (35.1%)	$\chi^2=38.03$ $p<0.0001$	16 (32.7%)	34 (30.9%)	11 (26.8%)	$\chi^2=29.04$ $p=0.001$
<i>Did not complete high school</i>	0 (0.0%)	15 (13.9%)	6 (10.5%)		12 (24.5%)	11 (10.0%)	8 (19.5%)	
<i>Completed high school</i>	1 (2.9%)	17 (15.7%)	7 (12.3%)		10 (20.4%)	9 (8.2%)	1 (2.4%)	
<i>Completed university</i>	13 (37.1%)	27 (25.0%)	2 (3.5%)		3 (6.1%)	4 (3.6%)	1 (2.4%)	

## Discussion

In the surveyed elderly population, frailty accounted for 24.5%, pre-frailty for 54.5%, and non-frailty for 21%. In rural areas, the percentages were as follows: 20.5% were frail, 55% were pre-frail and 24.5% were non-frail, as compared to 28.5% who were frail, 54% who were pre-frail, and 17.5% who were non-frail in urban areas. Even though the prevalence of frailty was higher in urban areas as compared to rural areas, the difference was not statistically significant ( $p>0.05$ ). This is consistent with the results of other studies that noted that urban residents have higher frailty levels than rural residents, particularly amongst women (Gu et al., 2009).

With respect to the frailty phenotype that consists of 5 components: unintentional weight loss, exhaustion, low energy expenditure, weak grip strength, and walk time, no statistically significant differences were found between rural and urban areas concerning weak grip strength and walk time. With respect to the ones who live in urban areas, they have more unintentional weight loss as compared to 18% in rural areas ( $p<0.05$ ); 39.5% suffer exhaustion as compared to 30% who live in rural areas, 29% have low energy expenditure as compared to 20% who live in rural areas. The association between unintentional weight loss, exhaustion, low energy expenditure, and the environment (urban/rural) was found to be statistically significant ( $p<0.05$ ). Weak grip strength accounted for the highest percentage (51.5%) amongst the participants who met one or more of the Fried Criteria for Frailty in both rural and urban areas. This outcome coincides with the results of a study conducted in

rural Korea where the weakness component accounted for 50.9% (Jung et al., 2016). On the other hand, unintentional weight loss accounted for the lowest percentage (22.5%) in rural and urban areas. Both percentages of weakness and weight loss contradict the results of a study conducted in rural Andes Mountains (Curcio et al., 2014).

Regarding the frailty status of elderly people living in urban areas and their association with socioeconomic factors, it was found that 36.8% of frail people are aged 80 years and over as compared to 33% of pre-frail ones aged 65 to 70 years old and 65.7% of non-frail ones aged 65 to 70 years. This outcome shows that the majority of young elderly are non-frail. On the other hand, 41.5% of frail elderly who live in rural areas are between 75 and 80 years old and 61.2% of the non-frail ones are aged 65 to 70 years. The association between the frailty status and age is statistically significant. This is consistent with the results of other studies that found that frailty increases with age for both women and men (Carneiro et al., 2016; Gu et al., 2009; Mello et al., 2014; Pegorari & Tavares, 2014; Runzer-Colmenares et al., 2014). This can be explained by the fact that advanced age was a risk factor for decreased self-care ability. Physical activity decreases later in life, which may be due to a lack of opportunities or encouragement. The frequency of physical activity was the strongest positive factor that explained self-care ability amongst the elderly population. In addition, food preparation was found to be a positive factor in self-sufficiency in rural areas; family support negatively affected self-sufficiency.

Concerning the gender of the participants, women were found to be frailer than men, with men being non-frail in both rural and urban areas. The association between frailty and gender was found to be statistically significant ( $p < 0.05$ ). These results agree with the results of other studies (Abdulraheem et al., 2011; Jung et al., 2016; Mello et al., 2014; Pegorari & Tavares, 2014; Woo et al., 2015).

Our findings revealed that the prevalence of frailty in rural areas was 63.4% for women and 36.6 % for men. This percentage is higher than the prevalence of frailty amongst rural women (44.6%), as reported in an AMEL (Aging and Malnutrition in Elderly Lebanese) study in rural Lebanon. The same applies to rural men where the same study found that the prevalence of frailty amongst rural men was 28.1%. This difference may be related to the different tools used for frailty screening, as well as to the different areas of residence and sample sizes of the population (Boulos et al., 2013).

More than half of frail older urban residents (56.1%) were widowed, whereas 80% of the non-frail ones were married. On the other hand, 63.4% of frail rural residents were married and 81.6% of non-frail rural ones were married. The association between marital status and frailty was found to be significant in rural areas but not in urban areas.

Moreover, the relationship between financial support and frailty was found to be statistically significant ( $p < 0.05$ ). This outcome coincides with the results of other studies that noted that being married is associated with a lower risk of frailty (Woo et al., 2015). Amongst frail rural residents, 51.2% had median financial support as compared to 81.6% for the non-frail ones. Amongst the urban frail elderly, 47.4% noted that their financial support was satisfactory; 51.4% of the non-frail ones noted that they have median financial support. Most of the respondents regarded their financial support as being median to satisfactory. Even though there was a difference between frailty status and the availability of a guarantor, the difference was not statistically significant ( $p > 0.05$ ). Most of the ones who were frail did not have a health guarantor; the majority of those who were not frail had a health guarantor.

Moreover, the relationship between educational level and frailty status amongst the elderly who live in urban and rural areas was statistically significant. In rural areas, most of the frail elderly people were less educated; for the non-frail elderly people, they were more educated. This outcome coincides with the results noted in the literature (Pegorari & Tavares, 2014).

Regarding the situational factors, there was a statistically significant difference between frailty status and the occurrence of events that were accompanied by physical, sexual, emotional, verbal, and financial abuse ( $p < 0.05$ ). Most of the non-frail elderly people who resided in urban areas (91.4%) and rural areas (91.8%) did not have such life events; this could be linked to the fear of reporting such abuses. Regarding the history of homelessness and its relationship with frailty status, there was no significant statistical association ( $p > 0.05$ ) amongst the elderly people who lived in rural and urban areas. Regarding the association between incarceration and frailty status, there was no statistically significant association in rural areas; however, the association was found to be significant in urban areas. It should be noted here that 85.7% of the non-frail ones were never incarcerated. In general, homeless individuals are more apt to become frail. In our study, the number of homeless people was too low to draw any reliable conclusions; future studies will eventually target these individuals.

The health-related factors including BMI, waist circumference, number of chronic diseases, visual problems, hearing problems, polypharmacy, depression status, loneliness, perception of health, cognitive impairment, MMSE, history of recent hospitalization, history of recent fall, urinary incontinence, and level of independence were assessed by means of ADL (Activities of Daily Living) and IADL (Instrumental Activities of Daily Living).

The results of the present study revealed that the association between BMI, number of chronic diseases, presence of visual problems, presence of polypharmacy, depression status, loneliness, perception of health, cognitive impairment, MMSE, history of recent hospitalization, history of recent fall, presence of urinary incontinence, level of functional capacity (ADL, IADL) and frailty status were statistically significant ( $p < 0.05$ ) in both urban and rural areas, besides hearing problems in rural areas but not in urban areas. Those who are frail, obese, have 3 diseases and more and have visual problems, tend to take more than 4 drugs. They are depressed ( $GDS > 5$ ) and lonely, perceive their health as poor, have cognitive impairment from moderate to mild, and had been recently hospitalized (43.9%), 40.3% had a recent fall, 19.3% had urinary incontinence, 49.1% were dependent according to ADL and 63.2% were dependent according to IADL in urban areas. In rural areas, those who are frail, are obese, have one to two chronic diseases, have visual problems, take more than four drugs, depressed (39.0%), lonely (46.3%), perceive their health as being average, have cognitive problems from mild to questionably significant (41.5%), had been recently hospitalized (41.5%), had a recent fall (26.8%), had urinary incontinence (39%), were dependent according to ADL (29.3%) and 36.6% were dependent based on IADL.

The elderly people under study avoided going outside for fear of falling; this fear affected their daily activities and functional capacity, thus increasing the risk of frailty (Çakmur, 2015). Most of the frail Lebanese elderly respondents were obese, in both rural and urban areas. The association of frailty and obesity was not surprising, as revealed in other studies too (Mello et al., 2014; Ng et al., 2014). Noteworthy is that the BMI mean value in our studied population was  $28.37 \text{ kg/m}^2$  and the mean waist circumference was 93.08 cm. This certainly increases the risks of chronic diseases, cardiovascular diseases, and diabetes (Wang et al., 2005).

With respect to the association between behavioral factors and frailty status, there was a statistically significant association between frailty status and smoking status, physical exercises, and agricultural work engagement in rural areas, with the exception of alcohol consumption. On the other hand, with respect to the association between behavioral factors and frailty status, there was a statistically significant association between frailty status and smoking status, physical exercises, and alcohol consumption in urban areas, with the exception of agricultural work engagement. Concerning urban non-frail elderly people, 62.9% currently smoke, 80.0% do not consume alcohol, 48.6% do physical exercises, and 94.3% do not engage in agricultural work. However, regarding rural non-frail elderly people, 63.3% do not smoke, 83.7% do not consume alcohol, 65.3% do physical exercises, and 59.2%



engage in agricultural work. These results clearly show that being physically inactive is a risk factor faced by the urban population, coupled with the fact that they do not engage in agricultural activities. The relationship between smoking, alcohol use, physical inactivity, and frailty may be bi-directional, in that frailty itself may result in avoidance of smoking, alcohol, and physical inactivity (Woo et al., 2015).

Moreover, there is a significant association between resource factors and the frailty status in rural areas. In urban areas, there was no significant correlation between the people they live with and the frailty status. Most rural frail elderly people live with a partner, and nearly one-third have social and spiritual engagements. On the other hand, 49.1% of frail urban elderly people live with a family member and 71.9% of these do not have social and spiritual engagements. It is important to note that for the non-frail urban elderly people, more than half live with a partner, and 85.7% have social and spiritual engagements. This is similar to the results of other studies that found that religious participation protected against frailty perhaps because of reduced psychological distress and improved spiritual coping, social support, or a more generalized and positive belief system (Gu et al., 2009). Finally, there was no significant association between environmental factors and the frailty status in urban areas, where hygiene and sanitation are regarded as being good. On the other hand, the same goes for the rural population.

## Conclusions

As a result of this study, several conclusions can be drawn:

- The studied population is between 65 and 75 years old; with more than half being males, 59.2% married, 32.8% widowed, 57.8% perceived their financial support as median, 53% had a health guarantor and more than half had completed elementary education.
- The prevalence of frailty amongst the rural elderly people of the studied population is less than that in urban areas due principally to daily agricultural works in rural areas, which satisfy physical activities participation.
- Only 13.8% of the studied population had life events that were accompanied by abuse, 4.2% had a history of homelessness and 3% had been incarcerated at one point in time.
- The socioeconomic factors revealed that three-quarters of the studied population had one to two chronic diseases, 38.8% had visual problems, 18.2% had hearing problems, 43% took more than four drugs, 29.8% were lonely, 39% perceived their health as being average, 16.2% had a cognitive impairment, 23.5% experienced a recent hospitalization, 13% experienced a recent fall, 11% had urinary incontinence, 10.2% had dependence according to ADL and 14.8% had dependence according to IADL.
- The mean BMI in the studied population sample was 28.37 kg/m<sup>2</sup>, with 28% being obese and 49.25% being overweight, with a mean waist circumference of 93.08 cm. The mean GDS (Geriatric Depression Scale) was 4.28, with 24.75% being depressed; the mean MMSE was 26.5, with 72.5% were questionably significant but not severe.
- Regarding behavioral factors, 43.2% of the studied population were nonsmokers and 37% were smokers; only 9.8% drank alcohol; about one-third (30.5%) engaged in physical exercises; and 28% engaged in agricultural work, of whom 51.5% lived in rural areas.
- More than half of the studied population lived with a partner and 63.2% had social and spiritual engagements.

- The majority (96.5%) of the studied population lived in areas that were not too close to pollutants (wastes, factories, etc.) where good hygiene and sanitation were present.
- The frailty status revealed that 24.5% of the studied population were frail, 54.5% were pre-frail and 21% were non-frail. The factors associated with frailty were socioeconomic, situational, health-related, behavioral, resource, and environmental factors. The frail elderly population consisted of people 80 years and over, females who were mostly widowed, without a health guarantor and having a low educational level. The non-frail elderly people did not experience life events like homelessness or incarceration.
- Most of the frail elderly people in the studied population were obese, having more than 2 chronic diseases, experienced visual problems, were depressed and consumed more than four drugs, felt lonely, perceived their health as being poor; 28.1% had moderate MMSE, were dependent, with a history of a recent hospitalization.
- Most of the frail elderly people in the studied population did not smoke, did not consume alcohol, did not engage in physical exercises, and were not involved in agricultural work.
- The majority of the frail elderly people in the studied population lived with a family member, and 85.7% of the non-frail people did engage in social and spiritual activities.

By all means, psychosocial factors play a somewhat significant role in the severity of frailty and should remain an important factor in medical practice and public health interventions. It is plausible that individuals may live to age 100 or beyond and remain relatively healthy by adhering to healthy lifestyles and avoiding identifiable risks. One key to healthy longevity is the prevention or delay of frailty and the facilitation of recovery from frailty via medical interventions or treatments.

In conclusion, the aging population in Lebanon is projected to be accompanied by increasing frailty; there is a need to focus on measures to reduce the frailty burden. The situation for the rural population is different: it has a shorter life expectancy and a lower prevalence of frailty, resulting in the lowest frailty burden.

## Study Limitations

The study had several limitations. To begin with, the nature of the study as cross-sectional prevented us from examining the cause-and-effect between frailty and the associated factors in urban and rural areas in South Lebanon. A second issue is that we did not take into consideration the elderly people who were taking antidepressants; thus, this could have affected the Geriatric Depression scale score and consequently the prevalence of depression in our sample. A third limitation was that the Fried Phenotype and our developed population characteristics sheet had several questions that were self-reported; given the ages of the participants, recall bias could have occurred. Finally, the handgrip was measured using a dynamometer shipped from China from a company called “KYTD DIGITAL”, model number “EH101”. Even though we have carried out a daily calibration of the device, a margin of error could have resulted.

## Ethical concerns

This study was conducted under ethical clearance from the Lebanese University, Faculty of Public Health, Branch 5. We declare that there is no conflict of interest.

## Generalizability

This study reflects some extent on the frailty situation in South Lebanon. It opens the doors for future studies about the subject matter in order to gain a better perspective of the true situation of frailty in the whole of Lebanon.

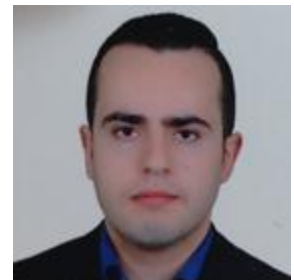
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## Why the Industry is Losing Faith in HSE Awards?

*250 Professionals Rethink!*

Harbans Lal<sup>(\*)</sup>

*A Retired Professor of Psychology, SNDT Women's University, Mumbai, India*

### Keywords

Safety  
Health  
HSE Professional  
Awards Criteria  
Behavior  
India

### Abstract

Health, safety, and environment (HSE) systems are at the crossroads while in each country hundreds of people are killed while working each year. This paper questions whether the HSE awards failed to recognize or promote best safety practices in organizations? Safety awards in the industry are for business excellence and/or safety excellence. This article explores the underlying reasons for HSE Awards through a research qualitative analysis involving 250 HSE professionals. Ten main themes were identified, the implications of which are discussed for promoting a positive safety culture. About 80% of professionals agreed that the industry was losing interest as HSE awards are merely document-based, the evaluation criteria are poor, and the awards are commercial.

### Introduction

Rewards give false value to a company; a business head of a multi-national company (MNC) emphasized (R. S. Rajan, personal communication, July 27, 2020). Why do we need the awards in the very first place other than for excellence recognition or bench-marking, when the safety systems are functional, being implemented and total employee participation is fully active in risk-correction at all work areas of the site or plant? Possibly, these awards can be used as a framework to follow when safety systems are in place but not fully functional. Secondly, the safety awards in the industry are used to balance business excellence and safety excellence, but more so for promoting business excellence and less for safety excellence. This divided focus could be a prime reason behind the people being killed at some workplaces despite winning HSE awards.

Every year the British Safety Council invites people to attend their awards ceremony to celebrate health and safety excellence across all industries in more than 50 countries worldwide (British Safety Council, 2020). The Confederation of Indian Industry's SHE Award is to evaluate an Organization's interest towards the wellbeing of its employees through adequate measures, not only for the regulatory requirements but also as a part of the Management's commitment towards ensuring that the workforce is adequately protected through effective Safety, Health & Environment measures (Confederation of

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Indian Industry, 2020). The Confederation of Indian Industry National Occupational Health & Safety Awards recognize best practices in OHS (Indian Chamber of Commerce, 2020). The National Safety Council awards are given annually to individuals and organizations that have demonstrated leadership in keeping people safe at workplaces (National Safety Council of India, 2020). Federation of Indian Chambers of Commerce and Industry emphasizes safety systems excellence awards every year or Industry (FICCI, 2020). The Government of India instituted National Safety Awards (NSA) in the year 1965, to recognize the safety performance of Industries to maintain the interest of both the management and the workers in accident prevention (DGFASLI, 2020). The National Safety Council of America offers a variety of individual, team, and corporate awards. Employers providing exemplary on-the-job safety and health programs are eligible for the Community Safety Award (NSC, 2020). The safety awards programs provide companies, a means to gauge their program against the industry it does business in.

“Critically speaking, there is a huge number of at-risk behaviors at every site and the companies still receive safety awards, this highlights doubts about the validity of such awards” (Kaila, 2011, p. 2135).

## Research Question / Objective Statement

The research objective was to explore the perceptions and reasons, to determine whether the people in the industry are losing faith in HSE awards, and to suggest the scope for improving various aspects of HSE awards management.

## Methodology

Open-ended questions based on interviews and personal in-depth discussions with 250 HSE, medical, education, management, and mental health professionals were conducted through remote data collection techniques over 3 months (July-September 2020) in India from diverse locations and organizations. The responses of these professionals are presented in the following 10 themes.

## Research Findings

About 80% agreed that they are losing interest or lost interest in applying for an Award as an Award is only document-based evidence of excellence, and also it would depend on the type of national or international, private or government agencies providing Awards, their evaluation criteria, but mostly commercial awards are being avoided, as stated by HSE professionals interviewed. Ten insightful aspects of 250 research participants' views on safety awards are described below.

### Awards are ornamental with not much value

The value of safety awards was questioned as being only ornamental for organizations. The responses received from 80 percent of the HSE professionals indicate that there is not much value in the HSE awards. They have become ornaments to showcase excellence in workplace safety management. According to a safety head, “I have all and sundry associations giving safety awards without doing any review. I do know, where just after a fatal incident, the organizations showcase safety awards from Delhi association”. An objective and thorough methodology of assessment is needed to bring in faith for these awards.

The safety awards to Massey Energy and Transocean were questioned after the coal and oil disasters (The Rural Blog, 2010). In relation to the oil disaster, the Deepwater Horizon was owned by Transocean but was under lease to British Petroleum (BP). For work on the Deepwater Horizon BP chose risky procedures to save time and money, often against the advice of staff and contractors. For

example, BP replaces the drilling mud with lighter seawater even though the rig's chief driller protested. BP did not rectify well design problems when warned of these by the subcontractors. "BP made choices that set safety aside in exchange for cost-cutting and timesaving decisions" (US Government Committee on Energy and Commerce, 2010, p.14). Transocean blamed the disaster on a flawed well design by BP.

The value addition of awards schemes that exist in the Occupational Health and Safety area is very limited (Hopkins & Gervis, 2006). These schemes can result in safety behaviors if they are focused, well implemented, and evaluated.

### **Rationale of awards**

This study results reveal that the organizations are not only losing faith in safety awards, but they are also generally worried about so many useless awards (about 84% of all types of awards), being pushed for commercial purposes these days. The majority of corporates are choosy and don't even apply for many such awards. Many organizations lack in sincere, honest, ethical approach in filling up the awards application. Even, the awarding agencies are interested in nothing more than the commercial aspects. (A. Garg, personal communication, July 20, 2020).

### **Criteria, fee and assessment are important**

Nearly 100 percent of HSE professionals emphasized that safety awards should be provided to organizations and the people who really demonstrate safety in the field. If the mechanism of giving a safety award is not sound, then one can face the problem of losing faith in the Safety Awards. According to a safety manager, "people are losing faith, as nowadays safety awards are linked with entry fees. In some awards, even assessment processes are also not up to the mark" (V. Maheashwaran, personal communication, July 30, 2020). "But yes, some awards are really worth due to their assessment process. Some agencies are following assessment based on an application. No data verification and site assessment" (R. Narayan, personal communication, July 24, 2020). The second type of assessment is based on application and data verification.

The third assessment has 3 steps which are quite comprehensive:

- Application assessment & data verification.
- Site assessment by independent bodies.
- Final presentation by the organization for best practices.

The University of Iowa (2020) suggested the review criteria to include annual safety reviews, implementation of corrective actions, departments not to be penalized for reporting incidents, engagement to improve safety culture, and innovations in safety practices.

### **Fairness of awards**

Much uncertainty exists regarding the effectiveness of safety awards (Goodrum & Gangwar, 2004, p.4). A safety head stated, "recent days, there are some open biases, and also some real achievers are recognized. I see it from my own experience. We got to be non-judgmental in evaluating the contributions". Nearly 84 percent of HSE professionals agreed that there is a huge scope of improvement in this area. It is crucial to guide organizations to provide fair information about safety performance even if it is not favorable (WorkSafe Travail Securitaire NB, 2020).



### Reputed awarding agencies matter

Nearly 54 percent of the HSE professionals expressed that the people believe in grabbing reputed organization awards like the Confederation of Indian Industries (CII), The Federation of Indian Chambers of Commerce & Industry (FICCI), National Safety Council (NSC), and British Safety Council (BSC) which can bring laurels to their organization. The award can be a big motivational tool. The main goal of the NSC awards is to support the broader mission to save lives and prevent injuries, from the workplace to any place (National Safety Council of India, 2020).

### Authentic awards do provide value

Is the Indian industry losing faith in the safety awards? “I don't think so”, as expressed by an EHS top leader of a multinational company (V. Banker, personal communication, August 14, 2020). “I am going to introduce one new award. If people are guided correctly, they are keen to work upon exact requirements in safety improvement and can achieve these awards (K. K. Sharma, personal communication, August 25, 2020). About 51 percent of the HSE professionals expressed that authentic and quality awards like that of NSC, OISD, Ministry are always welcoming. Rewards are recognition of demonstrated commitment to the safety of an organization ensuring that the workforce is adequately protected through effective HSE measures (Confederation of Indian Industry, 2020).

### Management perspective

Research respondents (25%) said that people still have faith in safety awards as such awards boost the morale of employees and marginally increases the faith of employees in their own safety systems. However, sometimes, the management takes it from a different perspective. About 75% of the HSE professionals expressed that nowadays management is mostly sales-focused, believing in statistics to use to answer to the board for workplace safety and health effectiveness. Research respondents stated that believed that for big companies like L&T and Tata, the awards can be purchased based on providing rosy information. Management thinks that awards for safety would help build a safety culture and keep workers working safely, but awards cause disinterests for everyone except the award winner as management perspective is to use awards for sales promotions (Burns, 2020).

### Self-realisation is the key

Over the years, the awards have motivated companies to adopt best safety practices and systems in their sector are benchmarked with the best in the industry (FICCI, 2020), but 70% of research respondents said that one has to be very critical if these best practices are only document-based. According to a veteran EHS Director, “It depends on which safety award we strive for. Getting a 5-star BSC rating is easy as it has become more of a business than an endeavor to improve industrial safety. Most of the safety awards are data-based, which is not the correct picture of the safety performance! Nearly 69 percent of the HSE professionals expressed that the self-realization and purpose behind safety drive itself is an award for the industry if each milestone achieved is celebrated, as safety is a journey and achieving every milestone brings self-satisfaction and self-appreciation to keep motivated to work safely.

### Seeking awards for safety culture

According to 76% of respondents, it was important to make ‘working safely’ in a continuous manner to set a standard as this will make a benchmark for the organization in a period of time. Then that will become the culture for the organization. So setting standards and establishing the system will provide the guidelines to work more safely, continuously working in a safe manner will be leading to a better culture, by following others to follow and adhere to the same.

Fifty-two percent of corporate professionals in the research study stated that they are promoting a safety culture in their worksites across Indian locations so that they could apply and achieve national safety awards and that they are working hard to strategically plan an approach to achieve awards. It is like planning forward, implementation backward. The Toronto Construction Association's (2020) Outstanding Safety Culture Award, recognizes a company that treats safety protocols with a genuine sense of urgency and is innovative and rigorous about ensuring workplace safety is paramount.

### **Awarded sites also have serious incidents**

Nearly 50 percent of the HSE professionals agreed that there are many serious incidents that happened at worksites across the globe at work premises that were certified and provided with an award by national or international agencies. This implicates several aspects, (1) that the awards are possibly limited to feel-good factor or appreciation, or (2) whether the sites get complacent after receiving these awards. A huge fire at an Indian Oil Corporation terminal was due to compromising the safety procedures (Business Standard, 2013). This workplace had achieved all national and international laurels and certifications.

The International Stainless Steel Forum introduced a Safety Award Programme that invited members to submit good ideas from their Safety Programmes. These good ideas are then circulated among members, following the principle that people would learn from the accidents of others (Core Sector Communiqué, 2020). This was a useful award program.

### **Conclusions**

1. There exists a large number of HSE awards to recognize workplaces with safety excellence; nevertheless, incidents and fatalities keep on increasing. Whether these awards deliver what they stand for is a million-dollar question. Each country has hundreds of work-related fatalities each year. For example, 110 Australian workers were killed at work in 2020 till 10 September. In 2019, 182 Australian workers were fatally injured while working, whereas, 3,751 workers were fatally injured while working over the 15 year period between 2003 to 2018 with the most common reason for fatalities in 2018 being vehicle collisions on roads (Safe Work Australia, 2020). However, these fatality statistics do not record that any of the companies that had a work-related fatality had won a safety award.
2. Eighty percent of HSE professionals perceived that the industry is losing interest, or has lost interest, in safety awards, for many reasons, that include that the awards are ornamental, useless, rationale, criteria, fee, and assessment. There is much scope for improvement in being fair while providing information, having reputable awarding agencies matters, authentic awards were valued, understanding management perspective, promoting self-realization, and seeking awards for improving safety culture. Respondents also concluded that some awarded sites had serious incidents.
3. Whether the industry is losing faith in the Safety Awards? The perspective of 80% of respondents was that people who are working in developing organizations benefited because when applying any new tenders having accreditation and awards for excellence may assist with obtaining the tendered work. Secondly, whereas the developed organizations are concerned, sometimes they do not believe the awards but assess the company's HSE implementation for itself. In India, for accreditation companies mainly focus on ISO certifications to enhance their systems and HSE implementation. The DuPont Safety and Sustainability Awards invite organizations that successfully implemented innovative ways of safeguarding employees,

communities, and the environment, while also contributing to the economic and social health of society to be nominated for Awards (DuPont Sustainable Solutions, 2020).

4. Seventy-five percent of respondents reported that Management focus is often on achieving business success rather than on safety when achieving national and international HSE awards and accolades. Twenty-five percent of respondents said that they knew of corporations that have awards that have subsequently had work-related fatalities. Besides awards, there are safety and occupational health experts, but accidents and fatalities still occur. Hence, 75% of study participants were of the view that safety awards are not meant to say that the organization has achieved safety excellence. Preventing workplace fatalities is a necessary goal of safety management systems, but sometimes the employers fail in their leadership roles and approach towards fatality prevention, the unthinkable happens and someone dies at the work (Walter, 2020).

## Recommendations and Implications

1. SRC Communications & Johnston (2019) observed that the safety culture was more than just working safely, it was about celebrating successes and continuously improving. The critical question is that when organizations on average have an almost 30% at-risk behavior, which obviously means they lack the safety culture, then how could they be considered for safety awards? On the other hand, award agencies should consider the behavioral aspects of safety, whereby behavior is the root cause of almost all incidents (Kaila, 2020). In this regard, if the accounting of at-risk behaviors is not part of awards criteria, then these awards are not valid, and incidents would surely occur, even after receiving the best safety awards. Unsafe practices/at-risk behaviors are the early warning signs of a potentially serious incident and the zero initiative ought to include steps like targeting zero injuries, empowering individuals, creating a positive reporting culture, reporting of near misses, managing workplace incidents, commitment to sustaining a safe workplace, communicating openly, influencing long-term change (Webcke, 2020).
2. In India most of the safety awards defy the fundamentals of occupational safety and health (OSH) which is generally defined by the International Labor Organization (ILO) as recognition and control of hazards arising from the work areas that affect the health of workmen as well as the impact on the environment (Alli, 2008). In principle, a safety award based on a well-rounded evaluation is required to determine the extent to which it is intended to show that the workers are safe in their workplace (Wegman & McGee, 2004). Safety awards criteria should assess the field-level increase of safety awareness of the employer and employees annually (Yumpu, 2020).
3. Some awards in India were perceived by 83% of research participants to lack much in their application value, ethical standards, value for life, etc. Most progressive companies affirmed that their business excellence is almost 100% when their HSE excellence is nearly 70-80 percent, which is questionable in view of their value for human life and zero-harm focus. It is clear that safety awards and having a positive safety culture do not always fit together (S. Desai, personal communication, September 5, 2020). There is a need to understand the safety awards criteria in the pretext of the existing safety culture in the industry. Safety policies and procedures differ so much in practices in every plant. According to a veteran Vice President (HSE) of an MNC, "Bent for profits of the managements over-writes safety culture, 'safety first' even becomes 2nd/3rd, it is OK, but safety takes the last seat in favor of business" (A. Dvaz, personal communication, September 15, 2020). Many safety culture awards are available with

well-defined criteria (Safe Work Manitoba, 2020) but incidents keep happening regularly which does not support the rationale/effectiveness of the HSE awards, particularly if an unexpected unplanned event occurs. This is why part of emergency management is business continuity planning.

4. All Indian work sites are not totally safe, as most companies revealed their safety culture management score is around 80 percent. Awards should only be given on the basis of the following 10 points criteria measurement (Kaila, 2020):

- There is a strong belief in behavior-based safety (BBS) concepts of all employees and management and BBS is rolled out among all employees at the site/plant.
- BBS is adopted as corporate policy/value and in employee performance management.
- BBS is being practiced on a daily basis by all employees and Associates.
- Online observations reporting in each department including contractors.
- Each department has eliminated reactive and dependent safety cultures.
- Motivational rewarding for best observers and departments are provided every month.
- People at the site don't bypass unsafe behavior but spot-correct it.
- Departments are aware of the Hot Spots
- Departments have an action plan to address the Hot Spots
- Head of Department is motivating employees and associates for BBS

For many companies in India to reach a score of 100, an improvement action plan is required, especially for contractors' staff, to move from having a dependent safety culture to an independent and interdependent safety culture. In a new action plan to make a positive safety culture as a way of life, there is a need to linking BBS to corporate social responsibility (CSR), communities, and colonies around as well as homes. Building a Safe System is a holistic, long-term exercise, and is based on shared responsibility (ITF, 2016).

According to an HSE Strategist, (S. Rao, personal communication, September 30, 2020), the HSE awards need to consider the following:

- Vision Zero can be achieved only if the BBS processes are meticulously followed;
- BBS - A Key element needs to include in HSE as the Key element in all industries.
- HSE guidelines need to be redefined in light of this global pandemic with BBS playing a key role.
- BBS influencing HIRA strategies inculcating responsible behavior in the minds of workers.
- BBS training shall be mandatory in the training calendar of every Industry.

According to AFCONS, Gopalpur Port Project, the Winner in CII (Confederation of Indian Industry) eastern region Safety, Health & Environment Award 2019-2020 (which achieved a higher score than the other 9 Construction companies that applied for this Award), "if you follow BBS guidelines, you can win every platform" (P. Mukerjee, personal communication, September 25, 2020). A senior professor at the National Institute of Industrial Engineering (NITIE) stated, "BBS reinforces the traditional safety systems aiming towards zero incidences in the workplace".

5. Eighty percent of research participants said that there was a low concern for safety for the contractors' staff. The absence of workplace protections reflects on the efforts to undermine worker safety (Leibenluft and Olinsky, 2020). According to 80% of research participants, most organizations admitted that they are able to develop a safety culture for their employees but failed to do so for contractors' workmen and asked how these companies receive the awards



when the benefit of positive safety culture has not been reached for all people at the work premises of the company. Hence, there needs to be a planned intervention to improve safety awareness among the low-paid contractual persons.

6. According to 50% of research participants practically, the corporates in India are not ready for safety awards, as they have not established a safety culture at sites for which they are awarded. There is a widespread failure to take safety regulations seriously (Dorrell, 2003). Sixty percent of participants said that the awarding agencies take this opportunity to award them for vested commercial interests. Proactively, either the companies must achieve safe workplaces and then go for awards, and/or the awarding agencies must enable, support, and develop the safety cultures and then award these aspiring applicants for awards. According to 50% of research participants, many corporations in India have stopped taking interest in these awards but are trying hard to remain focused on developing safe workplaces for their workforce as nobody likes to get even a first-aid injury.
7. Finally, the serious implications of the findings of this research can be imagined in terms of fake awards based on rosy information of safety leading to incidents of fire or fatalities sounding very critical in nature. While this scenario endangers the lives of people to the unmitigated risks that the employees and contract staff are exposed to. The role of the HSE is questioned in preventing accidents at work which would lead to more injuries and possibly lost lives (PFM, 2020). With these fake/so-called HSE awards being received based on mere documentation leading to a better image of the company for more sales promotions and insurance coverage for being awarded/certified sites, are some complications and violations of business ethos.
8. The benefits that the effective Board level ethics, organizational vision, leadership, and direction of occupational health and safety can bring in terms of health and safety of people and the overall business performance are inseparable. Then why is it that the business excellence is far ahead, and, the HSE excellence is far behind which puts the lives of employees at greater risks killing people each year? The organizations aspiring awards and the HSE awards agencies need to revisit this imbalance seriously in terms of ground realities of safe practices (Health and Safety Executive, 2006).
9. It is recommendable in view of the above proceedings of this paper that a company having weak safety culture should not be awardable, and awarding such an entity should be unlawful and to be avoided by the awarding agencies. It is hoped that these implications shall be interpreted positively as a piece of research information towards a scope of improvement in HSE awards for corporate safety and human life.
10. In view of the above discussions, there is a strong need felt for local governments' control over the wrongful selection criteria on the safety awards in India, and installing corrective action on agencies awarding companies with unsafe HSE cultures, in the larger interest of the society for developing safe systems based on innovation and excellence (Australian Government, 2020), and finally, to probe a vital question as to why so routinely the ethics of human safety are being sandwiched and bypassed between business profits and safety excellence, and someone gets killed.

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### Trip Attraction Models, Using Regression Analysis, for Shopping Malls in Lebanon

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#### Keywords

Shopping Malls  
Transportation Planning  
Trip Generation  
Travel Attraction Models  
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#### Abstract

The rapid increase in the number of shopping malls in Lebanon over the years necessitates proper transportation planning. The main step in the travel request process is the generation of trips. This research aims to provide travel attraction models for shopping malls in order to achieve a travel generation manual for Lebanon in the future. Seven shopping centers located in Beirut were studied, for which the number of vehicles that entered during rush hours on weekends, was gathered. In addition, the physical characteristics of the shopping centers were collected. The travel attraction rates were calculated based on the physical characteristics of the seven shopping centers. Multiple travel attraction models were generated based on the physical characteristics. Three attraction models were selected, which proved to be the most suitable for shopping malls. This study helps traffic engineers and urban planners to anticipate the impact of constructing a new shopping center in Lebanon, taking into account traffic on surrounding roads.

#### Introduction

A suitable transportation planning is the backbone of urban area development and the main objective of developing countries, given the fact that developing countries are facing a substantiated increase in urbanization, which subsequently necessitates proper management of Travel Demand (TD). The improvement of transportation planning relies heavily on a number of factors, such as journey time, distance, cost, comfort, and safety (Ullah and Dutta, 2017). Travel Demand is regarded as key to planning future transportation design facilities and services. In this respect, there exists a four-step model: trip generation, trip distribution, modal choice, and route assignment (Modi et al., 2011).

Trip generation is, by all means, the first stage of the TD models. For a successful long-term implementation, accuracy in this basic step is deemed necessary. Any errors in estimating the number of trips can negatively affect the entire estimation process. Trip generation is used in transportation planning to identify the number of the trip ends in a given area, from the trip origin to the destination

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points. In a trip generation, the planner attempts to quantify the link between activity and travel, with respect to Trip Production (TP) and Trip Attraction (TA) in a given Traffic Analysis Zone (TAZ) (Garrick, 2016).

Trip Production identifies the number of trips produced by households in the Traffic Analysis Zone. The factors that usually influence Trip Production are related to the household characteristics because the household is regarded as a major unit of Trip Production, such as household size, family size, number of employees in the household understudy, sexes of household individuals, household income, vehicle ownership, and ages of the persons living in the household, etc.

Trip Attraction recognizes the number of trips attracted to each activity center in the Traffic Analysis Zone. Moreover, numerous studies on TD have found that Trip Attraction has a solid correlation with land use, such as floor area, number of employees, and services (Jayasinghe, 2017). Amongst the many parameters that affect the Trip Attraction of an activity center, there is the Trip Attraction Rate (TAR), which is defined as the number of trips ends per unit time per unit of independent variables (i.e., per number of shops, per employee, per square feet of floor area, etc.). Generally, the estimation of Trip Attraction is less accurate than TP since it is hard to generate and model the parameters that affect one's choice to travel to a specific place. It is obvious that the trip generation depends on the purpose of the trip since travel behavior varies depending on the trip type. However, the primary contributing factor for Trip Attraction is work trips, and the secondary one is shopping trips.

By all means, shopping Centers (SCs) have become the centerpieces for revolutionizing cities in Lebanon; but, there is a problem that emanates from the fact that there is a lack of studies regarding the prediction of the number of shoppers that visit each Shopping Center, or when planning new ones. In this respect, regression Trip Attraction Models for SCs are very much needed in order to forecast new SCs and plan geometric design and traffic control schemes in the area that is in the proximity of the SCs.

## Literature Review

Trip generation is an investigation of the relationship between the number of trips made and certain quantifiable factors. Trip generation modeling starts with the reasons that a person is traveling from an origin point to a destination point. An individual makes a trip for a reason depending on where he is going to work, shop, go to school, or any other destinations. Trips can be classified by trip purpose, trip time of the day, and personality type (Mathew and Rao, 2007). The common factors that affect trip generation are location, population intensity in the land use understudy, accessibility to residential areas, socio-economic attributes of the people living in the area, roofed space offered for commercial, industrial, and other services, and the cost and quality of transportation services (Sanghai et al., 2014).

In an effort to guide traffic and transportation engineers about trip generation rates for all land uses and building types in the United States, the Institute for Transportation Engineers (ITE) developed a Trip Generation Manual. According to ITE's Trip Generation Manual, a standard regression equation can be used for all Shopping Centers located in suburban areas and ranging in size between 1,700 and 2.2 million square feet Gross Leasable Area (GLA) (ITE Technical Council Committee, 1976). However, caution is deemed necessary when trying to extrapolate the findings to other areas of the world (Institute of Transportation Engineers, 2012).

Many types of research and studies were carried out in order to evaluate the trip generation for specific areas. In 2009, Veenstra Tutert and Thomas attempted to specify the parameters that can affect the trip generation of grocery shopping in the Netherlands. As a result, the percentages of shoppers who visited the supermarkets once a week or less was 19%, 73% for more than once per week, and 8% for daily



shoppers. They determined that the average trip rate was about 2.6 trips per shopper per week (Veenstra et al., 2009).

Another case study aimed at developing an attraction rate and providing a suitable Trip Attraction Model for seven selected Malls in Vadodara city, India (Bali & Zala, 2017). The use of a socio-economic questionnaire (primary data) helped to collect data directly from the people (primary data). In addition, other data were assembled from the municipality and Mall owners (secondary data). The parameters used were: parking spaces for two and four-wheelers, floor areas, and restaurant floor areas. As a result, the independent parameters that affected the Trip Attraction were parking space for two-wheelers and the floor area of the Shopping Mall.

Another case study in Dhaka city, Bangladesh, attempted to determine the Trip Attraction rates of Shopping Centers of different sizes and located in different locations. The calculation of Trip Attraction rates of the Shopping Centers considered physical features, such as gross floor area, number of car parking spaces, number of employees, number of shops, and availability of restaurants (available or not) in the Shopping Centers (Mamun, 2014). The survey took place over two weekdays during peak hours, from 5:00 pm to 8:00 pm. Two models were constructed, one was related to gross floor area, availability of parking spaces and restaurants, and the other one was related to the total number of shops, the availability of parking spaces, and restaurants.

Three years later, another study took place in the so-called Uttara area of Dhaka city. The aim of this study was to collect data about the number of people per unit of time who came to Shopping Centers in this area and to discuss with them the influence of many physical features on the Trip Attraction rate of the Shopping Centers located in the same zone. Six Shopping Centers were surveyed over a two-day period, on Friday and Saturday, during peak hours from 4:30 pm till 7:30 pm. The data collected over the two days were used to estimate the difference in the number of shoppers between weekdays and weekends. The collected data helped to estimate the trips per 1000 ft<sup>2</sup> per hour, the trips per shopper hour, the trips per entry gate per hour, the trips per 100 employees per hour, the trips per 10 parking spaces per hour, the peak hour car Trip Attraction rate (trips per 10,000 ft<sup>2</sup> per hour) (Rahman et al., 2017).

Another study aimed at evaluating the developing shopping trip generation in a densely-populated, residential urban area, was conducted in Ahmedabad City, India. According to this study, 30.97% of the daily trips were simply for shopping purposes and 51.16% of the daily trips were for home needs (Parikh & Varia, 2016).

## Methodology

A trip is a movement of an individual from one place to another. Trip Attraction signifies a trip starting or ending in a non-residential area. Before illustrating the methodology steps followed in this study, the understanding of the approach used is essential. There are two essential approaches usually used to determine the Trip Attraction model. The microscopic approach estimates the TAR of separate shops one by one then it aggregates the TAR of all the shops to have a global TAR. This idea is founded on the understanding that the SC is divided into small parts and explains its properties better than the system being measured as an entire unit. This approach was not used in this study because of the difficulty encountered in performing counts for individual shops in SCs. This method, or the so-called microscopic model, could be used in the future to compare its outcomes regarding the Trip Attraction Rates of the SC with those of the macroscopic approach.

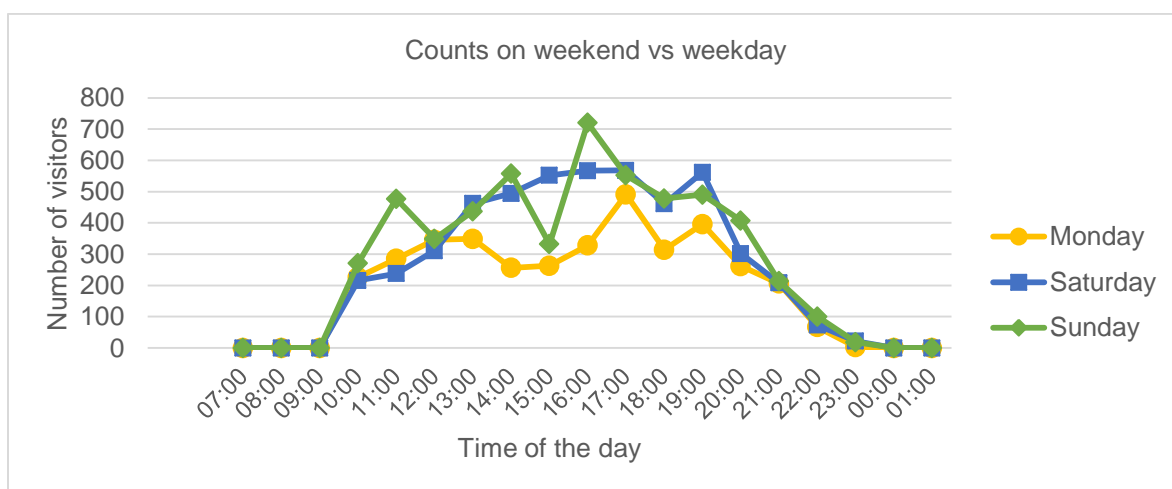
The macroscopic approach aims to study the SC as a whole unit and develop a relationship between the number of shoppers entering or leaving the SC and the physical features of the entire SC, without

getting any data about the features of the individual shops in the Shopping Center. This method is frequently used based on the idea that the characteristics of the entire system express its comportment better than considering the combination of physiognomies of the individual modules. In addition, this approach is easier to be conducted and the Trip Attraction of SCs developed in the ITE Trip Generation Manual is based on the macroscopic model. The steps that should be followed in order to succeed in this study are listed as follow: (a) Selection of the Shopping Centers for this study in the Beirut urban area. (b) Collection of the required data for the characteristics of each Shopping Center and the total number of visitors entering or leaving a Shopping Center in peak hours from 10 am till 12 pm and from 4 pm till 6 pm on weekends for the seven Malls. (c) Trip Attraction Rates should be computed based on each physical feature. (d) Selection of the three best-fit Trip Attraction Models for Shopping Centers in Lebanon using statistical methods.

## Data Collection

The Trip Attraction Rate of a Shopping Center was gained by counting the number of shoppers entering and leaving the SC for every 15 minutes interval. The number of visitors entering each SC was counted for an hour, then the average of the Trip Attraction Rate for every 15 minutes was calculated. As a first step, an investigation and statistical data collection for ABC Ashrafieh was conducted for complete weekdays from Monday to Sunday from 10:00 until 23:00. Those records were used to verify the peak hours that should be selected for this study in order to get the highest number of shoppers that could enter the SC and illustrate the variation in the number of visitors between weekdays and weekends.

The peak typical time for shopping during weekdays is after work exactly from 4:00 pm to 7:00 pm according to the statistics. Usually, Fridays attract more visitors than other weekdays. In addition, Saturdays and Sundays are the most used two days for shopping. It is obviously clear that the counts are logical in Figure 1. The counts for all of the Shopping Centers have to be conducted during weekends, also during peak hours that coincide with the surrounding traffic during the day from 10:00 am until 12:00 pm and 4:00 pm until 6:00 pm. In addition, the physical features for each Shopping Centre have been collected and tabulated in Table 1.



**Figure 1.** Variation of counts between weekend and weekdays

**Table 1.** Characteristics and average 15 minutes trip attraction for shopping centers

Shopping Centers	ABC Ashrafieh	ABC Dbayeh	ABC Verdun	City Center	CityMall	Le Mall Dbayeh	Le Mall Sin El Fil
GLA (m <sup>2</sup> )	42000	24095	50000	62000	80000	25000	12000
Number of Shops	170	100	180	179	220	77	80
Number of Restaurants & Cafes	20	12	20	40	31	27	11
Number of Employees	1000	800	1100	1620	1552	640	400
Cinema	2600	2900	3757	5000	4500	3000	0
Playground Area	629	740	1600	2500	4000	500	380
Number of parking	1300	1100	1700	2200	2500	1500	700
Free Parking	No	No	No	No	No	Yes	Yes
Free Wifi	No	Yes	Yes	Yes	Yes	No	No
Supermarket	No	No	No	Yes	Yes	No	No
TA for 15 mins	94	72	95	145	136.73	59.82	29.05

## Analysis and Results

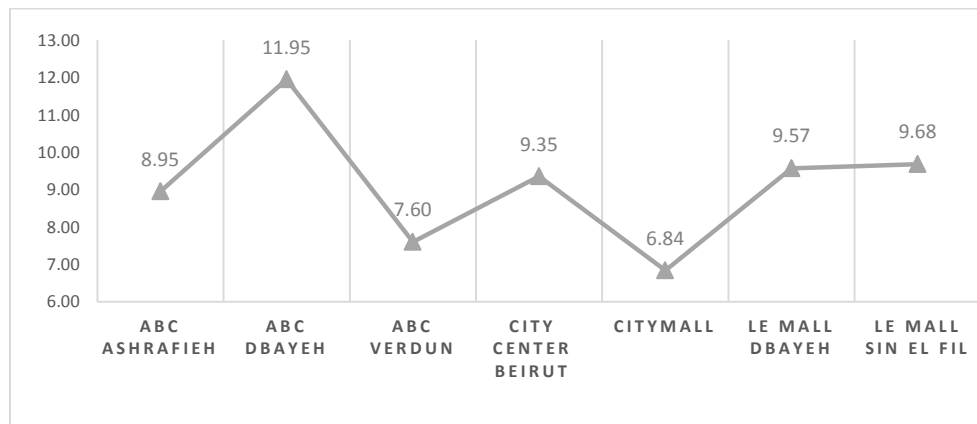
### Trip Attraction Rates

The Trip Attractions Rate of a Shopping Center is influenced by a number of features, like the time of day, day of the week either during weekend or weekday, season, weather, etc. The Trip Attraction Rate evaluated in this study is related to weekend peak hours. The number of people entering the SC every 15 minutes interval for one hour at an entrance gate was counted. The data collected and the average Trip Attraction for 15 minutes are shown in Table 1. TAR was computed with respect to diverse physical features, as person trips/1000 m<sup>2</sup>/hour, person trips/100 employees/hour, person trips/restaurant/hour, person trips/shop/hour, and person trips/10 parking spaces/hour, etc. In order to estimate the influence of each physical feature according to SCs, the different TAR is computed accordingly.

### Gross Leasable Area (GLA)

The equation used for the calculation of the peak hour person TAR per 1000 m<sup>2</sup> GLA is represented in “Eq. 1”. According to the results in Figure 2, the highest peak hour person TAR is in ABC Dbayeh with 11.95 person trip per 1000 m<sup>2</sup> per hour. This Mall attracts the highest number of person trips per hour per 1000 m<sup>2</sup> GLA because it is a popular Shopping Center with unique branded shops. The second highest value is 9.68 persons/1000 m<sup>2</sup>/hour for the CityCenter. This Mall is popular because of its strategic location in the Beirut Area. The lowest peak hour person TAR corresponds to ABC Verdun with approximately 7.6 person trips/1000 m<sup>2</sup> GLA/hour. This Mall has the same unique brand shops but it opened recently in 2017 and it is not as popular. In addition, a grand average of 9.14 person trips/1000 m<sup>2</sup> GLA/hour was calculated with a Standard Deviation (SD) of 1.52 for the seven Shopping Centers.

$$\text{Trips per 1000 m}^2\text{per hour} = \text{Peak hour person trip} / \text{GLA} \times 1000 \quad [1]$$



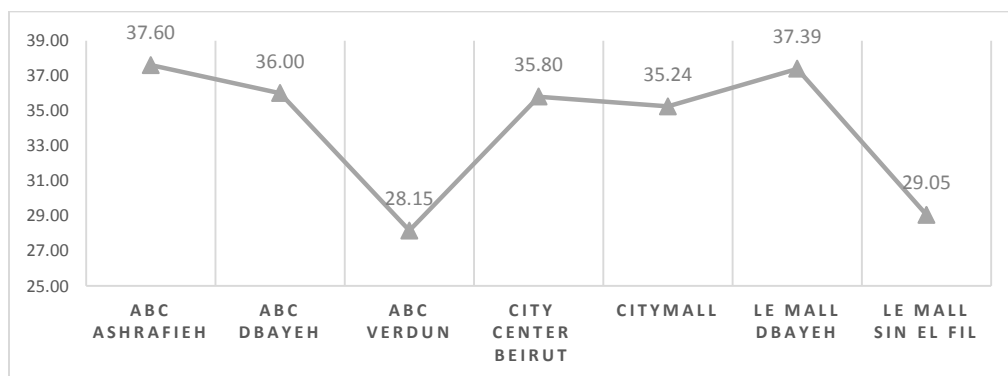
**Figure 2. Person trips per 1000 m<sup>2</sup> GLA per hour**

### Number of Employees

The equation used for the calculation of person trips/100 employees/hour is given by “Eq. 2”. In addition, Figure 3 depicts the peak hour TAR/employee/hour for the seven Shopping Centers. It seems that the variation is limited. Overall, an average of 34.18 person trips/100 employees/hour was determined for the Shopping Centers under study, with a standard deviation of 3.62.

$$\text{Trips per 100 employees/hour} = \text{Peak hour person trip/Employees} \times 100$$

[2]



**Figure 3. Person trips per 100 employees per hour**

### Number of Shops and Restaurants

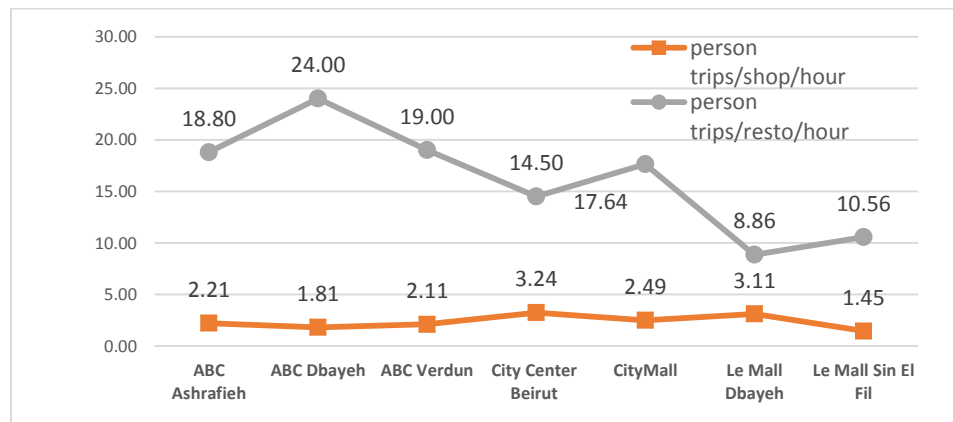
The equations used for the calculation of person trips/store/hour are given by “Eq. 3” and by “Eq. 4” for person trips/restaurant/hour. Figure 4 shows the variation in TAR in relation to the shops and restaurants. It is clear that person trips/restaurant/hour is higher than person trips/shop/hour. The variation is understandable given that a restaurant attracts more persons in one hour than a shop. Overall, an average of 2.35 person trips/shop/hour and 16.2 person trips/restaurant/hour were predicted for the Shopping Centers in the Beirut urban area, with standard deviations of 0.6 and 4.87, respectively.

$$\text{Trips per store per hour} = \text{Peak hour person trip} / \text{No. of Stores}$$

[3]

$$\text{Trips per restaurant per hour} = \text{Peak hour person trip} / \text{No. of Restaurants}$$

[4]



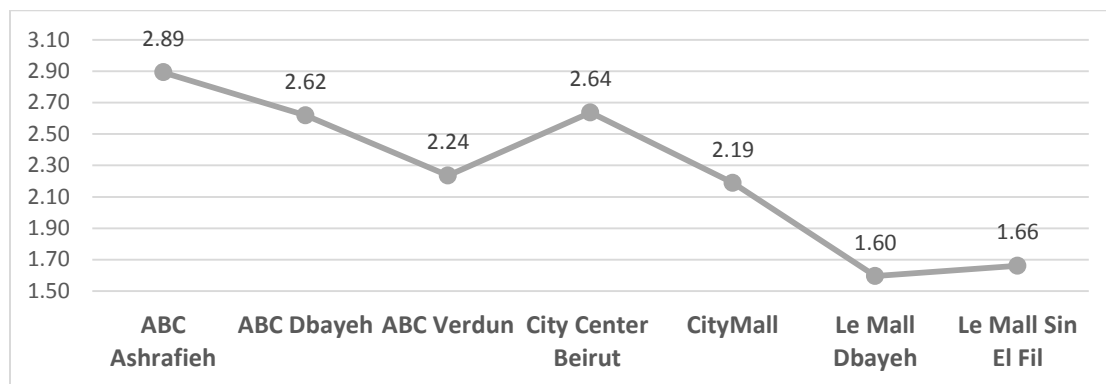
**Figure 4:** Person trips per store and restaurant per hour

### Number of parking spaces

The determination of person trips/10 parking spaces/hour is based on “Eq. 5”. According to Figure 5, the highest peak hour person TAR is in ABC Achrafieh, with 2.89 person trips/10 parking spaces/hour. The lowest peak hour person trips/10 parking spaces/hour correspond to Le Mall Dbayeh, with approximately 1.6 person trips/10 parking spaces/hour. Overall, an average of 2.26 person trips/10 parking spaces/hour, with a standard deviation of 0.46, was found.

**Trips per parking per hour = Peak hour person trip/No. of parkings  $\times$  10**

[5]



**Figure 5.** Person trips per 10 parking space per hour

### Cinema and playground

Person trips/10 m<sup>2</sup> cinema/hour are based on “Eq. 6”, and person trips/10 m<sup>2</sup> playground/hour are based on “Eq. 7”. Figure 6 depicts the variation in TAR, as a function of the physical cinema and playground features. It is clear that person trips/10 m<sup>2</sup> playground/hour is higher than person trips/10 m<sup>2</sup> cinema/hour. It can be concluded that a Shopping Center attracts a higher number of visitors/hour/10 m<sup>2</sup> playground, as compared to person trips/hour/ 10 m<sup>2</sup> cinema. Overall, an average of 1.16 person trips/10 m<sup>2</sup> cinema/hour and 3.4 person trips/10 m<sup>2</sup> playground/hour were predicted for the Shopping Centers in the Beirut urban area, with standard deviations of 1.01 and 1.48, respectively.

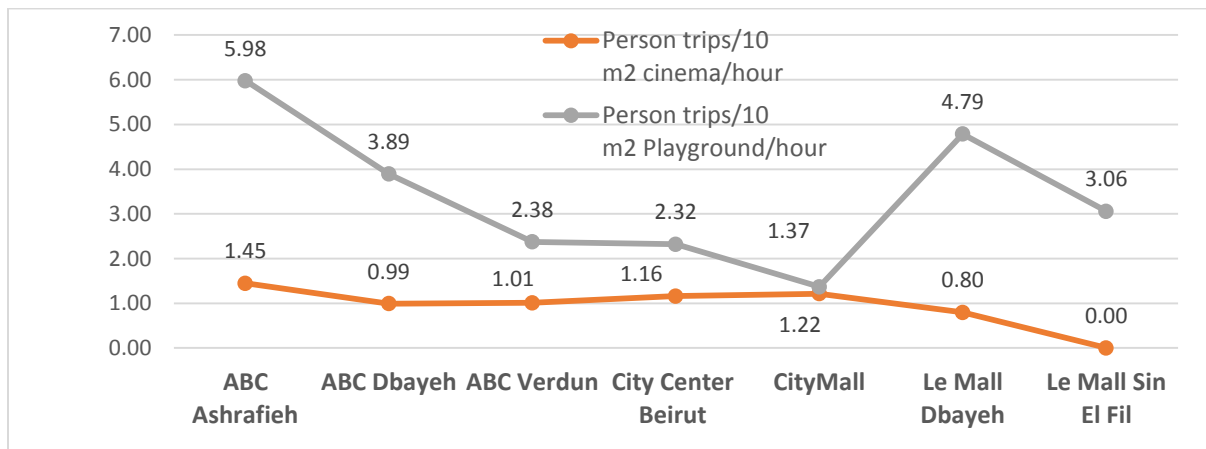
**Trips per 10 m<sup>2</sup> cinema per hour = Peak hour person trip/Cinema  $\times$  10**

[6]

**Trips per 10 m<sup>2</sup> playground per hour = Peak hour person trip/playground  $\times$  10**

[7]





**Figure 6.** Person trips per 10 m<sup>2</sup> cinema and 10 m<sup>2</sup> playground per hour

## Correlation and Regression Analysis

Correlation and regression analysis are linked by the concept of the relationships between variables. The correlation coefficient describes the strength of the linear relationship between variables. As can be deduced from the following correlation table, using the Statistical Package for the Social Sciences (SPSS), that there is a very high positive relationship between Trip Attraction per 15 min and GLA, which is statistically significant at  $\alpha=0.05$  [ $r(6) = 0.945$ ,  $p<0.05$ ].

**Table 2:** Correlation between Trip Attraction per 15 min and the independent variables

Variables	GLA (m <sup>2</sup> )	Shops Number	Restaurants Number	Employees Number	Cinema	Kids Area	Parking spaces	SuperMarket	Free Parking	Free Wifi
Correlation	0.945	0.885	0.81	0.996	0.91	0.874	0.915	0.84	- 0.759	0.67

It can be concluded from Table 2 that the correlation between Trip Attraction and the other variables is a positive one. In other words, when the variables under study increase, Trip Attraction increases too. The only variable that seems to negatively affect Trip Attraction is the availability of free parking spaces. In general, when parking spaces are free, the Shopping Center should be able to attract more trips; unfortunately, this is not the case in Lebanon. Although there is free parking in Le Mall Dbayeh and Le Mall Sin El Fil, they attract trips much lower than other Malls due to a number of factors, among which their small GLA, the availability of a Super Market, etc.

## Regression Models

The aim of this section is to come up with the best non-linear regression models to describe Trip Attraction, as a function of several independent variables.

- Using exponential regression analysis, the Trip Attraction model of SC, as a function of the number of employees, is represented by “Eq. 8”, where  $X_1$  is the number of employees and  $Y$  is the average Trip Attraction of a Shopping Center with respect to the number of vehicles per 15 mins. This model seems to be the best regression equation since the value of the coefficient of determination ( $R^2$ ) is 0.992.

$$Y = e^{(1.007 \ln(X_1) - 2.693)}$$

[8]

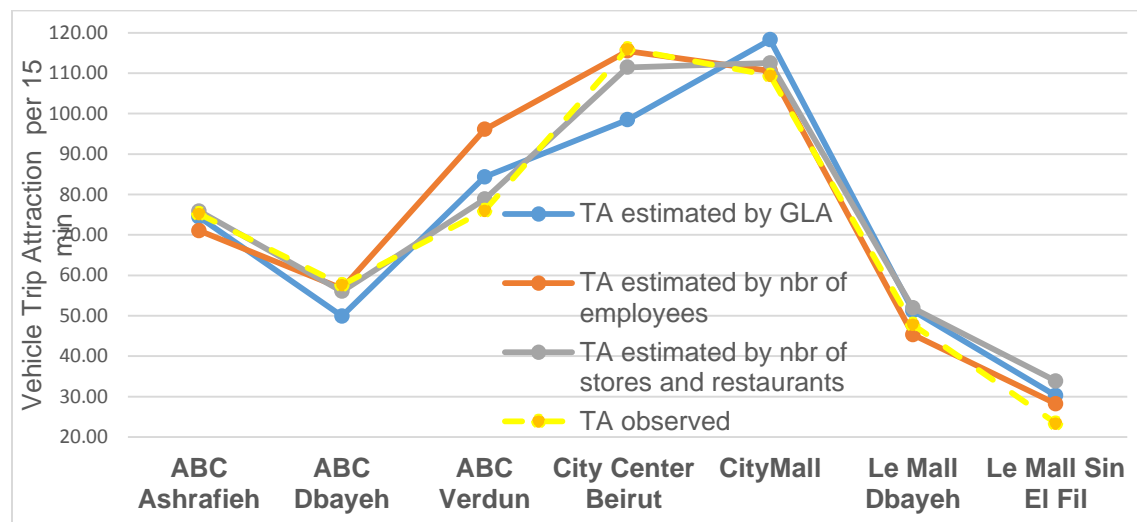
- The Trip Attraction equation of the SC, as based on the number of shops and restaurants (see “Eq. 9”), where  $X_2$  is the number of shops,  $X_3$  is the number of restaurants, and  $Y$  is the average Trip Attraction of a Shopping Center with respect to the number of vehicles per 15 mins. It should be noted that the number of shops and the number of restaurants are not collinear since the Variance Inflation Factor  $VIF = 1.46$  is below 10, meaning that the two variables could be included in the same regression equation. The value of  $R^2$  is 0.927, meaning that 92.7% of the variation in Trip Attraction are explained by the non-linear regression equation containing the number of shops and the number of restaurants.

$$Y = e^{(0.67 \ln(X_2) + 0.505 \ln(X_3) - 0.625)} \quad [9]$$

- The Trip Attraction model of the SC, as a function of 1000 m<sup>2</sup> GLA, is represented by the exponential regression equation “Eq. 10”, where  $X_1$  is the Gross Leasable Area per 1000 m<sup>2</sup> and  $Y$  is the average Trip Attraction of a Shopping Center with respect to the number of vehicles per 15 mins. The sign of  $X_4$  is positive as expected since the Trip Attraction seems to increase when the GLA for an SC increases. The value of  $R^2$  is 0.912, indicating that 91.2% of the total variation in Trip Attraction is explained by the non-linear regression equation containing the Gross Leasable Area per 1000 m<sup>2</sup>.

$$Y = e^{(0.719 \ln(X_4) + 1.622)} \quad [10]$$

The regression models 8 to 10, as functions of physical features of GLA, employees count, and the number of shops and restaurants at the six SC in the Beirut urban area, are depicted in Figure 7 against the observed TA.



**Figure 7.** Variation between the Trip Attraction regression models and the Trip Attraction observed for the six SC in the Beirut urban area

## Conclusions and Recommendations

Trip generation is the main step in the four-step trip modeling process. It encompasses both the attraction of travel and the production of travel by estimating the number of journeys made per unit of time, whether entering or exiting a particular traffic analysis zone, as a function of socio-economic characteristics and land use characteristics.

The aim of this study was to collect data on the number of visitors to SCs in seven shopping centers in an urban area of Beirut and to generate models for estimating the TARs of the SCs. The models could be used for planning and designing SCs, as well as for the geometric design features and traffic control schemes on the streets that are in close proximity to SCs. A series of surveys and data collection were conducted to obtain peak-hour counts and to determine the physical features of SCs, in order to estimate Trip Attraction Models for SC. The TAR per each physical feature was computed and the Trip Attraction Models based on SC characteristics were produced based on each physical feature. The three best Trip Attraction Models were selected according to  $R^2$  values. It was concluded that the Gross Leasable Area, number of employees, and number of shops and restaurants were the main physical features that influence the number of trips to SCs. After calculating the Trip Attraction Models, a comparison was made between the average TAR value assessed in Lebanon and other countries like the US, Saudi Arabia, Abu Dhabi, and Dubai.

Trip generation models are recommended for other activity centers during peak morning and afternoon hours, on weekends and weekdays, in order to improve the modeling of traffic flows in the future for better transport planning processes in Lebanon. Researchers are asked to study similar models for other Shopping Centers in Lebanon and check their validity. Additionally, officials and planners can use the results of the trip generation models presented in this study to estimate the number of shoppers that would visit a new Shopping Center in Lebanon. The same test could be done on weekdays to compare the results with the weekends. Finally, researchers are asked to collect a new data set in the future and apply the new data in the models developed in this study to ensure that the models will continue to be valid in the future, by comparing the estimated trips of the developed models with observed trips.

## Acknowledgment

The authors acknowledge the constructive impact of the management teams at the different mall centers in Lebanon, who provided us with updated data on the number of visitors per year for each of the Shopping Centers. Special thanks go to CityCenter Manager, Ms. Samar Akkou, who worked quite hard to provide us with all missing data about the physical features of each of the Shopping Centers. In addition, sincere thanks go to all the volunteers who helped us in data collection.

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(Type)

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Campus

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Name of School

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I subscribe to the above record and when approved will be governed by the Constitution and By-Laws of WSO and its Code of Ethics as I continue as a member. I furthermore agree to promote the objectives of the WSO wherever and whenever possible.

X

Applicant Signature

Date

**FOR MIDDLE SCHOOLERS ONLY:** WSO subscribes to the Family Educational Rights and Privacy Act (FERPA) philosophy in protecting student privacy and information. WSO may disclose "directory" information such as a student's name, WSO Student Chapter affiliation, name of school, grade in school, etc., along with group or individual photos in WSO NewsLetters, NewsFlashes, eNews, on WSO website, and on WSO's social media accounts.

☐ My student has permission to participate as outlined above.

☐ My student has permission to participate with exclusions:

X

Parent/Guardian Signature (Mid/High Student)

Date

X

WSO Student Chapter Mentor Signature  
(IF APPLICABLE)

Date





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# World Safety Organization Code of Ethics

*Members of the WSO,  
by virtue of their acceptance of membership  
into the WSO,  
are bound to the following Code of Ethics  
regarding their activities associated with the WSO:*



Members must be responsible for ethical and professional conduct in relationships with clients, employers, associates, and the public.



Members must be responsible for professional competence in performance of all their professional activities.



Members must be responsible for the protection of professional interest, reputation, and good name of any deserving WSO member or member of other professional organization involved in safety or associate disciplines.



Members must be dedicated to professional development of new members in the safety profession and associated disciplines.



Members must be responsible for their complete sincerity in professional service to the world.



Members must be responsible for continuing improvement and development of professional competencies in safety and associated disciplines.



Members must be responsible for their professional efforts to support the WSO motto:

***“Making Safety a Way of Life...Worldwide.”***





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