

# Evaluation of Freight Carriers' Potential Participation in City Logistics Solutions – An Exploratory Study in Jeddah, Saudi Arabia

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## Abstract

This article offers an initial overview of urban freight transport in Jeddah, Saudi Arabia with respect to its operational parameters and main challenges encountered. The study provides a detailed description of the various classes of freight vehicles, type of products transported, tracking and monitoring technologies based on responses received from 54 shippers and freight carriers in Jeddah. The study, which is the first for a Saudi city, applies a mixed methods approach to assess the interest of shippers and freight carriers to implement or participate in four proposed city logistics solutions (Freight ITS, Truck-only Lane, High Productivity Freight Vehicle and Public Logistics Terminal). The main factors that would impact the carriers' decision to participate are evaluated and ranked for each city logistics solution.

## 1. Introduction

Saudi Arabia's economy is considered the largest economy in the Middle East. Saudi Arabia has witnessed a significantly high urban growth rate over the last 30 years. It's estimated that around 57% of Saudi population lives in the three largest metropolitan areas in Saudi Arabia that are Riyadh, Jeddah and Dammam (Al-Hathloul and Mughal, 2004). Recently, the Saudi Government has embarked on a significant economic development program worth 93 billion dollars in new projects with large share of the expenditure spent in upgrading and developing the transportation infrastructure in the main cities such as Riyadh and Jeddah (SAGIA Transport and Logistics Sector 2010). These projects will result in increased freight transport in these cities creating more traffic congestion and negative impacts on the environment. Jeddah Metropolitan Area, which is a coastal city in the west of Saudi Arabia on the Red Sea, extends over 4,058 Km<sup>2</sup> while its population is 4.3 million (UN Data: Saudi Arabia 2011). The city is one of the largest manufacturing hubs in the Middle East with more than 1,200 factories mainly producing fast moving consumer goods, food, plastics, construction materials and household goods with 1,600 supporting logistics and services establishments. Most of these plants and supporting facilities are in two government-owned industrial estates (1<sup>st</sup> and 2<sup>nd</sup> Industrial City). They are located in south of Jeddah with an estimated area of 20 million m<sup>2</sup> and investment value of 27 billion US dollars (Hamid 2015). Furthermore, Jeddah is considered the lynchpin in the Saudi Logistics industry with Jeddah Islamic Port being one of the Middle East largest sea ports, which handles 4.1 million twenty-foot equivalent unit containers per annum (Al-Hamid 2013). Jeddah is currently experiencing a very strained and overly congested urban road network despite the huge road network. These inefficiencies and improper transport policies call for conducting a study about the potential of city logistics solutions to optimize and ameliorate urban freight transport in Jeddah.

Dependence only on building new roads or upgrading existing ones is not sustainable solution for the long-term freight transport requirement for the city. Thus, it is imperative that an integrated and sustainable urban freight transportation system is developed. City Logistics presents a sustainable and effective solution to improve the unsustainable urban freight transport in Saudi Arabia and reduce the negative impacts on residents and the environment. ITS technologies will enable enhanced utilization of the existing transport infrastructure in a higher quality and more effective approach while at the same time facilitates better sustainability, accessibility, efficiency and compliance of the freight transport systems (Crainic et al. 2009). Extensive review of relevant literature about urban freight transport in Saudi Arabia revealed that scholastic studies about current practices of freight transport companies and challenges experienced in urban areas was very limited. No previous academic research has examined and evaluated the sustainability of urban freight transport in Saudi Arabia or the likelihood acceptance and adoption of City Logistics solutions among Saudi stakeholders.

## **1.1 Article's Aim and Approach**

This research paper pursues to start filling this gap in knowledge by identifying current practices and activities of urban freight transport in Jeddah and evaluating knowledge and interactions of urban freight transport stakeholders. Furthermore, the potential participation in selected city logistics solutions will be assessed from perspectives of shippers and freight carriers. This paper conducts an attitudinal study to investigate shippers and freight carriers' operational characteristics and problems encountered in urban freight distribution. Moreover, their potential participation will be appraised regarding proposed city logistics solutions (Freight ITS, Truck-only Lanes, High Productivity Freight Vehicle and Public Logistics Terminal) in Jeddah, Saudi Arabia. The purpose here is to highlight and sensitize the freight carriers and shippers in Jeddah to city logistics solutions. This will further enable developing and proposing relevant and feasible City Logistics solutions that are suitable for the urban freight transport in Saudi Arabia based on actual evaluation of current practices and challenges to address the challenges and inefficiencies in the urban freight transport in Saudi Arabia. The remaining of the article is organised as follows: section 2 presents a review of the literature road transport industry in Saudi Arabia and the inefficient urban freight transport in Jeddah. Section 3 describes the mixed methods research approach utilized in this article. Section 4 provides the findings and analysis of results of the responses obtained from the selected experts in the semi-structured interviews. Section 5 illustrates the findings and analysis of results of the responses collected from participating shippers and freight carriers in the questionnaire. Section 6 provides a concluding summary and future research recommendation.

## **2. Literature Review**

### **2.1 Road Transport Industry in Saudi Arabia**

Saudi Arabia is a considerably large country with its main cities geographically spread out hundreds and thousands of kilometres apart. The country is served by an extensive road network with a total length of 150,000 km of which around 55,000 km are paved roads and more than 4,000 km of dual carriageway expressways (UN Data: Saudi Arabia 2011). The inter-city roads represent the backbone of the Saudi Transportation network, which are under the Ministry of Transportation and account for 55% of the entire road network. Intra-urban roads, which are under the Ministry of Municipal and Rural Affairs, represent 45% (SAGIA Transport & Logistics Sector 2010). Saudi Arabia is ranked among the top 10 emerging logistics markets by Transport Intelligence's report (Cuthbert 2011). In 2001, the Transport sector contributed about 20% of the overall GHG emissions in Saudi Arabia. In 2008, the CO<sub>2</sub> emission from road transport in Saudi Arabia was reported at 94 million metric tons (CO<sub>2</sub>

Emissions: Saudi Arabia, n.d.). There are around 7,100 road fatalities and 38,000 seriously injured people with 7% being permanently disabled annually in Saudi Arabia due to traffic accidents with freight trucks being one of the main factors (Al-Seghayer 2013). Freight Trucks accounted for 11% of all vehicles involved in traffic accidents in Saudi Arabia (Ratrouf 2003). Another study highlighted that 68% of truck accidents happened inside urban areas in Saudi Arabia (Issa and Ratrouf 2014). The study warned that lack of enforcement and monitoring of trucking industry's regulations contributed significantly to the large number of truck-related accidents in Saudi Arabia.

## **2.2 Unsustainable Urban Freight Transport in Jeddah**

Jeddah is experiencing strained and inefficient road transportation network due to several factors including improper urban transport planning, increasing urban expansion, high private vehicle ownership, huge traffic congestion and significantly exceeding capacity use of roads. Even though Jeddah is well served with extensive road network, however many links in the network are operating at extremely over capacity. For example, many major north-south corridors in Jeddah such as AlHarammain Expressway and King Fahd Road and Madinah Road are averaging more than 255,000 vehicles per day (Jeddah Transport Strategy 2009). Furthermore, large numbers of heavy freight vehicles use the same highways and main arterial roads with private cars, which further deteriorate the traffic conditions and increase traffic congestion. No smart transportation technologies are utilized to alleviate the traffic conditions nor efficiently monitor and control it. Another factor negatively affecting traffic conditions is that vehicle parking is largely uncontrolled of commercial vehicles parking and loading/offloading, which result in uncontrolled use of major roads for stopping and loading/offloading or even double parking. Moreover, urban freight transport regulations are the same regardless of the class of vehicle, product, service or loading/offloading time.

Currently the only means of control for freight transport within Saudi urban areas are through municipal regulations on street access, speed, maximum vehicle dimensions, parking and access time restrictions. They are significantly outdated and do not reflect nor take into consideration current business requirements and practices. In 2013, heavy freight vehicles were banned from entering Jeddah to ease traffic congestions during peak hours (Sunday-Thursday 6-9 AM, 12-3 PM and 5 PM – 1 AM, Friday 4 PM – 1 AM and Saturday 4 PM – 10 PM) as published on Saudi Gazette Newspaper (07 January 2013). Trucks violating the ban would be fined. However, the entry restrictions resulted in thousands of trucks lining up outside the city limits and on highways for long hours, as there are no designated parking spaces or waiting places for the trucks outside the urban areas. Furthermore, the vehicle access ban hampered deliveries and collections to and from businesses. More than 4,600 TEU containers are transported by heavy trucks daily from Jeddah Islamic port to businesses inside Jeddah (Mohammed 2013). Several government authorities reported that not all freight vehicles are adhering to the ban and it was difficult to enforce and penalize all offenders due to shortage of policemen as published on Arab News (22 January 2013).

## **3. Research Methodology**

A mixed methods approach using semi-structured interviews and interviewer-administered questionnaire was applied in this study. This was justified by the limited knowledge of the current operational activities and challenges of urban freight transport in Saudi Arabia coupled with the uncertainty of potential of City Logistics solutions. Semi-structured interviews were conducted initially with experts from selected shippers and freight carriers in Jeddah to inquire about the interactions and coordination between private and public stakeholders as well as understand the key challenges that undermine the daily operations of urban freight transport in Jeddah. Transport managers from four freight carriers and six logistics managers from leading manufactures in Jeddah participated in a one-hour individual interview. These

companies are considered leaders in their respective industries in Jeddah as follow: two from the food, one from FMCG, one from express mail, one from construction materials and one from petroleum products industries. Four of these companies conducted their freight transport activities using the company's own vehicles while the other two outsourced their transport activities to other freight carriers. This acquired knowledge facilitated in designing the questionnaire and proposing suitable city logistics for that would be practical for participating shippers and freight carriers.

Consequently, this study utilised an interviewer-administered questionnaire to acquire data about freight transport activities conducted by shippers and freight carriers, evaluate the challenges in urban freight distribution and assess the acceptability of proposed city logistics solutions. The questionnaire was composed of four sections. Sections 2 and 4 were adopted from the survey developed by Manzano dos Santos and Sánchez-Díaz (2016). Section 1 inquired about the company's operations: *operating times, main market segment* (Food, FMCG, Household Goods, Clothing & Textile, Industrial Products & Chemicals, Petroleum Products, Construction & Building Materials and Express Mail), *fleet composition, on-board communication & tracking technologies, delivery destination* (customer, internal warehouse) and *average vehicle fill rate*. Section 2 asked the participants to rank a list of identified challenges with respect to their impact on their daily operations. The following problems were included: *Traffic Congestion, Improper Traffic Regulations, Parking, Accidents & Injuries, finding receivers' address and unplanned deliveries*. Section 3 evaluated current implementation of various logistics measures and practices that aim to enhance operations and address environmental issues. The participants were asked to indicate if any of the following measures were implemented: (a) monitoring/recording vehicle fuel consumption and travelled distance, (b) using environmentally-friendly vehicle, (c) use of backhauling, (d) using routing and scheduling software to optimise delivery.

Subsequently, section 4 appraised shippers and freight carriers' interest in the proposed city logistics solutions and evaluated the factors that would impact their decision to implement the proposed solution. The following factors were included in this section: *Cost* refers to the cost saving or efficiency gained from implementing this logistics concept; *System Integration* refers to efficient integration between existing logistics operations and new operations by the new concept; *Regulations* refers to introduction of required regulations by local authorities to establish and regulate the new operations by the logistics concept; *Infrastructure Availability* refers the availability of required land, network and labour to establish and operate the logistics concept; and *Government Support* refers to willingness by local authorities to provide financial support and form partnership with logistics companies. For Sections 2 and 4 of the questionnaire a ranking scale (1-5) was used to measure the importance given to each challenge or factor. The score given ranges from 1 to 5; a 1-score means "limited impact" and a 5-score means "very high impact". The proposed four city logistics solutions were selected based on the discussion and consultation with the logistics managers during the semi-structured interviews. To check for content validity and reliability of the questionnaire, the researchers consulted with two logistics managers to pre-test the questionnaire and confirm that it established adequate coverage of the issue being investigated. Accordingly, one of the question was refined and simplified to eliminate any misunderstanding by the participants.

Stratified sampling strategy was used to select suitable shippers and freight carriers in Jeddah to analyse their current practices and assess their views and acceptance of City Logistics measures. The sample companies were randomly selected from strata representing the major industries operating in Jeddah. The list of companies to form the strata were acquired from Ministry of Commerce and Investment as well as Jeddah Chamber of Commerce. Accordingly, a random sample of 250 shippers and freight carriers were identified to participate in the questionnaire. Due to reluctance to release information outside the company, the lack of interest and excessive fear of competitors, it is significantly difficult to collect primary data from local companies in Saudi Arabia. The researchers utilized various methods to overcome these obstacles. The researchers used personal references to reach out to key personnel inside

these companies. Potential participants were contacted via phone to inform them about the study and acquire contact details of logistics managers. Phone calls and email reminds were sent prior to the meeting time to ensure the availability of the logistics manager. Accordingly, there researchers collected completed responses from 54 shippers and freight carriers, which represented a response rate of 22%. This might be considered a relatively low response rate compared to other similar studies. However, the collected responses present valuable and practical findings on the current state of urban freight transport in Saudi Arabia. Out of the 54 responses received, 36 were from freight carriers while 18 were from manufacturers and wholesalers (distributors) that delivered inside Jeddah using their own freight vehicles. All 54 participants will be referred to as freight carrier in the analysis part due to the fact all participating shippers transported their freight task using own-transport. **Fig 1** provides an overview of the participants and their respective industries (type of product delivered).

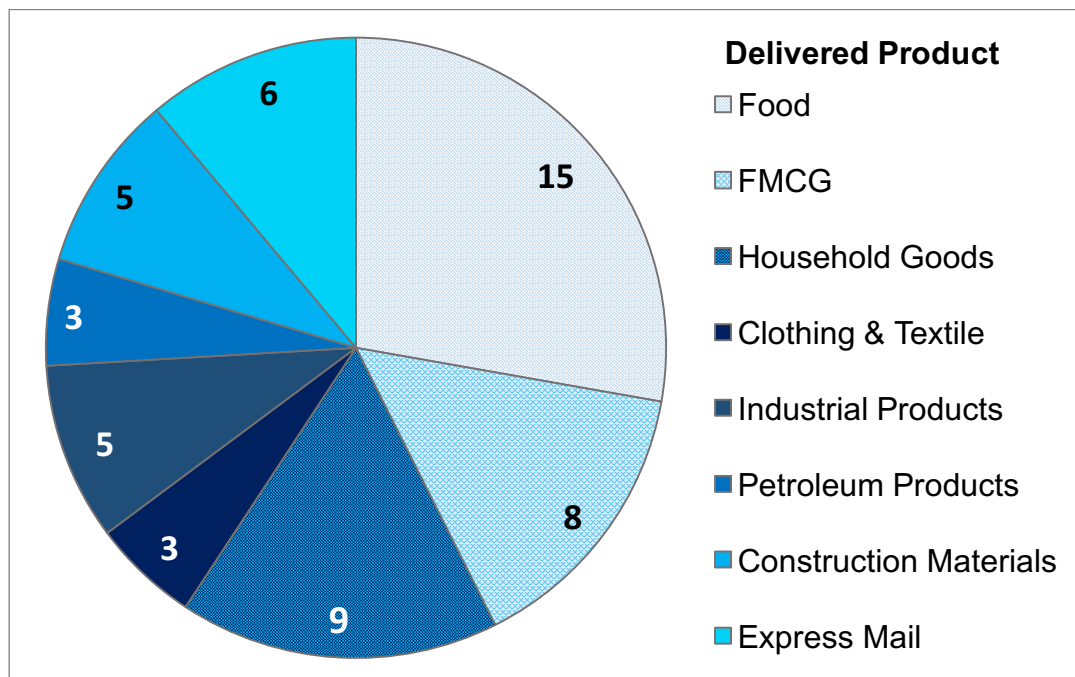


Figure 1. Number and Industries of Shippers and Freight Carriers that Participated in Questionnaire.

## 4. Analysis of Responses obtained from freight experts in Jeddah during semi-structured interviews

### 4.1 Experts Views on Urban Freight Transport Stakeholders' Awareness and Interactions

The responses obtained from the participants in the semi-structured interviews revealed that local authorities negatively impacted the efficiency of freight carriers in Jeddah due to improper planning and policies, negligence of coordination with private stakeholders and lack of freight transport expertise working for local authorities. The participants emphasized that there is a lack of awareness of urban freight transport issues and best practices among local authorities as well as lack of qualified planning personnel in the field of logistics working for responsible local authorities. Furthermore, the participants expressed that government agencies tend to not involve nor consult with private stakeholders in relevant decisions that are implemented in urban areas which negatively affect the deliveries and businesses. These agencies take decisions in isolation without coordinating and working with private stakeholders. This was

evidenced in complaints by key businesses in Jeddah regarding the impact of heavy trucks ban during peak hours on major highways in Jeddah and the failure to provide heavy trucks with temporary parking facilities off the highways during the entry ban. Furthermore, they indicated that there was no coordination and interaction between freight carriers and receivers especially with respect to delivery time as much as other countries where businesses play a significant role on the delivery time window. They attributed this due to the current practice of receivers in Jeddah making orders in large volume while anticipating and accepting the long delivery lead time due to congestion and inefficient urban freight transport operations. However, the logistics managers reported that receivers get more involved with both shippers and freight carriers only in urgent deliveries as they placed more pressure on shippers to release products to freight carriers. As imports constitute large volume of materials used by factories in Jeddah, customs brokers play a significant role in the freight carrier-receiver (factory) relationship. Due to inefficiencies and time-consuming processes to clear goods at Jeddah Islamic Port, customs brokers dictate the timing and decision-making of deliveries conducted by the freight carrier and factory inside Jeddah.

## **4.2 Experts Views on Suitable City Logistics Solutions for Jeddah**

When asked about suitable city logistics solutions to optimise and alleviate urban freight transport in Jeddah, the participants expressed their reservations about the suitability and practicality of solutions that focus on equipment and regulations such as road pricing, improving vehicle load factor or clean vehicles. Due to the lack of public regulations promoting use of eco-friendly vehicles coupled with the relatively lower cost of fuel in Saudi Arabia, freight carriers would not be compelled to switch to clean vehicles. They warned that lack of enforcement and qualified personnel working for local authorities might discourage logistics companies from investing in logistics solutions that require updating their fleet. They suggested that these solutions may not be as effective as solutions that facilitate more efficient use of infrastructure and advanced technologies such as dedicated lanes in highways, Intelligent Transport Systems and public consolidation facilities. They postulated that due to the recent government spending in transportation infrastructure in Jeddah, local authorities might be willing to dedicate specific parts of major roads to freight vehicles and allocate industrial lands to logistics facilities in freight-intensive corridors and areas in Jeddah.

## **5. Findings and Analysis of Responses Collected from Shippers and Freight Carriers in Questionnaire**

### **5.1 Operational Characteristics of Freight Carriers in Jeddah**

The responses obtained about the participating companies operational parameters are presented here, which were collected in section 1 in the questionnaire. The participating companies represented a diverse mix of shippers (manufactures and wholesalers) and freight carriers that conduct various freight transport activities in Jeddah. These transport activities included delivery from/to seaport to/from shipper's warehouses as well as intracity and interstate urban goods distribution. They were performed using various classes of freight vehicles such as light commercial vehicles (LCV), light truck (GVM up to 4 tonnes) and medium rigid truck (GVM up to 14 tonnes) with limited use of bulk tankers for the transport of chemicals, ready-mix concrete, fresh water and sewage. Significant figure of the interstate freight tonnage is transported from/to Jeddah by semi-articulated trucks (a prime mover towing a two-axle trailer with GVM up to 42 tonnes) with slight use of two-axle heavy rigid trucks (GVM up to 21 Tonnes). The typical working week in Saudi Arabia starts on Sunday and ends on Thursday. However, only 19% of participants indicated that they conduct freight transport activities during Sunday-Thursday. Moreover, 56% and 25% revealed that they operated six days and seven days per week respectively. As various receivers in Jeddah such as large supermarkets and factories operate 24 hours, many freight carriers mentioned that they

performed the deliveries to these businesses during the early morning hours. Furthermore, 5 of the participants indicated that they transported freight (raw material or work-in-progress) between their company’s internal storage facilities, which are located in different parts in Jeddah. The fleet size of the participating companies ranged between 20 and 380 freight vehicles with an average fleet size of 153 vehicles (66 LCV and 87 truck). **Fig. 2** illustrates the fleet composition (type and number of vehicles) of the participating companies. Freight carriers transporting industrial products, petroleum products and construction materials used more medium trucks while carriers transporting express mail indicated they depended more on LCVs. Moreover, carriers transporting food, FMCG and household goods used a mix of LCVs and medium truck as they used trucks to deliver to large retailers and businesses and LCVs to deliver to small and independent receivers in residential neighbourhoods in Jeddah.

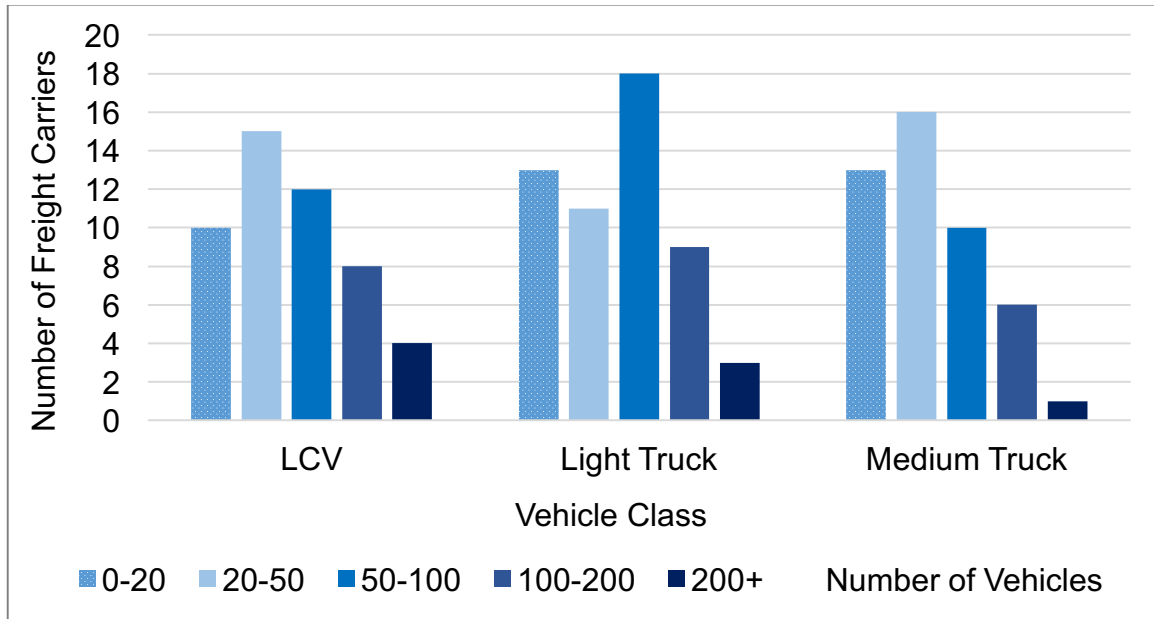


Figure 2. Breakdown of the Freight Vehicle Fleet of the Participating Shippers and Freight Carriers in Jeddah with Respect to Number and Vehicle Class.

The participants reported that the most used communication and tracking technology on the freight vehicle was Radio (32%) followed by GPS (21%), mobile technology (19%) and on-board computer (13%) while 15% of the participants stated they did not use any technology. With respect to the average fill rate of the delivery vehicle, 39% of the participants indicated that the vehicle left their depot about 60-80% full while 21% of the participants reported that the vehicle was more than 80% full compared with 10% indicating their vehicle was less than 40% full on average. However, this figure included all freight vehicle classes. Upon further analysis of the individual responses, it was evident that participants with high number of LCVs and light trucks reported much higher rate than medium trucks. The participants provided detailed responses on the average daily trips to receivers in Jeddah for all classes of freight vehicles as illustrated in **Fig. 3**. The total number of daily trips per freight carrier varied from 115 trips for a company with about 20 freight vehicles to 4,570 trips for a carrier with 380 vehicles. It was reported that 54% of freight carriers using LCV, the carrier performed more than 10 trips per vehicle on a typical day while using 44% of the carriers using light a truck made between 5-10 trips/vehicle. However, as the number of daily trips performed by the freight carrier is impacted by the type of freight vehicle used and the customer’s industry, these figures should be considered as an estimation accordingly.

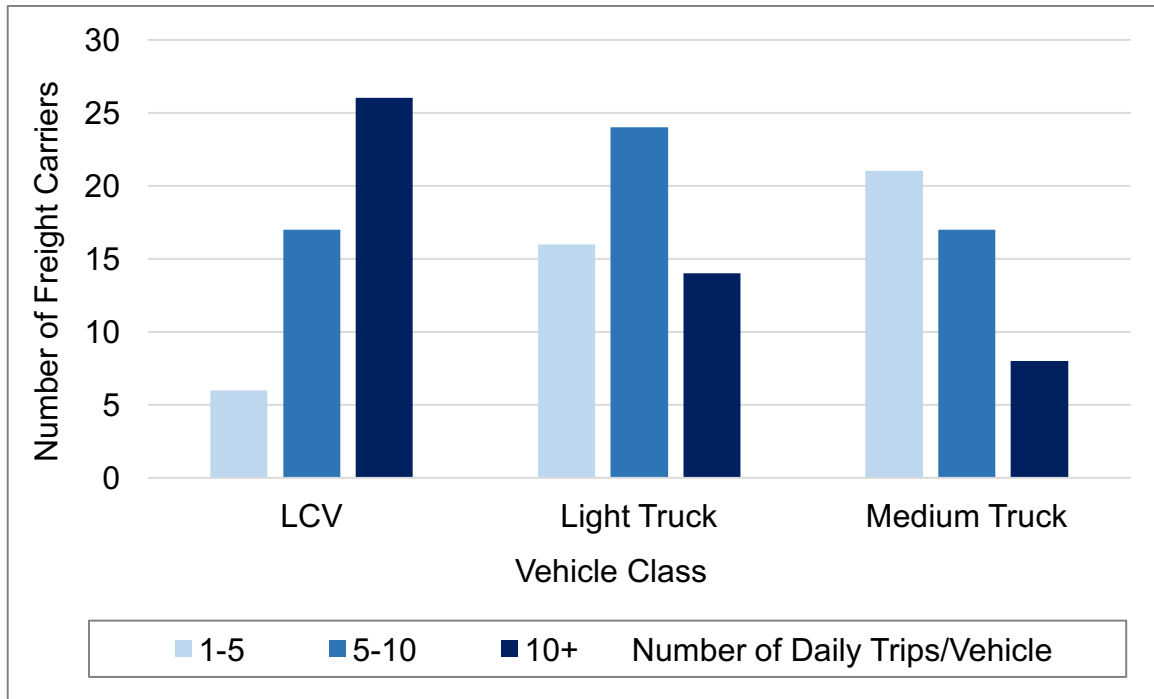


Figure 3. Distribution of the Average Number of Daily Trips per Vehicle Performed by Participants in Jeddah for Each Freight Vehicle Class.

## 5.2 Attitudinal Study of Freight Carriers' Views on Impact of Operational Problems on Efficiency of Urban Freight Transport in Jeddah

This section provides the results of sections 2 and 3 of the questionnaire, which investigated freight carriers' views regarding key operational problems and existing or likely implementation of selected logistics practices that aim to enhance operations and address environmental issues. Fig. 4 illustrates the carriers' opinions about how much these challenges impacted their freight transport activities in Jeddah. The closer the indicated value to 5.0, the higher impact on the daily operational activities as reported by the carriers in Jeddah. Traffic congestion was reported as the most impactful problem on carriers' daily operations with a median score of 4 (Standard deviation: 0.60) followed by improper traffic regulation, parking, accidents and injuries and customer's address with a median score of 3 (SD: 0.91), 3 (SD: 1.37), 2 (SD: 0.82) and 2 (SD: 1.19). However, carriers suggested that 'unplanned deliveries, i.e. urgent request by the customer in very limited time' did not have a similar impact on their operations. This problem was mostly evidenced with carriers transporting industrial products as some receivers placed pressure to shippers to deliver products in contingency situations. In Fig 4, it can be clearly seen that some problems did not have similar impact on the efficiency of carriers as evidenced in the variation of the level of impact for each problem with some problems displaying significant disparity in the ranking of the problem. For instance, carriers transporting food reported that parking significantly affected their operation especially in congested areas while carriers transporting industrial and petroleum products did not view parking as influential on their operations. Furthermore, carriers with high use of heavy trucks indicated the improper traffic regulation negatively impacted their operations especially after the introduction of heavy truck ban in Jeddah. On the other hand, carriers transporting express mail reported that finding the customer's address had sometimes more impact on their operations that even traffic congestion.



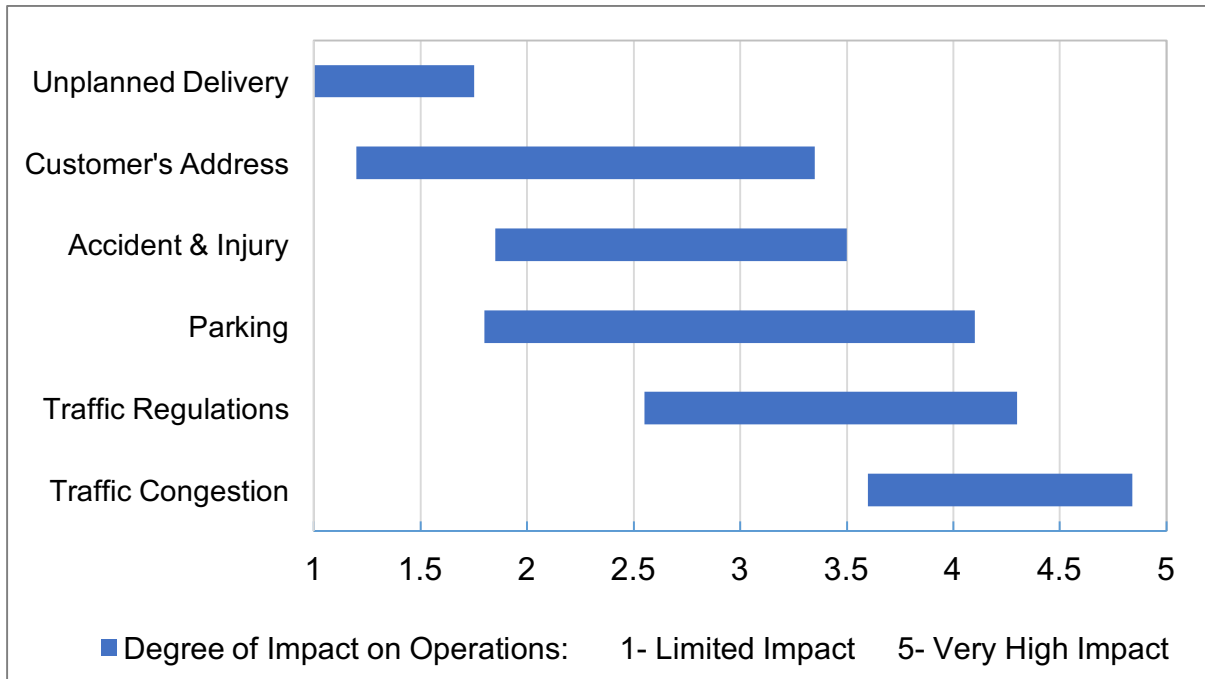


Figure 4. Impact of the Problems on the Efficiency of Freight Carriers in Jeddah Based on Ranking of the Influence of the Problem.

Most of the participants indicated that they monitored and recorded the vehicle’s travelled distance and fuel consumption while only 22% indicated that they used routing and scheduling software to optimise their deliveries. However, some carriers indicated that they still use manual reports to record fuel consumption and VKT while large freight carriers that implemented GPS and on-board computer technologies stated that all vehicle data is stored in the company’s system. Furthermore, two carriers reported that they were trailing hybrid LCVs, which were large international parcel courier. Several carriers suggested that local authorities need to set regulations and provide financial support to promote use of clean freight vehicles as the cost of fuel is relatively cheaper in Jeddah and there were no access restriction policies based on vehicle emission. Moreover, carriers that used large fleet of LCVS indicated that they would be interested in implementing a routing and scheduling software due to the increasing traffic congestion and large number of trips they performed daily. Most participants from factories argued that backhauling might not be relevant and beneficial to their operations. **Table 1** summarises the percentage of responses for each logistics measures included in section 3 of the questionnaire.

Table 1: Overview of Freight Carriers’ Existing and Likely Level of Implementation of Selected Logistics Measures that Target Sustainability of Urban Freight Transport

	Already Implemented	Plan to Implement	Don’t Plan to Implement	Not Relevant
Monitoring Vehicle’s Fuel Consumption and VKT	86%	10%	-	4%
Using Environmentally-Friendly Vehicle	5%	30%	47%	18%
Backhauling	39%	18%	14%	29%
Using Routing & Scheduling Software	22%	55%	11%	12%

### 5.3 Attitudinal Study of Freight Carriers' Perception and Interest in Proposed City Logistics Solutions

This section provides results of section 4 of the questionnaire that inquired about freight carriers' perception of four proposed city logistics solutions and the factors that would influence carriers' decision to implement or participate in the proposed solution. **Fig. 5** displays the carriers' interest in implementing or participating in the proposed city logistics solutions and the impact of each factor on their decision to their likely implementation. The closer the indicated value to 5.0, the higher influence of the factor on the carrier's decision to implement or participate in the solution as reported by the carriers in Jeddah. The "+" sign shown in **Fig. 5** indicates that there is a positive correlation between this logistics attribute and the respective factor in the carriers' decision to participate or not in the proposed logistics solution. The "-" sign shown in **Fig. 5** indicates that the lack of this logistics attribute negatively affect the respective factor in the carriers' decision. Freight ITS received the highest interest as 74% of the carriers indicated that they would implement this solution while 62% and 42% of the carriers reported they would participate in the truck-only lane and public logistics terminal initiatives. However, high productivity freight vehicle (HPFV) did not receive similar interest as only 28% stated their interest in the solution. As can be seen in **Fig. 5**, each factor had a different level of impact on the decision making of carriers with respect to each city logistics solution as carriers viewed the significance of each factor differently based on the solution being evaluated.

For Freight ITS, carriers indicated that cost reduction and enhancing operation efficiency had the most considerable influence on their decision to implement this solution. They commented that for this solution to be widely accepted, it must deliver significant cost savings and improvement in operational efficiency due to the prohibitive cost associated with ITS. Furthermore, infrastructure availability and government support received high scores from the carriers. Existing road infrastructure needs to be improved to facilitate the successful implementation of Freight ITS applications. They suggested that local authorities need to provide financial support to establish required infrastructure especially for vehicle-to-infrastructure (V2I) ITS applications. However, not all carriers viewed influence of government support similarly, which justified the variation of the level of impact for this factor as shown in **Fig. 5**. Carriers, which indicated their interest primarily in vehicle-to-vehicle (V2V) ITS applications, assigned low score to this factor. Moreover, integration with existing tracking and monitoring systems was a relatively crucial factor some carriers especially the ones that already utilise advanced technologies such as mobile and on-board computer technologies. Many carriers assigned a low-score to the regulation factor as they believed that success of Freight ITS application depended more on technology, infrastructure and financial support. There was a positive correlation between the existing on-board tracking and monitoring technology and the level of interest in Freight ITS. All carriers that utilised GPS, mobile and on-board computer technologies expressed their interest in the advancement of ITS in enhancing their operations.

For truck-only lane, government support and infrastructure availability received the two top ranking scores respectively. Carriers argued that local authorities would be instrumental in dedicating required lanes in freight-intensive corridors for the exclusive use of freight vehicles in off-peak hours. These infrastructural changes and upgrades require financial expenses, which should be provided by local authorities. For this solution to be effective, the selected location of the dedicated lanes should be optimised to provide efficient and well-connected road network that facilitate smooth transfer between major highways and local roads for both inter-city and intracity freight movements. Furthermore, the carriers stressed that local authorities need to establish proper regulations that ensure and monitor the exclusive use of these dedicated lanes for freight vehicles. However, most carriers did not view the cost and system integration factors as important in their decision to participate in the solution. This based on the assumption that local government would cover the setup cost of establishing

these dedicated lanes and there would be no road pricing schemes implemented for freight vehicles in these lanes.

CL Solution	Factors	Level of Impact	Implement		Logistics Attributes		
			Yes	No	Vehicle Type	Comm. Tech	Product Type
<b>Freight ITS</b>	Cost		40	14			
	System Integration					(+)	
	Regulations						
	Infrastructure Availability					(+)	
	Government Support						
<b>Truck-Only Lane</b>	Cost		33	21			
	System Integration						
	Regulations						(+)
	Infrastructure Availability					(+)	
	Government Support					(+)	
<b>HPFV</b>	Cost		15	39			(+)
	System Integration						
	Regulations						
	Infrastructure Availability					(+)	
	Government Support						(+)
<b>Public Logistics Terminal</b>	Cost		23	31			(+)
	System Integration					(-)	(+)
	Regulations					(+)	
	Infrastructure Availability						
	Government Support						

Figure 5. Freight Carriers Perception and Likely Interest in Proposed City Logistics Solutions.

Public logistics terminal received mixed interests from the participating freight carriers. The concept was more popular for carriers that specialised in transporting household goods, FMCG, clothing and textile with slight interest from some food and express mail carriers.

However, carriers transporting construction materials, industrial and petroleum products rejected the concept as it added complexity and liability issues in their operations as well as an unnecessary and additional level in their distribution network. Cost reduction was selected as the most important factor followed by system integration for most interested freight carriers. They suggested that the PLT should be established near Jeddah Islamic Port or east of Jeddah Ring Road. Furthermore, these location offers excellent road network connectivity, which facilitate efficient integration with participating freight carriers' existing logistics facilities. Furthermore, freight carriers stressed that local authorities' financial and regulatory support would be very important to attract substantial number of freight carriers. Local authorities need to provide financial subsidies and required land to establish the logistics terminal. Carriers recommended that it might be necessary to establish new access restriction and parking policies that favour the operator of the PLT in areas with substantial number of LCVs and severe traffic congestion. Some carriers indicated that the lack of existing communication technologies would negatively affect the efficient transfer and security of products via the logistics terminal to their receivers. This would affect the integrity and quality of the delivery activity, which consequently impacts the carriers to participate in the public logistics terminal. Further analysis of the individual responses revealed that carriers using mix of light and medium trucks with a 60% or less vehicle fill rate represented that highest interest in participation in this concept. This could be attributed to the carriers' belief that PLT would relieve them from delivery in highly congested areas with frequent trips and low fill rate.

HPFV was the least accepted solution among the four-proposed solutions due to its limited suitability and benefits to carries utilizing primarily fleets of rigid trucks and specializing in inter-city freight movements. This solution was more accepted by construction materials, industrial and petroleum products. For carriers interested in this solution, infrastructure availability was the most important factor for carriers to implement this solution. Carriers suggested the availability of required road network that can accommodate the operations of HPFVs would be very important in their decision to invest in acquiring these special heavy freight vehicles, which made cost the second most important factor. Moreover, they recommended local authorities to provide carriers with online tools and maps that provide information on suitable highways and roads for HPFVs in Jeddah. This would facilitate optimising route selection for the HPFVs in Jeddah. Carriers that specialized in the transporting containers from/to Jeddah Islamic port on semi-articulated trucks expressed their interest in this solution to accommodate the increasing volume of containers transport to large factories in 1<sup>st</sup> and 2<sup>nd</sup> Industrial City in south of Jeddah.

## 6. Conclusion

The analysis and findings provided a detailed description of the current operational parameters and main challenges encountered in urban freight transport in Jeddah. Participating shippers and freight carriers indicated that traffic congestion, improper traffic regulations, parking and accidents and injuries had the most severe impact on their daily operations. These challenges negatively affected the efficiencies and operating cost of freight carriers in Jeddah. Accordingly, freight carriers expressed more interest in city logistics solutions that enabled improved real-time traffic information and monitoring, enhanced utilisation of the existing transport infrastructure and provided more government regulatory support. Freight ITS and Truck-only Lane received the highest interest from the freight carriers. These solutions might be more effective and suitable in Jeddah with the high use of rigid trucks especially light and medium trucks, improper traffic and parking regulations, limited access restriction policies and rejection of road pricing schemes. Freight carriers selected cost reduction, infrastructure availability and government support as the factors with the highest impact on their decision to implement or participate in the proposed solutions. This high ranking of these factors is consistent with the ranking of the challenges by freight carriers with respect to their negative impacts on the efficiency and operating cost. Even though freight experts expressed their displeasure with local authorities, most participants viewed local authorities as an integral part

in the success of any future initiatives to enhance urban freight transport and assigned a high value to their role as initiator and regulator.

Prior to any future city logistics initiative, it is essential that local authorities update existing transport and local planning policies to incorporate freight transport requirements and legislate required regulations that support the daily operations of freight transport companies. Local authorities should work with academics and transport researchers to implement relevant freight data collection techniques to enable more thorough investigation of urban freight transport and be better informed. Due to the limited number of participants in this research, the results and findings may not be applicable to all shippers and carriers in Saudi Arabia. The reported interest in the proposed city logistics solutions represented the stated preferences of the participants. It can be argued that their responses have been biased towards suitable and applicable solutions to their individual operations and objectives. This does not incorporate benefits of other stakeholders in the Saudi urban freight transport. Nonetheless, the study provided an initial yet valuable and practical reference and insights of urban freight transport in Jeddah. Moreover, the findings facilitated an improved understanding and decision making for Saudi companies and local authorities contemplating offering services and applications relevant to the proposed solutions. A more holistic approach should be utilised in a future study to include all public and private stakeholders impacted by and involved in the urban freight transport to investigate in more details which city logistics solutions facilitate achieving the objectives of all stakeholders. Further research using real traffic local data should be conducted to optimise the selection of the potential locations in Jeddah to establish truck-only lanes and illustrate the benefits that the new transport infrastructure delivers to freight carriers.

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