

The extent of the Urban Freight Transport system on the Road Safety

Nassima LAARAJ

Laboratory of Energy & Sustainable Development (LPE2D)
Sidi Mohamed Ben Abdellah University - EST,
Road of Imouzzzer - BP: 2427 - Fez, Morocco
nassima.laaraj1@usmba.ac.ma

Imane MOUFAD

Laboratory of Energy & Sustainable Development (LPE2D)
Sidi Mohamed Ben Abdellah University - EST,
Road of Imouzzzer - BP: 2427 - Fez, Morocco
imane.moufad@gmail.com

Fouad JAWAB

Laboratory of Energy & Sustainable Development (LPE2D)
Laboratory of International Management Decision techniques and Logistics (MIDLOG)
Sidi Mohamed Ben Abdellah University - EST,
Road of Imouzzzer - BP: 2427 - Fez, Morocco
fouad.jawab@usmba.ac.ma

Youness Frichi

Laboratory of Manufacturing, Energy and Sustainable Development
Sidi Mohamed Ben Abdellah University
Fez, Morocco
youness.frichi@usmba.ac.ma

Kawtar Akoudad

Laboratory of Energy & Sustainable Development (LPE2D)
Sidi Mohamed Ben Abdellah University - EST,
Road of Imouzzzer - BP: 2427 - Fez, Morocco
kawtar.akoudad1988@gmail.com

Karim Zehmed

High School of Technology (HST)
Sidi Mohamed Ben Abdellah University (SMBAU)
PB 2427 Imouzzzer Road 30000 , Fez, Morocco
Karim.Zehmed@usmba.ac.ma

Abstract

Sustainable development with its dimensions, economic, ecological, and social is a central concept in terms of the quality of life. The urban freight transport UFT, while contributing to the creation of wealth and economic development of large agglomerations, is at the origin of negative externalities, such as pollution, noise and road accidents. The purpose of this work is to challenge the role of UFT in traffic accidents. We seek to determine its extent against to other forms of transport in urban areas, the nature of the accidents caused, the types of vehicles and goods involved, the zones and the schedules of the losses as well as the damage and their scale. Our methodology is based on the analysis of statistical data at the international level and is evolves over the last two decades.

Keywords

Urban Freight Transport system, Road safety, Agglomeration, Road accident.

1. Sustainable transport of goods in the city

In this first point, we will discuss the definition of sustainable development and situate the link between sustainable development and the transport dimension.

1.1 The concept of sustainable development

The term “sustainable development”, which first appeared in 1980, was published in the 1987 report of the World Commission on Environment and Development (Brundtland Commission), and raised to the rank of world mission by the United Nations Conference. Environment and Development (UNCED), held in Rio de Janeiro in 1992 (Emas, 2015). The Brundtland Commission has defined sustainable development as "development that serves the needs of the present without compromising the ability of future generations to meet their own needs" (Connelly, 2007). Other definitions were proposed, advocating for sustainability as an economic state in which demands placed on the environment by people and commerce can be met without reducing the ability of the environment to serves the needs of future generations. (Lagorio, Pinto, & Golini, 2016).

1.2 The sustainable transport

The sustainable transport is the expression of sustainable development in the transport sector (the European Commission uses sustainable mobility as a synonym). For several years, the mobility of people and goods has grown rapidly, leading to great economic and social progress. However, this development is likely to pose serious problems for countries wishing to implement a sustainable development policy (Moufad & Jawab, 2017a). The following figure illustrates the effects that transport can have on the economy, the environment and society (Morana, 2015):

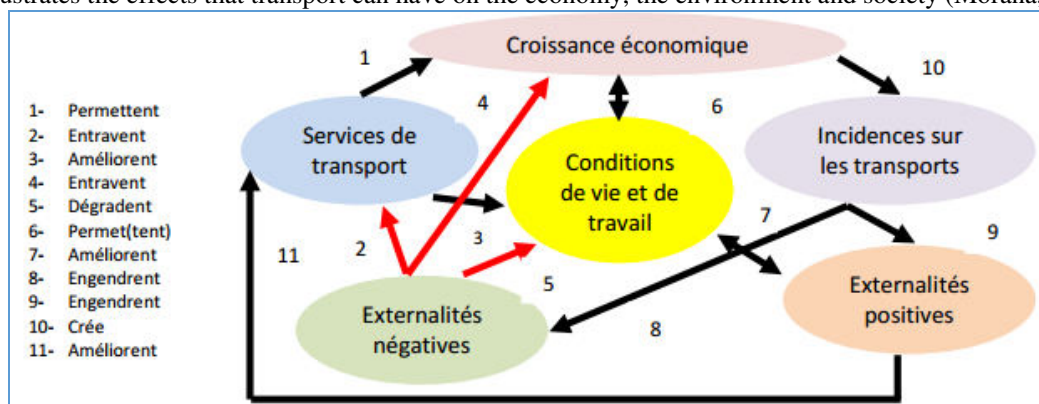


Figure 1 : Schematic illustration of the links between transport and economic development

1.3 The sustainable freight transport in the city

Although the transport of goods in cities plays a key role in the development of economic and social activities in urban areas, it must not be exercised at the expense of the environment and the liveability of cities for present and future generations (Morana & Gonzalez-Feliu, 2012a).

As a result, the main objective must be the sustainable transport of goods in the city, which requires the development of a system that takes into account social, economic and environmental imperatives (Moufad & Jawab, 2017a). Figure 5 presents the context of sustainable freight transport in the city. In the context of sustainable development, all factors are interdependent. Failure to tackle pollution, noise or security problems, for example, would end up threatening economic growth (Moufad & Jawab, 2017b).

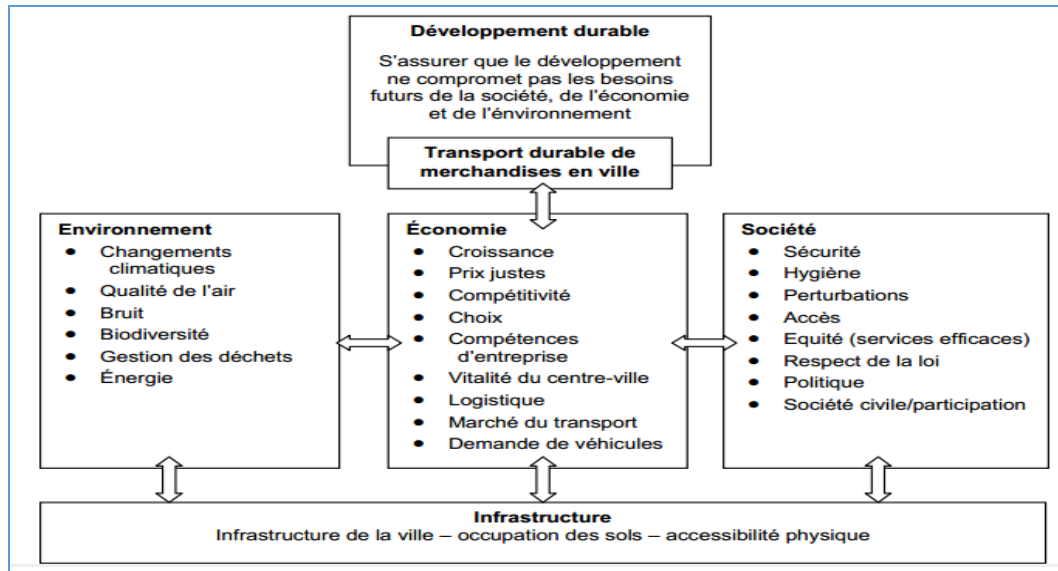


Figure 2 : The context of sustainable freight transport in cities (OCDE, 2003)

The economic contribution of goods transport in town is very important this can be explained by the quantity of goods transported. At the level of the European Union countries, for example, inland freight transport was estimated at more than 2,200 billion tons-kilometers (tkm) in 2014. The dominant mode of transport is road transport, three quarters of the goods were transported by road.

2. The impact of freight transport on road safety

The Freight transport is a sector that plays a fundamental role in economic development and human mobility, however it has significant externalities in terms of sustainable development, on the economic, ecological and social scale (Moufad & Jawab, 2016a). . In our work we focus on the impact of freight transport on road safety at the international level in the urban and interurban areas, and then we zoom in to the urban level, to question the role of urban goods transport in road accidents.

The evolution of research shows an increasingly important integration of urban issues including road safety and the transport and delivery of goods, an increasingly wide consideration of urban problems beyond the sole question of public transport (Yerpez & Fleury, 2001, Moufad & Jawab, 2017b). The consequences, often serious, of accidents involving goods delivery vehicles have greatly contributed to the negative image of these vehicles (Moufad & Jawab, 2016b). International organizations are beginning to feel the importance of acting on the problems of road accidents caused by the transport of goods in the city, and have prompted public and private authorities to put in place the necessary measures (OECD 2003).

The circulation of vehicles for the transport of goods is particularly critical because they produce an environmental impact and present a danger (rate of vulnerability and mortality) major compared to other vehicles that transit on the urban road network (Moufad & Jawab, 2016B).

In the city, streets are often congested due to heavy traffic, lack of space to develop infrastructure, signage at intersections of major avenues, traffic entering and leaving streets and buildings, parking on the way public and pedestrian traffic. The urban population is thus confronted with security problems on public roads such as (Moufad & Jawab, 2016a):

- Problems related to loading and unloading operations on public roads;
- Problems related to equipment density and population: In Japan, for example, the accident rate (number of accidents with fatalities or injuries / million vehicle-km) of goods vehicles is 0.96 in the city and 0.47 in the countryside. Their accident rate is thus twice as high in the city;

- Problems with excessive delivery requirements;
- Vehicle and load characteristics issues;
- Problems related to the transport of dangerous goods (example: gas cylinders): for example, in the United States, the transport of dangerous goods in transit in urban areas is subject to regulations which indicate, for each State, the routes prohibited for the movement of trucks carrying certain substances and the recommended routes for transporting these substances.

2.1 The contribution of freight vehicles on international road safety

Here we highlight the effects of freight transport on road safety. The figures available for unsafe road transport for goods mainly relate to the category of heavy goods vehicles or commercial vehicles. The statistical analysis makes it possible to question the extent of the transport of goods in road accidents. It should also be noted that the categorization of freight vehicles differs from one country to another as there are variations in the methods of counting road accidents¹.

The number of people killed by freight vehicle accidents in Europe is estimated at around 1,200. Although the number of people killed by accidents involving at least one transport of goods compared to other modes of transport present only 4.8%, the severity of these accidents remains significant at the economic and social level (Eurostat, 2016).

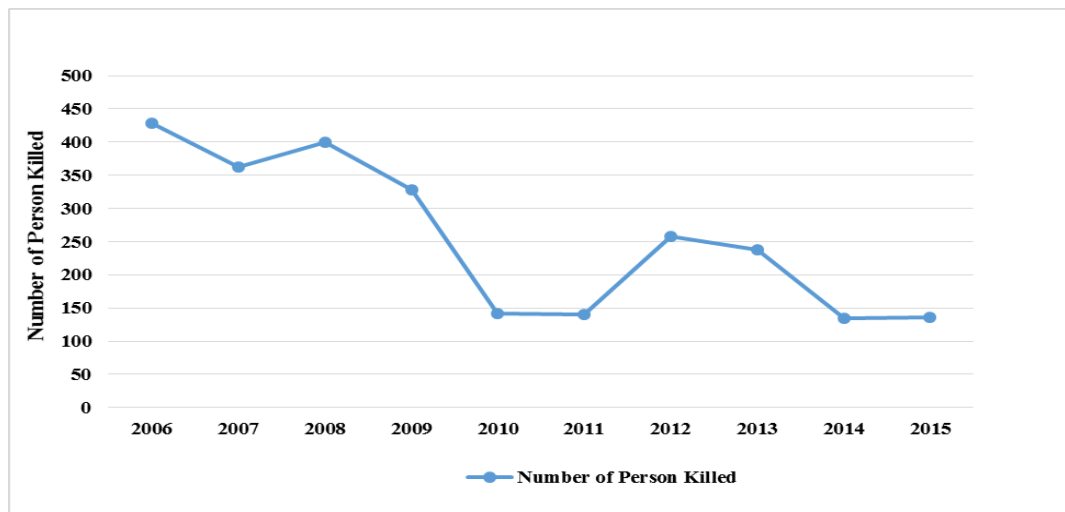


Figure 3 : Annual number of road deaths in accidents involving at least one goods transport vehicle in the EU, 2004-2013, basic index 100 = 2004. Source: Eurostat, 2016.

In addition to the human damage caused by accidents involving freight vehicles, there are socio-economic costs that result from each accident. In the United States, trucks were involved in 21.1% of fatalities, 4.7% of accidents with injuries and 7.8% of accidents with only material damage. Light trucks were involved in 60.3% of fatal accidents, 59.9% of accidents with injuries, and 63.1% of accidents with only material damage (NHTSA, 2008). For each accident, there are costs generated by the user itself (car insurance, medical and emergency services), in addition to the increase in travel time and emissions, and family impact of the user in the road killed or injured in the accident (Ranaiefar, 2011).

2.2 The involvement of goods transport in road accidents by type of vehicle

The light goods vehicles represent the most involved type of freight transport in road accidents. These vehicles are often vans or delivery trucks, which are not equipped with speed limiters (Eurostat, 2016).

¹ Voir “Migration of negative impacts of increased movement of freight”, World road association.

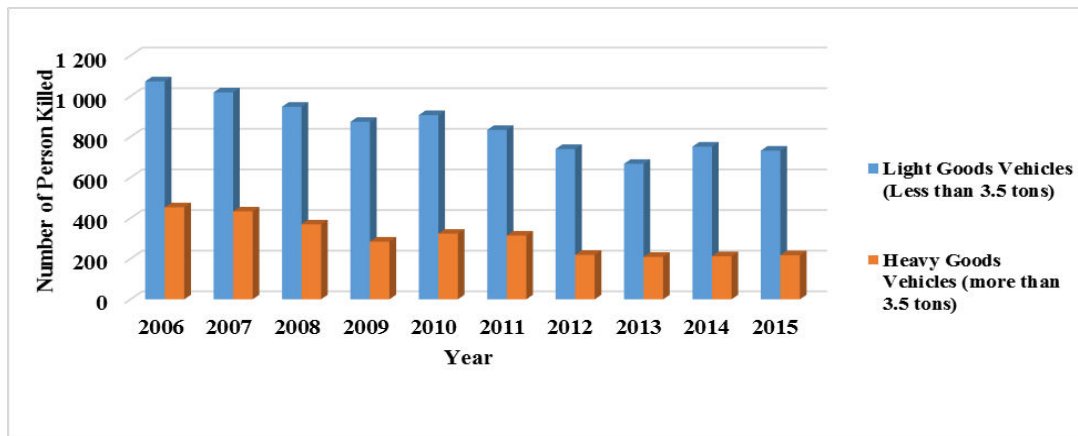


Figure 4 : Number of road crash deaths involving at least one vehicle transporting goods by category of vehicles in European countries 2006-2015. Source: Eurostat.

On the other hand, the accident severity rate for heavy goods vehicles (more than 3.5 tons) is higher than for light commercial vehicles (see Figure 5).

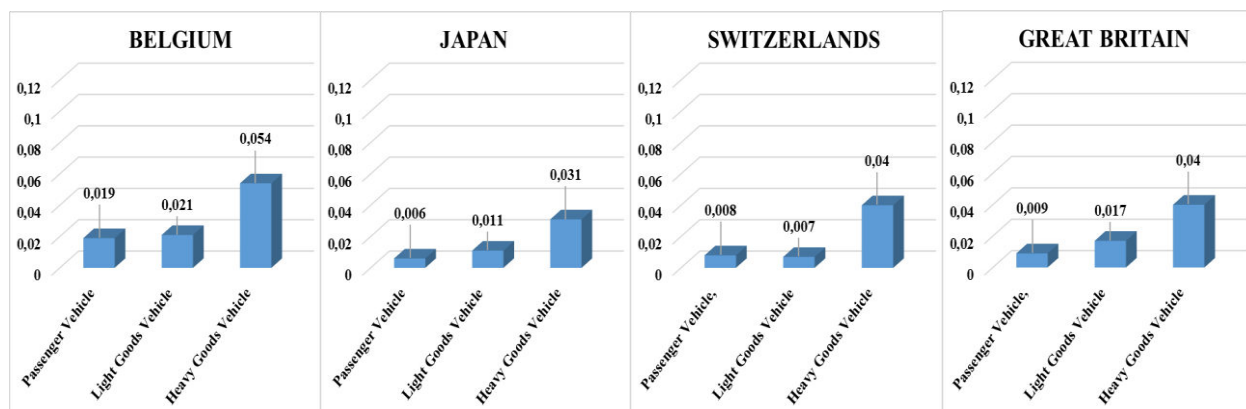


Figure 5 : The involvement rate of road accidents by type of vehicle. 2004-2007. Source: World Road Association.

The heavy goods vehicles, which have a lower involvement rate in road accidents than light-duty vehicles, tend to cause more serious accidents, with higher mortality rates (World Road Association (AIPCR), 2007).

2.3 The involvement of goods transport in road accidents by zone and by road

Generally, non-urban areas seem to be safer than urban areas. Highways have the lowest accident rate compared to national and municipal roads. In the United States, for example, the rate of serious accidents involving at least one goods vehicle on motorways is about half the rate for general roads (World Road Association (AIPCR), 2007). In Portugal, too, the mortality rate and the accident rate are low on major multi-lane roads, unlike general one-lane

roads, where the accident rate and the accident severity rate are higher (World Road Association (AIPCR), 2007).

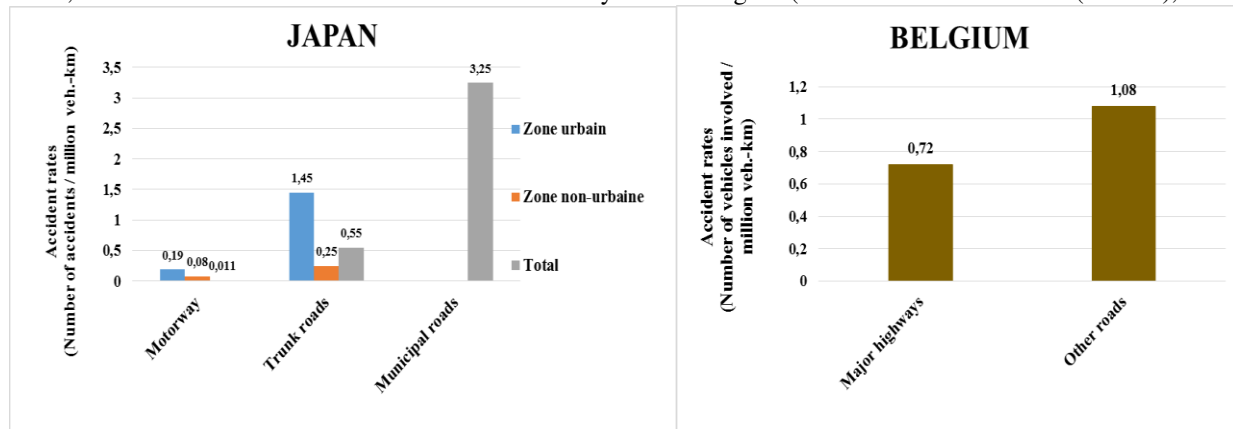


Figure 6 : Accident and Fatality Rates of Freight Vehicles by Zone and by Road Type 2004-2007. Source: World Road Association.

In Belgium the rate of fatal accidents, involving goods vehicles is relatively low at the level of main roads compared to other roads, but the gravity of accidents is higher. In Japan, the rate of road transport accidents is also lowest among motorways in urban and interurban areas (see Figure 6).

2.4 The involvement of freight transport in road accidents by time slot

The traffic of goods vehicles changes according to the time of day, it increases in the morning at the opening time of the stores. This period of the day coincides with the peak hour of daily migrations, which increases the congestion of road traffic (World Road Association (PIARC), 2007). The following figure shows the rate of accidents involving freight vehicles per day of the week and per time slot in Australia.

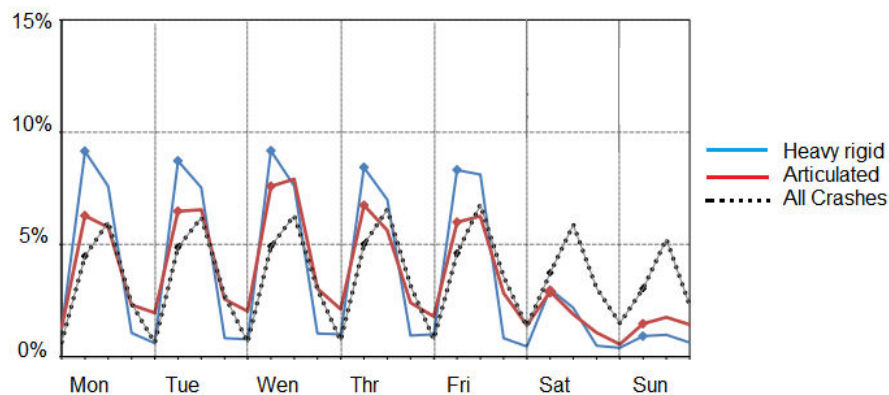


Figure 7 : Apportionment of accident rates by time of day and day of the week for freight vehicles in Australia, 2010-2014. Source : Astralian Department of Infrastructure and Regional Development 2016.

In the figure a day is divided into four part :

- first part from midnight at 5:59;
- Second part in the morning from 6h to 11h59 am;
- Third part in the afternoon from noon to 5:59 pm;
- Fourth part in the evening from 18h to 23h59;

It can be seen that during the morning period the accident rate is higher. The rate of accidents involving heavy vehicles (blue and red) is higher during the morning period, while the rate of accidents involving other types of vehicles is higher during the afternoon period. We also see that the accident rate is higher from Monday to Tuesday. The rate of accidents involving heavy vehicles for the week is about 92%, while the rate involving light vehicles is 74% (Astralian Department of Infrastructure and Regional Development 2016).

2.5 The impact of freight transport on road safety by category of goods transported

Detailed information about the involvement of freight vehicles in road accidents by category of goods, remains relatively insufficient internationally. In Australia a study was carried out by the NTARC research center (NTARC, 2015) on the involvement of freight vehicles in road accidents according to the category of goods transported, it was found that the presence of empty freight vehicles on the roads is about 20 to 25%. They are involved in serious accidents by a rate of about 12% in 2013. It was also found that the accident involvement rate has decreased when the vehicle is moving without goods transported (NTARC, 2015).

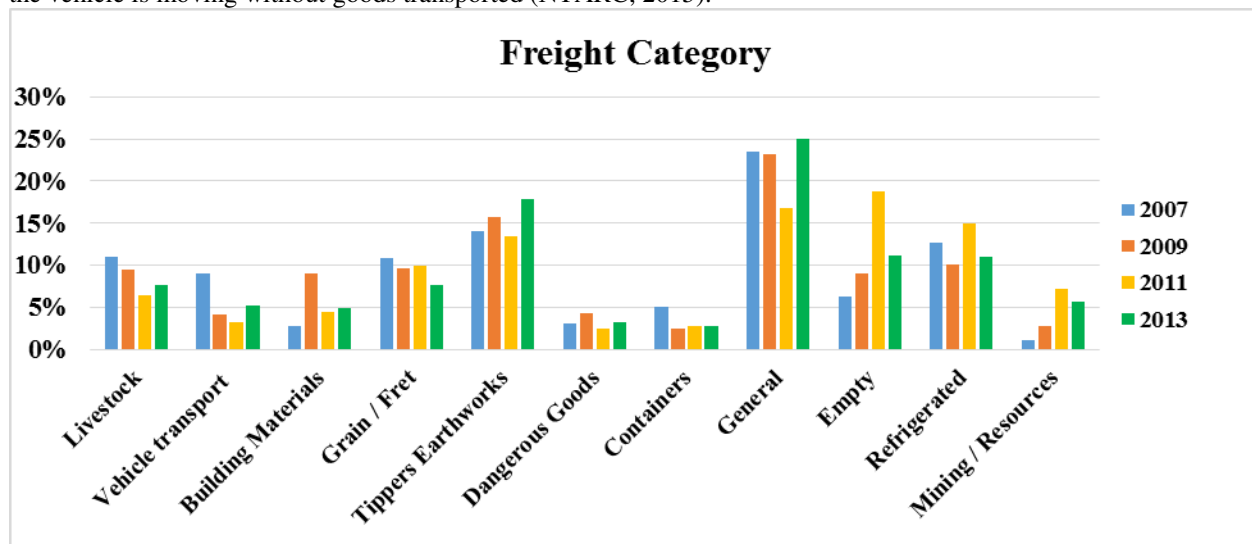


Figure 8 : The rate of freight vehicle involvement by category of merchandise in Australia 2007-2013.

It was found in this study that there were fewer serious accidents in operations involving mining and resources, and similarly for refrigerated goods and grain handling. One in four accidents involved general cargo vehicles. The involvement of dangerous goods vehicles is less than 5% (NTARC, 2015). The severity of accidents involving this type of vehicle is highly important. This is why the transport of dangerous goods is generally subject to specific regulations (Eurostat, 2016).

3. The impact of urban freight transport on road safety

3.1 The involvement of urban freight transport in road accidents

In Europe, the number of people killed by transport accidents in urban areas remains lower than the number of accidents caused by road freight transport outside urban areas. In 2014, the number of road accident fatalities in urban areas involving at least one means of transport of goods is estimated at about 218 accidents, of which 153 accidents involve light commercial vehicles (<3.5 tons). Outside the urban area, the number of people killed by road accidents was higher, estimated at about 1042 persons killed (Eurostat, 2016).

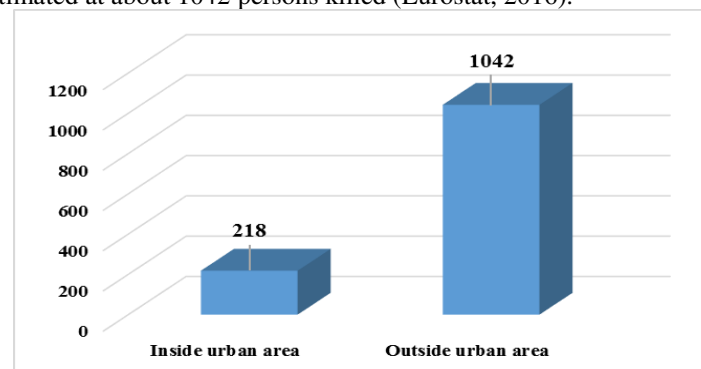


Figure 9 : Number of deaths by type of zone in the EU, 2014. Source: Eurostat

In Australia, 48% of those killed by freight accidents were registered in urban areas between 2010 and 2014, and 52% of those killed were registered outside urban areas. However, the number of people injured by this type of

accident is greater in urban areas, which accounts for 81% of injuries (Astralian Department of Infrastructure and Regional Development, 2016).

3.2 The involvement of UFT in road accidents by type of vehicle

The heavy goods vehicles are not particularly dangerous if we compare the number of accidents involving this type of vehicle with the number of accidents involving light commercial vehicles. In France, for example, it is estimated that less than 1% of the wounded and less than 2% of those killed are heavy truck users. On the other hand, the seriousness of urban road accidents in which they are involved is greater (World Road Association, 2013). In Australia, the accident severity rate involving at least one truck in the urban environment is higher compared to articulated trucks and light vehicles, human damage accounts for about 54% of fatalities and 81% of injuries (see Table 1) (Astralian Department of Infrastructure and Regional Development 2016).

Tableau 1 : The death rate and injuries in accidents involving a TMV vehicle. Source: Report -Heavy truck safety: crash analysis and trends-Australia 2016

	Death rate	Injured rate
Involving heavy truck vehicles	54%	81%
Involving articulated trucks	30%	57%
Involving light vehicles	49%	84%

In Australia, driving heavy vehicles is considered one of the most dangerous occupations (SafeWork Australia, 2011), accounting for 16% of the total number of road fatalities (BITRE, 2013). In this area of work, drivers of professional heavy vehicles are predisposed to a number of hazardous working conditions, including a high level of exposure to the road environment and tight delivery times (Thompson and Stevenson, 2014).

In Europe, heavy goods vehicles have the most critical accident severity rates in urban and interurban areas. (Road Association of the Road (PIARC), 2007).

This is due to several factors such as the large mass and configuration of these heavy vehicles, the slow propensity of heavy goods vehicles to respond to obstacles in urban areas with a higher concentration of traffic (World Road Association, 2013).

Light goods vehicles are involved in a larger number of road accidents in the urban area. This type of vehicle generally performs a much greater proportion of their distance traveled in urban areas than heavy goods vehicles (Browne, L. and Al 2010). At the European country level, trucks (less than 3.5 tons) caused 60% of deaths in road accidents involving at least one urban goods vehicle, (DaCoTA 2011).

3.3 The contribution of TMV vehicles to congestion and its impact on road safety

The mobility of freight vehicles, and their interaction with other modes of transport, creates a conflict between the transport of goods and other users of the urban public space. There are two forms of conflict :

- Accident: The increased risk of collision is a direct consequence of the conflict that occurs between users in circulation in a limited space divided, which may be intramodal or intermodal;
- Congestion: it is the critical reduction of the capacity of reception and flow of the public space, which is distinguished from its capacity in terms of circulation and parking.

The probability of occurrence of a road accident is higher in a congestion situation, because in such a situation the distances between vehicles are reduced, and the unexpected stopping and starting of other vehicles can cause risk of collision (OECD 2010). According to statistics in some European cities, commercial vehicles weighing more than 3.5 tons account for 10 to 20% of EVPs (private car equivalent) during the morning peak hours, this presents 5 to 10% of the vehicles involved. In addition to this, there is also an increase in the presence of light commercial vehicles of less than 3.5 tons in urban areas. In goods delivery operations in the city, the contribution of light commercial vehicles (less than 3.5 tons) to congestion is higher compared to heavy goods vehicles (more than 3.5 tons). This is due to the increase in light vehicle operations in urban areas, and their loading and unloading operations, which further reduce road capacity (OECD 2010). In Japan, for example, on the two-lane road, the higher the density of parking, the higher the probability of occurrence of accidents, so the number of accidents per million vehicle-Km recorded on two-lane roads is higher than four-lane roads (see figure 10). (Road Association of the Road (PIARC), 2007).

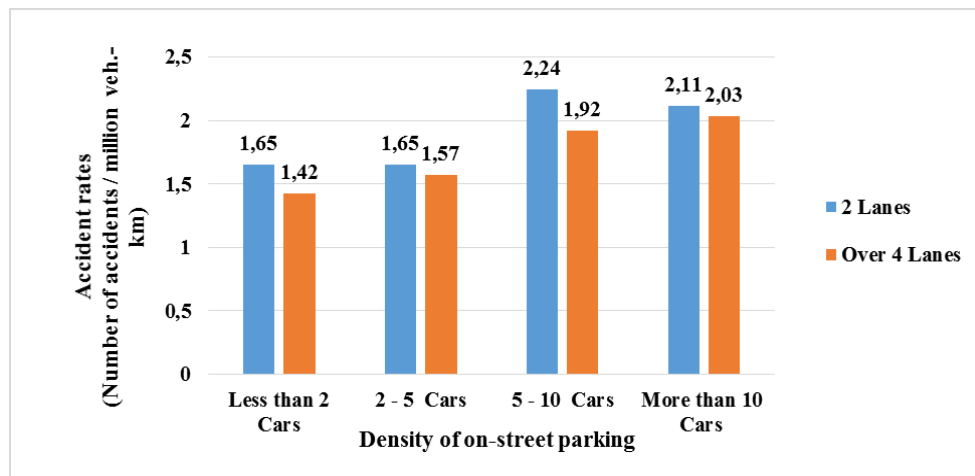


Figure 10 : Accident rate in Japan by number of lanes of the road, and by density of parking on pavement in urban area. Source (Freight Transport and Intermodality-World Road Association (PIARC) 2007)

The percentage of accidents in the Tokyo area where the parked vehicle is itself involved in an accident is only 0.3%, the on-street parking has an impact on several factors that contribute to road safety, such as the change the speed of acceleration and deceleration, the congestion generated by the decrease in traffic capacity and poor visibility. (Road Association of the Road (PIARC), 2007).

3.4 The Road accidents caused by UFT by type of road

In urban areas, road accidents caused by UFT are often more concentrated at communal roads and main roads (Bouceddour, S, Yerpez, J, 2005). In Australia, the rate of fatalities and injuries from accidents involving a UFT vehicle is more condensed in arterial roads. About 20% of the dead and 33% of the injured is recorded at this type of road between 2010 and 2014, followed by local and national roads, which accounts for 11% of deaths for each type of road (see Table 2). The lowest rate was recorded during the same period at collector Roads (Australian Department of Infrastructure and Regional Development 2016).

Tableau 2 : The rate of deaths and injuries in road freight accidents for urban goods by type of road. Source: Report-Heavy truck safety: crash analysis and trends-Australia 2016.

	National road		Arterial road		Collector Road		Local road	
	Fatal crashes	Injury crashes	Fatal crashes	Injury crashes	Fatal crashes	Injury crashes	Fatal crashes	Injury crashes
Rigid heavy vehicle ²	15%	26%	23%	33%	5%	6%	10%	15%
Articulated vehicle	17%	27%	9%	19%	2%	3%	3%	7%
Light vehicle	10%	14%	21%	36%	6%	11%	11%	22%
Total	11%	14%	20%	33%	6%	12%	11%	22%

Generally non-urban areas seem to be safer than urban areas, so road geometry affect relatively the road safety of goods vehicles (World Road Association (PIARC), 2007).

² Pour les caractéristiques des types des véhicules voir Heavy truck safety : crash analysis and trends-Australie 2016.

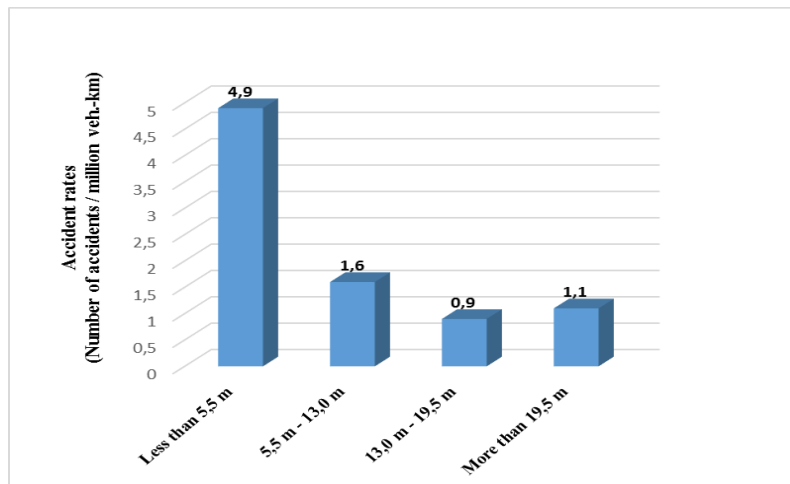


Figure 11 : Japan's Goods Vehicle Accident Rates by Road Type and Carriageway Width. Source: World Road Association 2007.

In Japan, the highest accident rate of commercial vehicles in 2005 was found at roads that are less than 5.5 m wide (see Figure) (World Road Association (PIARC), 2007). We also note that the rate of accidents of goods vehicles in urban areas is greater at the level of smaller roads.

4. Recommendations

The impact of freight transport on road safety is very important as reflected in the number and severity rate of accidents involving vehicles moving for freight transport, which shows considerable percentages as presented in the statistical analysis established in this work. In addition to the human damages, the cost generated by this type of accidents is very important. In South Africa, the cost of the externalities of road transport accidents is estimated at 750.27 million euros, and in the United States the social loss due to accidents involving freight vehicles is estimated at, 42, 5 million dollars for light commercial vehicles ; 131.5 million dollars for heavy goods vehicles ; and articulated trucks ; and 39 Million dollars for trucks (Laaraj, N., Jawab, F, 2018). It would be necessary to take the measures to reduce the impact of freight transport on road safety. Studies on the causes of accidents involving a freight vehicle, and the necessary solutions to take are carried out (Bouceddour. S, Yerpez. J, 2005) (Newnam, S., Goode, N., 2015) (Nations Unies CNUCED, 2015). Here are some recommendations from these studies:

- ✓ Involvement and collaboration between the public and private sectors ;
- ✓ Ensure sufficient investment for the improvement of an adequate infrastructure ;
- ✓ Integration of road safety management into the management framework of the freight transport sector ;
- ✓ Improvement of internal policies (Driver Training Program; Management of load planning and vehicles used; Safety audit and control of mechanical condition of vehicles; Control of physical and psychic capacity of driver; ...) ;
- ✓ Integration of the "Avoid,Shift,Improve" method (avoid inefficient freight transport, adopt more reliable and cleaner modes of transport, improve infrastructure, logistics and operations) ;
- ✓ Improved transportation policies for hazardous goods ;
- ✓ Adopt intelligent transportation systems (Shock and fire protection systems; Electronic engine control devices; Intelligent logistics solutions; Computerization of routing and scheduling; Fatigue detection systems;) ;

5. Conclusion

In this work, we have explained the extent and the weight of the UFT on road safety and more particularly traffic accidents. To do this, the methodology we have deployed is based on the analysis of statistical data at the international level and is spread over the last two decades. We first presented the concept of sustainable development in relation to the transport of goods in the city. Subsequently, we have identified, through international statistical data, the contribution of general freight transport to road safety by specifying the nature of the accidents

caused ; the types of vehicles and goods involved ; the areas involved ; and the schedule of the claims and the damage caused. Then, zoom in on the extent of urban goods transport on traffic accidents, which is the focus of this work. Through the analysis of statistical data, it can be seen that heavy goods vehicles are not particularly dangerous if we compare the number of accidents involving this type of vehicle compared to the number of accidents involving light commercial vehicles. In terms of accidents, the number of people killed due to transport accidents in urban areas remains as low as the number of accidents caused by road transport of goods outside the urban perimeter. We have also shown through statistics that in urban areas road accidents caused by TMV are often more concentrated at the level of communal roads, and roads. All these findings show the importance of TMV in the road safety of agglomerations. Finally, recommendations to reduce the impact of freight transport are suggested.

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Biographies

Nassima Laaraj received the engineering degree in industrial engineering from the National High School of Electricity and Mechanics in Casablanca, Morocco in 2014. She is a PhD student in the Laboratory of Manufacturing, Energy and Sustainable Development at Sidi Mohamed Ben Abdellah University, Fez, Morocco. Her research works are in the field of logistics and transport, and particularly focused on road safety.

Imane MOUFAD received the engineering degree in industrial engineering from the National School of Applied Sciences in 2013. She is a PhD student in the Laboratory of Manufacturing, Energy and Sustainable Development at Sidi Mohamed Ben Abdellah University, Fez, Morocco. His research interests are mainly focused on logistics and transport in particular urban logistics and urban Freight transport.

Youness Frichi received the engineering degree in industrial engineering from the National School of Applied Sciences in 2013. He joined the Ministry of Industry, Investment, Trade and Digital Economy since July 2014. He is, in parallel, a PhD student in the Laboratory of Manufacturing, Energy and Sustainable Development at Sidi Mohamed Ben Abdellah University, Fez, Morocco. His research interests are mainly focused on logistics and in particular hospital logistics.

Kawtar Akoudad is an industrial engineer from the National School of Applied Sciences and a PhD student at the Laboratory of Manufacturing, Energy and Sustainable Development at the College of Technology of Sidi Mohamed Ben Abdellah University - Fez - Morocco. She is interested in management sciences and industrial engineering and specializes in the field of logistics, international transport, and Supply Chain Management.

Karim Zehmed holds a master's degree in economics and management and he's, currently, a PhD student at Research Laboratory of International Management, Decision-making techniques and Logistic at the high school of technology of Sidi Mohamed Ben Abdellah University-Fez-Morocco. He is interested in the field of governance and performance of urban public transport.