

## CITY LOGISTICS AND SUSTAINABLE DEVELOPMENT

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### **Abstract**

*The life and survival of people in cities would be unthinkable without satisfying the basic needs that are conditioned by the daily logistics operations. Efficient distribution of goods is one of the basic imperatives affecting the sustainability of cities. In addition, a large concentration of people in cities requires and imposes the disposal of waste and other recycling materials. City logistics is the concept of integrating existing resources to solve problems caused by the constant rise in population and number of vehicles in urban areas. Logistics activities also represent a threat to the processes that is inexorably harder to maintain. Emissions, particulates, noise, destruction of vegetation, poor utilization of energy, resources and transport capacity, traffic accidents, general degradation of quality of life are just some of the negative impacts. Sustainable distribution of goods is a priority in many cities, for this reason many of the proposed measures would have a significant impact on the balance between a large population whose needs must be met and the negative impact of the processes that occur as a result of meeting the basic needs of the population. The paper will be presented to study the impact of the means of transportation involved in the distribution of goods, the flow of traffic, as well as their impact on the environment during the unloading of goods in retail stores.*

**Keywords:** *City logistics, Environment, Capacity lane*

### **1 INTRODUCTION**

The high concentration of people in cities and rich content of economic and social activities are constantly increasing, what shows us complexity of satisfying all needs. We are all living in a time when cities and their quality depends on the supply

and variety of the assortment of goods in retail stores. However, in order to achieve a high level of diversity of product range, or selection of goods, both basic to life, and those that give and raise the level of quality of life in cities, and that can be purchased only in the cities, there must be a well-organized logistics supply of retail goods, which, goods creates a direct relationship with the customer, or placed at the disposal of the city's population. Logistics is very important for the functioning of cities, and has an important impact on the quality of life, mobility of the population and the sustainability of cities.

Efficient distribution of goods is essential for life and the survival of people in cities. The main characteristic of the distribution of goods in cities is reflected in the fact that the delivery of goods small scale is quite frequent or common. Spatial distribution transport distance of goods in road transport is such that the largest number of transport tasks up to 5 km, and even 51% of the total volume of transported goods is realized at 10 km. [1]

In addition, as the distribution of goods in cities raises the level of competitiveness of urban areas, it has a positive effect on employment growth, which is directly related to the distribution of goods, performance of the transport of goods, and indirectly on retail stores and etc. However, in addition to the above distribution of goods in urban areas has negative characteristics to the traffic and the environment. Due to the high frequency, or frequency in the distribution of goods, delivery vehicles have a huge impact on the capacity of roads, especially during the unloading of goods in retail stores, as during the unloading of goods, delivery vehicles are generally parked on city roads. In addition, cause the emission of harmful gases, soot particles, creating a lot of noise, both on landing, and during movement. They have a negative impact on the environment in cities.

The aim of sustainable urban environment and the effective implementation of the distribution of goods in cities. City logistics should be subject to planning and policy of the city, because the logistics activities, also represent a threat to the processes that are inexorably harder to maintain. City logistics needs to find a balance between effective distribution of goods or satisfying basic needs of residents in the cities, and the impact of same on the efficient distribution of goods, as well as the influences that affect the environment.

This paper will be presented to survey the impact of transport equipment, which participate in the distribution of goods, both in traffic and on their impact on the environment, during the unloading of goods in the retail store, in a certain period of time.

### **2 THE CONCEPT OF SUSTAINABLE DEVELOPMENT**

Logistics activities have recently been focused exclusively on reducing the cost of the flow of goods in the supply chain, as well as improving the quality of logistics services, primarily to reduce delivery times, increased flexibility of delivery, reliability of delivery, readiness to deliver supplies correctness etc.

The concept of sustainable development has emerged as a result of large-scale climate change, global warming, the emergence of greenhouse gases and etc. These negative changes create or have a major impact on them and their

formation and transport of goods and passengers. The high concentration of people in urban areas, leading to a great need, both for their own movement, travel by car or public transport, and for meeting the basic needs for food, drink and the like. City authorities have mainly focused on solving problems traditionally associated with public transport, the use of passenger cars, other forms of passenger transport, while the transport and delivery of goods largely ignored. These vehicles have a major negative impact on both the climate change and on the scope and structure of traffic.

The concept of sustainable development refers primarily to meet current needs without compromising the ability to satisfy the needs of future generations. To make the concept of sustainable development was defined by the applicable term triple bottom line, which emphasizes that economic, social and environmental reasons are equally important in decision making. [2]

This term is known as the triple P (*People, Profit, Planet*), which means that the logistic activities that are planned, controlled and carried out during the flow of material goods equally focused, or both are important factors, in addition to the cost factor that occur during the running of goods and factors of meeting the needs of people, and a factor of environmental stredine.

### **2.1. City logistics impact on sustainable development**

The supply of people with basic necessities, as well as those associated, in terms of the diversity of the assortment of goods in cities, causing a series of negative and unsustainable activities. The functioning of these negative activity, or the formation of non-viable activity refers primarily to the population, the profit which is realized during implementation of various orders and their impact on the planet, as the impact on the environment.

The negative impact on the population, which is made by vans refers primarily to the effects of exhaust gases, which adversely affect the health of people and can cause a variety of diseases. In addition to the presence of exhaust gases and noise, generated by these vehicles, as well as various vibrations that create discomfort among the population. The presence of commercial vehicles in the total volume of traffic, also has a negative impact on the population, because it increases the risk of traffic accidents. Violation of the quality of life of residents, in terms of loss of green areas, and the loss of attractiveness of the area for transport and logistics infrastructure development.

When one looks at the impact of city logistics at a profit, or economic viability, there are two sides. One page refers primarily to profit from the flow of material goods. However, goods which are located in retail stores must be competitive in the market, both quality and price. Great impact on the price of goods that are located in retail outlets, has primarily transport. When it comes to transport, and in particular the delivery of goods in retail stores, the main characteristic of these transport tasks, is that very frequently, and frequent delivery of goods in retail stores. In addition, the vans that carry out freight delivery, or servicing goods retail stores, their cargo space is generally under-utilized, which by volume, which, according to the loading permitted weight of the

vehicle. This creates a waste of resources, and thus additional costs that affect profit. In addition, these vehicles to transport completed its task must participate in traffic, and thus create added congestion and reduce accessibility in cities because of its dynamic driving characteristics of the vehicle, causing an additional impact on profit. On that basis, brings into question the reliability and accuracy of delivery, which is directly related to quality of service, which also has a direct impact on profit alone.

The impact of the delivery of transport, in addition to the impact on the population and economic viability, or profit, has an impact on the environment. The negative impact is mainly reflected due to emissions of greenhouse gases, which cause these vehicles. When it comes to emission urban transport is among the causes of climate change. Also, it is important to note that these vehicles are currently using fuels that are fossil or non-renewable natural resources, which according to this criterion could be considered as unsustainable development. In addition, the maintenance of these vehicles includes the replacement of tires, motor oil and other materials whose disposal has a direct impact on the environment, and whose influence it one of the unsustainable are twofold.

### **3 DELIVERY OF GOODS OBSERVED RETAIL STORE**

Delivery of goods retail stores is one of the logistics of everyday activities that make life a lot of people in the cities richer, and provide a greater choice of various item, how the basics of life, and those accompanying. The importance of this activity, ie city logistics, is given only when the required items or goods are not made available to customers in the retail store. Only then is questioned how the city logistics functions in various cities, in circumstances takes place, what factors influence its development and delivery of goods retail stores. However, their city logistics operation, and striving to meet customer needs, creating negative consequences, affecting not to those users whose needs are relentlessly striving to meet.

Considered one retail store in a period of seven days. Based on the counting of deliveries per day observed deliveries given in Figure 1. In terms of deliveries, each delivery is realized in an average time period of 20 minutes. Very important to note that the retail store has only one server for receipt of goods, which means that if you are in the same time interval the appearance of two or three vehicles, unloading will be done only for one vehicle, while the rest one or two cars are waiting to unload. Also, it is very important to note that while the goods are unloaded from the vehicle or vehicles while waiting to unload goods retailer, these vehicles are stationed or parked on the carriageway. Lane where the vehicles are stationed during unloading or while waiting at the unloading has two lanes in one direction. It means that the capacity of the carriageway is reduced by 50 [%] in the time interval when it is unloaded, or waiting for the delivery vehicle to the unloading of the goods. However, when it comes to capacity, the vehicles in addition to this part of the street network, the real problem overall street network.

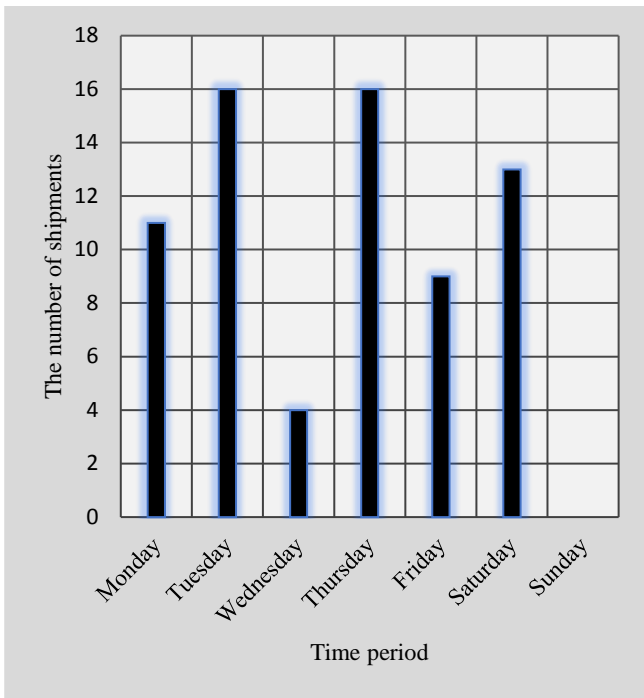


Fig. 1 The number of shipments of goods observed retailer

During the research, observed retail store receives goods or delivery till 2 p.m. every day. Also, it was noted during the study that the maximum number of delivery vehicles that occurs on unloading at the same time interval is three vans, and a delivery vehicle is unloaded, and two vans waiting to unload, which means that on carriageway are three parked vehicles.

### 3.1. The impact of commercial vehicles on the environment

Delivery vehicles used for carrying out these activities, belong to a heterogeneous fleet, or in structure, can be classified as light trucks. Light-duty vehicles have characteristics which give them this type of transport tasks, because they have good maneuverability, and in contrast to heavy goods vehicles much easier to find a place to stop and parking while unloading goods in a retail store. However, it is very important to note the basic difference between them, but this is primarily related to capacity, as well as the relationship between the weight of goods transported and power of vehicles that transport goods. So in terms of environment, the occupation of space, the capacity of roads and air pollution, light trucks don't have advantages compared to heavy-duty vehicles. The main reason is that the use of light-duty vehicles generates a higher number of deliveries, which is the feature of the delivery transport or distribution of goods. This promotes higher frequency of the vehicle in carrying out its transport assignments.

When it comes to light commercial vehicles used in the distribution of retail goods, we can not avoid the impact on the environment. Vehicles used for delivering goods to retailer observed are mostly older than 15 years. Refurbishing of fleet used for delivery of goods in

cities, is slower from refurbishing of fleet used in long-distance transport of goods. The main reason for this is that distribution of goods mainly deals with smaller companies, that in order to reduce the cost competitiveness use older vehicles.

Based on study [3], light trucks emit gases, and these are primarily CO, and carbon monoxide, volatile hydrocarbons NMVOC, nitrogen oxide NO<sub>x</sub>, particulate matter PM, nitrous oxide N<sub>2</sub>O, ammonia NH<sub>3</sub>, as well as other substances which have a detrimental effect on the environment and the inhabitants. Of course, these are vehicles with a drive unit with internal combustion engine, which is fueled with diesel fuel. Based on the research [3], Table 1 shows the contamination of the light-duty vehicles which is emitted while discharging the goods to the retailer. It was the winter period when unloading of goods to the retailer was observed. It is assumed that the main reason of the work of the vehicle during unloading was heating the cab driver, and ensuring pleasant working conditions.

Table 1 Emissions from a delivery vehicle [g/kg fuel]

Exhaust gases of a vehicle	[g/kg fuel]
CO	11
NMVOC	1,75
NO <sub>x</sub>	15
PM	2,8
N <sub>2</sub> O	0,069
NH <sub>3</sub>	0,014
In total	30,633

Based on this we can conclude that a delivery vehicle produces 30,633 g / kg fuel emissions during a delivery of goods to retailer. This is the average value, which is based on our research [3]. Various standards and regulations prescribe limits for exhaust emissions of motor vehicles, or in the Republic of Serbia has no regulations that limit the vehicles can be used for purposes of city logistics and transport tasks to perform in cities.

Based on the research, by using regression analysis for the observed retail store, a model of pollution by exhaust gases from commercial vehicles could be made, where the number of deliveries during the day is independent variable and the dependent variable is impact of commercial vehicles on the environment based on exhaust emissions of these vehicles. Data is the linear equation (1) that represents the relationship between these two variables.

$$y = 30,633 x \quad (1)$$

Based on regression analysis, we can conclude that if increase the number of deliveries of goods to retailer, it will increase pollution produced by delivery vehicles, and their emissions of gases. That will negatively affect both the population and the environment, as well as quality of life.

### 3.2. The impact of commercial vehicles on the road capacity

When delivering goods to retailer, both for unloading, vans use traffic lane for parking, both for unload, so also for waiting to unload. Carriageway consists of two traffic lanes for vehicles moving in that direction. So that during the performance of discharging the goods, or the mode of delivery vehicles to the unloading, the flow of traffic uses only one traffic lane, wherein the lane capacity is reduced by 50 [%]. Very important to note is that retail facility is receiving deliveries by commercial vehicles till 2 p.m. So vans, when carrying out its transport assignments or during unloading or waiting for unloading, they park in a traffic lane in the morning peak hour.

Retail has one server for receipt of goods, where the average time of delivery 20 minutes. In one hour of receipt of the goods server can serve a maximum of three vans. Based on research, there was a maximum of three vans in one time interval. However, the capacity of the carriageway, in that time interval, is reduced to a single lane for a time period of 1 h. In this situation the third delivery vehicle will wait 40 minutes to unload, and will spend 20 minutes for unloading. It means that the vehicle will be placed 1 h on that lane.

With regard to the capacity of the lanes, the lanes on the maximum capacity is 3000 [PA / h / direction], on the basis of a HCM-2000. With taken into consideration all constraints, the maximum capacity of a traffic lane in 1500 [PA / h / line]. This is about the maximum capacity, which means that on this road does not appear such a large number of vehicles, because it occurs more than 1500 [PA / h / direction] in a situation when the delivery vehicle is unloading the goods, or waiting to unload, transport could not take place. However, in the future, considering that the degree of motorization increases, special care must be taken and given to these situations.

Featured depending on the model between the number of deliveries, and time spent on lane. Based on regression analysis, a model where the independent variables are deliveries of goods to retailer, a dependent variable is the time a vehicle spends on the basis of the time of unloading on the carriageway. Delivery truck waiting to unload is not taken into account, because if a delivery van is waiting for unloading it means that the other vehicle which had come before it, is unloading. The main reason for this observation is because the vehicle that is being unloaded and the vehicle waiting to unload, are parked in the same lane. So to have the same impact on capacity, regardless, whether they are in the lane of one or more of parked vans. Data is the linear equation (2) that represents the relationship between these two variables.

$$y = 20 x \quad (2)$$

Based on this model, it can be concluded that the higher number of deliveries means the greater number of time occupancy of lane, which in this case is represented in

minutes. The higher occupancy of lane, expressed in minutes, on the other side brings less capacity lane.

### 4 CONCLUSION

Based on the research it can be concluded that it is very difficult to find a balance between meeting the basic needs of the population, and their quality of life, in terms of environmental protection, reduction of noise, vibration and the like. Reducing the travel time is the need of residents in cities. It is reflected in the accessibility and capacity of roads. Based on research and mathematical models, it can be concluded that the higher number of deliveries, will increase the level of pollution caused by vans carrying out its transport tasks. On the roads and at the intersections, and the entire street network in the city. Vans must use the road network for completing their delivery tasks. The main measures for the sustainability of city logistics, that is, finding a balance between two already mentioned components that affect their interests poor on the other, are:

- Higher commitment to city logistics to solve its problems and optimize the entire process, with the aim of maximizing the effectiveness and efficiency, taking into account optimizing costs, and meet the needs of residents and the environment as a factor that needs attention in the planning and implementation of the current burdens;

- Avoiding peak period for the implementation of transport tasks by delivery vehicles in cities, which would be the result of previous traffic counts and determined traffic volumes during the day, and based on that, determine the time periods during the day when the delivery transport should be realized in the cities;

- Do not overwrite city logistics transport policy from other cities because every city has a different traffic volume, traffic structure, as well as the different supply and demand, but policy planning city logistics in the particular case, with the input data of observed city;

- Greater involvement of the city, in terms of paying attention to the overall traffic planning, as well as the adoption of the strategy by the city for city logistics, its planning, implementation, sustainability, with regard to the adoption of the law on the restriction of the number of delivery of a particular part of the city in a week, and in view of the limitations of conditions to be met by vans to establish regular distribution of goods in the city;

- The tendency of greater utilization of space of delivery vehicles, realization of distribution of goods by using vehicles with higher capacity, which in the existing state of impact on reducing frequency of deliveries to retailer would significantly have an impact on the reduction of environmental pollution by emissions;

- Using a delivery vehicle for the realization of the distribution of goods in cities, whose age does not exceed one year, and whose emissions corresponds strictest emission standards, with the aim of crossing vans with fuel to electricity.

In the future, great attention must be paid to city logistics, work on its optimization, weigh no spillage of resources, but their savings as well as the planning of city logistics, making development plans for a specific time period.

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