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THE IMPACT OF CYCLING INFRASTRUCTURE ON CONSUMERS' PERCEPTIONS OF BICYCLE TRANSPORT

ВПЛИВ ВЕЛОСИПЕДНОЇ ІНФРАСТРУКТУРИ НА СПРИЙНЯТТЯ СПОЖИВАЧАМИ ВЕЛОТРАНСПОРТУ

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Гнітецький Є.В., Царьова Т.О., Лимар О.С. Вплив інфраструктури на сприйняття споживачами велотранспорту. Оглядова стаття.

Метою роботи є дослідження впливу розвитку інфраструктури на вибір споживачами велосипедів як альтернативного екологічного транспорту. В статті розглянуто проблеми та перспективи розвитку велотранспорту. Проведено аналіз причин вибору споживачів щодо використання велосипедів як транспортного засобу для повсякденного життя. Розглянуто позитивний досвід розвитку велотранспортної інфраструктури у провідних країнах Європи. Досліджено основні вимоги для розвитку велосипедної інфраструктури та визначено основні критерії її розбудови, зокрема у місті Києві.

Ключові слова: поведінка споживачів, забруднення навколишнього середовища, велосипедна інфраструктура, транспортна інфраструктура, транспортні викиди, екологічний транспорт

Gnitetskyi I.V., Tsarova T.O., Lyamar O.S. The impact of cycling infrastructure on consumers' perceptions of bicycle transport. Review article.

The aim of the article is to research the influence of developing the cycling infrastructure on the consumer's choice of bicycles as an alternative to eco transportation. The article talks about the problems and perspectives of developing a cycling infrastructure. An analysis of reasons was conducted in regards to the consumer's choice using bicycles as means of everyday transportation. Also, a positive experience in developing the cycling infrastructure in leading European countries was discussed. The article researched key requirements for developing the cycling infrastructure and identified basic criteria of its development, in particular in Kyiv city.

Keywords: consumer behavior, pollution, cycling infrastructure, transportation infrastructure, transport emissions, eco transportation

For many years people aimed to adapt to the environment and provide comfortable living conditions for themselves. Although it is worth noting that the Earth's ecosystem is complete and all internal processes are interdependent. Human activity influences the environment like nothing else does and, unfortunately, changes made by us are reflected not only on the planet but also on all forms of life.

One of the main problems is pollution of the air with toxic substances, such as black carbon and CO₂ (carbon dioxide). Most of these substances originate from transport which harms the environment. Black carbon is a product of incomplete combustion of coal, diesel or biofuel which plays a big role in pollution and climate change. Solid particles of black carbon in the atmosphere pose a risk for human's health and as it is also light-absorbing it fastens climate change (it traps heat 680 times faster than CO₂).

Consequently, lessening the amount of CO₂ and black carbon poses as the most important challenge for modern scientists and practitioners. Many organizations and independent researchers are working hand in hand trying to solve this issue. Some examples are International Energy Agency, TomTom N.V, Dr. Silke Borgstedt, Franziska Jurczok, Tim Gensheimer, the People For Bikes Foundation, Kyiv Cyclist's Association (U-Cycle).

In 2018 the research lead by the International Energy Agency showed that almost 75% of transport

pollution accounts for automobile transport, where the biggest part (45.5%) comes from cars and buses (Figure 1). Private cars produce the most pollution - close to 270g CO₂/km per person. Pollution from buses is three times lesser than from cars – 95g

CO₂/km per person. As 21% from the whole scope of pollution accounts for transport segment, automobile transportation accounts for the third of it, which means that automobile transportation makes 15% of the overall CO₂ pollution.

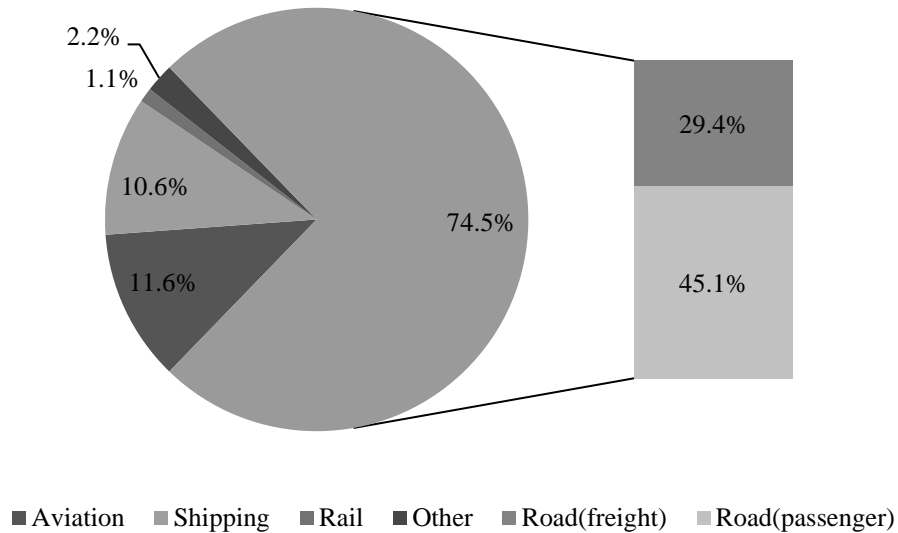


Figure 1. Global CO₂ emission from the transport sector

Source: compiled by authors on materials [5].

The problem lays in the overload of the road transport network which is not suited for the constant growth of cars on the streets. They complicate, sometimes even paralyze the work of the public transportation. This creates traffic which extends the work of the car engine in the idle mode which is characteristic of the unnecessary waste of fuel and as a consequence it creates more pollution of toxic substances into the atmosphere.

In 2020 TomTom N.V. published a rating [Illustration 2] which highlights the level of traffic in

416 cities in 57 countries. This rating is based on the traffic index which is counted by comparing the average time of traveling with minimal traffic to the average time of traveling the same route during the rush hour. For example, if the roads are overloaded by 50% you would have to spend an hour and a half on average on commute, where if there was no traffic at all you would spend a maximum an hour. So, with this data they made the following rating of countries with the worst traffic (by the level of the traffic index).

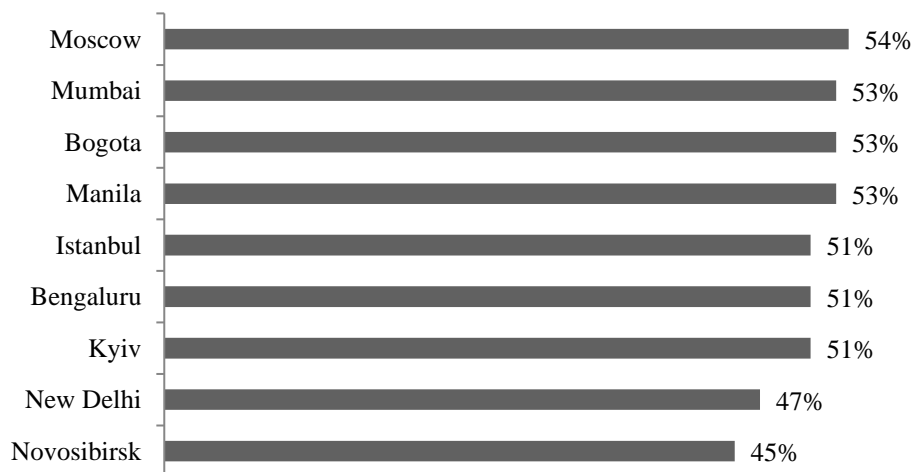


Figure 2. Cities with the biggest level of the traffic index

Source: compiled by authors on materials [6].

All problems of big cities indicated above, such as the overload of streets, the inability of widening roads, the air pollution as a result of the mass usage of cars, lessen the quality of people's lives and the economic viability of cities. To combat transport problems, cities initiate different programs to raise the mobility of the population. An attractive alternative to raise the mobility is cycling which is the most ecological, reasonably fast and comfortable type of transportation in cities. However, the implementation of such an alternative is due to a number of contributors related, first of all, to factors influencing the perception of bicycle transport by consumers.

The aim of the article is to research the factors influencing on consumer's perception of bicycles, in particular their readiness to view bicycles as an alternative of private and public transportation; to determine people's demands to the cycling infrastructure and what is an indicator of it being suitable for cycling in their minds.

The main part

The advantages of bicycles to cars:

- Less energy is needed to produce a bicycle and they also run without toxic batteries or motor oil;

- Less steel is needed to produce a bicycle, where a car needs 120 times more steel to be produced;
- The need for space and resources for their production is 0.085% of the needs for the production of the car;
- 10 bicycles can be parked in just one car parking spot;
- Ecological footprint (a level of using natural resources by humans) of a person who uses a bicycle is 12 times less than that of a person who drives a car;
- The amount of CO₂ pollution of a bicycle is 16 g/km. Even if the number of bicycles in the city rises immensely this indicator will always be in the lower digits.

Additionally, during the COVID-19 pandemic there has been a behavioral change in people's mobility. The results of a German research, Bicycle Monitor 2020, showed the following changes in behavior of people: comparing to the same timeframe last year (June/July 2019) there are two times more people who started using a bike more often than those who are using a bike less (Figure 3).

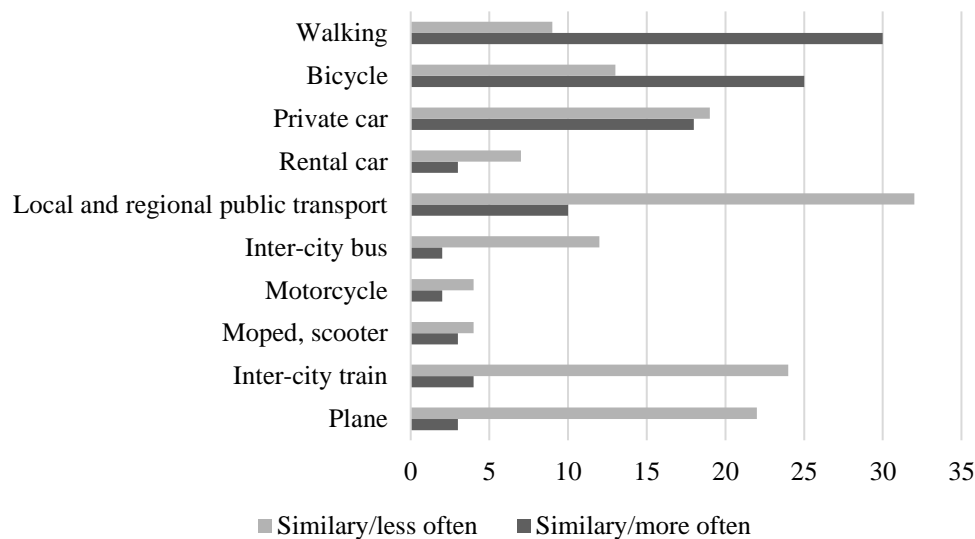


Figure 3. The frequency of using transportation comparing to the same timeframe in 2019

Source: compiled by authors on materials[8].

Also, so that the potential of using a bike stayed on the same level and even developed further in the future, we need a well-developed infrastructure which allows people to get to their destination safely, effectively and fast.

For example, people who live in Denmark cannot imagine their lives without cycling. 95% of them own a bike and travel 900km a year by bike. It culturally developed, that in this Scandinavian country people prefer bicycles to expensive cars. Not only a cultural component facilitated this but also a well-developed infrastructure. In Denmark there are traffic lights specifically for bicycles and neatly marked bike paths that are maintained in a perfect state. There are more

than 12 000 km of bike paths, 350 km of them are in the capital where there are 5 times more people who ride a bike than those who drive a car. The country is filled with equipped bicycle parking lots; some of them are even roofed. You can find bicycle rent stations almost everywhere, and a system of public bike renting is adjusted to train and metro stations.

There is a so-called "green wave" set up in the cities which makes riding a bike even simpler. In the morning, during the rush hours, a person can ride a bike to the downtown almost without stopping. Those bike traffic lights which were mentioned before are the main reason for this, as they are directing the flow of traffic to the center of the city. They are

coordinated in such a way, that a person maintaining a specific speed (20 km/hour) will always have a green light. In the evening, the traffic lights are set up the other way from the center.

Most of the researches show that the biggest restricting factor that hinders the popularization of bicycles is the dangers of riding one on the road.

In 2015, a new national USA survey from "People For Bikes" foundation found out the following:

- 31% of all respondents would like to use a bicycle but a poorly developed infrastructure is the major hinderance for them;
- 64% of people who would like to ride a bike more are sure that safe and distanced from cars bike paths will influence their choice of transport;
- 60% of adults would like to ride a bike more often but they are afraid of getting into an accident with a car.

As a result, we can say that the majority of people who want to use a bicycle on a daily basis are holding back because of the dangers it might bring. So, to attract people the main task is to create a safe environment and to minimize accidents on the road. An effective solution to problems mentioned above can be bike streets and/or freeways.

A bike street is the main highly maintained bike route. Such bike streets are better suited for student towns or suburbs.

It is worth noting, that bike streets will not replace already built bike paths on busy streets. Besides, they cannot be an alternative to an infrastructure which is created specifically for long distances. Bike streets are perfect for short rides around the neighborhood to school or a park. Their attractiveness lays in safety and low cost. This is the easiest way of developing urban cycling infrastructure.

As an example, to build a mile (1.6 km) of bike streets in Portland, Oregon it costed only 150 000\$. In three years, the city has built almost 100km of them, thus people started using bicycles by 60% more often.

A bicycle freeway is a high-quality functioning bike route which focuses on long distance rides. It can consist of bike paths or routes that are separate from an already existing road infrastructure.

Bike freeways can make riding long distances daily easier. It can be a regional connection, a route to a business center or a route between suburbs. In addition, they are the basis of a bigger bicycle network as bike freeways usually connect local networks to each other.

In 2018 in London such freeways led to people riding from East to South 55% more from 2016 when they have finished building them (London Transportation Committee Assembly, 2018).

To make bicycles a full-fledged means of transportation we need to take measures to adapt the pre-existing road infrastructure and take into consideration the main contradictory demands:

- Cyclists are a separate peculiar category of drivers. They need their personal space on the road.
- A cycling infrastructure should be implemented into public space but there is a lack of space to

begin with. It means contradictory needs of citizens should be combined while maintaining a comfortable public space.

A cycling infrastructure should meet the following requirements:

- Safety. Cyclists do not present a danger on the road but usually they are the ones being exposed to danger while riding amongst cars. The danger is connected to a significant difference in mass, speed and a separate path away from cars.
- The lack of obstacles. A cyclist should have the ability to get to the final destination by a straightforward and short route. The minimization of deviations and obstacles which lessens the time of commute makes bicycles a competitive means of transportation on short distances opposite to cars.
- The possibility to connect. This option shows the ability to ride a bicycle from one point to another within just one network. In short, it means that cyclists need a cycling network that connects a whole neighborhood or the whole city with other transport networks. Bus stops, public transport interchanges, buildings, enterprises – they all should be accessible by bike and connected to a bicycle network.
- Attractiveness. A cycling infrastructure should be integrated into an appropriate environment. This concerns feelings and perceptions which can motivate people to use a bike or un motivate them. Besides the quality of project decisions and the attractiveness of the surrounding landscape, we need to account for the realistic and subjective perception of "personal safety". It is especially important during the night time.
- Comfortability. The wrong choice of coating or poorly maintained roads lead to uncomfortable bumps, hits and the need to maneuver in between the pits and cracks on the road. This makes it harder to ride a bike and creates an unnecessary need to overly concentrate and control the balance even more. Riding a bike should require minimal physical and mental efforts.

The majority of European countries have started to actively implement different infrastructural projects with the aim to fulfill these requirements.

Relying on previous investments into cycling routes Cycle Superhighway and Quietway, in 2019 in London more than 86 miles of cycling network were sponsored with the aim to develop safe routes. The main task was to raise the level of safety for cyclists and to prevent cars from invading bike paths.

Different infrastructural approaches are used on different streets but the selection of quality criteria guarantees that all new areas of network offer consistent high quality. Segregation is used on more busy streets. Its purpose is to make cycling safer while keeping it away from the main stream of traffic. To reduce traffic on residential streets an appease and filtration of traffic was used.

According to data analysis based on route CS6, the number of cyclists has risen to 124% from 2014 to 2017, and on route CS3 the numbers have risen to

200% during the same time period accordingly. TFL polls revealed that 84% of people who used CS3 felt safer which shows which new routes eliminate the barriers of dangers.

Wide bike paths in Frankfurt am Mein. New and wide bike paths can provide a safer environment although such network concept is not suitable for every city. A Road Traffic Department representative Klaus Oesterling explained, "We have created new bike paths on main roads which were painted red according to the Holland concept. They occupy a lot of space which is already limited but the first surveys came out with positive outcomes: most citizens are welcoming new bike paths. In general, 14% said that they are using their cars less. As a result, we have a better traffic situation which is also useful for those who live in the suburbs and need to use a car as their work place is far away." Oesterling suggests to put up even more cycling road signs to help cyclists to orient even better on the road, and wants to populate such bike paths throughout Frankfurt in the future.

Bicycle highways in Germany. A Federal Minister of Transport and Digital Transportation Andreas Scheuer stated, "Cycling makes us healthier and happier! At least when the route does not look like some sort of an obstacle course. This is why the BMVI (Federal Ministry of Transport and Digital Transportation) is facilitating building cycling highways. They will serve as an ability to change a car seat for a bike seat. This will not only have a positive effect on one's well-being, but will also be an active protection of the climate. Bicycle highways that are wide, safe and well-developed are perfect even for long distances."

Cycling highways will be wide enough, have a good lightning and one would be able to ride without

stopping with some exceptions. This makes bike highways even more comfortable for urban and metropolitan areas. Also, such roads will help bicycles to become a real alternative to cars.

The federal government supports building bicycle highways by providing each year 25 million Euros (as a whole it costs € 318 millions till 2030). Bicycle highways will:

- be more than 10 km long;
- account for more than 2000 bike rides daily;
- be 3m wide for a one-way road and 4m for a two-way road;
- be structurally separated from other means of transportation (especially pedestrians);
- have safer and more comfortable crossroads;
- have high-quality coating and low incline;
- be constantly maintained, including during winter.

All projects and initiatives aimed at expanding the usage of bicycles in different European countries which have already been or will be realized soon, are already bringing some benefits. After implementing wide bike paths into the infrastructure in Frankfurt am Mein the number of people who used to drive only a car has lowered in 14%. As a result, there has been less traffic and less pollution.

So, investing into cycling infrastructure justifies itself not only in lessening traffic in the city but also in improving people's health as a whole due to increased environmental safety.

As of now, Kyiv is behind in the development of bicycle infrastructure from other prosperous European cities. The question of popularization of cycling is highly relevant as most emissions come into the atmosphere from the transport sector (Figure 4).

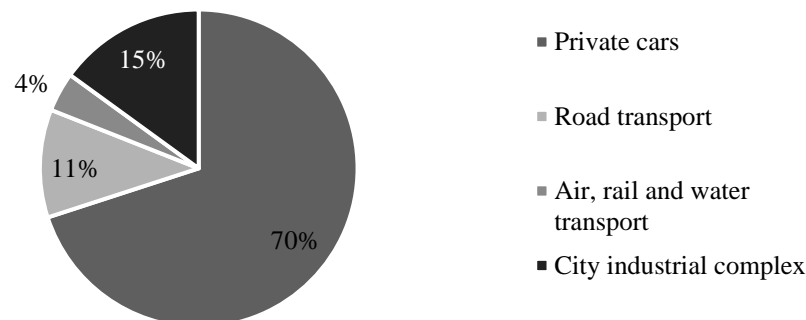


Figure 4. The sources of pollution of the air in Kyiv according to the researches in 2021

Source: compiled by author on materials [15].

It was researched that most of the emission is exuded when the engine starts and stops, and when it is working in the idle mode. Consequently, the biggest density of toxic substances in the cities is concentrated on the crossroads, near the traffic lights and in traffic, where Kyiv citizens spend 207 hours. If Kyiv citizens were to switch to bicycles it could be the solution to this problem.

But the majority of people do not have the ability to even partially use a bike as a transportation method as the infrastructure is poorly developed and quite dangerous. In addition, by the results of the research conducted by U-Cycle in fall 2020, it was revealed that the number of cyclists has risen in two when compared to the same period last year.

This can be beneficial in many ways for a city with a population of over 3 million:

- can reduce air pollution;
- can reduce traffic;
- can create more means of transportation (nowadays the majority chose cars since they do not have any other alternative);
- can reduce the level of noise.

But even if there is a positive dynamic in the number of cyclists, 70% of them did not feel safe to ride besides cars. This is why riding a bike in Kyiv is not only problematic but also dangerous. There is a lack of bike paths, special markings on the pedestrian crossings, and no bicycle traffic lights like in other prosperous European capitals.

Even though Kyiv has an extraordinary asset – the space (streets, sidewalks and roads are quite wide which can fit a separate bike path, plus all of them are connected to many parks and boulevards), but how this space is used is not rational.

Based on the research we can make a conclusion that to be able to improve the cycling infrastructure in the capital, first of all, there should be created routes of the I category (the categories were coined according to German "Recommendations for the arrangement of bicycle infrastructure ERA"), as they are the very basis of the cycling network. This category implies an intra-city high-speed bicycle traffic for the daily use. Bicycle routes of the I category are usually located on the roads and streets where the majority of the traffic is concentrated. They should be of the highest quality as they need to be able to ensure the average speed of 15-25 km/h (including time spent at traffic lights).

The following routes belong to the I category:

- main bicycle routes – they connect more remote areas with the more popular destinations (the length of them is no longer than 5-10 km);

— transport bicycle routes – they connect remote neighborhoods to the nearest metro station and/or other public transport where one can safely leave their bicycle (intercepting parking lots) and change to public transportation which will get them to the final destination (the length is 2-4 km).

As the expected payback period for the project is less than one year, using the city budget in the development of cycling infrastructure is a smart financial decision. As usually for the transport infrastructure objects this period is 5 to 15 years, this indicator can be thought of as excellent.

Conclusions

As it has been already mentioned, such ecological issue as pollution of the air is becoming more and more acute and needs to be dealt with as soon as possible. Not only the transport in it itself but traffic is the biggest center of pollution. Based on the above, a fairly rational solution to this global ecological problem would be the introduction of bicycles into our daily lives.

However, the research showed that the most significant factor in consumers' perception of cycling, in particular their readiness to view bicycles as an alternative of private and public transportation, is cycling infrastructure.

In leading European countries, the cycling infrastructure is rapidly developing and bringing significant results. They are implementing bicycle streets and highways, widening bike paths which provide the safety cyclists need. And as a positive result, more and more people change to bicycles.

Unfortunately, in Kyiv the cycling infrastructure is not developed and is not safe. Even though the capital has a lot of opportunities, projects that are focused on the cycling infrastructure are not being implemented fast and effectively enough compared to other European countries. Therefore, this area requires a deeper analysis of all its aspects.

Abstract

Air pollution from toxic substances such as black carbon and carbon dioxide is currently a major environmental problem. As particulate matter, black carbon in the atmosphere poses a risk to human health, and because of its light-absorbing properties, it also accelerates global warming.

Therefore, reducing CO₂ and black carbon becomes one of the most important challenges facing modern scientists and practitioners.

The International Energy Agency investigated in 2018 that almost 75% of transport emissions originate from road transport, with the majority (45.1%) coming from cars and buses. The situation is also complicated by the congestion of the road network, which has recently not kept pace with the steady increase in the number of vehicles.

To solve transport problems, cities initiate different programs to raise the mobility of the population. An attractive alternative to raise the mobility is cycling which is the most ecological, reasonably fast and comfortable type of transportation in cities. However, the implementation of such an alternative is linked to a number of contributors, primarily related to the factors influencing consumers' perception of cycling.

The objective of this work is to investigate the factors affecting consumers' perception of bicycles, in particular their willingness to consider bicycles as an alternative to private and public transport; and to define people's requirements for cycling infrastructure.

The paper examined how bicycles are viewed as a means of transport for consumers in countries where the culture of cycling is more advanced. The positive experience with infrastructure requirements, which is one of the most important factors in consumers' perception of the bicycle, was also discussed.

Most of the leading European countries are developing bicycle infrastructure, introducing bicycle streets and highways, and expanding bicycle lanes to provide safety for cyclists. And as a positive consequence, an increasing number of people are switching from cars to bicycles.

Unfortunately, in Kyiv the cycling infrastructure is not developed and is not safe. Even though the capital has a lot of opportunities, projects that are focused on the cycling infrastructure are not being implemented fast and effectively enough compared to other European countries. Therefore, this area requires a deeper analysis of all its aspects.

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