BICYCLE TRANSPORTATION – RESULTS OF A SURVEY IN SZEGED, HUNGARY

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Abstract: *Bicycle transport with all its necessary and complementary components has to be a part of the smart city infrastructure. Szeged smart city future vision document contains several statements determining future development plans regarding cycling. These include cycling friendly road network, building bicycle facilities, community bicycle transport system etc.*
Financed by the Social Renewal Operational Programme a survey was conducted in 2015. This paper summarizes the results of the analysis considering public opinion on cycling frequency, bicycle transport and financing in Szeged. Nearly one thousand residents took part in the survey. The following examinations were performed: frequency of bicycle use by different characteristics of the participants, association measurements with Cramér's V and hypothesis were also examined with z-test.
A large percentage of city residents use bicycles as transport, so it is important to maintain and develop the cycling possibilities in the city. The characteristics of bicycle users (gender, age, etc.) has little effects on their cycling habits, so city residents can be considered a homogeneous group.
Most of Szeged's population attach importance to the development, improvement and interconnection of bicycle paths and consider safe storage sites near central places important. Therefore, more attention is needed and money should be spent on these in the future. It would also make sense to develop a smartphone application for cyclists to monitor bicycle (and other kinds of) traffic.
Keywords: *bicycle public opinion, bicycle transportation, smart city, survey, Szeged*

Introduction

The population of Szeged has increased significantly in recent decades. The urban infrastructure has to server more and more people, should provide more and higher quality services to the city residents.

The services must be provided in a sustainable way. Settlements with outdated infrastructure are not able to perform their duties, so the infrastructure has to be developed. If this development is not well planned, this can lead to expensive and – in many cases – forced solutions. City infrastructure

(residential, commercial, service and industrial zones, connecting roads, public transport etc.) developments bearing sustainability in mind should not be ad hoc performed. Instead, thoughtful panning should take place first in order to create the environment that is suitable from a socio-economic perspective, which provides a decent living environment for the inhabitants (Rifaat 2014).

It is a fact that data, information and knowledge are essential resources. They have become production factors in addition to the "traditional" resources. The value of information and communication technologies have increased significantly. This all became the basis for today's modern (computer and Internet-based) digital economy and the "Smart City" concept. The smart (or liveable) city is a settlement where the available technological possibilities and particularly the information and communication devices are used in an innovative way in order to develop a sustainable environment (Horváthné and Lados 2011). According to a study, financed by IBM, the smart city invests into human capital, traditional and modern information and communication infrastructure which promotes, encourages sustainable economic development and raises the standard of living, while it manages natural resources wisely and responsibly (Dirks et al. 2010). Services and infrastructure in the smart city are closely related to each other, so they operate more intelligently and more efficiently which creates new exploitable opportunities (Horváthné and Lados 2011).

A city is built on several basic systems: people, business, services, communications, water and energy management and transportation. Inhabitants live inside, but some outside of the town. Both groups are interested in bicycle road network for easier access and environment-friend life (Gál and Gálné 2009). What is bicycle traffic with its infrastructure doing in the life of a modern city? What is the bicycle doing here which started conquering the world in the 1860s and by the 1900s it became an affordable mass product (Guroff 2016)?

Bicycle transport with all its necessary and complementary components has to be a part of the smart city infrastructure for bicycle usage has a number of beneficial effects:

- it can contribute to less carbon dioxide emission and the reduction of air pollution, it may also contribute to economic benefits (for example decrease of economy losses due to less traffic jams) (Vinke 2015);
- it can complement public transport by cooperating with it (Kager et al. 2016);
- and last but not least, the physical activity associated with cycling (in a non-harmful environment) may have mental and physical benefits as well (Cole-Hunter et al. 2015).

The official document about the future vision of Szeged smart city (version 2, February 2016) contains several statements which determine the future trend of urban cycling in Szeged and the surroundings. Here are some important points regarding the concept of bicycle traffic (Clarity Consulting, 2016):

- Full transformation of the city road network to make it bicycle friendly by designating, renewing or building bicycle traffic facilities;
- Set up of community bicycle transport with the support of the Szeged Transport Company Ltd.;
- Development of Bike and Ride sites, further improvement of CityBike Szeged system;
- Creation of bicycle storage facilities in terminals, stops and even on public transport vehicles;
- Secure bicycle storages near train and bus stations;
- Further development of bicycle roads on city outskirts;
- Exclusive use of bicycles (and electronic vehicles) in green areas and parks;
- Development of intelligent transport solutions for cyclists (intelligent traffic information etc.)

The radial and circular structure of the main road network in Szeged gives significant advantage. The public transport system is highly developed in the city. The cycling route network began to evolve in the last decade (Fig. 1).

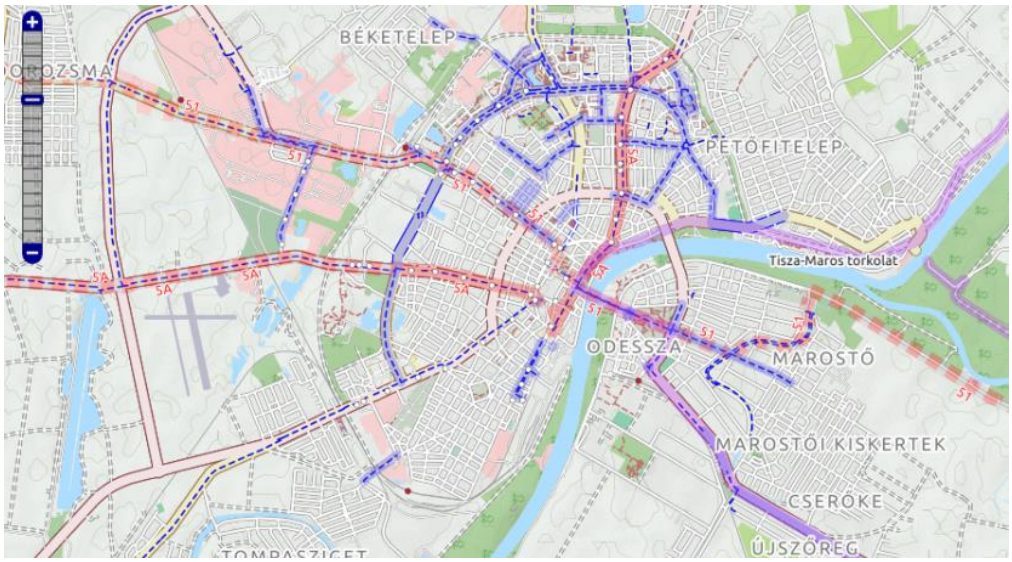

Fig. 1. Szeged roads and bicycle route network
(source: http://www.kerekparos.com/terkep/szeged-kerekparut)

Goals

The aim of this paper is to summarize and analyse the data collected with a questionnaire within the scope of a research financed by the Social Renewal Operational Programme. Nearly one thousand city residents were asked to take part in the survey where several questions related to cycling habits and bicycle transport.

Methods

The survey was performed in the districts of Szeged city (which has a population of around 162,000) in the first part of 2015. The responses of the participants were processed in Excel spreadsheets. The following examinations were performed:

- Frequency distributions: frequency of bicycle use by
    - gender,
    - number of years spent in school (education period),
    - age,
    - place of birth and actual place of residence,
    - district,
    - occupation,
    - financial situation and
    - floor of apartment where the person lives.

  The results were displayed in pie charts.
- Measures of association: Cramér's V was used to determine whether there is a correlation between the frequency of cycling and
    - gender,
    - number of years spent in school (education period),
    - age,
    - place of birth and actual place of residence,
    - district,
    - occupation,
    - financial situation and
    - floor of apartment where the person lives.

Cramér's V shows the strength of association between the two examined criteria. The number can be between 0 (no association) and +1 (strong association). It is computed by taking the square root of the chi-squared statistic divided by the sample size and the minimum dimension of the table containing the grouped data minus 1:

$$V = \sqrt{\frac{\chi^2}{N \times \min(row - 1, column - 1)}} \quad (1)$$

- Ten hypotheses were tested at 5% significance level with z-test. The empirical value of z can be calculated by taking the portion of the sample meeting the criterion (k), the sample size (n) and the hypothetical value to compare with (P):

$$Z = \frac{k - nP}{\sqrt{nP(1-P)}} \quad (2)$$

The z-test value then has to be compared to the z critical value at 0.05 significance level.

Results

The frequency of bicycle use

According to the answers of 972 persons, more than a third of the respondents do not use bicycles for transportation (Fig. 2) and only a fifth of them use bicycles on a daily basis.

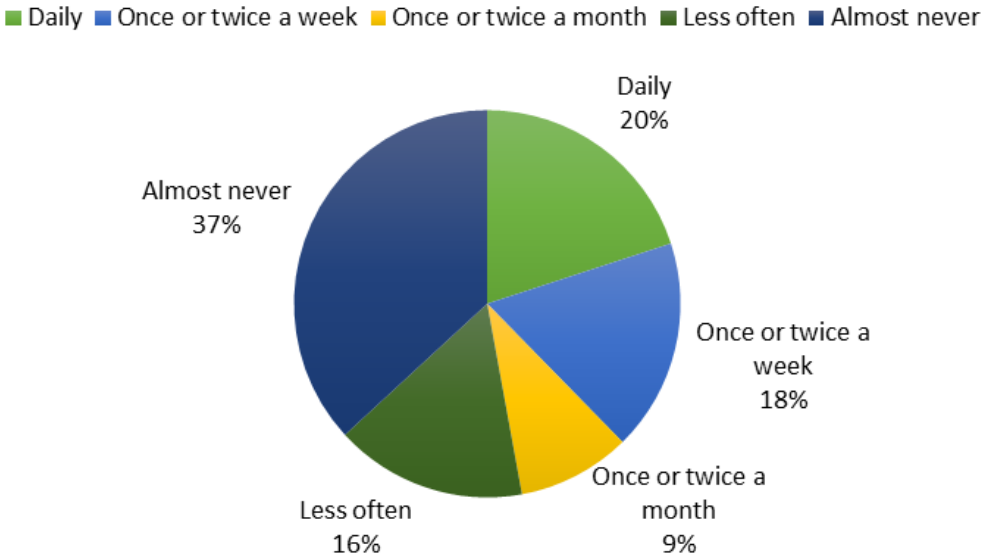

Fig. 2. The frequency of bicycle use (n=972) (Source: authors' construction)

There was no significant difference found between the bicycle use frequency of the male and female sample, although there were about twice as many never cycling female than male.

From the people who declared themselves as ethnic gipsy (only 2.1% of the sample), 43% ride a bicycle regularly or 1-2 times a week, 57% of them sits on a bicycle less often or never.

Looking at the frequency by school years, it can be seen that most of the less educated people use bicycle less often compared to those who are highly qualified (Fig. 3).

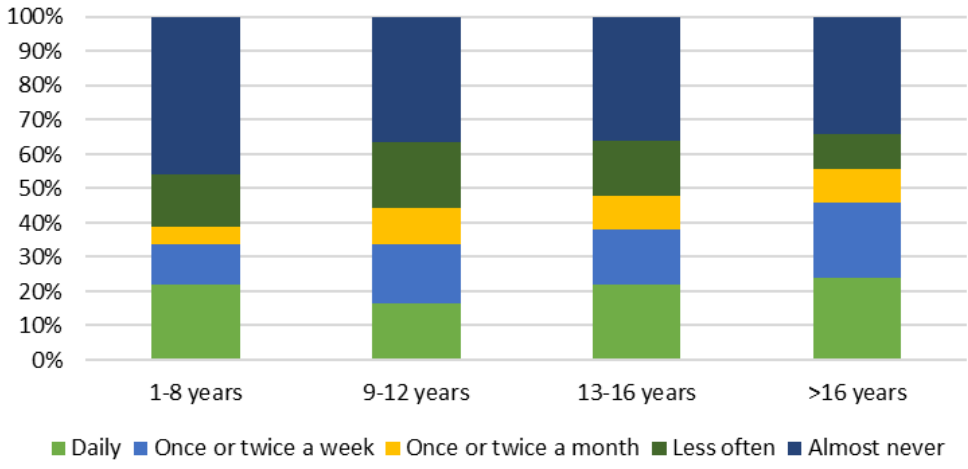

Fig. 3. Frequency of bicycle use by years spent at school (n=948)
(Source: authors' construction)

Based on Fig. 4 it can be stated that with aging, people use bicycles less often for transportation. When organizing by age groups, the answers showed that the portion of people never cycling increased while at the same time the portion of the daily users decreased steadily.

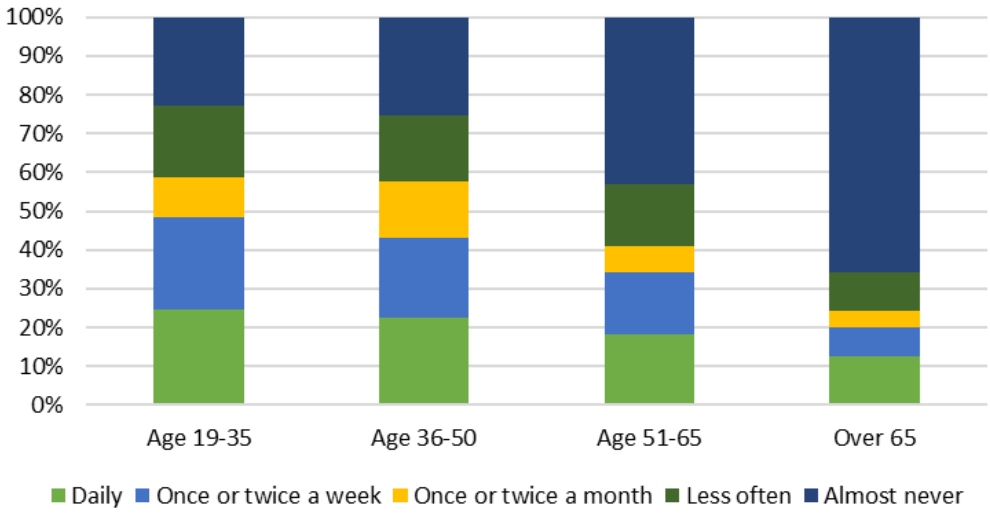

Fig. 4. Frequency of bicycle use by age (n=961) (Source: authors' construction)

On the one hand, bicycle riding is most popular among people who were born in Szeged or born elsewhere but live in the city since school years or adulthood. On the other hand, people almost never cycling are mostly those who were born in Szeged but currently live somewhere else, or those who were not born in the city but live there from childhood.

Looking at the cycling frequency by city districts, it can be observed that mostly residents of Újszeged, Felsőváros, Belváros and Tarján ride bicycles on a daily basis. But it can be also observed that these districts have a high proportion of city dwellers not using bicycles at all as well (Fig. 5) These districts have highly developed infrastructure, a dense network of public transport and a well-developed bicycle path network too.

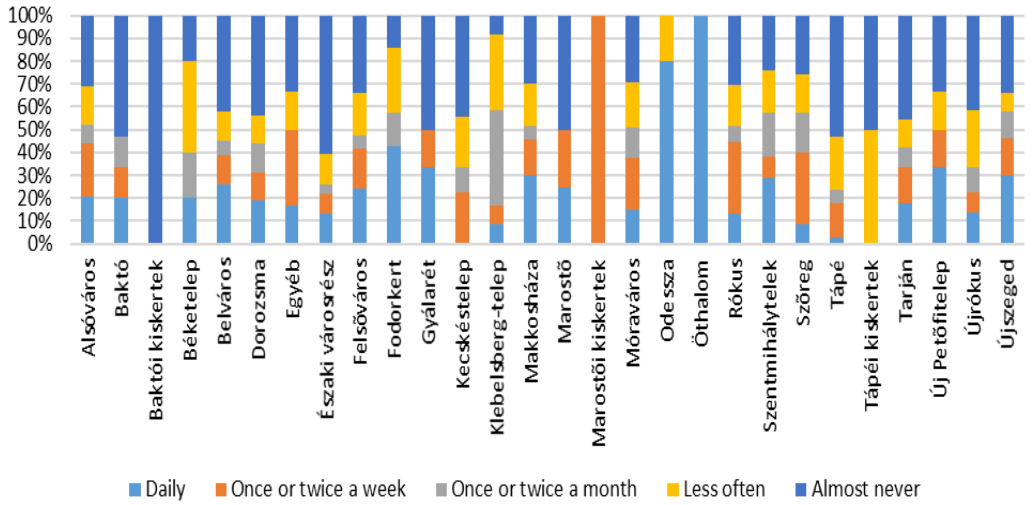

Fig. 5. Frequency of bicycle use by town districts (n=935) (Source: authors' construction)

Subordinate intellectuals and skilled workers are those, who use bicycle for transportation the most often. Farmers and senior managers almost never ride a bicycle according to the sample.

Comparing the data by the financial situation (Fig. 6), it can be seen that with the improvement of the financial status, the portion of those who almost never use bicycle, shrinks. Daily cycling is highest among those, who live in deprivation and cannot afford other means of transport.

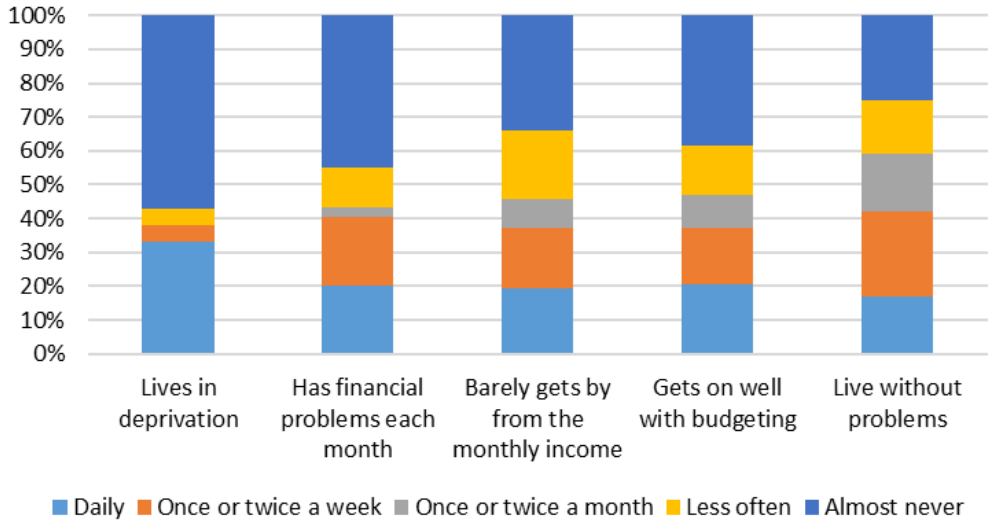

Fig. 6. Frequency of bicycle use by financial situation (n=945)
(Source: authors' construction)

According to the sample, the floor of the flat the city residents live has no effect how often they use a bicycle (Fig 7). The main reason for this may be that many flats have bicycle storage on the ground floor or at the basement, so carrying up or down the equipment is not an issue.

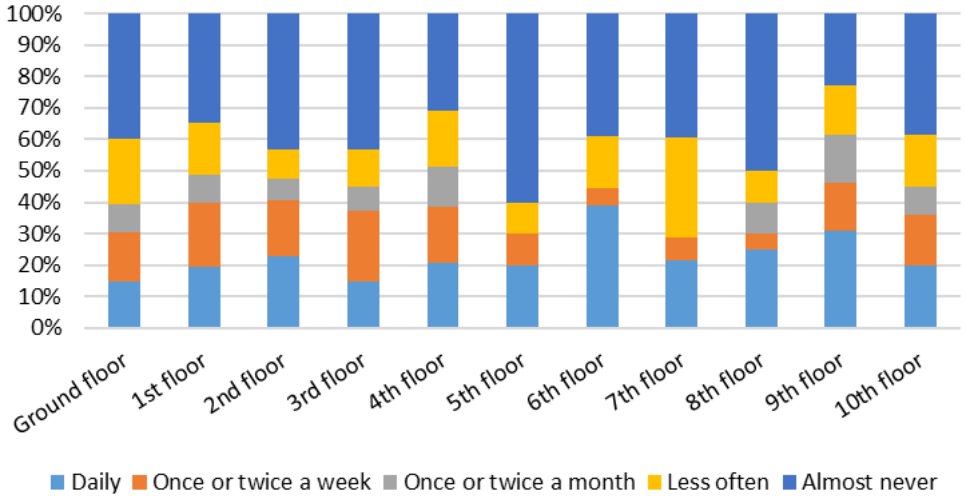

Fig. 7. Frequency of bicycle use by floor or flat (n=745) (Source: authors' construction)

Opinions about the funding of bicycle transportation

This part of the survey was answered by around 450 participants. According to nearly two-thirds of the respondents, more funds should be offered to the development of new cycle paths than at present. The majority believed that the money spent on the renovation of the existing bicycle path network was sufficient. In addition, more than half thought that the available funds to connect the present paths was enough.

The opinions were divided on whether the money to expand current bicycle storages and to create secured (maybe covered) storage places was sufficient or more money should be spent on these. However, more than half of the participants claimed that more funds could be spent on storage facilities operated near public institutions, post offices, and railway and bus stations.

The money spent to improve the security of storage places was insufficient and more should be paid according to the majority of those who have answered the questionnaire (for example surveillance cameras should be mounted).

More than two-thirds did not want to spend more on bicycle assistance points. Although we now from informal inquiry that some people would be happy with a smartphone application to monitor bicycle (and other kinds of) traffic.

Almost as many interviewed people thought that the city was spending enough money on community bicycle use and renting, as many thought that the funds should be reduced in this area. Those, who wanted to spend more money on community bicycles were a minority.

The details of the city residents' opinions can be seen in Fig. 8.

Correlation tests

The relationship, the strength of association was calculated with Cramér's V between the frequency of bicycle use and the characteristics of the respondents. The results, in descending order according to the strength of the association:

- frequency of bicycle use and district: V = 0.204 (the relationship between the two criteria is weak)
- frequency of bicycle use and gender: V = 0.197 (the relationship between the two criteria is weak)
- frequency of bicycle use and age: V = 0.194 (the relationship between the two criteria is weak)
- frequency of bicycle use and occupation: V = 0.141 (the relationship between the two criteria is weak)
- frequency of bicycle use and floor of apartment: V = 0.111 (the relationship between the two criteria is weak)

- frequency of bicycle use and financial status: V = 0.091 (there is no connection between the two criteria)
- frequency of bicycle use and the years in school: V = 0.079 (there is no connection between the two criteria)

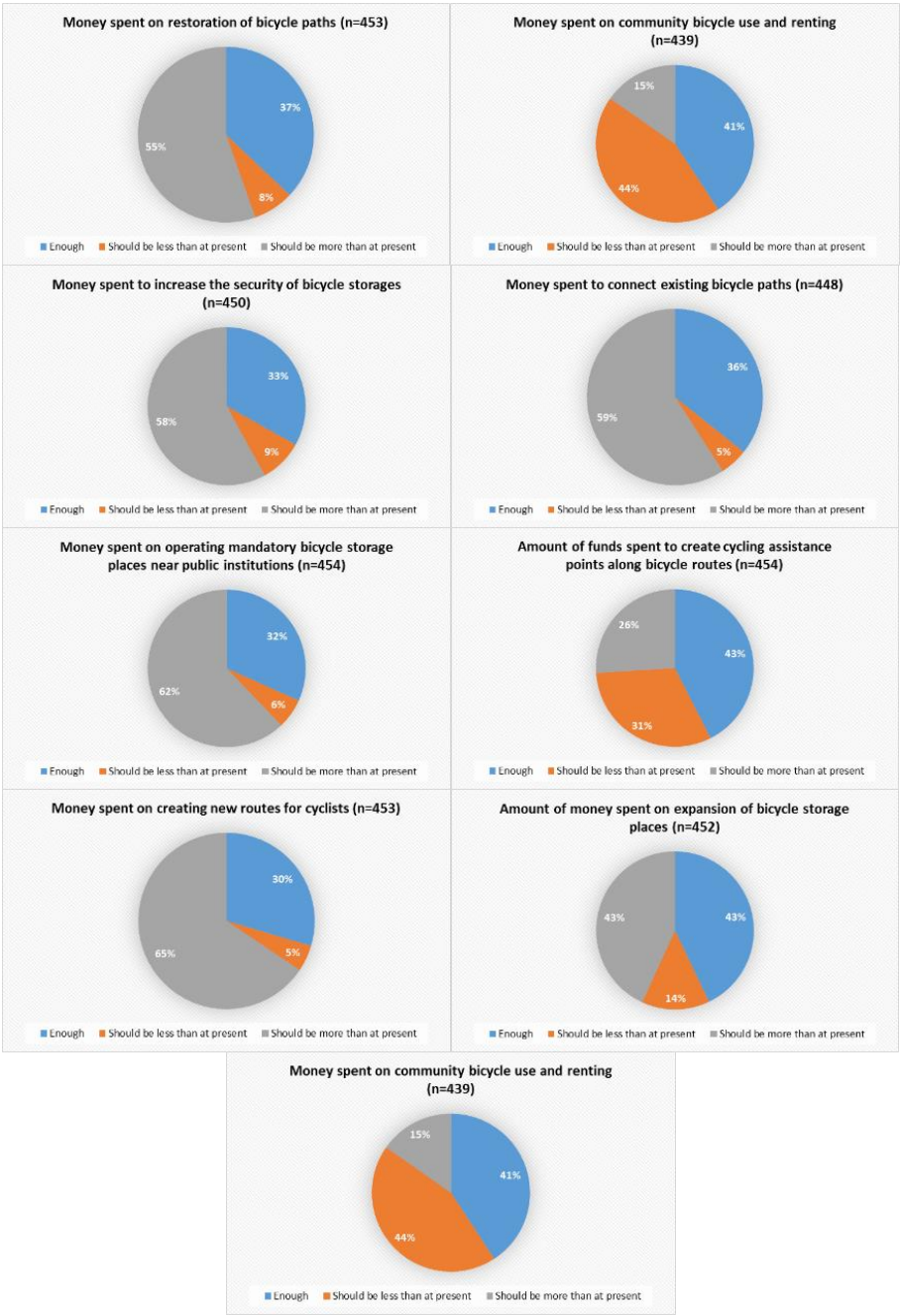

Fig. 8. Opinions about the funding of bicycle transportation among the surveyed (Source: authors' construction)

The results clearly show that, based on the collected sample data, there is only a very weak correlation (at best) between the cycling frequency and the other characteristics of the city residents taking part in the survey.

Hypothesis tests

Hypothesis 1: At least 51 per cent of the city residents think that more money should be spent on the renovation of the bicycle routes.
k=254, n=453, P=0.51, Z_{crit}=-1.649 (where k: the portion of the sample meeting the criterion, n: sample size, P: the hypothetical value to compare with, Z_{crit}: z critical value at 0.05 significance level)
H_0: p≥0.51, H_1: p<0.51

$$z_{emp} = \frac{254 - 453 \times 0.51}{\sqrt{453 \times 0.51(1 - 0.51)}} = 1.877 \quad (3)$$

The calculated empirical value of the z-test (z_{emp}) is higher than the critical value (z_{crit}). We accept (or fail to reject) the null hypothesis; so most of the people think that more money should be spent on the renovating the bicycle paths.

Hypothesis 2: More money should be spent on the expansion of the bicycle storage places according to at least 51 per cent of the people.
k=195, n=452, P=0.51, Z_{crit}=-1.649
H_0: p≥0,51, H_1: p<0.51

$$z_{emp} = \frac{195 - 452 \times 0.51}{\sqrt{452 \times 0.51(1 - 0.51)}} = -3.342 \quad (4)$$

The empirical value of the z-test (z_{emp}) is smaller than the critical value (z_{crit}), so we reject the null hypothesis. Most of the city residents say that the money spent on the expansion of bicycle storage places is adequate or should be less.

Hypothesis 3: At least 51 per cent of the population thinks that more funds should be spent to create new bicycle paths.
k=297, n=453, P=0.51, Z_{crit}=-1.6449
H_0: p≥0.51, H_1: p<0.51

$$z_{emp} = \frac{297 - 453 \times 0.51}{\sqrt{453 \times 0.51(1 - 0.51)}} = 6.200 \quad (5)$$

The value of the z-test (z_{emp}) is higher than the critical value (z_{crit}), so we do not reject the null hypothesis. According to the people living in the city, more money should be spent to create new bicycle routes.

Hypothesis 4: At least 51 per cent is satisfied with money spent on creating bicycle assistant points.
k=336, n=454, P=0.51, $|Z_{crit}|$=1.960
H_0: p=0.51, H_1: p≠0.51

$$z_{emp} = \frac{336 - 454 \times 0.51}{\sqrt{454 \times 0.51(1 - 0.51)}} = -3.618 \quad (6)$$

The empirical value of z (z_{emp}) falls outside the range specified by the critical values [-1.96, 1.96] so the null hypothesis has to be rejected. Less than 50 per cent of the population is satisfied with the money spent on creating assistant points for cyclists.

Hypothesis 5: According to at least 51 per cent of the city residents, more money should be spent on mandatory bicycle storage places near public institutions.
k=282, n=454, P=0.51, Z_{crit}=-1.6449
H_0: p≥0.51, H_1: p<0.51

$$z_{emp} = \frac{282 - 454 \times 0.51}{\sqrt{454 \times 0.51(1 - 0.51)}} = 4.737 \quad (7)$$

The value of the z-test (z_{emp}) is bigger than the critical value (z_{crit}), thus we fail to reject the null hypothesis. At 0.05 significance level more funds should be used to maintain mandatory bicycle storages near the public institutions according to most of the city dwellers.

Hypothesis 6: At least 51 per cent is satisfied with the funds to expand the number of secure bicycle storages.
k=180, n=445, P=0.51, $|Z_{crit}|$=1.960
H_0: p_0=0.51, H_1: p≠0.51

$$z_{emp} = \frac{180 - 445 \times 0.51}{\sqrt{445 \times 0.51(1 - 0.51)}} = -4.452 \quad (8)$$

In this case the null hypothesis should be rejected. The value of the calculated z (z_{emp}) is smaller than the critical value (z_{crit}). The people are not satisfied with the money spent to expand the number of secure storages for bicycles.

Hypothesis 7: According to at least 51 per cent of the city population, more money has to be spent to connect the existing bicycle paths.

k=265, n=448, P=0.51, Z_{crit}=-1.6449
H_0: $p_0 \geq 0.51$, H_1: $p<0.51$

$$z_{emp} = \frac{265 - 448 \times 0.51}{\sqrt{448 \times 0.51(1 - 0.51)}} = 3.452 \quad (9)$$

Since the value of z (z_{emp}) is higher than the critical value of z (z_{crit}) we fail to reject the null hypothesis. Therefore, we can say that most of the residents think that more money is necessary to connect the existing bicycle routes.

Hypothesis 8: More money should be spent on securing bicycle storage places according to at least 51 per cent of the city residents.
k=261, n=450, P=0.51, Z_{crit}=-1.6449
H_0: $p \geq 0.51$, H_1: $p<0.51$

$$z_{emp} = \frac{261 - 450 \times 0.51}{\sqrt{450 \times 0.51(1 - 0.51)}} = 2.970 \quad (10)$$

The result shows that the value of the empirical z (z_{emp}) is bigger than the critical value (z_{crit}) which means that we can accept the null hypothesis: most people think that even more money can be spent to secure the bicycle storage places.

Hypothesis 9: At least 51 per cent of the residents think that less money should be spent on public cycling and bicycle renting.
k=193, n=439, P=0.51, Z_{crit}=-1.6449
H_0: $p \geq 0.51$, H_1: $p<0.51$

$$z_{emp} = \frac{193 - 439 \times 0.51}{\sqrt{439 \times 0.51(1 - 0.51)}} = -2.949 \quad (11)$$

According to the calculation, the calculated empirical value (z_{emp}) is smaller than the critical value (z_{crit}), the null hypothesis has to be rejected: less than 51 per cent thinks that less money is enough for public cycling and renting.

Hypothesis 10: According to at least 51 per cent of the city population, more funds should be spent on the priority of bicycle paths.
k=202, n=454, P=0.51, Z_{crit}=-1.6449
H_0: $p \geq 0.51$, H_1: $p<0.51$

$$z_{emp} = \frac{202 - 454 \times 0.51}{\sqrt{454 \times 0.51(1 - 0.51)}} = -2.773 \quad (12)$$

The value of the test (z_{emp}) is smaller than the critical value of z (z_{emp}) at 0.05 significance level, thus the null hypothesis has to be rejected: less than

51 per cent of the townspeople say that more money is necessary on prioritizing bicycle paths.

Conclusions

The survey showed that a large percentage of city residents use bicycles, thus it is important to maintain and develop the cycling possibilities in Szeged. The characteristics of bicycle users (gender, age, education, financial situation etc.) has no, or negligible effects on their cycling habits, so in terms of bicycle transport development actions city residents can be considered a homogeneous group.

Measures to promote cycling is mainly supported in the city, actions and possibilities like renting or community use, more storage places may lead to the increase of bicycle users.

Most of the townspeople attach importance to the development, improvement and interconnection of bicycle paths and consider safe storage sites near central places (railway and bus stations, institutions, markets, hypermarkets etc.) important. Measures to ensure and improve covered and secure storage sites are also supported. Therefore, more attention is needed and money should be spent on these in the future.

It would make sense to develop a smartphone application for cyclists to monitor bicycle (and other kinds of) traffic.

It would also be reasonable to separate the pedestrian sidewalk form the bicycle path in order to prevent accidents, even if this means reorganization of traffic in some districts, mainly in the inner city (Belváros).

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