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TRANSPORTATION HABITS OF SZEGED CITY RESIDENTS

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ABSTRACT

A smart (or liveable) city is a settlement which is able to utilize the available technological possibilities and particularly the infocommunication devices in an innovative way in order to develop a sustainable environment. A sustainable urban environment is increasingly necessary since the portion of urban population is constantly growing. This might require the rethinking of the development of traffic in the city as well.
In 2015 a survey was conducted in Szeged related to the ongoing smart city project. The main goal of the survey was to get information about the transportation habits, opinions and expectations of the city residents. This paper summarizes some of the interesting results of the research in the field of public transport, bicycling, car transport, parking and walking. The research methods used were descriptive statistics, measuring relationship between variables and hypothesis testing. The results can also be the base of a later similar survey, where the possible financial consequences of the expectations are also communicated to the participants.

Keywords: Smart city, Szeged, transportation, survey

1. INTRODUCTION

The population of Szeged has increased significantly in the last decades, from 104,000 to 162,000 in sixty years. The city's infrastructure has to serve more and more people, it should provide more and higher quality services to its residents and visitors.
The city 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 Settlements with outdated infrastructure are not able to perform their duties, so the infrastructure has to be developed.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, roads, public transport etc.) developments bearing sustainability in mind should not be ad hoc performed. Instead thoughtful planning 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 [1].
Nowadays it is fashionable to talk about smart cities, and try to implement the concept behind it. The "smart city concept" has not yet fully crystallized; there are many interpretations. A comprehensive overview can be found in the paper of [2] and [3]. According to the latter, a smart city has several core components and elements (Fig. 1).
The concept integrates many areas of intervention: economy (dynamism and innovation), energy (sustainability and optimization), mobility (movement), environment (enhancement) and community (participation and communication) [4]. Smart city strategies can be built on local level, although they can also include a region or even the entire country [5]. Both solutions have benefits and disadvantages as well.
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 [6]. 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 [7]. 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 [6]. Efforts that lead to the smart city are expected to have an effect on efficiency, effectiveness, productivity, transparency and sustainability of the city [3].
The official document about the future vision of Szeged smart city (version 2, February 2016) contains several statements which determine the future of the settlement [8]. According to the document: "The Smart City can achieve a better quality of life and a competitive, sustainable economy by organizing

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intelligently the life of the community ranging from public services through urban transport, health care, education and commerce up to supporting local, self-organized communities."

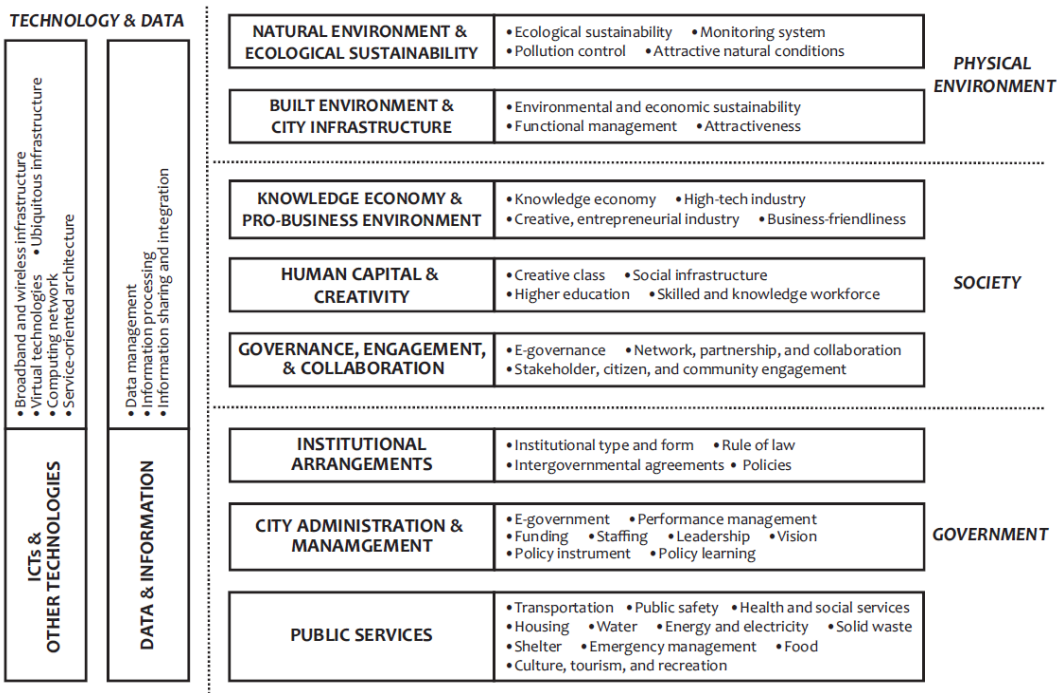

Figure 1. A comprehensive view of smart city components and elements (Source: [3])

A well-organized road network and transportation system is essential for building a modern, smart city. The radial and circular structure of the main road network in Szeged was very advantageous for the traffic in the past with much lower traffic. Nowadays, unfortunately, this is an endowment which diverts traffic mainly to the centre without escape routes and causes traffic jam at peak times. The public transport system is highly developed in the city. A bicycle road network is an essential accessory of a smart city too, for easier access and environment-friend life [9], [10]. The cycling route network began to evolve in the last decade.

2. MATERIALS AND METHODS

The aim of this paper is to summarize and analyse the data collected with a survey carried out in 2015. The residents of Szeged were asked to fill in a questionnaire where several questions related to transportation habits, opinions and expectations.
The survey was performed in different parts of Szeged city (which has a population of around 162,000) in the first part of 2015. The answers of the participants were processed in Excel. The following examinations were performed:

- Frequency distributions: frequency of public transportation, car and bicycle usage by
  - Gender,
  - Marital status,
  - Level of education,
  - Possession of a driving licence,
  - District of residence,
  - Number of persons living in the household,
  - Ability to save money,
  - Current financial situation,
  - Change of financial situation last year,
  - Source of income,
  - Workplace and
  - Job position.

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- Measures of association: Cramér's V was used to determine whether there is a relationship between the frequency of the use of transportation type and the criteria mentioned above. Cramér's V shows the strength of association between two examined criteria. The number can be between 0 (no association) and +1 (strong association). It is computed as in (1) by taking the square root of the chi-squared statistic divided by the sample size (N) and the minimum dimension of the table containing the grouped data minus 1:

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

- Regression analysis was done to check if the combination of the criteria has significant effects on the frequency of transportation use.
- The existence of correlation was calculated between the frequency of public transport use, the frequency of cycling and the frequency of car usage. The results were tested at 5 per cent significance level. According to the null hypothesis, the criteria are independent (H_0: $r_{yx}=0$, H_1: $r_{yx}\neq 0$ where r_{yx}: linear correlation coefficient). In case of rejecting the null hypothesis the correlation is significant. The test (2) bases on the correlation coefficient estimated from the sample:

$$t = \frac{\hat{r}_{yx}\sqrt{n-2}}{\sqrt{1-\hat{r}_{yx}^2}} \quad (2)$$

The test follows t-distribution with n-2 degrees of freedom if the null hypothesis is true.

3. RESULTS

This section contains information acquired form the data gathered from the 973 randomly selected survey participants.

3.1. The characteristics of the participants

Of the 973 persons, 54 per cent were female and 46 per cent were male. The vast majority (80%) were between the age of 21 and 65. Half of them were born in Szeged and lived in the city since then. One third of the participants were born elsewhere, but lives in the city since school years or adulthood. Slightly more than half had at least secondary school qualification (53%) and a fifth had a higher education degree.
There are several official and unofficial parts, districts in the city; nearly thirty was mentioned in the survey, but most of the collected data came from six of them: Felsőváros (12%), Újszeged (12%), Belváros (10%), Tarján (9%), Rókus (9%) and Móraváros (6%).
According to the collected data, the number of persons living in one household is low: 1 person 14%, 2 persons 36% and 3 persons 23%. Most survey participants were either married and live with their spouse (47%) or unmarried and live with no partner (20%).
More than the half of the asked persons told that they are not able to save money (55%). Nearly half of them get on well every month with tight budgeting (46%), a third of them barely get by from the monthly income (34%). The percentage of those who live without problems (8%) or have financial difficulties (9%) are much less and almost the same.
According to the answers, the basic source of income was mainly a full-time job (49%) or pension (21%). Most of them were subordinate white-collars (28%) and skilled workers (24%).

3.2. The frequency of using different means of transport

The answers show that 72 per cent of the participants use some kind of public transport. It should be noted that this is 10-15 per cent higher than the data acquired from other surveys. A third of interviewed travel by bus, trolleybus or tram every day (Fig. 2).

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It can also be seen that there are a lot of people who almost never use any types of public transport.
Nearly a quarter of the residents taking part in the survey use buses only the most frequently for travelling in Szeged (23%). Almost a fifth of the people selected all three kinds of transport as most frequently used ones (18%). The other possible combinations (trolleybus, tram, trolleybus + tram, bus + tram, bus + trolleybus) were selected by 10-14 per cent of the participants.
According to the data collected about the frequency of cycling (Fig. 2) there are a lot of people using bicycles for their own transportation. There were only 37 per cent who believed that they almost never use a bicycle and a fifth of the asked residents cycle on a daily basis.
Many city residents have driving licence; this answer was marked by nearly two third. Unfortunately, 346 persons did not answer this question, but according to the responses of the rest, two third use a car for daily transport or at least once or twice a week (Fig. 2). According to the parking rules, vehicles need a parking ticket in the inner part of Szeged. It was surprising, that according to the data most people (85%) use daily or hourly tickets instead of season tickets. This may be because they find ways to avoid paid parking zones.

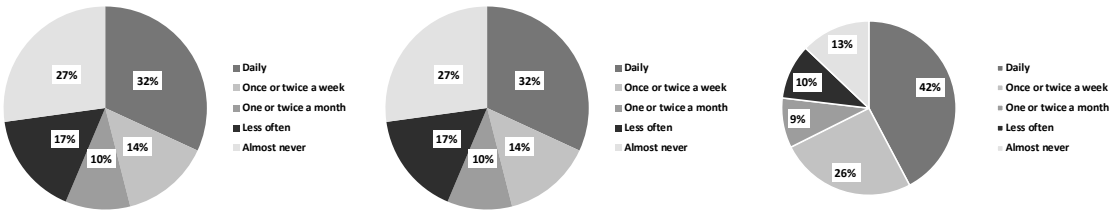

Figure 2. Frequency of public transport (left)(N=960), bicycle (middle)(N=972) and car usage (N=627) (Source: author's editing)

3.3. Frequency of usage by the characteristics of the participants

The frequency of using public transportation, cycling and car usage were examined by several characteristics of the participants (already listed in section: Materials and methods).
Fig. 3 for example shows the relationship of cycling frequency of the people taking part in the survey and their financial situations.

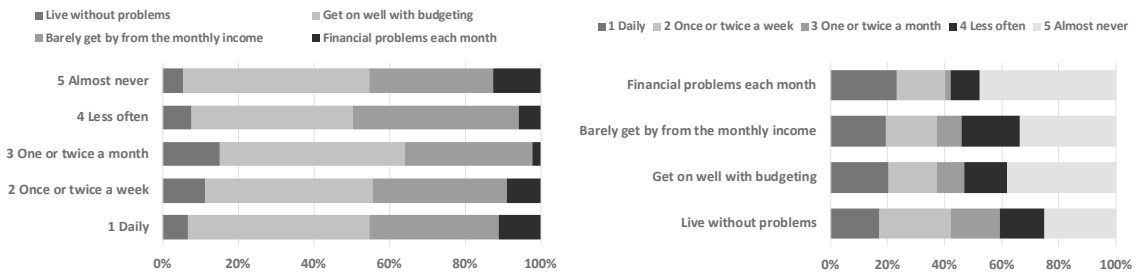

Figure 3. Relation of frequency of cycling and the financial situation (%, N=945) (Source: author's editing)

Although it may seem that there are some connections between transportation habits and the other features based on the charts (of which one example is Fig. 3), examining the criteria with Cramer's V, the relationship proved to be minimal. Tab. 1, Tab. 2 and Tab. 3 shows the values of the strength of associations in descending order. In the case of car usage, driving license was omitted because those answering the related questions all had one.
According to the regression analysis, the twelve characteristics of the respondents have only a very little impact on cycling habits (r^2=0.098) and the public transport usage (r^2=0.183), while they contribute to the value of car usage frequency to a high extent (r^2=0.793).

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Table 1. The strength of association between the frequency of using public transport and the characteristics of the participants (Source: author's editing)

Frequency of using public transport and	χ2	N	min(r-1,c-1)	Cramér's V
Driving licence	79.98	958	1	0.29
Gender	53.12	960	1	0.24
District of residence	194.32	947	4	0.23
Source of income	91.31	946	4	0.16
Job position	69.81	859	4	0.14
Marital status	65.57	942	4	0.13
Level of education	55.07	950	4	0.12
Number of persons in household	39.90	944	4	0.10
Workplace	9.53	496	2	0.10
Financial situation	15.53	933	3	0.07
Change of financial situation last year	16.01	940	4	0.07
Ability to save money	2.54	891	1	0.05

Table 2. The strength of association between the frequency of using a bicycle and the other characteristics of the participants (Source: author's editing)

Frequency of cycling and	χ2	N	min(r-1,c-1)	Cramér's V
District of residence	166.77	959	4	0.21
Gender	36.52	972	1	0.19
Driving licence	34.17	969	1	0.19
Source of income	122.01	956	4	0.18
Number of persons in household	68.94	955	4	0.13
Marital status	62.48	954	4	0.13
Job position	52.43	865	4	0.12
Ability to save money	10.42	902	1	0.11
Workplace	9.64	500	2	0.10
Financial situation	26.55	945	3	0.10
Change of financial situation last year	22.94	952	4	0.08
Level of education	18.85	962	4	0.07

Table 3. The strength of association between the frequency of using a car for transport in the city and the other characteristics of the participants (Source: author's editing)

Frequency of car usage and	χ2	N	min(r-1,c-1)	Cramér's V
Gender	33.66	627	1	0.23
District of residence	121.05	617	4	0.22
Marital status	83.13	621	4	0.18
Source of income	65.99	617	4	0.16
Job position	57.90	564	4	0.16
Workplace	14.92	385	2	0.14
Financial situation	30.91	610	3	0.13
Number of persons in household	40.84	613	4	0.13
Ability to save money	8.95	576	1	0.12
Level of education	28.86	621	4	0.11
Change of financial situation last year	25.59	614	4	0.10
Parking ticket	8.60	478	4	0.07

3.4. Opinions about the funding of transportation

There were several questions asked about opinions on funding different aspects of transportation in Szeged. Questions concerning public transport included:

- Separate season tickets for bus, tram and trolleybus,
- Purchase (season)ticket on smartphone and Internet,
- Increase of line density,
- Public information at stops and terminals,
- More gas operated vehicles (instead of petrol),
- More tram and trolleybus instead of bus,

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- Purchase (season)ticket from vending machine on vehicle,
- Public information on smartphone and Internet,
- More comfortable stops,
- Flexible fare system and
- Boarding possibilities for the disabled.

Fig. 4 shows the responses of the survey participants. The data is arranged by opinions about the funding needs.

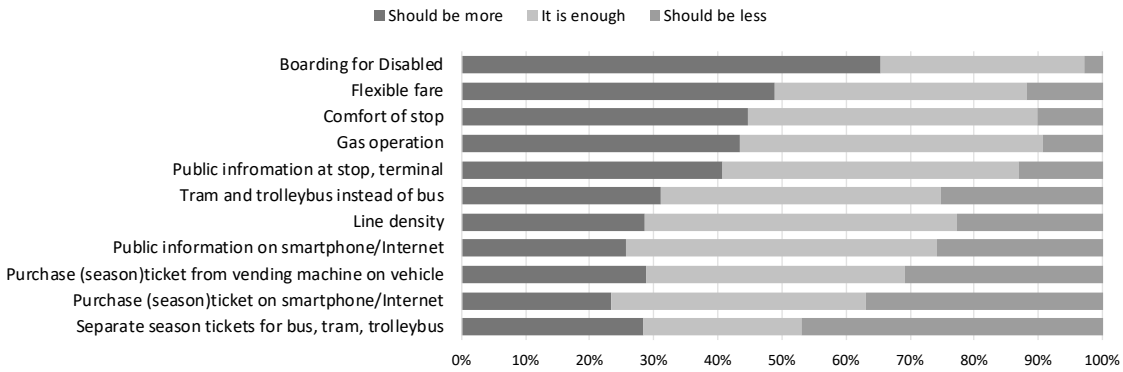

Figure 4. Funding the development of public transport according to survey participants (%, N=973) (Source: author's editing)

Two fifth of the opinions were that the funds are enough and there were nearly as many opinions showing that more money should be spent on the different areas of public transport.
The questions about funding bicycle transport:

- New bicycle paths,
- Renovating bicycle paths,
- Connecting bicycle paths,
- Priority of bicycle paths,
- Expanding storage places,
- Security of bicycle storages,
- Increasing the number of secure storages,
- Bicycle renting,
- Bicycle aid places and
- Mandatory storages near public institutions.

Fig. 5 shows the opinions of the survey participants about funding areas connected to cycling. The chart is arranged by the opinions about the funding needs.

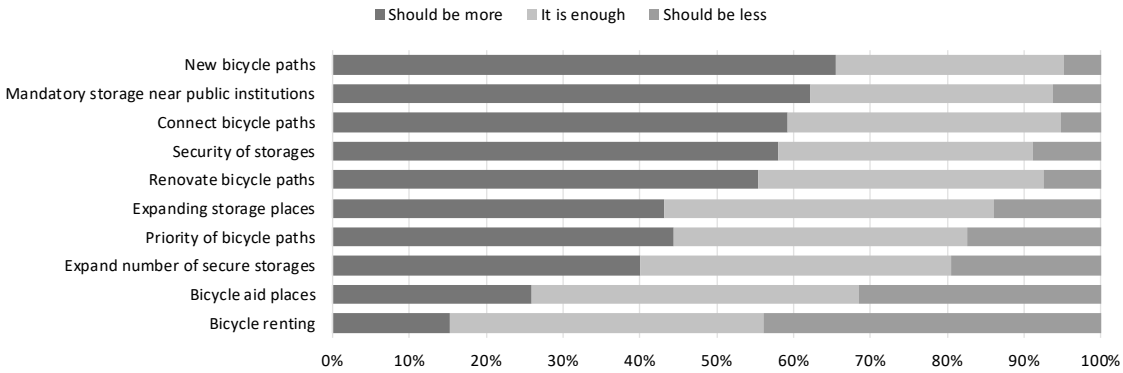

Figure 5. Funding the development of bicycle transport according to survey participants (%, N=973) (Source: author's editing)

Nearly half of the answers (47%) indicated that more money is necessary in this area, while 37 per cent of the answers signed that people are satisfied with the funds.
Enquiries about funding car transportation:

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- Road maintenance,
- Road above railway track,
- More roundabouts,
- Solid surface on roads,
- Roads signs,
- Smart lamps showing remaining time,
- Traffic dependent smart lamps,
- Digital information board above roads,
- Digital speed monitoring signs,
- Mobile dam along quay road and
- City-wide “yellow angel”.

Fig. 6 lists the opinions of the survey participants about the funding to support vehicle transport in Szeged. The list is arranged by the funding needs.

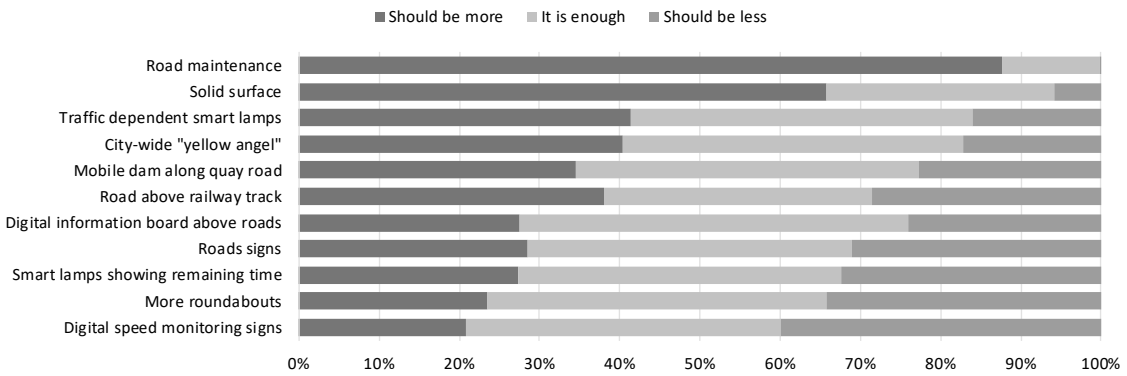

Figure 6. Funding the development of vehicle transport according to survey participants (%, N=973) (Source: author’s editing)

On the one hand, nearly a fourth of the answers indicated that there are some aspects of the vehicle traffic where less money would be enough. On the other hand, forty per cent of the replies specified that more funding is required.

Questions about funding the city parking were the following:

- Increase number of parking places,
- More places to buy parking tickets,
- Installation of parking machines,
- More underground garages,
- More parking places near public institutions,
- More parking places near railway stations,
- More parking places near bus stations,
- Minute-based tariff,
- Discount when arranging official tasks and
- Grace period to buy parking tickets.

Fig. 7 illustrates the opinions of the participants about the funding different aspects of the city parking system. The criteria are arranged by the funding need opinions.

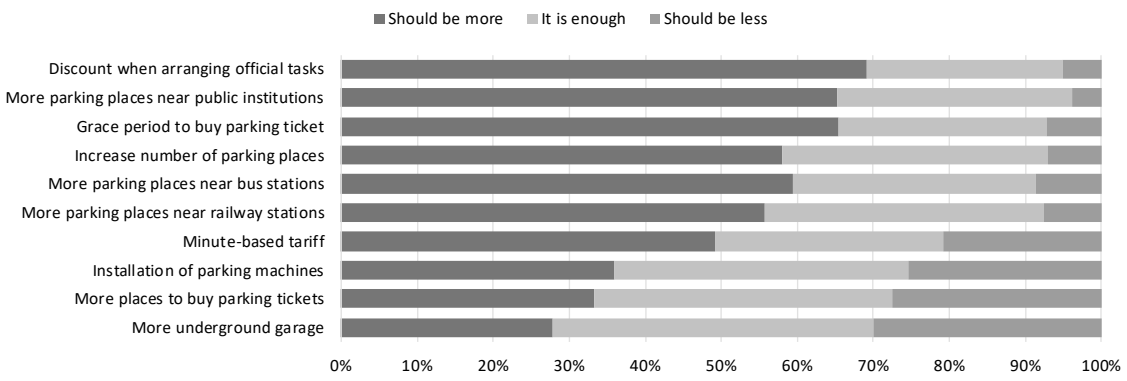

Figure 7. Funding the development of the parking system according to survey participants (%, N=973) (Source: author’s editing)

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By and large the majority is not satisfied with the money spent on the city parking system (only a third is pleased), 52 per cent of the answers point out that the funding should be more.
Opinions about the funding of pedestrian traffic was also evaluated:

- Decrease of vehicle traffic,
- Methods to decrease speed of vehicles,
- Increase the number of pedestrian streets,
- Private traffic-free city centre,
- Railing between road and pavement,
- Security of pedestrian crossings,
- Separation of pedestrians and bicycles,
- Increase the number of pedestrian crossings,
- Crosswalks with traffic light and
- Increase the time of crossing.

Fig. 8 illustrates the opinions about the funding of the pedestrian traffic. The list is sorted according to the funding need opinions.

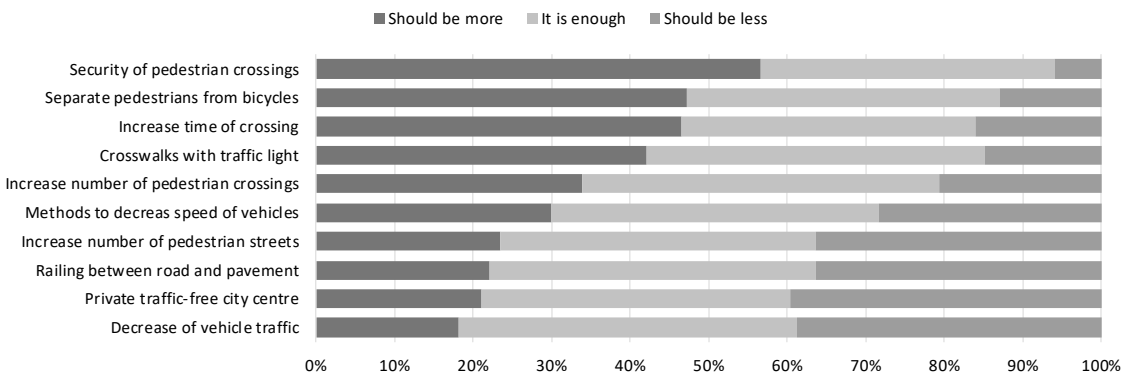

Figure 8. Funding the development of pedestrian traffic according to survey participants (%, N=973) (Source: author's editing)

Based on the answers, one can say that the results are similar to the opinions about funding the public transport: most of the data show that the majority is satisfied (41% of the answers), a little bit less answers indicate that the funding should be more (34% of the answers).

3.5. Hypothesis tests

Hypothesis 1: H_0: Frequency of public transport use and frequency of cycling are independent.
Hypothesis 2: H_0: Frequency of public transport use and frequency of car usage are independent.
Hypothesis 3: H_0: Frequency of cycling and frequency of car usage are independent.
The results calculated in Excel spreadsheet can be found in Tab. 4. According to the tests, there is significant moderate (negative) downhill correlation between the frequency of using means of public transport in Szeged and the frequency of travelling by car. The other two possible combinations show no relationship.

Table 4. The results of the hypothesis testing (Source: author's editing)

Criteria 1 Frequency of…	**Criteria 2 Frequency of…**	**Correlation coefficient**	**t-test**	**P value**	**Decision**		
public transport use	cycling	-0.067	-1.657	0.098	P value > 0.05	not significant	H_0 accepted
public transport use	car usage	-0.469	-13.195	0.000	P value < 0.05	significant	H_0 rejected
cycling	car usage	-0.069	-1.717	0.086	P value > 0.05	not significant	H_0 accepted

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4. DISCUSSION AND CONCLUSIONS

In order to ensure the planned development of the smart city, those responsible have to be aware of the characteristics, habits and opinions of the resident community. In case of the transportation this means travelling habits in the city, the attitude toward the funding of different areas of transport (public, car and bicycle) etc. This was the purpose of the survey carried out in 2015.

Based on the results obtained from the data collected from a random sample of nearly a thousand city residents, the following conclusions can be drawn:

Many city residents use bus, trolleybus or tram to travel in Szeged. The ratio of those who travel every day by public transport, instead of gas-powered cars, could be and should be increased to make the city a more environment-friend settlement.

The above statement also applies to cycling. Measures should be taken to encourage city residents to use their own, or rented bicycles more frequently to travel all over Szeged.

Using cars for transportation is also very popular among city dwellers. The collected data shows that many people can afford to use cars, it would still be preferable to persuade them to use public transport or bicycle instead.

Association test shows little or no connection between the frequency of different means of transport usage and the several characteristics of the city residents. This means that these characteristics (age, gender, marital status, financial situation etc.) do not have impact on the people's travelling habits within city boundaries.

The regression analysis indicates that the different values of the residents' characteristics together have influence on the car usage frequency. The values explain the dependent variable to nearly eighty per cent. The created model may be imported into a simulation system for further analysis.

In case of public transport, people consider boarding the vehicles for the Disabled the most important and a more flexible fare system which takes into account for example the travelled distance is an essential opinion, too. Smart applications to buy (season)tickets and to view the timetable and other public information about traffic is much less important. When surveying the opinions about transportation, the survey and the interviewer did not focus on describing the financial consequences of the different expectations and this is clearly observable in this case.

According to the townspeople, new bicycle paths are essential as well as mandatory storage places near the public institutions. People in Szeged do not put emphasis on bicycle renting. Further examination is needed to determine the cause of this latter result.

Not surprisingly, in the theme of the development of vehicle transport, the most important is to put more money in road maintenance and cover all roads with solid material. There are several roundabouts in Szeged and according to the survey results, replacing crossroads with more roundabouts is not important. Digital speed monitoring signs besides or over the roads are considered less important. This is not surprising, since vehicle drivers can easily monitor their speed by other means.

In the field of city parking, discounts to arrange official affairs, more parking places and a grace period to give enough time to buy the ticket are considered the most important, while spending more money on more parking machines and parking places as well as building underground garages are not supported by the majority. Many public institutions are there in the city centre and when someone visits these places by car, he or she is forced to pay for the parking. There are daily periods when it is difficult to find a free parking place in the inner city, so more garages would be necessary but since it is not possible to build underground garages (and this is also not supported by the residents) the solution may be to create more parking places in the suburbs or move the public offices there.

In pedestrian traffic the most important areas are the security of the crossings, the increase of time to let pedestrians cross the roads and the separation of pedestrians and bicycle traffic. Crossing can be made more secure by traffic lights and the proper placement of clearly visible signs. Changing programmes of traffic lights should be carefully implemented, because the lamps have to be synchronized to avoid traffic

jams during peak hours. Separating the cyclists from the walkers is important to prevent accidents. In my opinion, for an eco-friendly environment less air pollution and to achieve this, less vehicle traffic and a private traffic-free city centre would be advantageous, but to spend more money on the arising tasks is not supported by the survey participants.
There is a significant, but only medium opposite relation between the frequency of car and public transport usage. Those, who use car often for transport are less likely to travel frequently by bus, tram or trolleybus.

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