Evaluation of the bikeability of a Greek city: Case study "City of Volos"

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Abstract: - Driving a bike in a Greek city is not an easy case. There are no bicycle facilities available and the bicyclists and the car drivers are not used to each other in mixed traffic situations. The primary goal of the study was the evaluation of the road infrastructure and the ability of the bicyclists to bike safely in the city of Volos. The secondary goal of the study is the finding of the main problems of the bicycles in the city, the level of the bicycle use and the purpose of the bicyclists' daily trips. The study took place in November 2008. 100 bicyclists participated in the study and answered a questionnaire of 8 questions, which consisted of more sub questions. 38 of the participants were students in the University of Thessaly and the rest citizens of the city. The bicyclists were of different age, sex and profession, in order to have a more independent sample. The questions concerned about the road safety of the bicyclists both in bikeways and in rest of the road network, the road safety level on the intersections' crossing, the behavior of the car drivers to the bicyclists, the behavior and the safety measures of the bicyclists, the amount of the daily bike trips and their destination. Using a rating scale from 1 to 6, with 1 considering the worst and 6 the best grade, in the first 5 of the 8 questions of each questionnaire, the bicyclists put a grade to each question. Finally, calculating the summary of each questionnaire and the average of the whole sample, with a rating scale of 5 to 30, with 5 considering the worst and 30 the best road environment, we evaluated the bikeability level of the city.

Key-Words: - Bikeability, Bicycle facilities, Bikeways, Bicyclists' safety, Bicyclists' behavior, Drivers' behavior

1 Introduction

Bicycle is a transport mode, which uses the human force in order to move. Bicycle is a sustainable transport mode, part of a different and new tends of living in our cities, designing and operating them with human and not automobile scale. Community authorities all over the world are constantly under pressure to provide the ability to their citizens to use their bicycle with safety and easy in the road network. Bicycling is a great way to cover the daily transport needs in the urban environment, promoting the sustainable way of living and the benefits that come with it.

1.1 The benefits of bicycling

There are clear benefits from the bicycle use, both in local and in country level. The bicycle doesn't need fuel to move, decreasing the energy consumption, the air pollution and the amount of the CO2 emissions. The decrease of the oil imports helps the economy and the energy efficiency of the country.

The use of a bicycle can also reduce the amount of money that households need to preserve their cars. In United States (US), 22% of the annual household income is necessary for the car use [1]. On the contrary, the annual cost of the bicycle use is estimated to be 100$, much less than cars [2]. People do not see the bicycle as an investment, but as a waste of money.

The bicycle needs less space to move and park in the city. Comparing it to the car, it relieves the traffic congestion problems and the necessity for constructing new infrastructure for the motor vehicles, which costs a lot. It is estimated that 10 bicycles can park in a car parking place, saving precious public space [3]. The necessary space for a bicycle to park is between 1.3m^2 and 2-3m^2 [4].

Better provision of bicycle facilities in a city raises the accessibility of the public space. Also, enables longer than walking trips from citizens that cannot afford to buy a car or they are too young to have a driving license, or they do not want or have the ability to use the public transportation.

Bicycle is the fastest transport mode for door to door trips, for distances shorter than 6miles [5]. In US, bicycle can play a different role in citizen's

lives, because 25% of the trips are shorter than one mile and 50% are shorter than three miles, equal to 15-20 minutes of bicycling time [6]. In US, the bicycle sales have raised 20% from 1992 to 2006, showing a light tend to the bicycle use [7]. In London, bicycle use has raised 83% from 2000 to 2007 [8]. In many European countries mainly in Northern Europe, like Netherlands or Denmark, bicycle trips represent about 20-30% of the daily urban trips [9]. On the contrary, in Southern European countries like Greece or Italy, the bicycle use percentage is less than 5% of the daily urban trips.

Bicyclists can move with a proper speed, even on sidewalks when there is traffic jam in the road network, estimating better the necessary time for an urban trip. This is an important factor for companies who do not want their employers to be late to work for unexpected reasons. Many companies promote bicycle use and demand the building of bicycle parking facilities close to their building's entrances. Bicycle use can also be a part of a company's environmental policy, creating a better image profile [10].

The bicycle use can further reduce the car trips if it is properly connected with the bus or urban train network. The integration of the bicycle and public transport network facilities is a critical component of the success of a transit system. Bike on transit services enables bicyclists to travel greater distances and overcome topographical barriers. The integration of the two modes can also enlarge the transit's catchment area by making it accessible to travelers who are beyond walking distances from transit stations, using their bike to go there [11].

On the contrary, auto-dependence creates many public health problems such as lack of exercise, obesity, social isolation, mental and physical diseases and road safety dangers [12]. Obesity rates in US have increased from 12% in 1991 to 20% in 2001 [13]. Bicycle use can improve personal health. According to Anderson and Lars Bo (2000), the daily use of the bicycle in house to work trips can reduce the possibility of death by 40%, resulting from a sample of 30000 citizens [14]. The "Cycling 100 Trial" study refers that the LDL level has reduced and the HDL level has risen. Moreover, the possibility of heart attack has reduced [15]. According to Fitzsimmons and Buettner, senior adults who use their bicycle present reduced levels of depression, comparing to people who do not bike [16].

1.2 The risks of bicycle users

The bicycle is a vulnerable transport mode. Not only the bicycles suffer more risks when they ride their bike, but also the bicycle itself is vulnerable. The bicycle can easy be stolen or vandalized. The bicycle theft is a factor that discourages citizens to buy and use one [17]. Also, many bicycle users that their bicycle was stolen do not bye a new one in order to replace it, because they consider they will loose it again [18].

The risk of bicyclist's road safety is high, because they are considered to be vulnerable road users. In 14 European Union countries, 1188 bicycle users have lost their life in 2006, 34% less to 1997 when 1809 bicyclists had lost their life [19]. Bicycle road accident fatalities present a peak in age of 15 years old and older than 65 years old. Urban road network is the main area for bicyclists' fatalities in EU in 2006, (55%) [19]. In Greece, 71% of the bicycle fatalities take place in urban areas [19]. In urban areas, intersections are the most dangerous places for a bicycle accident. Bicycle fatalities tend from 40% to 75% in EU countries [19]. It worthwiles, that in Greece 100% of the urban bicycle fatalities take place in intersections [19].

In US, 698 bicyclists have lost their life in 2007, comparing to 814 dead bicyclists in 1997 (14% less) [20]. The injured bicyclists in 2007 were 43,000, comparing to 58,000 injured bicyclists in 1997 (26% less) [20]. The total cost of the dead and injured bicyclists was estimated from 5.4 to 8 billion $ [21]. 7 times more men than women bicyclists have lost their life in 2007 [22]. The peak age of fatalities is presented in the ages of 13 years old and between 45-49 years old [22]. 92% of the bicyclists do not wear a protective helmet, which has proved to be very effective in a bicycle related accident [22]. The use of alcohol is a very important factor in bicycle related accidents. In 33% of the bicycle fatalities, either the bicycle or the car driver had consumed alcohol [22].

1.3 The bikeability criteria of a city

The land use and the level of the road infrastructure is not the same in every city. There are many differences thanks to economical, cultural and geographical factors. Moreover, there are also serious differences even in neighborhoods of the same city. The turning to more sustainable transport modes like bicycle, demands the providence of the proper road infrastructure. Some communities are more bikeable than others, friendlier and common to bicycle, depending on some specific criteria. There are many criteria that describe the term of bikeability, which are [23]:

- The providence of high level bicycle road infrastructure
- The condition of the pavement of the road infrastructure
- The ease of crossing the intersections of the road and bicycle network
- The ease of riding the bike
- The behavior of the vehicle drivers
- The behavior of the bicycle drivers
- The use of protective devices (helmet, lights) from the bicyclists

The bicycling behavior relates the bicycle ownership, the frequency, the purpose and the distance of the bicycle trips. The bicycle behavior depends on the following factors:

- Individual factors: bicycling preference and comfort
- Social – environment factors: bicycle culture
- Physical – environment factors: bicycle infrastructure and land use mix

For bicycling, ownership is likely to be even more important in explaining use, as "getting a ride" is not possible. Previous bicycling studies show that bike ownership is a vital and decisive component of biking behavior [24].

Bicyclists riding in areas without bike paths or lanes feel more danger for their road safety, mostly from the motorists. Furthermore, they are more dissatisfied how their community deals with them and their transport needs. Moreover, frequent bicyclists tend to have a strong preference for more bike lanes over more bike paths, while infrequent bicyclists display no marked preference for either [25], [26].

2 Description of the study

2.1 Description of the city road environment

Bicycling in a Greek city is not very easy, because there is no providence of the proper bike infrastructure. There is no bicycle network, but only some bikeways which do not attend the bicyclists' needs. Greek society has not paid attention on the bicycle as a transport vehicle, but considers it more as a theme of entertainment and sport. In the last years the bicycle use has changed in Greece from recreational purpose to more business trips. The raise of the bicycle users has provoked skepticism to many local authorities, who are constantly under pressure to upgrade the urban road environment to become friendlier to bicycle users.

Except the hostile road environment, there is also no proper driving education of the bicycle users, unless they have a driving license for motor vehicles or motorcycles. Moreover, vehicle drivers are not used to move in the streets together with bicycles. Bicyclists do not always pay attention to the traffic signs and signals or move contra flow surprising the vehicle drivers.

In order to evaluate the bikeability of a typical medium scale Greek city we studied the case of the city of Volos. Volos agglomeration consists of two Municipalities with an overall population of 155,000 people. The city is located in the Prefecture of Magnesia, in the Region of Thessaly in central Greece. It is a mainly industrial city with a seaport with cargo and passenger traffic. The city is developed in two axes, one horizontal parallel to the sea and one vertical towards the mountain Pelion. It is a city with no significant slopes, which helps the bicyclists to bike with a minimum human force. Moreover, the traffic congestion is basically observed in the main streets, which can easily be overpassed from the bicyclists if they choose to move across the port where a bikeway has been constructed (Fig.1), or use the local streets through neighborhoods.

Figure 1: Bikeway across the port

There is a limited length bicycle network in the city which doesn't attend the needs of the bicyclists. A bikeway has been constructed in "Rigas Feraios" street, a street where traffic calming measures have been implemented (Fig.2). That is why many bicyclists use existing roads, sharing them with motor vehicles, or moving on sidewalks with pedestrians. One of the characteristics of the road network of the city is the amount of the one way streets, which helps the bicyclists to organize better their trips and cross the intersections with higher safety level.

Figure 2: Bikeway in "Rigas Feraios" street

2.2 Study design

The primary goal of the study was the evaluation of the road infrastructure and the ability of the bicyclists to ride their bikes with safety in the city. Furthermore, the secondary goal of the study was the survey of the bicyclists' behavior, the amount of daily bicycle use and the purpose of the bicycle trips.

The study took place in November 2008. The first step of the study was the collection of the data. In order to achieve that, we used a questionnaire of 8 questions, which consisted of more sub questions. The data collection method to fill in the questionnaires was the personal interviews of the bicyclists. Because of the lack of many bicycle users in the city we tried to find a sample of as many bicycles as possible. Finally, 100 bicyclists participated in the study, 38 of them were students in the University of Thessaly (UTH) and the rest citizens of the city. Many of the bicycle users in the city of Volos are university students, considering them as representative bicyclists. So, we asked 38 students to answer the questionnaire. In order to enrich the sample we stopped bicyclists moving in the center of the city to answer the questionnaire.

Collecting data was not very easy because we had to explain the meaning of many questions, especially to the older ones. Moreover, many bicyclists did not want to take part, or were disappointed of the improvement of the bikeability of the city. Finally, reaching a goal of 100 participants, the bicyclists were of different age, sex and profession, achieving to have a relative independent sample.

Separating them by sex, the bicyclists were:

- 60 men (60%)
- 40 women (40%)

Separating them by age, the bicyclists were:

- 45 bicyclists 15-25 years old (45%)
- 18 bicyclists 25-35 years old (18%)
- 13 bicyclists 35-45 years old (13%)
- 24 bicyclists over 45 years old (24%)

Separating them by profession, the bicyclists were:

- 9 public workers (9%)
- 24 private workers (24%)
- 38 university students (38%)
- 9 pupils (9%)
- 8 households (8%)
- 12 pensioners (12%)

The second part of the study was the analysis of the data and the providence of results, using a specific methodology which is following presented.

2.3 Methodology

The questionnaire included 8 main questions. Using a rating scale from 1 to 6, (Fig.3), with 1 considering the worst and 6 the best grade, in the first 5 of the 8 questions of each questionnaire, the bicyclists put a grade to each question [23, 27].

We calculated the summary of each questionnaire and the average of the whole sample, with a rating scale from 5 to 30, where 5 represented the worst and 30 the best road environment. Moreover, we calculated the average of each question's grade, in order to have more analyzed results. Additionally, we analyzed the results by sex and by age of the bicyclists, in order to understand better their opinion. Finally, we calculated the total grade of the bikeability of the city.

Except of the grading, bicyclists answered yes/no to more sub questions of the main questions, concerning the main problems they faced and their bicycle behavior. We calculated the percentage of the positive or negative answers, in order to result the opinion of the bicycles into specific themes.

Figure 3: Evaluation rating scale

3 Results

3.1 Results of the questionnaire

3.1.1 Question No 1 – "Is there a place to bike safely on/off road?"

In the first part of the first question, we asked the bicyclists if there was a place to bike safely on the

road, sharing it with motor vehicles. Their answer was:

- Yes, 27%
- No, 73%

This result means that there are indeed parts of the road network where the bicyclists feel safe. The bicyclists use the existing bikeways, which are limited length and moreover they use local streets with low vehicle flow, where they feel safe. But, as we expected, the majority of the bicyclists (73%) consider that the road network with mixed traffic condition does not provide them safety.

The main problems were:

- 66%, the lack of space for bicyclists to ride safely
- 12%, the poor lighting of the streets
- 24%, the presence of tracks or buses
- 39%, the fast moving vehicles

Putting some comments on the previous problems, we conclude that the bicyclists face indeed problems in their daily trips. Two of the three bicyclists consider that there is no proper space for them to bike safely. It means that the providence of bikeways is necessary.

Bicyclists ride their bike also at the night. Lighting condition is very critical for their road safety. Only 12% of the bicyclists consider poor lighting as a problem. This is due to the existing lighting in the streets for the automobiles and pedestrians movement. Furthermore, it seems that bicyclists move during the night in streets where there is enough road lighting, in order to enhance the level of their road safety.

Bicycling in mixed traffic conditions, buses and tracks are considered as being more dangerous than cars for the bicycles. Drivers of those vehicles cannot handle their vehicles very easy or see the bicyclists. 24% of the bicyclists need to move in mixed traffic with bicycles and cars, which mainly move in arterials. So, the bicyclists move indeed in arterials and main roads at least in one part of their trip, where bikeways need to be constructed.

The speeding of the vehicles is a critical issue to the levels of the road safety of the bicyclists. 39% of the bicyclists consider that the drivers move with high speed. So, either the drivers do not pay attention to the bicyclists, or the bicyclists move in main urban roads. Moreover, in case of an accident, the possibility of bicycle fatalities is raised.

In the second part of the first question, we asked the bicyclists if there was a place to bike safely on an off-road path or trail, where motor vehicles were not allowed. Their answer was:

- Yes 88%
- No 12%

This result means that there are specific parts of the city like bikeways, pedestrian precincts or the area across the port, where the bicyclists can bike without the avoidance of the cars and apparently they use those areas for their daily trips. But even these bikeways or bike paths present some problems which are:

- 93%, bikeways end without warning
- 91%, the bicycle network is not enough for the city
- 93% do not cross major streets

The existing bikeways end without warning or end to places where bicyclists cannot move further (Fig.5). Furthermore, 91% of the bicyclists consider that the bicycle network is inadequate for the city and that is true (Fig. 1, 2). Finally, the existing bikeways, being located in local streets do not cross major streets (Fig. 9), as 93% believe so.

3.1.2 Question No 2 – "How was the surface you rode on?"

In the second question, we asked the bicyclists how the surface that they rode on was. Their answer was:

- 16%, good road surface
- 84%, problems on the road surface

The bicyclists consider that on the roads, the bikeways and the sidewalks they move with their bikes, there are specific problems on their surface. They answered that the main problems were:

- 16% the lack of proper maintenance
- 61% the uneven surface or gaps
- 29% the slippery surfaces when wet
- 33% the cracked or broken pavement on the sidewalks and pedestrian precincts

It seems that the lack of maintenance of the pavement and the uneven surface creates serious problems to the bicyclists (Figure 7). Also, the poor drainage of the water creates slippery surfaces. This situation leads to serious problems to the bicycle users, because it is more difficult for the bicyclists to ride their bicycle. Not only they cannot reach a higher speed but also they face serious danger to fall from their bike and get wounded.

Almost 30% of the bicyclists considering that the surface of the surface is slippery when wet, means that they use their bicycles when it rains or after. Furthermore, a great amount of the urban road network is slippery not only for bicycles, but also for motorcycles and even cars.

33% of the bicycle users think that there are cracked or broken pieces of pavement on the sidewalks. It means that not only there is poor maintenance of the pedestrians' road surface, but

also that many bicyclists move on sidewalks because of lack of bikeways or dangerous traffic conditions.

3.1.3 Question No 3 – "Did you bike easy through intersections?"

In the third question, we asked the bicyclists how easy they rode through intersections. Their answer was:

- 75%, they rode easy
- 25%, they faced problems

It seems that a serous percentage (75%) of bicyclists did not have major problems riding through the intersections. It is due to the movement in local roads in neighborhoods where there are not main intersections. The main problems the bicyclists faced were:

- 40%, the waiting too long to cross the intersection
- 64%, the lack of traffic signals for bicycles
- 22%, the low level of visibility of incoming and crossing traffic
- 36%, being unsure where or how to cross the street in the intersection

It seems that in signalized intersections the bicyclists use the green and red traffic signals to cross the intersection with safety. In the rest intersections, mainly in the neighborhoods, they had only to pay attention on the incoming traffic, which makes their crossing ambiguous and unsafe. They have to care in mind to respect the traffic signs and yield when they must do so.

40% of the bicyclists believe they wait too long to cross a street, especially in signalized intersections when there is no providence for bicycles. So, it is usually common the bicycles to cross the road with red traffic light, when they think there is a proper gap in the traffic flow.

22% of the bicyclists consider that there is poor visibility of the incoming vehicles in the intersections. This is thanks to the existence of parking cars or other obstacles like trees or road signs. Poor visibility is a serious problem, because bicyclists are uncertain to cross the street in unsignalized intersections.

36% of the bicyclists, a remarkable percentage, are unsure where or how to cross a main intersection. Worrying of the high vehicle flow, the best way to cross the intersection is sometimes with the pedestrians using the crosswalks.

3.1.4 Question No 4 – "Did the car drivers had a proper behavior towards bicycle users?"

In the forth question, we asked the bicyclists if the drivers behave properly to the bicyclists in the mixed traffic road environment. Their answer was:

- Yes, 13%
- No, 87%

Apparently, the drivers are not used to the existence of a bicyclist in the road. The main problems were:

- 62% the drivers passing close of the bicycles
- 69% the drivers being inpatient and rude, not yielding in the intersections
- 81% the lack of attention during the night

It seems that the lack of proper driving behaviour of the car drivers is obvious. 62% of the bicyclists reported that the car drivers passed to close to them. This behavior is very dangerous because the bicyclists may loose control of their bike.

69% of the bicyclists reported that the car drivers did not yield them in the intersections when they had right of way. Apparently, the car drivers consider the bicycle users as second class road users.

The 81% of the car drivers did not pay attention to the bicyclists during the night. This makes more difficult for the bicyclists to ride at night with safety.

3.1.5 Question No 5 – "The use of the bike was easy?"

In the fifth question, we asked the bicyclists if it was easy for them to use the bike. Their answer was:

- Yes, 75%
- No, 25%

We see that the majority of the bicyclist do not find hard to move with their bike in the city. The main problems they faced were:

- 16% the lack of marks, signs or road markings
- 33% the lack of safe or secure place to park the bicycle at the destination place
- 7% the difficulty to find a direct route
- 95% the difficulty to take the bicycle on bus or train
- 52% the necessity to move contra flow
- 57% the necessity to move on sidewalks

Bicyclists use the existing traffic signs and markings to move in the city, not considering it as a serious problem.

Bicycle parking is a critical issue. 33% of the bicycles do not find a safe place to park their bicycle. There are limited parking places in the city and the bicycle can be relative easily stolen or vandalized. The bicyclists mainly lock their bicycle on tree boles or traffic signs.

Finding a direct and less tiring route to the destination place is not difficult. In order to achieve that, bicyclists can either move contra flow (52%) or move on sidewalks (57%). Moving contra flow is not necessary dangerous for the bicyclists if they pay more attention in the intersections. Furthermore, in limited width roads, especially with slope, bicyclists are anxious when followed from vehicles, their drivers being impatient. Moving on sidewalks can shorten their route and raise their road safety, but they cannot move fast. Furthermore, they may have conflict with pedestrians.

Intermodal transportations like taking the bicycle on the bus are not allowed from the law. But 5% of the bicyclists answered positive, which is an ambiguous result for taking it on the bus, but probably on the train for suburban trips.

3.1.6 Question No 6 – "What did you do to bike with safety?"

In the sixth question, we asked the bicyclists what were their actions, in order to make themselves moving safer. They had to answer the following alternatives:

- 9% wore a bicycle protective helmet
- 40% used lights when riding at night
- 46% move in a straight line
- 75% obeyed traffic signals and signs

Only a few bicycle users (9%) wore a protective helmet. All of them should wear one, but they did not. Furthermore, the traffic law does not mention anything of the oblivion of the bicyclists to wear one. Less than the half bicycle users (40%) used lights on their bicycle when they rode at night. It is obviously that all the bicyclists should have installed a light on their bike, but they have not.

When riding their bike, 46% of the bicyclists moved in a straight line, in order to be more predictable to the car and motorcycle drivers. Moreover, 75% of the bicyclists obey traffic signs and signals in order to move safer in the streets. That is a high percentage but not enough. Comparing it with the car drivers' one is much lower.

3.1.7 Question No 7 – "How often did you daily use your bike?"

In the seventh question, we asked the bicyclists how often they used their bicycle for daily trips. Their answer was:

- 24%, one trip per day
- 22%, two trips per day
- 54%, three or more trips per day

As we see, bicycle users use their bike a lot and more than 50% of them for more than 3 trips per day, considering it as the main transport mode they daily use.

3.1.8 Question No 8 – "What is the purpose of your trips?"

In the eight and last question, we asked the bicyclists what were the most common purpose of the bicycle trips. Their answer was:

- 42%, business
- 39%, entertainment
- 19%, sport

A relative high percentage of 42% of the bicyclists' urban trips has as destination the working place. This is a very important result, because there is a serious tend of using a bicycle for trips more important than sport or entertainment. Bicycle users who move to their working place need to move fast and reach more places with safety. Moreover, they are more economic dependent and can put some serious pressure to the local authorities in order to improve the road network, in bicycles favor.

3.2 Results of the grading of the questions

The bicyclists that took part in the survey had to put a grade in the first 5 questions of the questionnaire, in order to evaluate the bikeability of the city.

3.2.1 Grading the Question No 1 – "Is there a place to bike safely on/off road?"

In the first question, the bicyclists put a grade on the providence of a proper road environment of the city, where the bicyclists can ride with safety, with the rate of 3.83. It means that the road environment is good but there are some problems. The rate according to their sex was:

- Men, 3.82
- Women 3.85

The bicyclists' rate according to their age was:

- 15-25 years old, 3.78
- 25-35 years old, 3.22
- 35-45 years old, 4.30
- Over 45 years old, 4.13

We conclude that both men and women put the same grade. According to their age, bicyclists 25-35 years old were more skeptistic, rating the safety of the urban road environment with 3.22, which means that they face some problems when they ride their bike. On the other hand, older bicyclists are more optimistic, maybe because they are more used to the road traffic conditions (Fig. 4).

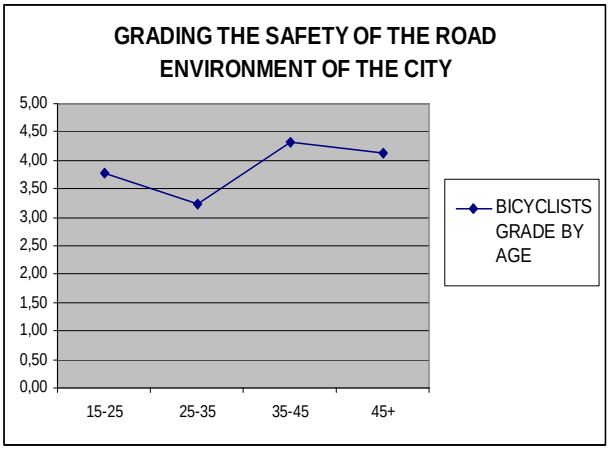

Figure 4: Grading the safety of the road environment of the city

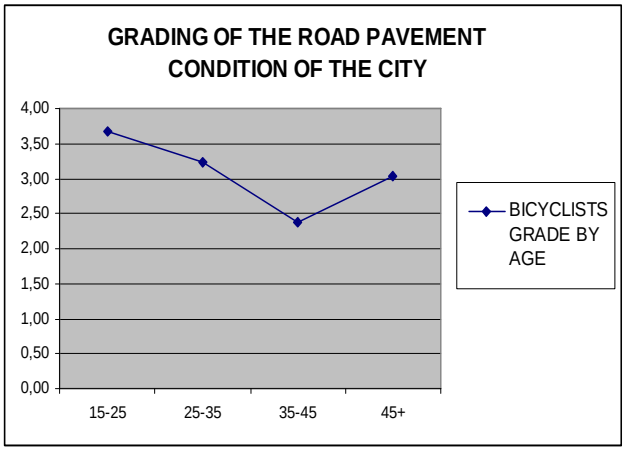

Figure 6: Grading of the road pavement condition of the city

Figure 5: End of the bikeway across the port

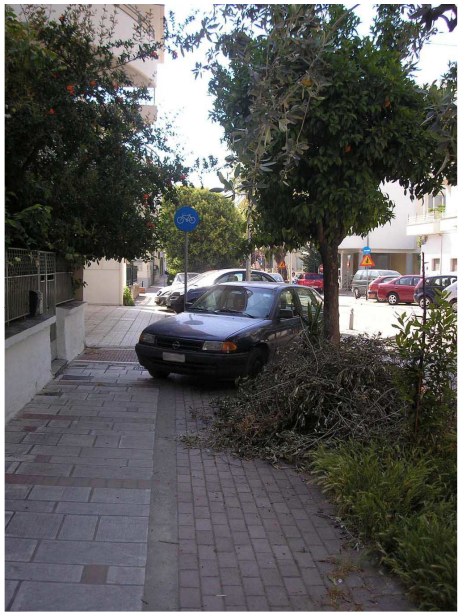

Figure 7: Obstacles and illegal car parking on the bikeway in "Rigas Feraios street"

3.2.2 Grading the Question No 2 – "How was the surface you rode on?"

In the second question, the bicyclists graded the pavements' maintenance with the rate of 3.27. It means that there are some problems of the road pavements conditions. The rate according to their sex was:

- Men, 3.43
- Women, 3.03

The bicyclists' rate according to their age was:

- 15-25 years old, 3.67
- 25-35 years old 3.22
- 35-45 years old, 2.38
- Over 45 years old, 3.04

Men were more optimistic, but women faced more problems with the condition of the pavement they rode on. According to their age, younger bicyclists that can handle better their bike consider that there is better maintenance of the road infrastructure comparing to older ones, but problems still exist (Fig. 6).

3.2.3 Grading of the Question No 3 – "Did you bike easy through intersections?"

In the third question, the bicyclists graded the ease of crossing the intersections with the rate of 3.89. It means that they cross the street relative easy. The rate according to their sex was:

- Men, 3.95
- Women, 3.80

The bicyclists' rate according to their age was:

- 15-25 years old, 3.73
- 25-35 years old, 3.67
- 35-45 years old, 4.15
- Over 45 years old, 4.21

Men and women crossed the streets with the same ease. According to their age, older bicyclists could cross easier the intersections probably because

they are more experienced than younger ones (Fig. 8).

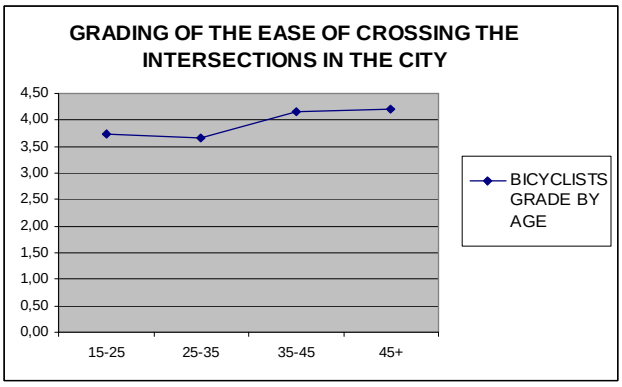

Figure 8: Grading of the ease of the crossing the intersections in the city

Figure 9: Intersection and bicycle crosswalk in "Rigas Feraios" street

3.2.4 Grading of the Question No 4 – "Did the car drivers had a proper behavior towards bicycle users?"

In the forth question, the bicyclists graded the drivers' behaviour towards them with the rate of 3.14. The rate according to their sex was:

- Men, 3.25
- Women, 2.98

The bicyclists' rate according to their age was:

- 15-25 years old, 3.18
- 25-35 years old, 2.72
- 35-45 years old, 3.31
- Over 45 years old, 3.29

Bicyclists consider that the drivers' behavior towards them is problematic. Both men and women had the same opinion. According to their age, bicyclists 25-35 years old consider that the drivers did not behave well, facing many problems. The bicyclists of the other age groups face some problems, but consider their behavior better (Fig. 10).

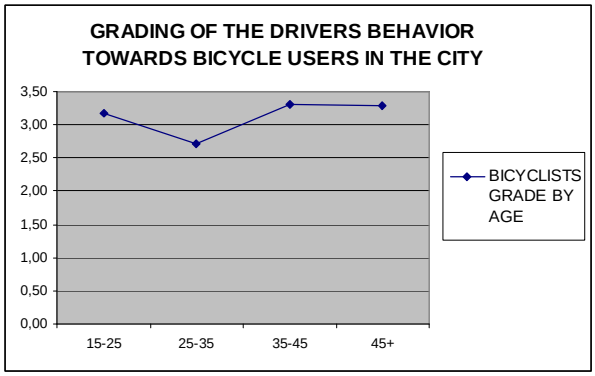

Figure 10: Grading of the drivers behavior towards bicycle users in the city

3.2.5 Grading of the Question No 5 – "The use of the bike was easy?"

In the fifth question, the bicyclists graded the ease of riding their bike with the rate of 4.00. The rate according to their sex was:

- Men, 3.85
- Women, 4.23

The bicyclists' rate according to their age was:

- 15-25 years old, 3.80
- 25-35 years old, 3.72
- 35-45 years old, 4.77
- Over 45 years old, 4.17

Surprisingly, women could ride easier their bike than men, without facing problems. According to their age, bicyclists 35-45 years old could ride their bike very easy and the rest bicyclists simply good (Fig. 11).

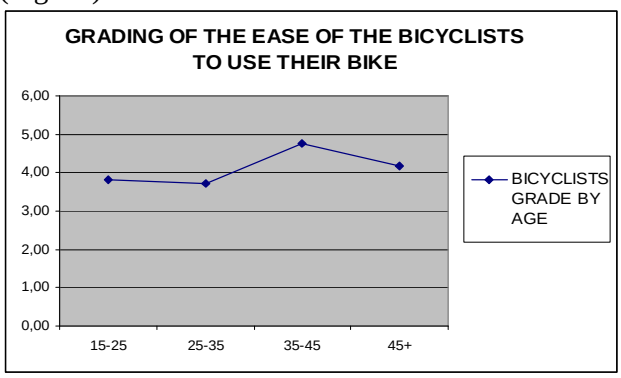

Figure 11: Grading of the ease of the bicyclists to use their bike

3.2.6 Grading the bikeability of the city

The total grade, as a summary of the 5 questions was **3.63** or in the rating scale of 5-30, **18.13**. This means that the bikeability of the city is "Good but with some problems". The rate according to the bicyclists' sex was:
Men, 3.66 (18.30)
Women, 3.58 (17.88)

The difference was not important. Both men and women consider that the bikeability of the city is good, but there are some problems. The bicyclists' rate according to their age was:

- 15-25 years old, 3.63 (18.16)
- 25-35 years old, 3,31 (16.56)
- 35-45 years old, 3.78 (18.92)
- Over 45 years old, 3.77 (18.83)

This rating means that younger bicyclists 25-35 years old are not very satisfied with the bikeability level of the city and face some problems that hamper them to bike easy. Older drivers are more used to traffic or do not have the proper education to judge properly (Fig. 12). In figures 13&14, we present the summary of the grading of the bikeability for each question.

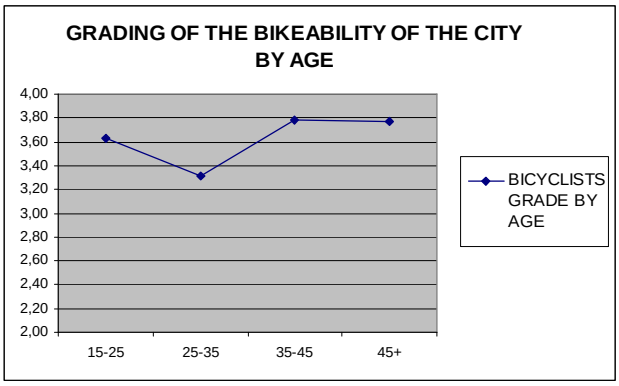

Figure 12: Grading of the ease of the bicyclists to use their bike

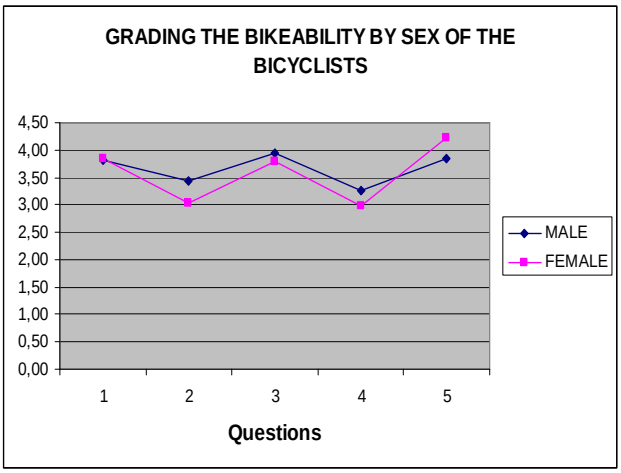

Figure 13: Grading the bikeability of the city by sex of the bicyclists

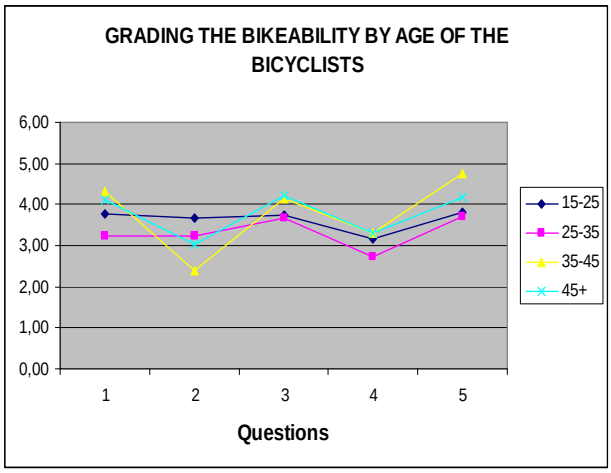

Figure 14: Grading the bikeability of the city by age of the bicyclists

4 Conclusions

Riding a bike is not an easy case, especially in a Greek city. There are many problems, but the situation can be improved in the city of Volos. Basically, it seems to be necessary the design and implementation of a functional bicycle network in the city. Moreover, the education of the bicyclists, even the necessity of a bicycle driving license could be useful in order to improve their road safety. Specifically, the conclusions were:

- The mixed road traffic is not proper for the bicycle users, feeling safer when biking separate from cars.
- The existing bicycle network of the city is not complete to cover the needs of the bicyclists.
- Poor road maintenance creates serious problems to the bicyclists.
- Crossing the intersections was not a serious problem, if the bicyclists obeyed the traffic signs and signals.
- Car drivers do not mostly behave well or pay attention to the bicyclists.
- Car and bicycle drivers are not used to each other.
- Bicyclists ride their bike relative easy.
- Bicyclists were not allowed to take their bike on the bus.
- Bicyclists move mostly (75%) in local streets, avoiding arterials.
- Bicyclists rarely wear helmets for their protection (10%), but many of them use lights on their bikes moving during the night (40%).
- Bicyclists use to obey traffic signs and signals (75%).

- Bicyclists use their bike for many trips per day, mostly for business and entertainment.

Enhancing bicycle use and walking is the answer to the daily transportation problems of the cities. Cities that reinforce their use become more sustainable, accessible, friendlier for their citizens and finally economically more competitive. Emphasis on the bikes' infrastructure construction is not a waste of money, but the proper future for our cities.

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