Perceptions of pedestrians for interventions at the urban environment

Lazou O[1]., Sakellariou A[1]., Basbas S.[1] and Politis I.[2]

[1]*Faculty of Rural & Surveying Engineering, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece, smpasmpa@auth.gr*
[2]*Faculty of Civil Engineering, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece, pol@civil.auth.gr*

Abstract
In the framework of the present paper, two pedestrian streets which are located in the central area of the Municipality of Kalamaria, Greece, were selected and their LOS is calculated through the use of HCM 2010. The data collected for the calculation of LOS include the geometric characteristics of the pedestrian streets, pedestrian flows and pedestrian speed. The survey period was November – December 2013. The objective of the research is to identify (if any) possible observed differences between the two pedestrians streets, as they are perceived by the users (pedestrians). For that purpose, 300 questionnaires were collected, equally distributed between the two pedestrian streets during the period October-November 2013. The perceived level of service was estimated by the users through the selection amongst six (6) different cards; each card represented difference walking conditions in terms of pedestrian flow, available free surface per pedestrian, obstacles and conflicts etc. The paper presents a descriptive and inferential statistical analysis in order to identify possible differences on the perceptions of the pedestrians between the two pedestrian streets. Depending on the measurement scale of the variables, various statistical bi-variable tests have been performed. The inferential analysis, identify differences on the perceptions of the pedestrians between the two pedestrian streets for most of the issues examined (e.g. the attractiveness of the existing land uses, safety and the security feelings, cycling attractiveness etc.). Finally, the analysis showed that the responder are perceiving the provided level of service in a different manner compare to the level of service as it is calculated by the Highway Capacity Manual 2010.

Keywords: Pedestrians, Level of Service, HCM, Kalamaria

1. Introduction

Modern communities worldwide try to improve the quality of life for their citizens through the development of Sustainable Urban Mobility Plans (SUMP). Walking is considered as one of the basic pillars of a SUMP. Good examples of SUMP elements and activities are included in the report "Guidelines – Developing and implementing a sustainable urban mobility plan" (Rupprecht Consult – Forschung und Beratung GmbH., 2011). The benefits of walking refer to better environmental conditions in terms of air pollution, energy consumption, traffic noise and visual intrusion and also to health and safety. As far as the infrastructure is concerned, pedestrian streets offer the ideal environment for pedestrian trips when they are properly designed. The pedestrian level of service (LOS) can be used in order to evaluate existing pedestrian facilities or design new ones. Measuring pedestrian LOS can be done by using the Highway Capacity Manual (HCM) of the Transportation Research Board, USA (TRB, 2010).
There are numerous studies in the literature, examine the LOS of pedestrian roads, as well as developing new methodologies for the optimum calculation of LOS. Leather et al (2011) for example, examined the walkability and the level of pedestrian facilities in 13 main Asian cities and observed low rates of satisfaction.
Asadi-Shekari et al (2014) developed a new extended LOS index (PLOS) in order to calculate the LOS for pedestrian road at campuses, based to a previous work (Asadi-Shekari et al, 2012) which was concentrated primariry at urban roads. Similar works can be also considered the studies of Cervero & Duncan (2003), Landis et al (2001), Polus et al (1983), Petrittsch et al (2006) etc.

In the framework of the present paper, two pedestrian streets which are connected (part of Komninon Str. and part of Metamorfoseos Str.) and which are located in the central area of the Municipality of Kalamaria, Greece, were selected and their LOS is calculated through the use of HCM 2010. LOS as perceived by the users (pedestrians) was also investigated based on the results of a questionnaire survey that was conducted at the two specific pedestrian streets.
The paper presents a descriptive and inferential statistical analysis in order to identify possible differences on the perceptions of the pedestrians between the two pedestrian streets. Depending on the measurement scale of the variables, various statistical bi-variable tests have been performed.

2. Study area

The study area is the center of the Municipality of Kalamaria which is located in the eastern part of the Thessaloniki Metropolitan Area, Greece. According to the results of the national census of 2011, the population of the Municipality is 91270 inhabitants and the population density is 14258.71 inhabitants/km^2 (Municipality of Kalamaria, 2014). There are two main pedestrian streets in the study area, namely part of Komninon Str. and part of Metamorfoseos Str. The first pedestrian street (Komninon) which is the oldest one is characterized by the large number of coffee bars and retail stores, thus attracting a large number of visitors on a daily basis. Viewpoints of the Komninon pedestrian street are presented in Figure 1.

Figure 1: Viewpoints of Komninon pedestrian street

The construction of the second pedestrian street (Metamorfoseos) has started in 2011 and is now (year 2014) fully operational. It is connected with the pedestrian street of Komninon and they form together the basic pedestrian street network in the Municipality. It is characterized by a large number of retail shops and a bicycle path. It must be noticed that there is one-way street for the vehicular traffic alongside the pedestrian street. The one-way street is a traffic calming oriented street and serves private vehicles at low speed as well as public transport (buses). Viewpoints of the Metamorfoseos pedestrian street are presented in Figure 2.

Figure 2: Viewpoints of Metamorfoseos pedestrian street

3. Calculation of pedestrian Level of Service

The data collected for the calculation of LOS for the pedestrians include the geometric characteristics of the pedestrian streets, pedestrian flows and pedestrian speed. The survey period was November – December 2013. A specific, representative, segment of Komninon was selected for the purpose of

LOS calculation. It has a length of 106 m. and a width of 9.4 m. The speed of pedestrians is based on 100 counts and its was found equal to 1.35 m/s. Pedestrian flows are presented in Table 1.

Table 1: Pedestrian flows in Komninon pedestrian street

Time period	Pedestrian flow (both directions)
12:00-12:15	408
12:15-12:30	382
12:30-12:45	428
12:45-13:00	378
13:00-13:15	328
13:15-13:30	295
13:30-13:45	250
13:45-14:00	249

According to methodology of the HCM2010 walkway LOS can be calculated taking into account the average space, the average speed, the flow rate and the volume/capacity ratio (v/c). Using the HCM2010 methodology, LOS is found to be A in all cases (where level A is the best value and level F the worst value). This means that pedestrians can move in their desired paths without any problem and they do not have to alter their movements (TRB, 2010).
The above mentioned steps are followed in the case of Metamorfoseos pedestrian street. A specific, representative segment of Metamorfoseos was selected for the purpose of LOS calculation. It has a length of 89,2 m. and a width of 2.8 m. The speed of pedestrians is based on 100 counts and its was found equal to 1.24 m/s. Pedestrian flows are presented in Table2.

Table 2: Pedestrian flows in Metamorfoseos pedestrian street

Time period	Pedestrian flow (both directions)
11:30-11:45	150
11:45-12:00	150
12:00-12:15	179
12:15-12:30	166
12:30-12:45	189
12:45-13:00	160
13:00-13:15	163
13:15-13:30	168

Taking into account all the criteria (apart from average speed) under consideration for the Metamorfoseos Str., LOS was found to be A. When the criterion of average speed is used in the calculations, LOS for the specific pedestrian street was found to be C. The latter can be possibly explained by the fact that pedestrians make more stops due to the large number of retail shops (they stopped to look at the window and therefore they reduce their speed).

4. Questionnaire-based survey for the perceived LOS

LOS as perceived by the users (pedestrians) was also investigated based on the results of a questionnaire-based survey that was conducted at the two specific pedestrian streets. The objective of the research is to identify (if any) possible observed differences between the two pedestrians streets, as

they are perceived by the users (pedestrians). For that purpose, 300 questionnaires were collected, equally distributed between the two pedestrian streets during the period October-November 2013.

The questionnaire consisted of three sections; at the first section the main socioeconomic characteristics of the responder were collected such as the age and the gender, at the second section the mobility profile of the responder related to the specific pedestrian street was identified such as the frequency and the trip purpose. Additionally, at the second section, the perception of the pedestrians for issues such as the safety and security at the pedestrian street, the quality of public transport services nearby the pedestrian street, the parking conditions as well as the attractiveness for cycling were also examined.

Apart from the current perceptions, the responders were asked to evaluate whether the reconstruction of the network (e.g. rebuilt of the pedestrian street Komninon Str. and the pedestrianization of Metamorfoseos Str.) have improved or not all these abovementioned issues. Finally, at the third section the perceived level of service at the pedestrian street was given by the users. The perceived level of service was estimated by the users through the selection amongst six (6) different cards; each card represented difference walking conditions in terms of pedestrian flow, available free surface per pedestrian, obstacles and conflicts etc. These cards are designed by Skepastidou (Skepastidou 2008) in the framework of her Master Thesis.

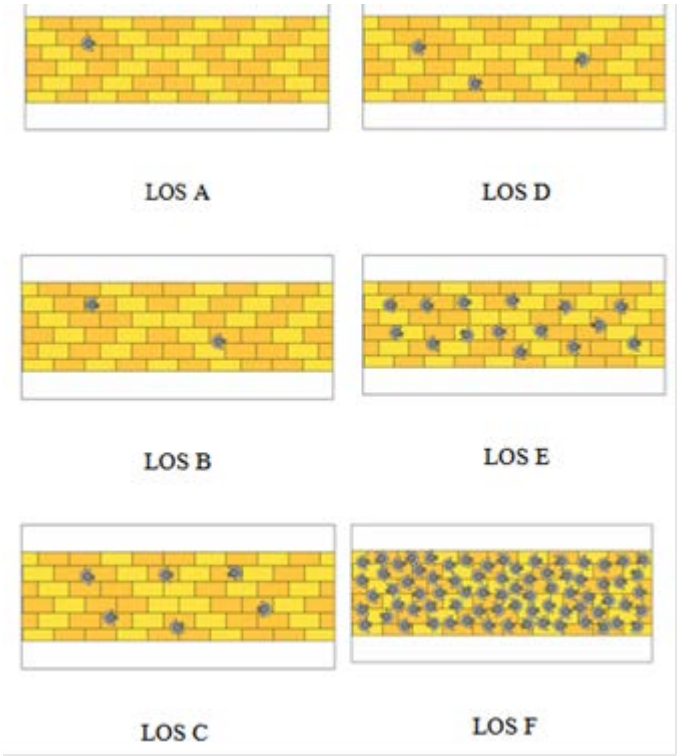

Figure 3: Cards representing pedestrian LOS

Source : (Skepastidou 2008)

4. Comparative analysis between the two pedestrian roads

Table 3 presents the results of the questionnaire-based survey as far as the issues of comfort, safety and security are concerned. It must be mentioned at this point that safety refers to “road safety” (i.e., road accidents) and security refers to “personal security” (i.e., stealing). At Table 3, “1” refers to responses of “Very Good”, “2” refers to responses “Good”, “3” refers to responses “Medium” and “4” refers to responses “Poor”.

Table 3: Perception about comfort, safety and security in the examined pedestrian streets

	Komninon Street				Metamorfoseos Street			
	1	2	3	4	1	2	3	4
Comfort	10.67%	75.33%	10.67%	3.33%	39.33%	42.00%	15.33%	3.33%
Safety	8.67%	76.00%	12.00%	3.33%	26.00%	54.00%	16.00%	4.00%
Security	12.00%	73.33%	13.33%	1.33%	43.33%	44.00%	10.00%	2.67%

Table 4, presents the results of the inferential statistics for the perceptions of “comfort”, “safety” and “security” between the two pedestrians roads examined. As it can be easily concluded, comfort and security are statistical different between the two roads with p-value<0.001.

Table 4: Statistical tests concerning comfort, safety and security

	Comfort	Safety	Security
Mann-Whitney U	8928	10072.5	8069
Wilcoxon W	20253	21397.5	19394
Z	-3.499	-1.851	-4.809
Asymp.Sig. (2-tailed)	0.000	0.064	0.000

From the Tables above, it can be easily concluded that pedestrians perceive Komninon Str. as a more comfort street compare to Metamorfoseos Str. The latter is observed to have better performance only to the perception of security. These outcomes seems to be plausible since Komninon Str. is a pedestrian road with high width and is used exclusively by the pedestrians; on the other side, Metamorphoseos Str. is only half used by pedestrians and half by cars. This fact may cause limitations in comfort feelings for pedestrians. Finally, Metamorfoseos Str is having better performance regarding security perceptions due to the fact that less pedestrians are using this road and therefore it is not so easy for someone to steal a wallet etc.

Another critical point of the study was the calculation of the walkway LOS and its comparison with the perceived level of service. Table 5 presents the results of the questionnaire-based survey as far as the level of service is concerned.

Table 5: Level of Service as perceived by the pedestrians in the examined pedestrian streets

Level of Service	Komninon Street	Metamorfoseos Street
A	0.67%	6.00%
B	9.33%	12.67%
C	40.00%	30.00%
D	28.67%	36.00%
E	14.00%	12.67%
F	7.33%	2.67%
Calculated LOS	A	A

In order to identify statistical differences between the two pedestrian roads, a similar to the previous case inferential tests was performed. Table 6 presents the results of this analysis.

Table 6: Inferential statistic test for the perceived Level of Service between the two pedestrian roads.

	Level of Service
Mann-Whitney U	10412
Wilcoxon W	21737
Z	-1,163
Asymp. Sig. (2-tailed)	0,245

As it can be seen from the above mentioned table, the pedestrians do not stated any statistical significant difference between the two roads regarding the perceived level of service (LOS). This outcome is similar to the calculated walkway LOS provided by the HCM manual where same LOS were calculated.
Inferential statistics were also used, in order to identify potential significant differences between the two roads, as regards the perceived level of service and various socioeconomic and mobility characteristics. Table 7, presents the z-scores together with the two tailed probability values for the two roads examined regarding the perceived level of service (control variable) and the age and mobility frequency intervals. As it can be seen, for both the two roads, the perceived level of service can be different according to the age and the frequency of using the specific road.

Table 7 Age and Frequency examination of statistical significance with the control variable of LOS for the two pedestrian roads

	Komninon Str		**Metamorfoseos Str**	
	Age	Frequency	Age	Frequency
Z	-4,44	-6,525	-5,419	-4,427
Asymp. Sig. (2-tailed)	0	0	0	0

6. Discussion

Taking into account all the criteria under consideration for the Komninon Str., LOS was found to be A. Taking into account all the criteria (apart from average speed) under consideration for the Metamorfoseos Str., LOS was found to be A. When the criterion of average speed is used in the calculations, LOS for the specific pedestrian street was found to be C.
The inferential analysis, identify differences on the perceptions of the pedestrians between the two pedestrian streets for most of the issues examined (only those elements which was found to have a statistical significant difference were presented at this paper). Finally, the analysis showed that the responder are perceiving the provided level of service in a different manner compare to the level of service as it is calculated by the Highway Capacity Manual 2010, but this difference was not statistical significant .

References

Asadi-Shekari, Z., Moeinaddini, M., & Zaly Shah, M. (2014). A pedestrian level of service method for evaluating and promoting walking facilities on campus streets. Land Use Policy, 38, 175-193.

Asadi-Shekari, Z., Moeinaddini, M., & Zaly Shah, M. (2012). Disabled pedestrian level of service method for evaluating and promoting inclusive walking facilities on urban streets. Journal of Transportation Engineering, 139(2), 181-192.

Cervero, R., & Duncan, M. (2003). Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay Area. American journal of public health,93(9), 1478-1483.

Landis, B. W., Vattikuti, V. R., Ottenberg, R. M., McLeod, D. S., & Guttenplan, M. (2001). Modeling the roadside walking environment: pedestrian level of service. Transportation Research Record: Journal of the Transportation Research Board, 1773(1), 82-88.

Leather, J., Fabian, H., Gota, S., & Mejia, A. (2011). Walkability and pedestrian facilities in Asian Cities. Asian Development Bank.

Municipality of Kalamaria, www.kalamaria.gr (last accessed July 2014)

Petritsch, T. A., Landis, B. W., McLeod, P. S., Huang, H. F., Challa, S., Skaggs, C. L., ... & Vattikuti, V. (2006). Pedestrian level-of-service model for urban arterial facilities with sidewalks. Transportation Research Record: Journal of the Transportation Research Board, 1982(1), 84-89.

Polus, A., Schofer, J. L., & Ushpiz, A. (1983). Pedestrian flow and level of service. Journal of Transportation Engineering, 109(1), 46-56.

Rupprecht Consult – Forschung und Beratung GmbH., 2011, Guidelines – Developing and implementing a sustainable urban mobility plan, Sustainable Urban Mobility Plans, Supported by Intelligent Energy Europe.

Skepastidou A., 2008. Investigation of needs for pedestrian trips. Master Thesis. Supervisor: Basbas S., Inter-departmental Postgraduate Programme , “Planning, Organization and Management of Transport Systems”, Aristotle University of Thessaloniki, Department of Civil Engineering and Department of Rural and Surveying Engineering, Hellenic Institute of Transport.

Transportation Research Board of the National Acedemies (TRB), 2010. Highway Capacity Manual (HCM2010), Volume 3: Interrupted Flow, Chapter 23: Off-street pedestrian and bicycle facilities, Washington, DC.

Lazou O. and Sakellariou A., 2014. Investigation of pedestrians’ level of service in pedestrian streets of the Municipality of Kalamaria. Diploma Thesis. Supervisor: Basbas S., Faculty of Rural & Surveying Engineering, Aristotle University of Thessaloniki, (in Greek with English abstract).