Investigating Commercial Vehicles' Parking Habits in Urban Areas: The Case of Thessaloniki, Greece

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Abstract. The COVID-19 pandemic changed the way modern societies are organized and perform in so many ways. Inevitably, Urban Road Freight Transport (URFT) has also been affected by the pandemic in many ways. For example, e-commerce has increased over the last 3 years compared to the traditional shopping ways that required the physical presence of the buyers at the retail shops; last mile delivery has changed due to the necessity of mobilizing environmentally friendly vehicles and abandoning gradually vehicles with internal combustion engines, etc. Despite the above, URFT still requires specially designed areas and facilities for its activities to be undertaken. Such areas are the parking spaces dedicated to be used only by commercial vehicles (VCs) in order to perform loading and unloading activities. This necessity seems not only to be constant but also to be on the increase. At the city of Thessaloniki, Greece, our research team has, over the last 14 years, been periodically monitoring these parking spaces in terms of their evolution concerning their number and location as well as their level of usage. The present paper presents the evolution of the number, location, and level of usage of the abovementioned parking spaces to become a useful tool for the local decision-makers (municipal authorities). The issue of determining the locations of these loading and unloading parking spaces for commercial vehicles must be based on scientific data and the true needs of the URFT's stakeholders. After all, public space in urban areas decreases year after year. It is important and almost self-evident that the way the available public space is used should maximize society's benefit. In this framework, the current paper presents the key findings of this evolution in the city of Thessaloniki, enumerating proposals on how to achieve maximum usage of the parking spaces without affecting the URFT's level of performance.

Keyword: Parking spaces for commercial vehicles · Logistics · Thessaloniki

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1 Introduction

The COVID-19 pandemic affected the life of all societies for almost 3 years in many ways. Central governments worldwide applied mobility restriction measures, lockdowns, teleworking and many other measures to minimize the effects.

Inevitably, Urban Road Freight Transport (URFT) was also affected by the pandemic in many ways. During the lockdowns and mobility restrictions measures, e-commerce increased as people had to find ways to continue their lives without being able to continue shopping with the traditional way: with physical presence at the retail shops. Last mile delivery also changed as the demand was decreased and delivering goods required a non-touching process due to health protocols. Even when the pandemic was set under partial control at least at the more advanced societies, the necessity of mobilizing environmentally friendly vehicles and abandoning gradually vehicles with internal combustion engines was brought to the surface. Despite all the above-mentioned, URFT still requires specially designed areas and facilities in order for its activities to be undertaken, dedicated for this purpose parking spaces. This necessity is constant and perhaps now is increasing as urban mobility is not achieved.

At the city of Thessaloniki, Greece, the authors have been (over the last 14 years) periodically monitoring these parking spaces in terms of their evolution (i.e. number, locations and level of usage). The paper presents this evolution aiming to become a useful tool at the hands of the local decision-makers (municipal authorities). The issue of determining the number and the locations of these parking spaces must be based on scientific data and the true needs of the URFT's stakeholders. After all, available space in urban areas becomes more and more difficult to be found, making harder and harder for the local and regional policy makers to decide how to use it. It is important and almost self-evident that the available public space must be used in such way that maximizes society's benefit.

In this framework, the paper also presents the key findings of this evolution in the city of Thessaloniki, enumerating proposals on how to achieve maximum usage of the parking spaces without affecting the URFT's level of performance by Pitsiava-Latinopoulou et al. [1]. The paper is structured as the following: Sect. 2 presents the Literature Review, Sect. 3 present the Methodology followed for the data collection, Sect. 4 presents the Analysis and results and finally Sect. 5 the main Conclusions.

2 Literature Review

A significant number of case studies research private cars parking problems in urban areas by Abbood et al. [2], Andreeva and Muzykin [3], Magdin et al. [4], Cempirek et al. [5], Shen et al. [6], Holguin-Veras and Amaya [7], Jacob and Menedez [8] while other are focused on the commercial vehicles' (CVs) parking problems as Vorhes et al. [9], Kawamura et al. [10], Jaller and Holguin-Veras [11], Kim and Wang [12], Tamayo et al. [13], de Oliveira and Guerra [14], Wenneman et al. [15], Betkier and Macioszek [16] and finally Giraldo et al. [17].

As mentioned above, as urban areas become denser, available land for parking decreases, making it increasingly difficult for CVs to find a parking spot. Additionally, the high cost of land in urban areas makes it economically unfeasible to construct new parking spaces to cover the carriers' needs.

Another challenge is the limited time CVs are permitted to park in certain areas. During this time window, loading/unloading activities must be implemented making it difficult for the drivers to complete their tasks efficiently as mentioned by Figliozzi [18] and Pinto et al. [19]. This limitation can result in drivers spending more time searching for parking spots than completing their tasks.

The lack of available parking spaces and time limitations can lead to increased traffic congestion, fuel consumption, and emissions. Furthermore, low hourly occupancy of these parking spaces by the CVs' drivers in some cases is explained by the fact that they prefer to park illegally as closer as they can to their final destination than to these specially constructed parking places as mentioned by Lizbetin and Bartuska [20] and Bouhouras et al. [21] creating thus bottle-necks and congestion phenomena, especially when more than one CVs approach simultaneously the same parking space as mentioned by Chiara and Cheach [22] and Ezquerro et al. [23] Parking choices and decision making criteria of the CVs' drivers as well as other issues have been examined by many researchers: ways to improve mobility through the optimization of of loading/ unloading bays' usage by Alho et al. [24]; identifying the impact of traffic congestion when optimizing delivery routes in real time by Alvarez et al. [25]; planning the on-street loading/ unloading spaces by Aiura and Taniguchi [26]; analyzing available space proper usage concerning delivery practices by Gardrat and Serouge [27].

3 Methodology

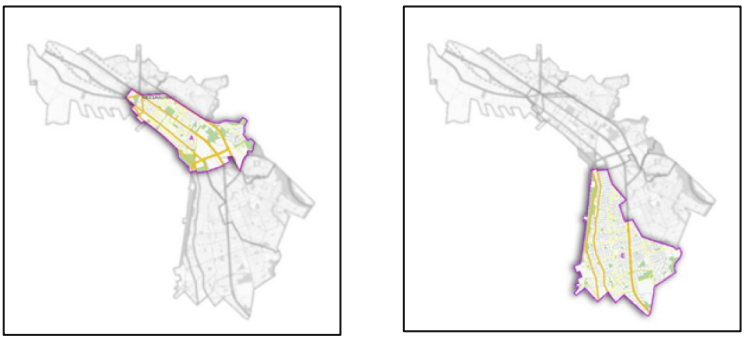
The under-study area concerns the Municipality of Thessaloniki, covering almost 19km^2 according to Municipality of Thessaloniki [28] and specifically a) city's commercial central area/Municipal Community A and b) the eastern area/Municipal Community E as presented in Fig. 1 according to Municipality of Thessaloniki [29].

Since 2007, the authors have been monitoring periodically (nonconsecutive timeline) URFT system in the city of Thessaloniki, collecting data about geographical position (coordinates) and the number of the above-described dedicated CVs' parking spaces.

The present paper presents in a summarized way the main findings of our research over the last 14 years. Through in situ surveys, the undergraduate students (research teams) of School of Rural & Surveying Engineering of the Aristotle University of Thessaloniki in the framework of their Thesis recorded the geographical locations of these parking spaces using mobile GPS devices (after 2014) as well their number and relative parking legislation by Adamou and Oulis [30], Zimis and Lamprou [31], Kakarakis et al. [32], Giannoudis and Emmanouilidis [33], Danelatos and Tsakiris [34] and Koenta [35].

The research teams walked along the entire road network of these two areas to identify by the vertical and horizontal respective signage the CVs' parking spaces.

This process was time consuming and, in some cases, the crews faced tough weather conditions (rain, snowfall, strong wind). Because the research teams were using mobile GPS devices provided by the Laboratory of Transportation Planning, Traffic & Highway



(a) (b)

Fig. 1. (a) Municipal Community A; (b) Municipal Community E of the city of Thessaloniki (Municipality of Thessaloniki, 2022)

Engineering the precision on the parking spaces location is ±2m. To minimize the deviation, the research teams in the field measured the distance of the parking spaces' borders from permanently established elements of the sidewalks (e.g. streetlights and/ or neighboring buildings).

Moreover, the research teams recorded where possible ancillary data such as the status of these parking spaces (free, occupied by CVs, occupied by other type of vehicles, occupied by other items such as trashcans).

When this process was completed and the respective database was developed, the research teams returned to the field to record data at predefined parking spaces concerning their hourly occupancy by CVs (the number of CVs using the parking space for loading/unloading procedures during the period of one hour).

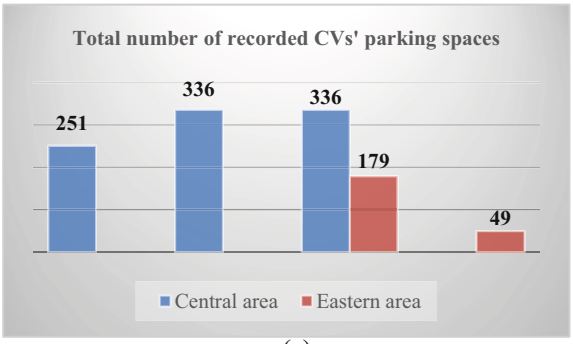
It must be mentioned that the research teams were advised to also collect data concerning CVs illegally parked (a distance smaller than 20 m from the parking space being surveyed) to perform loading/ unloading activities.

4 Analysis and Results

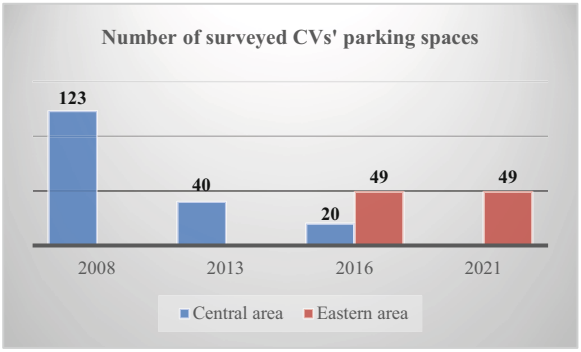
Based on the data presented in Fig. 2(a) and 2(b), the number of CVs' recorded parking spaces over exceeded the number of the surveyors. As a result, it was not possible to conduct simultaneous surveys for all these parking spaces.

Therefore, the surveys were spread over time covering each time a single 'time frame' of the (at the time) current situation. When all surveys concerning hourly occupation were completed, the collected data were analyzed as presented in Fig. 2(c).

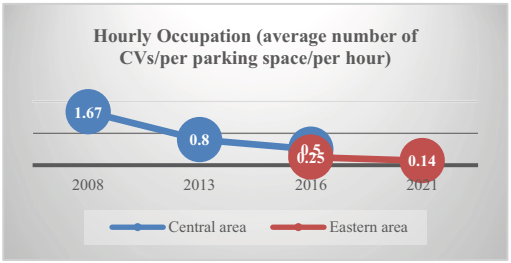
During the surveys in 2014, the surveyed CV's parking spaces (40 in number) were located at the central area. Most of these surveys concerned illegally occupied parking spaces mainly by private cars and in a few cases by trashcans [32]. During the surveys in 2017 in the eastern area, 58 loading/ unloading activities were recorded in total. By those, 43 (74%) concerned CVs parking illegally while the rest 15 (26%) concerned CVs using legally the parking spaces [34].



(a)



(b)



(c)

Fig. 2. (a)Total number of recorded CVs' parking spaces; (b) Number of surveyed CVs' parking spaces; (c) Hourly Occupation (Own elaboration)

Regarding the central area during the 2017 surveys, 98 loading/ unloading activities were recorded in total. By those, 83 (85%) concerned parking illegally while the rest 15 (15%) concerned CVs legally using the parking spaces [34].

Finally, during the 2022 surveys in the eastern area, 11 loading/ unloading activities were recorded. Five of them (45%) concerned illegal parking, while the rest six (54%) concerned legally parking CVs [35]. Although in many cases CVPS were occupied by private cars or trashcans, not allowing thus the drivers of the CVs to use them, the drivers

chose not to search for the next closer to them available parking space, but instead they decided to park illegally to load/ unload the commodities/ goods.

The above-mentioned collected and analysed data are presented in Figs. 3, 4, 5, 6 and 7. Specifically, Fig. 3 presents the evolution of the available CVPS between 2008 and 2016 as recorded in three periods (2008, 2013 and 2016) in the central area of the Municipality of Thessaloniki. The number of CVPS between 2013 and 2016 remained the same but their locations were different.



Fig. 3. Recorded available CVPS in the central area of the Municipality of Thessaloniki for the years 2008, 2013 and 2016

Figure 4 presents the evolution of the available CVPS between 2016 and 2021 as recorded in two period (2016 and 2021). The total number of the available CVPS in this area was slightly increased; the locations of just few of them were different between the surveys.

Regarding the surveyed level of usage of the CVPS located in the two above-mentioned areas, Figs. 5, 6 and 7 present (as heat maps) the hourly occupancy (number of CVs using the CVPS during a period of one hour) of the CVPS in order to implement loading/ unloading procedures for the following cases a) the central area for the year 2016, b) the eastern area for the year 2016 and c) the eastern area for the year 2021.

Based on Fig. 5, the higher number of CVs using a CVPS during an hour is three (3). That means that in average the crew of each CV required 20 min to implement their loading/ unloading procedures. Furthermore, the locations with the higher occupancy are located at the core of the commercial center of the city (the area enclosed by Tsimiski str., Leoforos Egnatia, Dodekanisou str. And Aggelaki str.). In this area, most of the retail shops are located as well as residents and of course other types of land uses. Tsimiski str. as well as Leoforos Egnatia serve in a daily basis significant traffic volume. Tsimiski str. is a one-way road heading from East to West with three (3) lanes for the general traffic as well as one (1) bus lane. Leoforos Egnatia, is a two-way road with two (2) lanes per



Fig. 4. Recorded available CVPS in the eastern area of the Municipality of Thessaloniki for the years 2016 and 2022

direction for the general traffic as well as one bus lane. Finally, Figs. 6 and 7 present the hourly occupation of the CVPS at the eastern area for the years 2016 and 2021.



Fig. 5. Recorded hourly occupancy at the CVPS in the central area of the Municipality of Thessaloniki for the year 2016



Fig. 6. Recorded hourly occupancy at the CVPS in the eastern area of the Municipality of Thessaloniki for the year 2016



Fig. 7. Recorded hourly occupancy at the CVPS in the eastern area of the Municipality of Thessaloniki for the year 2021

By analysing Figs. 6 and 7 during this period of 5 years, the hourly occupancy presenting high values remained only for one area (1), as area (2) disappeared. Furthermore, low hourly occupancy values were recorded in three (3) new area in 2021 compared to 2016 near the coastal zone and along Vas. Olgas str. The remaining high hourly occupancy value concerns the intersection of 25 Martiou and Delfon streets. Many retail shops are installed along those two streets that serve significant traffic volumes on a daily basis.

5 Conclusions

There are some quite interesting conclusions extracted from this paper, despite the limitations acknowledged. The main limitation concerns the fact that during the surveys, the number of surveyors was not sufficient to collect data simultaneously regarding hourly occupancy from all surveyed CVPS. That means that the surveyors were able to collect data from a specific number of CVPS per day, recording just a frame of how the URTF system performed each day. The second significant restriction concerns the fact that the timeline of the surveys is fragmentary and not consecutive. This is because the surveys were implemented by (at the time) undergraduate students at School of Rural and Surveying Engineering of the Aristotle University of Thessaloniki in the framework of their Theses.

In the central area, despite the increase of the available CVPS between 2008 and 2016 (33.9%), the hourly occupancy has been decreasing and specifically between 2008 and 2013 has decreased by 97%. In the eastern area, based on the identified CVPS (without calculating the assumed CVPS) there was an increase on their number between 2016 and 2022 (32.4%) but the hourly occupancy was decreased by 44%. Researchers suggest that low values of hourly occupancy seem to be a common problem in urban areas according to de Oliveira & Guerra (2014), while others highlight the fact that in several cases the drivers of CVs prefer to park illegally close to their final destination rather than use a CVPS even if it rather close to that location (not over 50 m) [23]. It can be strongly assumed (based on the collected and analysed data) that the URFT system in the Municipality of Thessaloniki is underperforming. Furthermore, it is rather obvious that the network of CVPS is not properly designed in terms of their numbers and locations. Despite increasing their numbers, hourly occupancy is decreasing meaning that the CVs park illegally rather than suing them to perform loading/ unloading procedures. Another interesting aspect (remains though to be thoroughly analysed by the authors) concerns if and in which level the Municipal Police supervises the CVPS ensuring that they are free and properly used by the CVs. The Municipal Police is assigned to supervise not only traffic and parking but many other aspects of the city's life, with a restricted number of personnel.

Innovative solutions could be applied concerning monitoring the CVPS by using sensors installed at them which inform the respective authorities about a) which CVPS are occupied, b) for how long and c) by which vehicles (the registration plate of the vehicle is scanned). Through this approach, Municipal Police will not be forced to supervise the CVPS in situ. Another measure, could consider the installation of an Urban Consolidation Centre serving the under-study area with Light Goods Vehicles (LGVs) instead of Medium and Heavy Goods Vehicles (MGVs/ HGVs) [36]. Although this would require a higher number of trips to serve the needs of the receivers (as the loading capacity of LGVs is smaller than MGVs and HGVs) which could lead to higher air pollution as higher number of vehicles should be mobilized, new technologies as well as alternative types of vehicles (tricycles, bicycles, electric vehicles) could perform as counterweight.

It is necessary for the respective authorities to develop a holistic approach not only for CVPS' network and their level of usage, but the way the URFT system in the city of Thessaloniki is designed and performing. It is important to monitor (with the highest

possible frequency) the aspects presented in this paper, so that any decision made is based on scientific data covering the real and true needs of the URFT system's stakeholders.

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