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A Model Proposal for Determining Heavy Vehicle Parking Capacities in Rural Areas: A Case Study of Izmir

Kırsal Alanlarda Ağır Vasıta Araçlarına Yönelik Park Tesisleri Kapasitelerinin Belirlenmesi: Izmir Kırsalı Örneği

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Abstract

Effective planning of heavy vehicle parking areas is a significant factor in providing accessibility in urban and rural areas. Because of unplanned or unqualified planning of heavy vehicle parking areas, heavy vehicles park in undefined areas within the city instead of parking facilities. Such areas are freight-transported facilities, urban gaps, rural areas and most importantly trackside. Roadside parking of heavy vehicles in rural and urban areas causes many transportation problems. The aforementioned type of parking creates traffic safety and traffic capacity problems. Traffic accidents and congestion are increasing due to roadside parking on winding and fast roads between districts and villages in rural areas. At the same time, those parking movements slow down the traffic and reduce accessibility. While there are many studies on capacity and location selection of heavy vehicle parking areas in urban areas in the literature, methods for determining the capacity of heavy vehicle parking areas in rural areas are insufficient.In this study, the capacities of heavy vehicle parking areas in rural areas have been estimated under various assumptions by utilizing the data of the Izmir Sustainable Urban Logistics Plan- Logistic Analysis and Suggestions Report for Rural Development Regions. The non-transit heavy vehicle volumes in the districts were calculated from the traffic assignments made within the scope of the plan, while the rates of heavy vehicles in the districts, roadside parking rates and post-operative waiting times were also calculated using roadside driver surveys. With the generated approach, heavy vehicle parking requirements in rural areas defined within the scope of the mentioned plan were determined based on districts.

Keywords: *Rural area, Heavy vehicle, Parking, Izmir*

Öz

Ağır taşıt park alanlarının etkin şekilde planlanması kentsel ve kırsal alanlarda erişilebilirliğin sağlanması açısından önemlidir. Ağır taşıt park alanlarının planlanmaması ya da niteliksiz planlanması sonucunda ağır vasıtalar araçlarını park tesisleri yerine kent içindeki tanımsız alanlara park etmektedirler. Bu alanlar yük taşınan tesisler, kentsel boş alanlar, kırsal alanlar ve en önemlisi yol kenarlarıdır. Ağır vasıtaların kırsal ve kentsel alanlarda yol kenarı parklanması yapması pek çok ulaşım sorununa sebep olmaktadır. Anıla parklanma türü trafik güvenliği ve trafik kapasite sorunları yaratmaktadır. Özellikle kırsal alanlarda, ilçeler arası yollarda ya da köy yollarında virajlı ve hızlı yollarda yapılan yol kenarı parklanmalar nedeniyle trafik kazaları ve sıkışıklıkları yaşanmaktadır. Aynı zamanda anılan parklanmalar trafiği yavaşlatmakta ve erişilebilirliği düşürmektedir. Kentsel alanlarda ağır taşıt park alanlarının kapasite ve yer seçimlerine yönelik pek çok çalışma mevcutken kırsal alanlarda ağır vasıta park alanlarının kapasitelerinin nasıl belirleneceğine yönelik metot ve yöntemler yetersizdir. Bu çalışmada, kırsal alanlardaki ağır vasıta park alanlarının kapasiteleri İzmir Sürdürülebilir Kentsel Lojistik Planı'nın verilerinden yararlanılarak çeşitli varsayımlar için bulunmuştur. İlçelerdeki transit olmayan ağır vasıta hacimleri plan kapsamında yapılan trafik atamalarından, ilçelerdeki ağır vasıta oranları, yol kenarı parklanma oranları ve operasyon sonrası bekleme süreleri de plan kapsamında yapılan yol kenarı sürücü anketlerinden yararlanılarak hesaplanmıştır. Üretilen yaklaşım ve model aracılığı ile plan kapsamında tanımlanan kırsal bölgelerdeki ağır vasıta park yeri ihtiyaçları ilçe bazında tespit edilmiştir.

Anahtar Kelimeler:*Kırsal alan, Ağır taşıt, Parklanma, İzmir*

1. Introduction

According to the data on traffic accidents with fatalities and injuries published by the General Directorate of Highways, 3,770 of the 66,976 accidents that occurred in rural areas or in non-residential areas involved trucks. Of those accidents, 122 of the 3,206 drivers who died were truck drivers [1]. The most important factor in the increase of accidents is the choice of roadways in passenger and freight transport modes. In particular, the high number of heavy vehicles used in freight transport (trucks, tow trucks, etc.) and the severity of accidents involving such vehicles increase the rate of deaths and injuries [2]. Professional truck drivers are known to have a higher average age than the general driving population and drive for a different purpose and spend more time on the road than the general public [3-4]. In order to reduce heavy vehicle accidents, inspections should be increased, road traffic should be reduced, and use of alternative modes of transportation should be increased. Effective planning of logistic processes and parking areas for heavy vehicles is important in reducing downtimes and traffic congestion. At the same time, parking spaces need to be integrated into planning within accessibility constraints and corridors, not on a point basis[5]. Illegal parking of heavy vehicles is estimated to be one of the reasons behind accidents involving heavy vehicles. However, little has been done to investigate the causes of illegal parking and to develop strategies to reduce it [6].

Heavy vehicles parked in rural areas reduce the level of traffic safety, especially in curved roads where the project speed is high. For traffic flow and safety, it is important for drivers , to wait in parking areas specially designed for them. Drivers of vehicles carrying cargo for commercial purposes whose maximum weight exceeds 3.5 tons, and vehicles carrying passengers for commercial purposes exceeding 9 persons including the the driver are allowed to work no more than 9 hours in total and more than 4.5 hours continuously within a period of 24 hours. [7]. Based on this article, it is necessary to construct parking areas for heavy vehicles in suitable areas on these roads in the geographical area where heavy vehicles travel, covering every 4-8 hours of distance , taking into account road and climate conditions . Truck parks should be adequate in terms of social infrastructure and at accessible locations. They should be suitable for purchasing fuel and resting, they should be integrated with modern, hygienic, intelligent transportation systems, and they should be secure and adequately illuminated. Road superstructure problems should be resolved and isolated from judicial problems and be cost-effective [8]. On this point, it should be taken into consideration that drivers who have fulfilled their basic needs, are stress-free, well-slept and rested will be involved in or cause fewer accidents. The effectiveness and quality of recreational areas indirectly affect traffic volumes [9]. The models used in the literature do not take into account locally varying waiting times and travel patterns.

When the regulations about the facilities to be built and operated near the highways is examined; we find that heavy vehicles must park in suitable areas so that they do not put pressure on traffic during the waiting periods required for loading and unloading; that these areas should be close to loading-unloading areas, inter-city transit roads, maintenance and repair services of heavy vehicles, and away from urban traffic. It is understood that the areas to be selected as the parking places of heavy vehicles should not affect the normal traffic flow and should be close to the loading-unloading points for transport [10]. There are several approaches to determining parking demand for heavy vehicles. These approaches are generally evaluated through two categories; as macro level and micro level models [11]. These approaches generally take into account service times, retrospective parking trends and driver preference rates [12]. Demands for heavy vehicle parking spaces are generally made on the basis of national corridors; models that take into account intra-district movement are not common [13].

In 2019, the "***Izmir Sustainable Urban Logistics Plan- Logistic Analysis and Suggestions Report for Rural Development Regions***" was prepared by the İzmir Metropolitan Municipality in order to determine the status of logistics activities, to identify problems and bottlenecks and to develop solutions in this context. Afterwards, analysis and recommendations for rural development regions and solid waste logistics were developed within the scope of the plan. It has been determined that heavy commercial vehicles coming to rural areas in İzmir park on the roadside due to lack of suitable parking areas and this situation causes traffic safety problems and traffic congestions, while visibility is prevented in these areas, thus causing accidents and access problems to occur [14].

In this study, the capacities of the heavy vehicle parking areas in rural areas were calculated under various assumptions using the data of the İzmir Sustainable Urban Logistics Plan. The non-transit heavy vehicle volumes in the districts were calculated using the traffic assignments. Modal split ***(the ratios between heavy vehicle types such as bus, truck, pick-up etc. and have been generated by surveys***) rates for heavy vehicles, roadside parking rates and post-operative waiting times were obtained from roadside driver surveys. According to this approach, heavy vehicle parking capacities in rural areas are defined within the scope of the plan; identified, compared and evaluated with variations created with different options regarding facility waiting times and post-operational waiting times. The results show that each district has different travel patterns and waiting times, so those details need to be taken into account when determining demand.

2. Material and Method

2.1.Method

A three-step method has been developed to determine the parking capacities for trucks and other heavy vehicles in rural areas and has been applied to rural districts of İzmir. The data used in the developed method was obtained from the Logistics Analysis and Recommendations for Rural Development Regions report, which is the sub-section of the İzmir Sustainable Urban Logistics Plan (LOPI). Mentioned flowchart is given in figure 1.

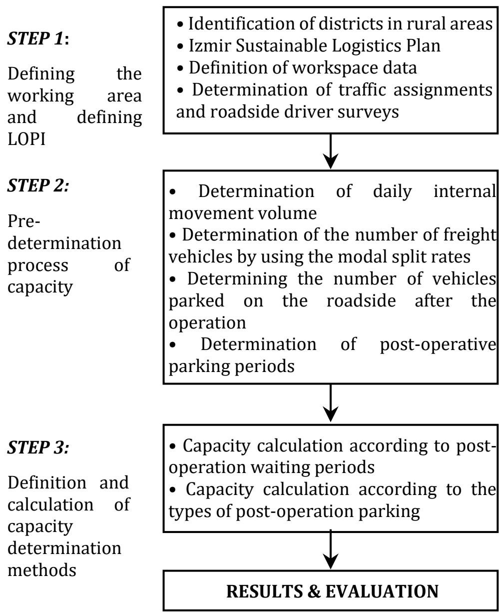

Figure 1. Flow chart of the method used to determine the requirement for parking spaces for heavy vehicles in rural areas

In **Step 1**, rural districts were defined, general information and planning processes were defined, driver surveys were conducted in rural areas and logistic assignment results and the findings of the traffic model in rural development regions were given. In **Step 2**, the internal mobility rates of the districts were identified by evaluating the transitions and turns from the screen lines with the "screen line" method. Then, the modal split ratios obtained from the questionnaires and the ratio of heavy vehicles excluding the trucks were determined. After that operation, the number of vehicles parked on the roadside and the post-operative parking times were determined. In **Step 3**, *waiting times of 5 hours and more / waiting times of one day and more / post-operation roadside parking rates / parking rates at the evacuated facility* were evaluated and parking requirements were determined on a district basis.

2.2. Study area

In 2019, the "İzmir Sustainable Urban Logistics Plan" was prepared by the İzmir Metropolitan Municipality in order to determine the status of logistics activities, to identify problems and bottlenecks and to develop solutions in this context. The aim of the plan is to provide an outlook for the efficient implementation of urban logistics activities by minimizing the negative social and environmental impacts. A participation model was developed, analyses and recommendations were advanced for urban logistics, rural development regions and solid waste logistics. In the development of the proposals for rural development regions, suggestions were made for easy access of the products to consumers in the agricultural development regions, determination of storage needs, planning for raw material and equipment logistics and the location of heavy vehicle parking areas. İzmir is divided into three main cores within the scope of the study considering economic, logistic elements and spatial characteristics. The first core consists of central business areas and urban areas; the second core consists of wholesale trade and non-residential urban industrial areas, and occasionally also agricultural activities and transition areas, industrial areas and regions with mixed land use structure. The third core is the districts where agricultural production is concentrated in rural areas. The mentioned districts are Dikili, Kınık, Bergama, Karaburun, Çeşme, Selçuk, Tire, Ödemiş, Kiraz and Beydağ. Figure 2 shows the urban nuclei and their boundaries.

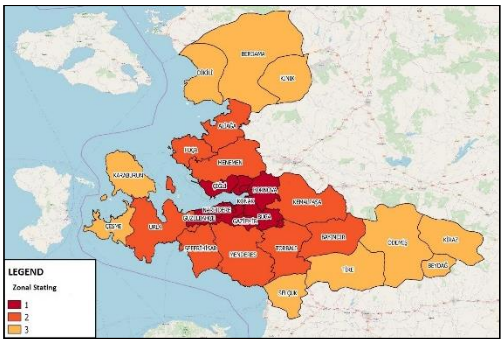

Figure 2. Urban nuclei and boundaries [14]

Within the scope of the model studies, the traffic network was entered into the Visum transportation planning software. 36,168 links, 3,266 connectors, 13,305 nodes and 825 analysis regions were entered as part of the network elements study. Thefreight travel model was established by utilizing data from retail trade, wholesale trade, the service sector, logistics storage activities and the production sector. Following the traffic assignment, validation and calibration stages for 2018 values were completed and traffic assignments for 2030 were made. Figure 3 shows the 2030 traffic assignment results for trucks and trailers.

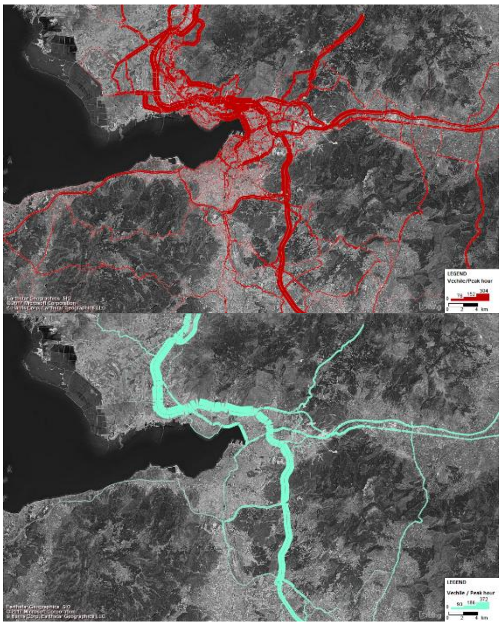

Figure 3. 2030 Traffic assignment results [14]

According to the results of traffic assignment (inadequacy analysis) in 2030, in rural areas, the highest volume value in the link is 150 - 300 vehicles / peak hours / section for truck type vehicles; for trailers, it is calculated as 180 - 300 vehicles / peak hour / section [14].

Within the scope of collecting and evaluating new information, 4,595 roadside driver surveys were conducted at 20 points. The survey was conducted on weekdays. In determining the survey points, careful consideration was given to the geographical structure of the İzmir province, the location of the transportation axes, compliance with the cross-sectional counting points, the safety of the pollsters, the non-interruption of traffic, monitorability, the measurement of entrances to and exits from large settlement areas at the district level, information gathering at the load hauling and production points, and spreading out the conducting of surveys throughout the day. General questions were answered, and vehicle information, travel information and freight information characteristics were revealed by the questions asked within the scope of the survey [14]. Figure 4 shows the roadside driver survey points.

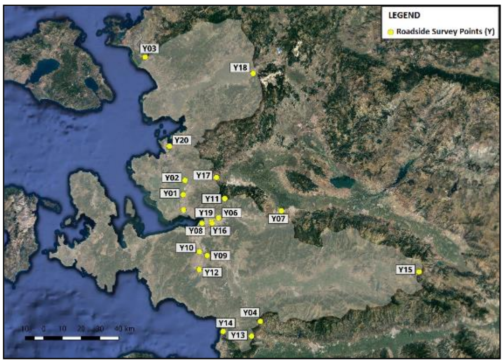

Figure 4. Roadside Driver Survey Points (Y1-Y20) [14]

3. Results

3.1. Determination of modal split for districts

Roadside driver surveys (RDS) were conducted to cover all types of freight vehicles. The modal split includes trailers, trucks, vans, tankers and other vehicles. Since the trucks were not considered as heavy vehicles, the number of heavy vehicles in the districts was determined by removing them from the existing distribution. The mentioned ratios are given in Table 1.

Table 1. The ratio of heavy vehicles in the districts (%)

District	*RDS Code*	*Modal Split Rate*
Ödemiş	Y15	0.58
Kiraz-Beydağ	Y15	0.58
Kınık	Y18	0.82
Dikili	Y03	0.87
Bergama	Y18	0.82
Karaburun	Y13	0.70
Çeşme	Y13	0.70
Tire	Y15	0.58
Selçuk	Y04	0.94

3.2. Calculation of daily freight vehicle mobility within the districts

According to the results of the model, the North (Bergama-Kınık-Dikili) Corridor and the East (Beydağ-Kiraz, Ödemiş, Tire) Corridor show high freight mobility. The Southern Corridor and the Selçuk Region are considered to be on transit traffic. It is observed that the freight traffic in the peninsula is low in volume compared to other corridors. The increase from Kınık to Bergama gives way to a decrease when directed to the Dikili axis and increases once again when moving towards the center. The number of vehicles coming from the south is split into northern and western directions. It can be said that the return traffic operates proportionally. In the Karaburun-Ceşme Region, it is seen that the transit of freight vehicles is low and they are not located on the main traffic. Daily load mobility ratios for corridors are given in Figure 5. When the number of vehicles arriving towards and departing from İzmir is subtracted from each other, the amount of cargo vehicles participating in the internal movement in the district is determined both in the direction of departure and in the direction of arrival. The sum of these two values gives the total load movement in the district. This freight movement does not all consist of heavy vehicles.Daily heavy vehicle mobility in the districts was determined by modal split ratios. Those values are given in Table 2.

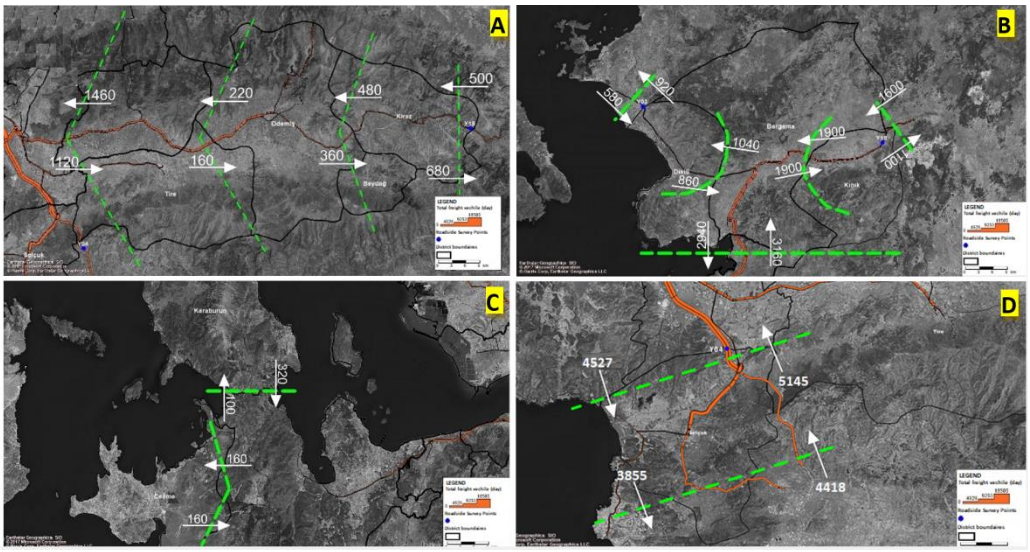

Figure5. The Kiraz, Ödemiş and Tire Line (East Corridor) (A) / The Bergama, Dikili and Kınık Line (North Corridor) (B) / The Karaburun and Çeşme Line (West Corridor) (C) / The Selçuk Line (South Corridor) (D) daily freight vehicle mobility [14]

Table2. Determination of daily heavy vehicle volumes in districts ***(vehicle)***

		Direction towards Izmir			Direction towards Izmir				Internal Movement		
Districts	***RDS***	Entrance To District	Exit from District	Daily Number of Vehicles	Entrance To District	Exit from District	Daily Number of Vehicles	***Modal Split Ratio (%)***	Heavy vehicles towards İzmir	Heavy vehicles from İzmir	**Total**
Ödemiş	**Y15**	220	480	260	360	160	200	0.58	151	116	267
Kiraz-Beydağ	**Y15**	480	500	20	680	360	320	0.58	12	186	197
Kınık	**Y18**	1,600	1,900	300	1,900	1,100	800	0.82	246	656	902
Dikili	**Y03**	580	860	280	1,040	920	120	0.87	244	104	348
Bergama	**Y18**	1,040	1,900	860	1,900	860	1,040	0.82	705	853	1,558
Karaburun	**Y13**	100	320	220	0	0	0	0.70	154	0	154
Çeşme	**Y13**	160	160	0	0	0	0	0.70	0	0	0
Tire	**Y15**	220	1,460	1,240	1,120	160	960	0.58	719	557	1,276
Selçuk	**Y04**	4,418	5,145	727	4,527	3,855	672	0.94	683	632	1,315

3.3. Evaluation of waiting times for post-operation reloading

In rural areas, heavy vehicles generally do not turn empty after unloading the freight they carry, instead they take another freight and start off in another direction or in the direction they came from. There is a waiting period between those two operations. This time is the post-operation waiting time for freight.

Average waiting times for the consecutive non-operational freight were measured by roadside surveys. This measurement was made in both directions; entering to and exiting from Izmir. Waiting times for the next loading post-operation were determined and registered in the categories of 0-1 hours, 1-2 hours, 2-3 hours, 3-4 hours, 5-10 hours, 1 day, 2 days and 3+ days. When it is considered that operations take at least 2-3 hours, it can be inferred that waiting times under 5 hours and in some situations even waiting times under 1 day do not influence the need for parking spaces. Parking operations under 5 hours will be covered by entries and exits during parking circulation within the day.It can be said that short-term entries and exits will be low and will not affect the overall capacity. The mentioned waiting times are given in Table 3.

Table 3. Waiting Time for Post-operation Reloading ***(Hours)***

Waiting Time for Post-operation Reloading (Hours)	***RDS Codes***				
	Y18	**Y15**	**Y03**	**Y13**	**Y04**
0-1	0	0	0	0	0
1-2	114	0	0	0	13
2-3	0	0	0	0	2
3-4	0	0	39	1	68
5-10	72	114	1	75	5
1 Day	38	1	187	3	158
2 Days	5	83	0	146	0
3+ Days	1	0	4	0	5
TOTAL	**230**	**198**	**231**	**225**	**251**
1 day and more waiting time	**0.19**	**0.42**	**0.83**	**0.66**	**0.65**
5 hours and more waiting time	**0.50**	**1.00**	**0.83**	**1.00**	**0.67**

When the waiting periods in the survey points are evaluated, it can be estimated that waiting periods of 1 day or more require parking space and waiting periods of 5 hours or more also have the potential to create a parking space requirement. According to the surveys, it was observed that the waiting times of 5 hours and more were high across the board, while the waiting times of 1 day and more were high yet varied from district to district.

3.4. Evaluation of waiting places after unloading

After the unloading of the cargo, the heavy vehicles wait until the next loading. The places where heavy vehicles wait are important in terms of traffic safety and traffic congestion. Heavy vehicle drivers spend their idle time in the facilities they visit, in private vehicle parks or on the roadsides. Those rates are obtained by roadside driver surveys and are given in Table 4.

Table 4. Rate of waiting places of the surveyed drivers post-operation ***(vehicle)***

Waiting Area Distribution after Discharging	***RDS CODES***				
	Y18	**Y15**	**Y03**	**Y13**	**Y04**
Facility Park	66	108	117	107	213
Private Park	1	1	31	4	11
Roadside	163	89	83	114	27
TOTAL	**230**	**198**	**231**	**225**	**251**
Roadside Parking Ratio	**0.71**	**0.45**	**0.36**	**0.51**	**0.11**

Survey results show that roadside parking accounts for more than half of all idling in rural areas. The other half consists of waiting at the destination facilities and it can be considered as a problem. The vehicles should preferably wait in the private facilities for heavy vehicles, not in the parcels of the destination facilities.

3.5. Determination of heavy vehicle parking demands for districts

There are two categories that are taken into account when calculating the capacity of parking spaces. These are waiting times and post-operation waiting places. Waiting periods are defined as those who wait for one day or more and wait 5 hours or more. Waiting areas are divided into two as waiting at the destination facility and waiting at the roadside. According to the variances of these items, parking lot capacity calculations were calculated. Table 5 shows the parking requirements for 2030 according to the approach types.Local government elections have a significant impact on determining the traffic pattern. How long vehicles wait and where they wait is directly related to these choices. Determining the requirement for all vehicles means directing the volume of parking in destination facilities to the heavy vehicle parking facilities. In addition, selecting vehicles that park for 5 hours or more means directing short-term parking to parking facilities. Sending the vehicles parked for one day or more to the parking facilities means that the requirement for parking is reduced. Those are options that differ according to the interpretations of policy makers and planners and include a degree of relativity.

Parking requirements for four options are given in Figure 6.

Table 5. Determination of parking requirements for 2030 according to approach types ***(vehicle)***

Districts	***For all vehicles waiting 1 day or more***	***For all vehicles with a standby time of 5 hours or more***	***For vehicles with roadside parking of 1 day or more***	***For vehicles with roadside parking of 5 hours or more***
Ödemiş	112	**267**	50	120
Kiraz-Beydağ	83	**197**	37	89
Kınık	171	**451**	122	320
Dikili	285	**289**	103	104
Bergama	296	**779**	210	553
Karaburun	102	**154**	52	79
Çeşme	0	**0**	0	0
Tire	536	**1,276**	241	574
Selçuk	842	**881**	93	97

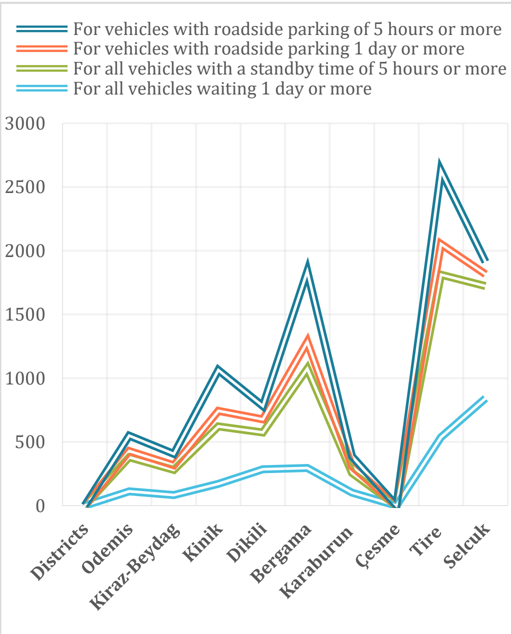

Figure 6. Parking requirements of districts according to approach types ***(vehicle)***

The highest rates are obtained when the capacity is determined for all vehicles waiting 5 hours or more. The lowest rates are obtained when the capacity is determined for vehicles parked on the roadside for one day or more. When waiting periods of 5 hours and more were evaluated, it was observed that Bergama and Tire stood out and Tire and Selçuk districts reached the highest values when all vehicles waiting for 1 day or more were selected.

Despite the fact that the local authority will decide which of the results will be used, the most effective decision is underlined. The second choice should be considered in planning process by policy and decision makers. Mentioned alternative has been generated "**for all vehicles with a standby time of 5 hours or more**" and emphasized by bold letters in Table 5. The reason for the alternative selection is the relaxation allowance time threshold for truck drivers.

If it is intended to prevent roadside parking, parking fees should be reduced and accessibility values increased. On the other hand, waiting times, waiting places, traffic and load carrying pattern of the region should be taken into consideration in the selection. The developed method aims to provide alternatives that can respond to the planning parameters of decision makers.

4. Discussion and Conclusion

In this study, the data of the Logistics Analysis and Suggestions Report for Rural Development Regions prepared within the scope of İzmir Logistics Sustainable Urban Logistics Plan were used. The various data and results presented in the report have been developed and interpreted. In the third region, which is defined as rural core, heavy vehicle parking needs of the districts have been tried to be estimated by various approaches. Non-transit heavy vehicle volumes in the districts were calculated from traffic assignments, modal split rates for the heavy vehicles in the districts, roadside parking rates and post-operation waiting times have been calculated by utilizing roadside driver surveys. With the developed model, the needs for heavy vehicle parking in rural areas were calculated with different approaches. Waiting times and locations were evaluated with variations created with different options. The results show that different travel patterns and waiting times occur in each district, so these details should be taken into account when determining capacity. Parking requirements for heavy vehicles should also be assessed with a high-scale approach by identifying national freight corridors. Drivers' accommodation and accessibility needs must be handled and evaluated holistically. The proposed model may be integrated with the position and assessment of national load corridors in the future. Finally, the reasons why heavy vehicles wait at the target facilities should be interpreted. This is considered to be a relative issue where different subjective opinions may exist.

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