AUSUD
BANDIRMA ONYEDİ EYLÜL ÜNİVERSİTESİ
JITSA

Research Article

Evaluation of the Geometry of Placement of Traffic Lights at Roundabouts on the Basis of Zoning Plans

Selim TAŞKAYA*
Artvin Vocational School, Department of Architecture and Urban Planning, Artvin Coruh University, Artvin, Türkiye
*Correspondence: selim_taskaya@artvin.edu.tr
DOI: 10.51513/jitsa.1102058

Abstract: It is important to make proper planning to ensure a healthy traffic flow. Especially in city centers where traffic density is high, a critical plan is important. From this point of view, while a zoning plan is being made in the zoned areas, a study was carried out to pay attention to which parameters create the connection network on the land where the zoning islands are placed. Within the scope of the study, the criteria in the traffic vehicle regulation are only to place lights, signs, etc. along the road route. it was determined that the intersection geometry was simply applied to the terrain upon measuring the horizontal distance. Along with the formation of the roundabouts with these road connections in the zoned areas, apart from the criteria such as the width of the road and the radius of the intersection, a proposal has been made on how the intersections should be placed at these points as a result of their correlation with the criteria such as precedent, height, commercial, and housing at these points during the processing of the intersections. These propositions were made with a mathematical model as a logical proposition. The mathematical model expresses how much distance average should be added to the standard lengths of the connection intersections, depending on the identity characteristics of the surrounding zoning islands, regardless of how many branches they have. In a zoning plan, which should be formed by determining the intersections connected to the roads on the main lines, in a basic zoning plan, non-standard increases in the relevant lights depending on all the characteristics of the islands to be formed in the directions of these lines were examined.

Keywords: Roundabout, Traffic Lights, Zoning Plans

Dönel Kavşaklara Trafik Işıklarının Yerleştirilme Geometrisinin İmar Planları Bazında Değerlendirilmesi

Özet: Trafik akışının sağlıklı bir şekilde sağlanması için düzgün bir planlama yapılması önemlidir. Özellikle trafik yoğunluğunun fazla olduğu şehir merkezlerinde kritik bir plan önem arz eder. Buradan hareketle imarlı alanlarda bir imar planı yapılırken imar adalarının yerleştirildiği arazinin üzerinde bağlantı ağını oluştururken hangi parametrelere dikkat edilmesi için bir çalışma yapılmıştır. Çalışma kapsamında trafik taşıt yönetmeliğindeki kriterlerin sadece yol güzergahı boyunca ışık, levha konulması vb. basit şekilde kavşak geometrisinin yatay mesafe ölçümlenmesi üzerine araziye aplike edildiği tespit edilmiştir. İmarlı alanlarda bu yol bağlantılarının olduğu dönel kavşakların oluşumu ile birlikte trafik ışıklarının yolun genişliği ve kavşak yarıçapı gibi kriterlerinin dışında, kavşakların imar planlarına işlenmeleri esnasında bu noktalarda imar adalarının emsal, yükseklik, ticari, konut gibi kıstasları ile korelasyonu sonucunda nasıl yerleştirilmesi gerekliliği üzerine önerme getirilmeye çalışılmıştır. Bu önermelerde mantıksal önerme olarak matematik model ile yapılmıştır. Matematik model ile kaç kollu olursa olsun bağlantı kavşaklarının standart uzunluklarına çevresindeki imar adalarının kimlik özelliklerine bağlı olarak ne kadar mesafe ortalama eklenmesi gerektiği ifade edilmiştir. Esaslı bir imar planında önelikle ana hatlardaki yollara bağlı kavşakların belirlenmesi ile oluşturulması gerekli bir imar planında bu hatların istikametlerinde oluşacak adaların tüm özelliklerine bağlı olarak ilgili ışıkların standart dışındaki artışları incelenmiştir.

Anahtar Kelimeler: Dönel Kavşak, Trafik Işıkları, İmar Planları

* Corresponding author.
E-mail address: selim_taskaya@artvin.edu.tr
ORCID: 0000-0002-4290-3684
Received 12.04.2022; Accepted 28.02.2023
Peer review under responsibility of Bandirma Onyedi Eylul University.

1. Introduction

One of the biggest problems with the increase in the number of motor vehicles on highways is traffic congestion. For years, problems encountered in traffic have aroused great interest in many people from many parts of the world, and many different studies have been carried out to provide solutions to these problems. Researchers have left the general framework of transportation and transportation science aside and focused on traffic management, which is a more specific field under transportation science (Çakıcı, 2014). Various traffic control methods have been proposed for highway intersection areas to reduce traffic accidents that occur especially in areas where more than one highway intersects and causes material and moral losses. Roundabouts are at-grade intersections, which are applied to manage the traffic at the intersection, in the middle of the intersection, where there is usually a circular island that directs the traffic entering the intersection (Çakıcı, 2014). To eliminate the central density in the city, some intersections are arranged as roundabouts with the thought that they offer higher capacity (Kızollı, 2017). Correctly designed, placed, and operated traffic lights systematically direct the traffic flow and increase the traffic management capacity of the intersection (Aksoy, 2019). The operation of intersections is the most important factor that determines the capacities of especially urban roads. For this reason, it is expected to be highly professional in intersection arrangements for the high-capacity functioning of road networks. In the arrangement of intersections, life safety, order of traffic flow, and vehicle safety are essential. All-round safety and comfort should be a priority. For these priorities, the field of view from the approach arm should be very good. Junctions should not be a place of sudden surprise, especially for drivers. All factors that prevent drivers from seeing intersections from a distance should be removed (Guncu, 2019). He defined the road area used jointly by traffic flows in different directions as an intersection (Alemdar, 2019; Yayla, 2015). The intersection is theoretically expressed as the common areas formed by the intersection or merging of two or more highways (Alemdar, 2019; Başa, 2016). It can be expressed as areas that need to be specially designed and managed where vehicles and pedestrians overlap in the city and outside the city (Alemdar, 2019). Roundabouts are defined as intersections that allow vehicles to move in a circular motion and turn in different directions, and are directed clockwise for the situation where the traffic flows from the left around a central traffic island, and counter clockwise for the situation where the traffic flows from the right (Öğütveren, 2019; Janssens, 1994). Especially in cities with high populations, with the congestion and delays in urban intersections with heavy traffic reaching large sizes, the issue of passing superiority of vehicles turning in the intersection was discussed for the first time, and as a result, the rule of giving way to the vehicle turning around the island was applied at the existing roundabouts (Öğütveren, 2019). The report titled Suggested Design Principles for Modern Roundabouts, prepared by Sweroad, it is aimed to integrate modern roundabouts into Turkish design principles as a standard intersection type (Öğütveren, 2019; Advice on the application and use of modern roundabouts by adapting the proposed design principles to Turkish conditions). (Öğütveren, 2019). Roundabouts are directed intersections in which traffic moves counterclockwise or clockwise (relative to the direction of movement of the traffic flow) around a central traffic island (Janssens, 1994; Tanyel, 2001; Kayacan, 2022).

After giving preliminary information about the roundabout and traffic, when its relation with the zoning is examined, many factors of the route selections passed between the cadastral parcels on normal intercity roads are chosen only as climatic and ground surface, while the placement of intersections on the roads in the city depends on the zoning plans arranged as the upper and lower base. While the zoning plans are being made, it is trying to be formed in a way that will meet all the needs of the population living on the land. In this way, junctions and connection points are provided to connect the construction and common areas that will be formed by adhering to the base factors that may be caused by the clearing of untreated parcels, old cadastral roads, streams, slopes, arcs, etc., called cadastral as a base.

2.Theoretical Framework and Scope

An intersection is a common area in the road network where two or more roads intersect, converge or diverge. The intersection of vehicles coming from different directions complicates the traffic flow. For this reason, the number of accidents increases at these points, the traffic speed decreases, and traffic

jams occur, so fuel consumption, environmental pollution, and time loss increase significantly. For these reasons, the intersection it is very important for the healthy continuity of the traffic flow to be determined well, the design is made by the engineering discipline and the operation is well done (Kayacan, 2022).
Junctions are defined as the areas where traffic flows coming from 2 or more directions intersect, merge and separate in the road transport network. Most of accidents on highways occur at intersections. In addition, because the vehicles coming to the intersection want to move in different directions, while the average vehicle speed at these points decreases, the average vehicle delays, fuel consumption, and the damage of the vehicles to the environment increase. For these reasons, it is necessary to choose the intersection correctly and to design and operate the intersection in a way that gives the best performance (Öğütveren, 2019).
The following points should be considered in the design of intersections;

• The importance of the intersection in the transportation network,
• Existing traffic characteristics,
• Geometric features of the roads connecting to the intersection,
• The amount of change in traffic volumes,
• Control methods applied at close intersections and intersection performance,
• Driver and pedestrian behavior,
• Topographic and environmental conditions (Öğütveren, 2019; Umar and Yayla, 1992).

Intersection geometry is a process that proceeds in coordination with the urbanization plan by creating a model in the mathematical terrain. This geometry should be processed on the zoning plan depending on the width and height paths in parallel, especially with the topography and contour curves. If it is processed in this way, it is geometrically located in the zoning plan in the form of a series of derivatives and integrals.

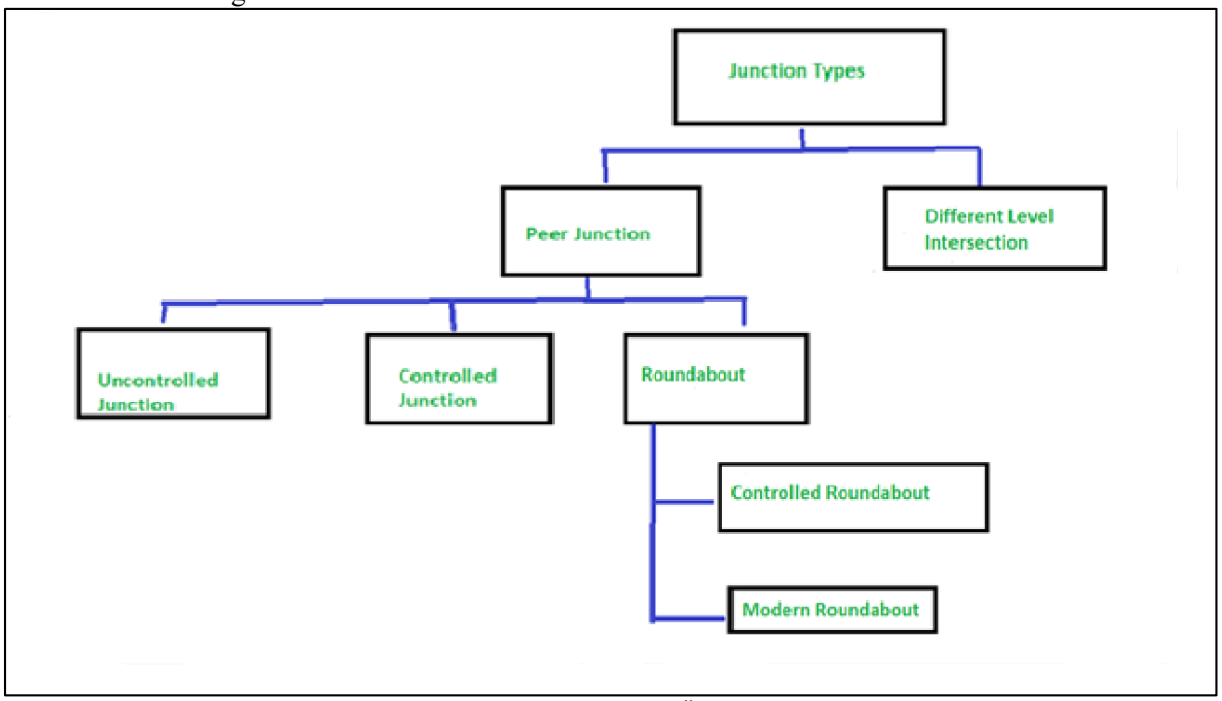


Figure 1. Types of Junctions (Öğütveren, 2019).

In Figure 1, junctions can be divided into different classes in terms of their characteristics, but they are classified into two main groups according to the planes where the approach branches intersect; At-grade (At-grade) intersections, cross-level (Köprülü) intersections (Öğütveren, 2019).

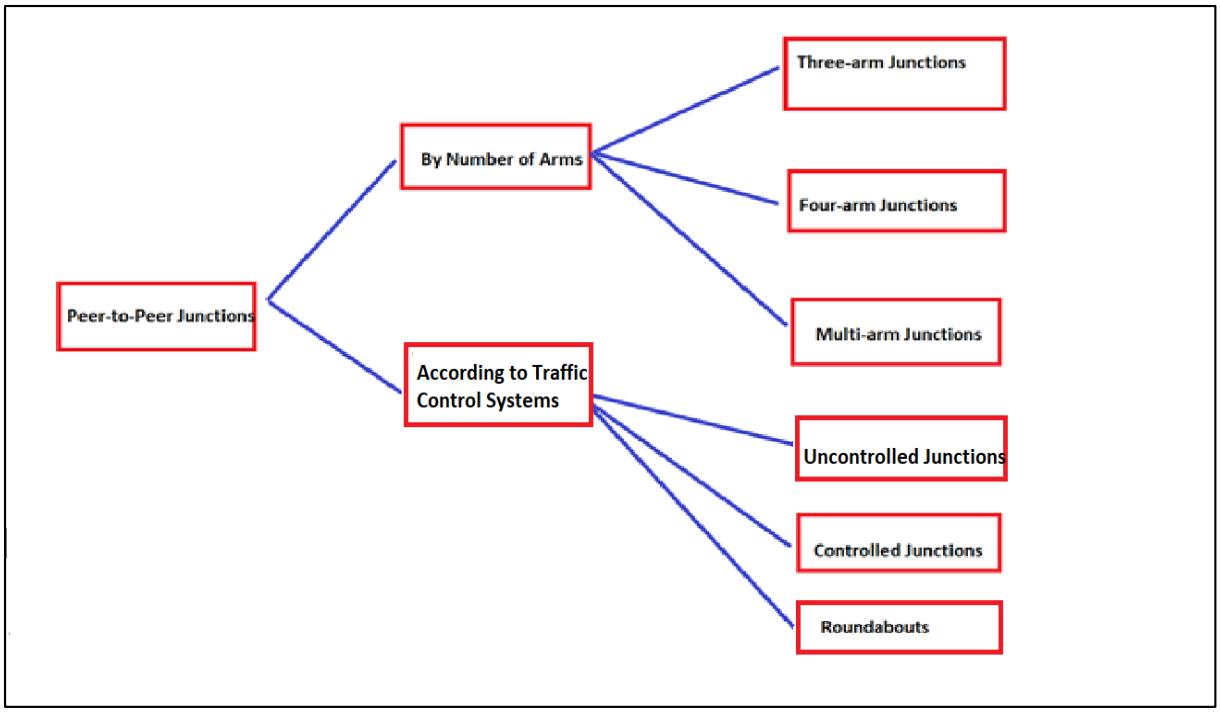


Figure 2. Classification of at-grade intersections (Öğütveren, 2019).

In Figure 2, at-grade intersections are differentiated according to the number of branches and traffic control systems (Öğütveren, 2019).

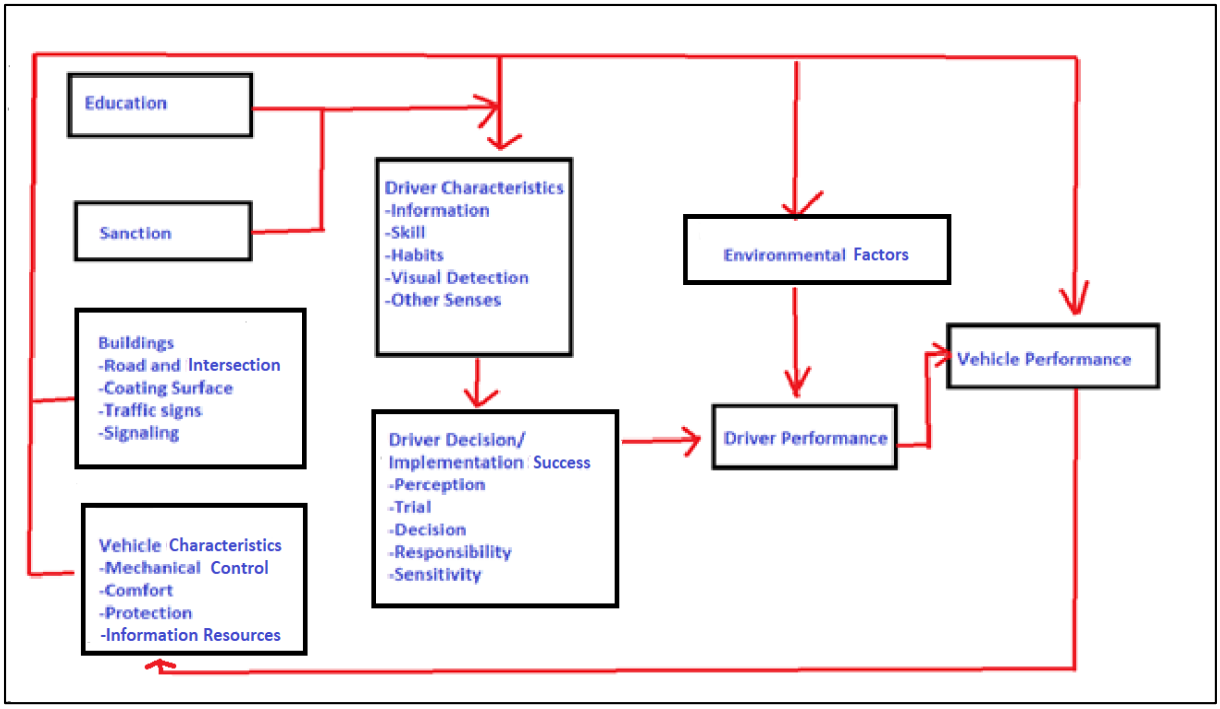


Figure 3. Traffic engineering main elements and their relations (Boz, 2019; Yılmaz, 2006).

In Figure 3, all land vehicles have their vehicle characteristics. These are values such as braking distance and acceleration time. Structures are the name given to all of the roads, intersections, and lights that we interact with in traffic at any time. The human factor assumes two different functions in transportation. These functions are the pedestrian state and the person driving the vehicle, that is, the driver. In the traffic system, the level of education, knowledge, decisions, and behaviors of a person as a driver appear as the most important factor affecting traffic (Boz, 2019). The period in which the

concept of urbanization showed the fastest rise was the industrial revolution. The use of vehicles shortly after the industrial revolution started the traffic phenomenon, which is one of the changes in urban life. With the industrial revolution, large factories were established. To work in the established factories, people started to migrate to the big cities where the factories were established. Factories have been established near cities to meet their requirements (Anbari, 2020).

Traffic signal control systems are attracting worldwide attention due to their social and economic impact.

As a result of the increase in the number of private car owners in urban areas, the problem of traffic congestion is increasing. Traffic congestion at intersections is becoming one of the main problems of urban cities due to the increase in the number of vehicles with the limitation of road infrastructure (Mohammed Ali, 2021). The importance of this becomes even more evident in crowded city centers. Traffic signal control optimization is an important and interesting problem in the field of intelligent transportation system. In addition, despite the wealth of scientific literature on the subject, it is still considered an active research area (Mohammed Ali, 2021; Rasheed et al., 2020). Traffic signal control is a method used at intersections to manage the overlapping movement of traffic flows by determining the right of way to a particular congested traffic flow for a given time (Mohammed Ali, 2021). A comparison was made between 10 African countries using indicators such as personal risk, traffic risk, road condition, education level, urban population, health status and GDP. Two different methods were used. The first is the simple averaging method and the second is a method based on theories, experiences, and literature. As a result of the study, the researchers suggested that the most appropriate indicators should be preferred in future studies instead of the best available data (Yılmaz, 2021; Oluwole et al., 2013).

All over the world, traffic counts are made in every place where there is a road, and while these counts are made, different methods are used at the level of available possibilities. Although these methods have positive and negative aspects relative to each other, there is no difference in counting the tools, which is the main purpose. Performance analyzes of intersections, whose geometry has been created and the number of vehicles passing over them, can be performed with many different computer programs today (Sarı, 2021). It is expected to respond to the transportation demand that will pass over the intersections with optimum performance. It is inevitable to provide transportation services without sacrificing security while responding to demand in this way at predetermined service levels. Crossroads, which are universally accepted as a special field of study all over the world, have been and continue to be the subject of many theses and scientific studies (Sarı, 2021; Tunç, 2003).

Intersections are the common areas of use for flows coming from two or more directions, where traffic flows meet and diverge. To prevent these accidents and to minimize the loss of life and property at intersections, which are the areas where traffic accidents are frequently seen, their designs should be made by certain criteria (Yellow, 2021; European Commission, Annual Accident Report, 2018). In intersection designs, it is important to enabling drivers to move more efficiently, to allow enough time for drivers to notice other vehicles and to react promptly, and to ensure that the driver can find enough space in the decision-making process at the intersection (Yellow, 2021; FHWA, 2004). The geometric design of intersections is a combination of three-dimensional features. The main goal is to design a collision-free intersection that flows smoothly. There are two prominent issues when designing intersection corners. These two aspects are related to the area that the vehicles scan while turning. These considerations are the pavement widths and minimum turning radii at the time of turning off the vehicles. In the determination of the intersection corners and pavement widths for different vehicle types according to the inner edge radii, the curve radius is selected depending on the design vehicle type, the traffic volume of the vehicles turning right, the speed, and the presence of a guiding island. (Yellow, 2021; Highways Design Handbook, 2007).

From the content and explanations of the figures above, after giving the applicability parts of the intersection and roundabouts in terms of traffic, when the correlation with the zoning plans is examined, technically, while the zoning plans are being made, the flat, inclined, current population amount of the land is the planning process that will be sufficient in case the population increases in a way that will meet the need after many years. Especially at the points, we call flat areas, while the zoning islands are planned as the upper base, there are road routes that adjust the two general entrances and exits of the cities, namely the northern and southern ring roads. In the city, based on these two main lines, interconnection roads are created as two, three, and four-armed intersections and

artificial networks connected. However, it is spent in the light of private properties in its cadastral parcels as a base. While passing the main and interconnection roads, care should be taken to pass them on public land, which will not coincide with expropriation. That is, in this way the main and interconnection zoning paths are created. On the mountainous land, the main connection zoning road with the only entrance and exit of the city is created.
Thus, the stable radius and distances of the roundabouts, which are already connection points according to the traffic vehicle regulation, are usually clear in the application of the zoning plan on paper. After the completion of the construction process of the intersections transferred from the paper zoning plane on the area, when the job comes to the point of ensuring traffic and human safety, this time the proportion of the population living in the construction islands formed around these roads and intersections should be considered as a factor that should be taken into account when placing these traffic lights on the roundabouts. is necessity.

3.Material and Method

When the layout of traffic lights is examined from a different point of view than the normal literature, it will be best to put the zoning plans at the rotational junctions by putting various factors into play. Evaluating these factors as propositions;

The soft set on U, where U is the non-empty universal set, E is the universal parameter set, A is the non-empty subset of E, and P(U) is the power set of the U set (Orbay, 2014),

$$F: A \to P(U) \tag{1}$$

obtained with the help of the transformation and shown as (F,A) pair. In other words, a softset on U is a parameterized family of subsets of the set X. With $\alpha \in A$, the set F (α) will be called the α–approximation set of the soft set (F,A) (Orbay, 2014; Molodtsov,1999).

For example, $U = \{u_1, u_2, u_3, u_4\}$cluster of houses, E={with garden, expensive, duplex, sea view, apartment}=$\{x_1, x_2, x_3, x_4, x_5\}$set of parameters, features that houses can have and $A = \{x_1, x_2, x_3, x_4\} \subset$ E never mind. The (F,A) soft set shows the features of these houses (Orbay, 2014).

F: A → P(U) (1)

(with garden) = $\{u_1, u_2\}$ 'u_1 *ve* u_2 houses have gardens.'

(expensive) = $\{u_2, u_3\}$ 'u_2 *ve* u_3 houses are expensive.'

(duplexes) = $\{u_3, u_4\}$ 'The houses of u_3 *ve* u_4 are duplexes.'

(have sea view) = $\{u_1, u_2, u_3\}$ 'The houses u_1, u_2, u_3 have sea view.'

We can express the soft set (F, A) as follows:

$(F, A) = \{(x_1,\{u_1, u_2\}), (x_2,\{u_2, u_3\}), (x_3,\{u_3, u_4\}), (x_4,\{u_1, u_2, u_3\})\}$ is.

(U) shows the set of all soft sets on U (Orbay, 2014). As seen in the example, the taxonomy of definition and value sets is made by making correlations between them.

$$M(u) = \begin{cases} 0, & u < x \\ \frac{v-x}{y-x}, & x \le u \le y \\ \frac{z-u}{z-y}, & y \le u \le z \\ 0, & u > z \end{cases} \tag{2}$$

A fuzzy number μ on U can be characterized by a dispersive function parameterized by a triplet (x,y,z). μ is the membership function of the fuzzy number (Orbay, 2014; Kaufmann and Gupta, 1991). Based on a certain point, the way that the intersection parameters will be followed mathematically is,

$$D\left(D^{-1}f(s)\right) = D^{-1}(Df(s)) \quad (3)$$

$$D^{-1}(S) = \frac{1}{D}f(s) = \int (f(s))\, dS + k \quad (4)$$

$$D\left(D^{-1}f(s)\right) = D\int f(s)\, ds^{\pm k} = f(s) \quad (5)$$

Fractional derivatives and integrals are very useful methods in understanding and solving real events in the world (Kısa, 2022).
From equations 1,2,3,4 and 5, information was obtained about how to design the intersection geometry together with the connecting branches mathematically, about the derivative and integral expansions and their geometries.
While talking about the general geometry of a subset or closed convex shape above, it is necessary to take into account the identity characteristics of the islands on the line when placing the intersection on the land where the diameter and radii are determined on the paper at a certain distance, compass position, and placing the traffic lights by taking the direction from the midpoints of the intersections.
It would be correct to place the angle and distance, and the traffic light within a certain meter range, in line with the factors such as the amount of population that can live on that zoning island, the amount of facade and length, the density of the work entry and exit hours, to the distance to be taken as fixed.

4. Findings and Discussion

When the planning of an area is city-based, the zoning planning process comes into play. To ensure the zoning order, many legal regulations, zoning plans, and regulatory procedures have been established, and violations of these rules have been subject to various administrative sanctions. As a result of the freedom of settlement, which is considered at the constitutional level, there are rules that individuals should pay attention to in the stages of construction or building (Kaya, 2020). The zoning plans are made by the local administrations of the relevant city, by the master development plan of the ministry, with an implementation plan of 1/1000. With this plan, the required zoning islands and roads are placed on the site. It should be done by considering parameters such as population, zoning island density, density-dependent height coefficient, total construction precedents, number of branches of intersections, the width of the road, and intersection radius, in connection with mainline roads and intermediate line roads to the area. In the study, a proposal has been made on how to place traffic lights in the content factors of the zoning islands, especially around the intersections on the plan.

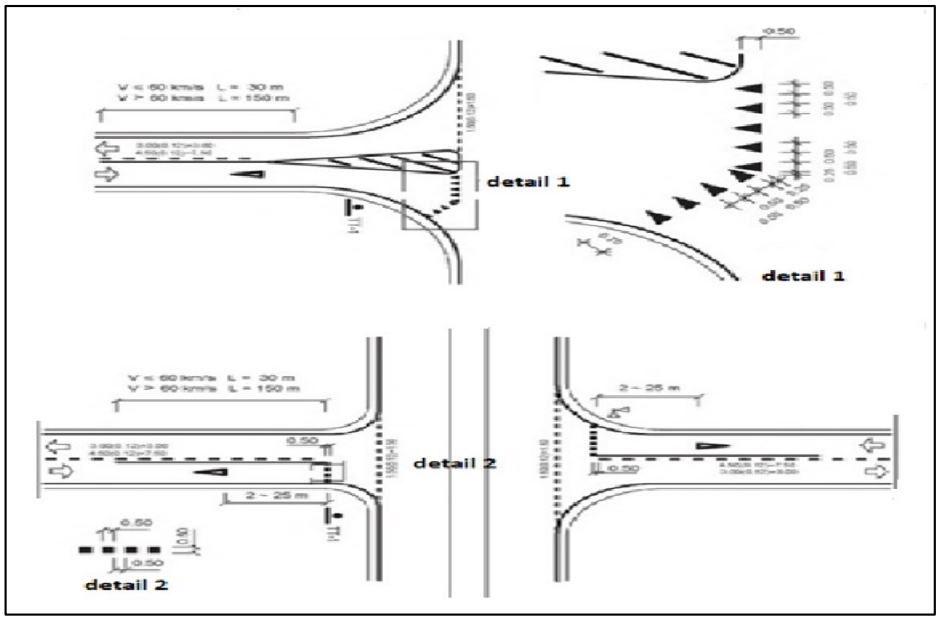
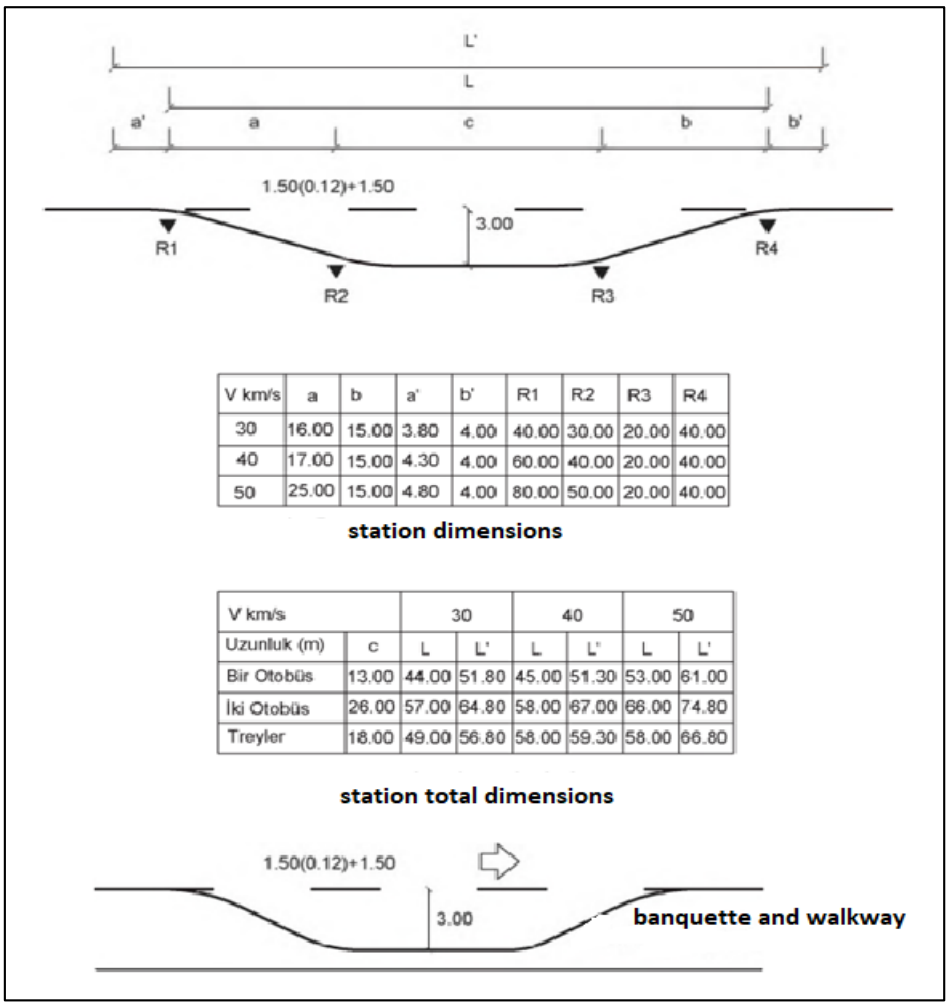


Figure 4. Display of intersection points only in terms of speed and distance (Url 1, 2022).

Figure 4 is an example that shows how to pass the distances of the vehicles, especially if the vehicles are only 60 km above or below 60 km speed, while determining the intersections according to the highways, and the roundabout pass between 2 and 25 road routes.



V km/s	a	b	a'	b'	R1	R2	R3	R4
30	16.00	15.00	3.80	4.00	40.00	30.00	20.00	40.00
40	17.00	15.00	4.30	4.00	60.00	40.00	20.00	40.00
50	25.00	15.00	4.80	4.00	80.00	50.00	20.00	40.00

station dimensions

V km/s		30		40		50	
Uzunluk (m)	c	L	L'	L	L'	L	L'
Bir Otobüs	13.00	44.00	51.80	45.00	51.30	53.00	61.00
İki Otobüs	26.00	57.00	64.80	58.00	67.00	66.00	74.80
Treyler	18.00	49.00	56.80	58.00	59.30	58.00	66.80

station total dimensions

Figure 5. The placement of the stops according to the speed according to the highways (Url 1, 2022).

In Figure 5, a table has been prepared on how to apply distance according to speed in station placements according to highways. As this example shows, the fixed idea has often been speed and distance. The starting point of our propositions is the correlation of such parameters with the zoning plan. Highways have set the standards for placing all lines and signs (Url 2, 2022).

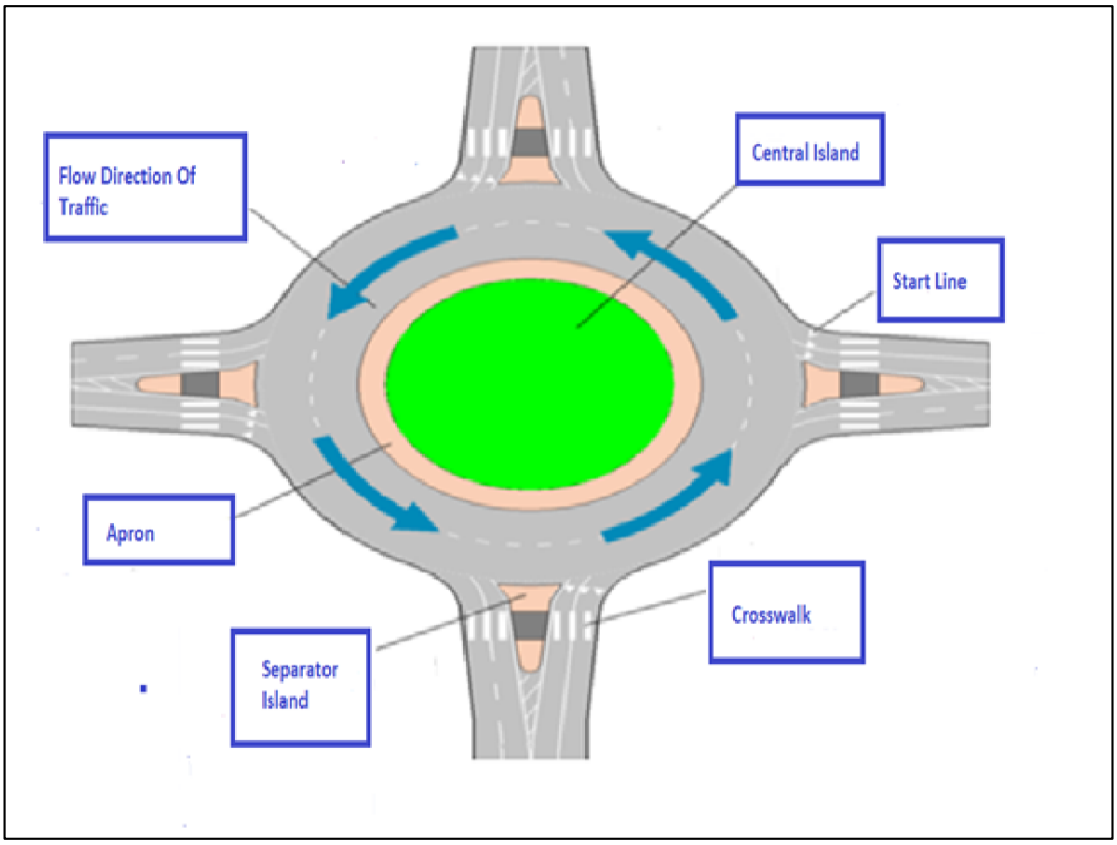


Figure 6. General representation of roundabouts by highways (Url 3, 2022).

Figure 6, gives general information about the general standards of highways and modern intersections, and looks at the classification and relation network and the propositions on how to put traffic lights in the zoning plans (Url 4, 2022);
The width of the road and the diameter of the junction will be included in the work as a proposition at the junction points of the zoning plans, creating a correlation with the zoning island precedent value, the island height coefficient, and its identity as residential or commercial. If an average proposition p and q is constructed,

$$\dot{\Sigma} = p(x)\,\mathrm{d}x \pm q(x)\,\mathrm{d}x \tag{6}$$

$$\left[A_{1_{n_0}}\right] \tag{7}$$

From the unit matrix to the diagonal matrix, $\mathrm{A} \Rightarrow \left(\mathrm{A}^{\mathrm{T_p}}\mathrm{A}\right)^{-1}\left(\mathrm{A}^{\mathrm{T_p}}\mathrm{A}\right)$ factor correlations can be examined by establishing equation.
Above, if V is taken as correction matrix, A coefficients matrix will take whatever factor will affect the relevant zoning plan, and L correction matrix will enter the mean radii of the roundabouts and read the angle distance such as 50-100-150-200 grads in the V correction matrix. the result will give the horizontal distance that will be added to our radii.
From equations 6 and 7, information was obtained about how to design the intersection geometry together with the connecting branches mathematically, about the derivative and integral expansions and their geometries.

In the zoning plan, the zoning islands where the residential, commercial, residential + commercial and social areas will be determined are arranged. This factor is also a factor in the number of branches of the junctions of the main and intermediate road lines, called connection points.
Thus, with this factor affecting the width of the main and intermediate roads, in the light of the width of the roads in meters, in the light of the radius from the point where the roundabouts are placed, how much deviation in meters and traffic lights should be placed.
Apart from the road width, the precedents of the zoning islands, that is, the total construction precedent areas, were determined according to the characteristics of being a residence, etc., in which the characteristics called legends are determined, in how many meters they should be placed by taking the direction from the middle point of the intersection.

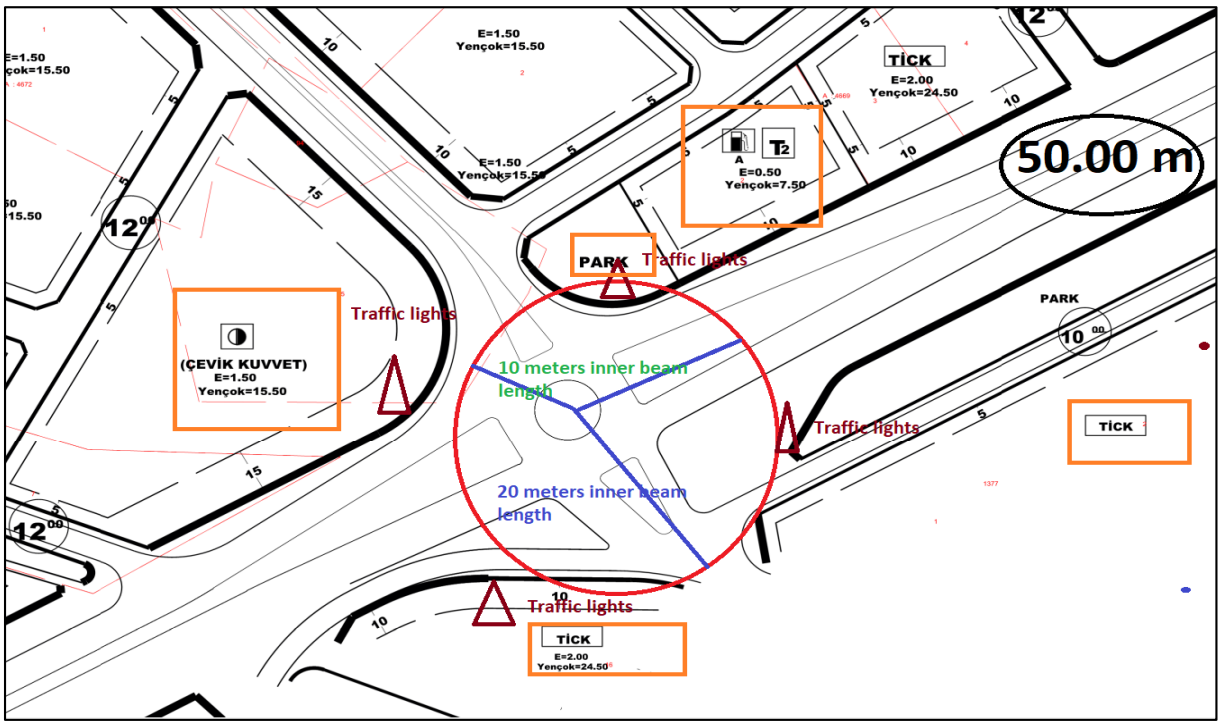


Figure 7. 50-meter main road 4-arm intersection point traffic lights layout display

In Figure 7, in the zoning plans, the zoning islands are specified in legends such as T (Commercial), TİCK (Commercial + Housing), only Housing. Legend means the property of the island. The roundabout has been found suitable from the settlement correlation matrix of the roundabout from a radius of 15 meters and a diameter of 30 meters, since there is a petrol station and an official institution area in the north of the intersection, which is given as a 4-arm, and there are tick islands in the south, as well as a 50-meter main road connection point.

Table 1. Junction diameter distances according to road width

Road Width (D) (meters)	Radius/R meters
20	12,5
24	13
24	13
25	15
28	16
30	17,5
35	27,5
40	25
50	30

Table 1 shows how the road width and the diameter distances of roundabouts are entered into the plans. Especially in the zoning plans, if the area is flat as the northern and southern ring roads, a main line is formed by processing. The connection intersections and roads with this line are covered by the

network theory as the island and road, with the width of the 20-meter and 50-meter roads. This process is how the traffic lights should be placed in the direction of the diameter distances by taking the clockwise direction from the middle of the roundabouts. The table is a representation of the ground-axis distances where the traffic lights will be placed, from the road width and the diameter distances of the intersections.

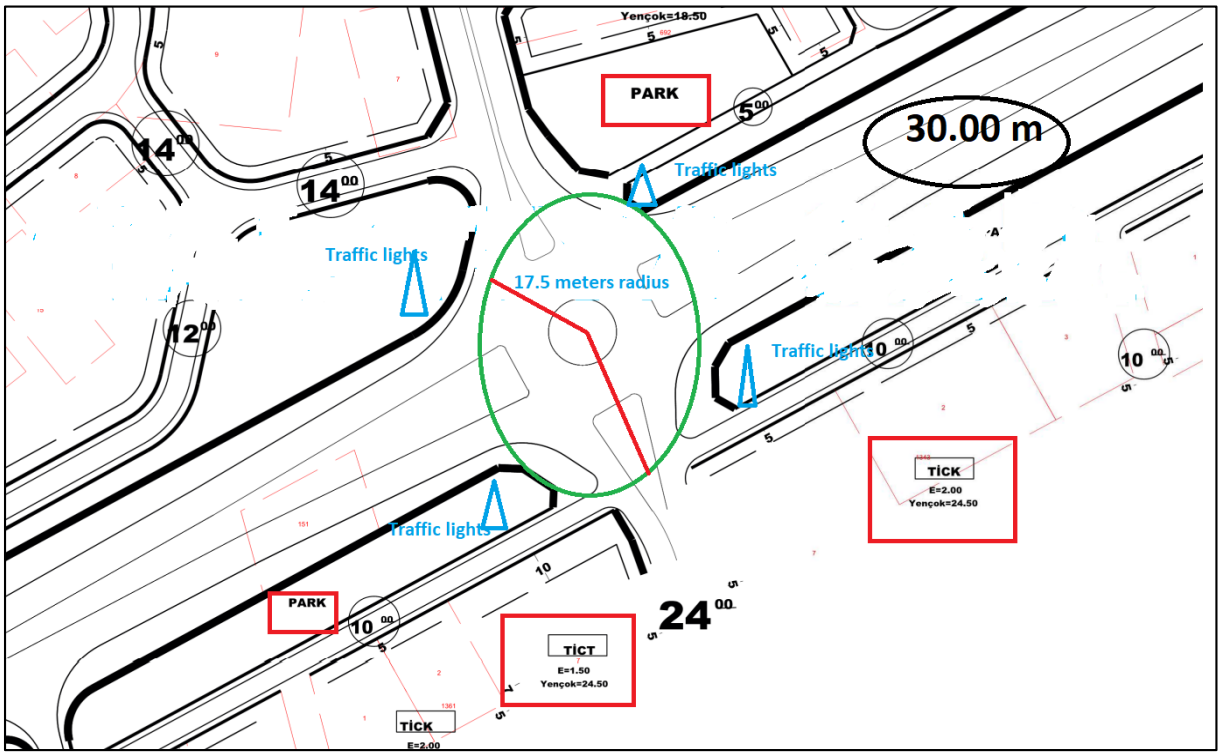


Figure 8. Representation of the 30-meter road line and the surrounding island feature

It is a demonstration of placing traffic lights at the corner points of the 4-arm intersection, approximately 17.5 meters from the 30-meter main line, after emphasizing the road width and diameter above. Except for the 30-meter line relationship, the relationship parameter should be examined according to the residence and other legends.

Table 2. Traffic lights intersection radius relation by island legend

Island legends	Traffic lights intersection correlation (m)
Housing	20
Trade	25
Residential trade	30
School	30
Mosque	30
Hospital	35
Official institutions	25
Liquid fuel	45

In Table 2., when placing traffic lights at three, four or five-armed intersection corner points, the horizontal distances are averaged from the intersection midpoint in elliptical form, taking into account the relevant island legends.

$$\Sigma f(x)\,\mathrm{d}x + \Sigma g(x) j d_x \tag{8}$$

Especially at the points where the fuel areas are located, the placement of the lights will be maximum on the basis of radius, and the minimum distance around the residential development blocks will be at

a minimum distance for the livelihood of the pedestrians. From equation 8, information was obtained about how to design the intersection geometry together with the connecting branches mathematically, about the derivative and integral expansions and their geometries.

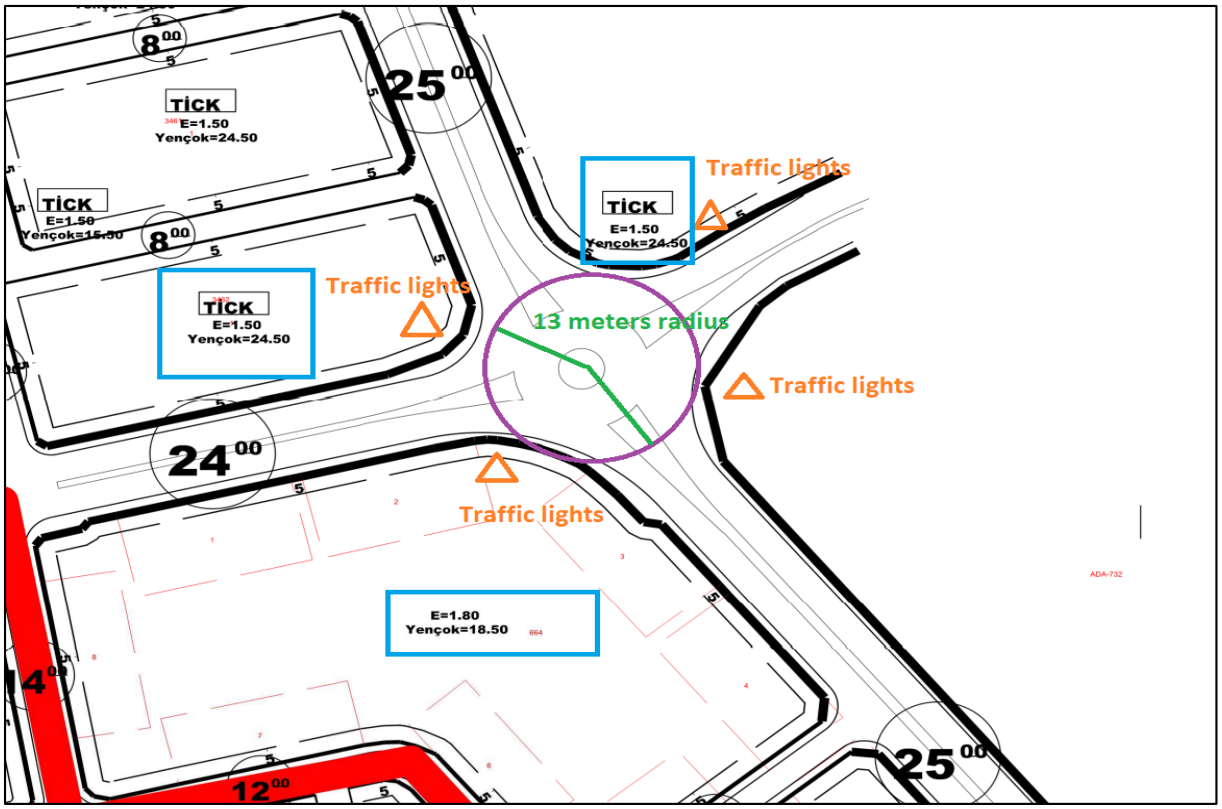


Figure 9. Placement of traffic lights at the junction points of commercial residential islands

In Figure 9., while the radius of the intersection is 13 meters, especially at the intersection of the 24 and 25-meter roads, the lights are placed by paying attention to the corner points for 17 meters, since tick areas exist at the corners. The reason for placing it in this way is that the building at the base, that is, the parcel, is used as a shop in tick areas.

Table 3. Relationship between traffic lights and island peer values

Equivalent Value	Traffic corner light placement distance (m)
0.30	12
0.60	15
0.90	18
1.20	21
1.50	24
1.80	27
2.10	30
2.40	33
2.70	35
3.00	37
3.30	39
3.60	41

In Table 3., it is stated how the horizontal distances to be formed in addition to the connection intersections corresponding to the island fronts with precedent values in the zoning islands will increase. Adding to the average intersection radii will result in an increase in traffic lights depending

on the population ratio. When it is calculated that there will be an average of 4 people per block from 0.30, that is, the islands that will correspond to 2 floors, 3.60, which will correspond to approximately 12 floors, and it is estimated that 48 people will use the route, it will be found how the traffic lights corresponding to the equivalent value will be calculated from the connection points.

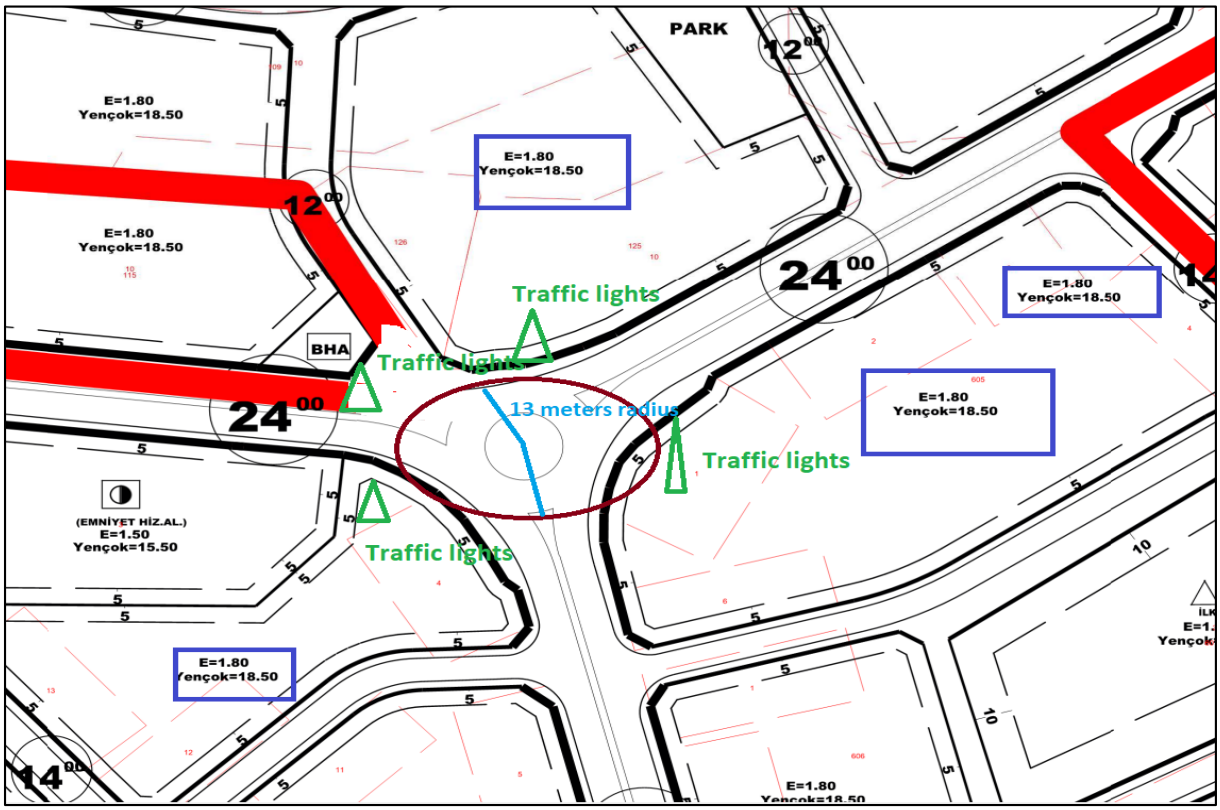


Figure 10. Layout representation of traffic lights according to height coefficients

In Figure 10, since the traffic lights at the junction point where the zoning islands are located, shown with the legend of Yençok, are in such a way that they correspond to the intersection of roads with an average of 24 meters and an average of 6 floors, the radius of the intersection on the width of the main road is 13 meters, and in the case of the plan, with the addition of 14 meters, it is in a circle of approximately 27 meters. lights will be placed.

Table 4. Correlation of Height Coefficients and Traffic Lights

Height Quantity (m)	Light Settlement distance (m)
6.50	15
9.50	18
12.50	21
15.50	24
18.50	27
21.50	30
24.50	33
27.50	35
30.50	37
33.50	39
36.50	41
39.50	43

In Table 4, a proposal will be made on adding traffic lights to the corners of an area by adding the average number of people to live according to the height of 13 meters above the radius intersection at the junction points of 18.50 meters, whose height is given over an average of 6 floors.

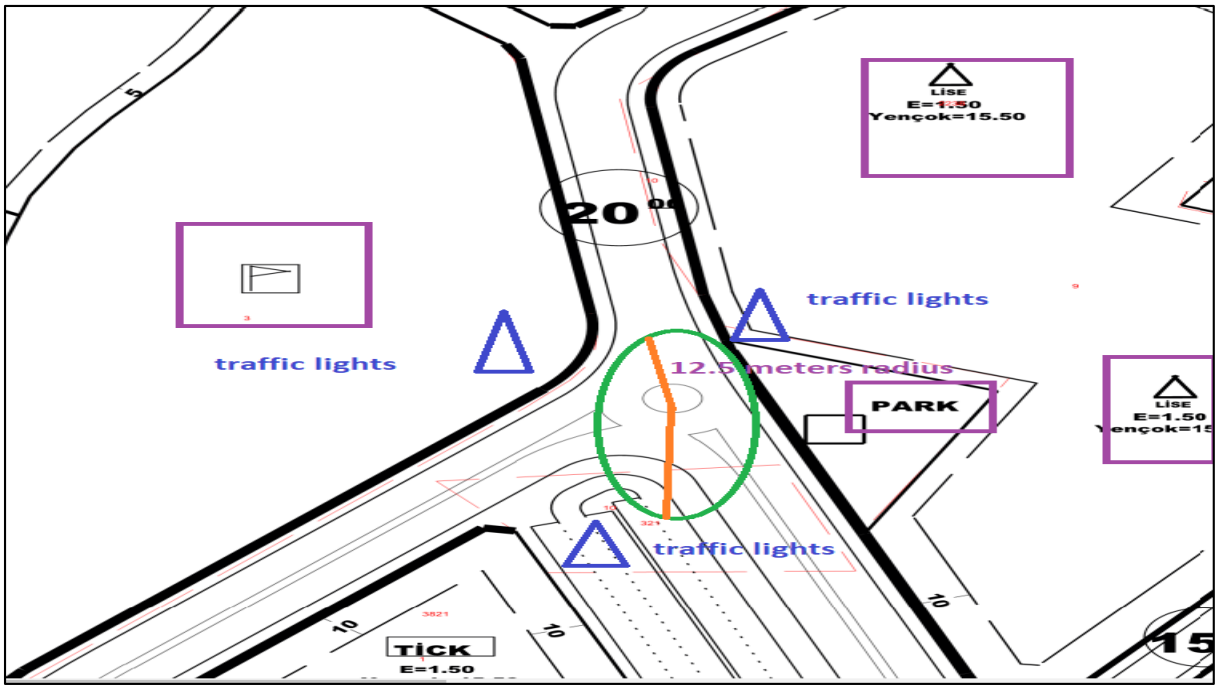


Figure 11. Distance display of the lights to be placed at the connection points of official institutions and school areas

In Figure 11., traffic lights of corner points will be placed by adding an average of 10 meters to the intersection radius formed by the average road width at the junction points of areas such as schools, official institutions and sports facilities around the 20-meter road intersection.

Table 5. Distance Correlation of Traffic Lights on Official Institution, Sports Facility, Park Legendary Islands

Other Island Legends	Traffic Light Distance (m)
Official institutions	10
Sports Facility	10
School	10
Park and Marketplace Area	10

In Table 5., traffic lights should be added to the corners of connection points by adding 10 meters in addition to the radius of the intersection point of the road width in these type of zoning islands where there is only certain hours of the day and night, except for residences and commerce.

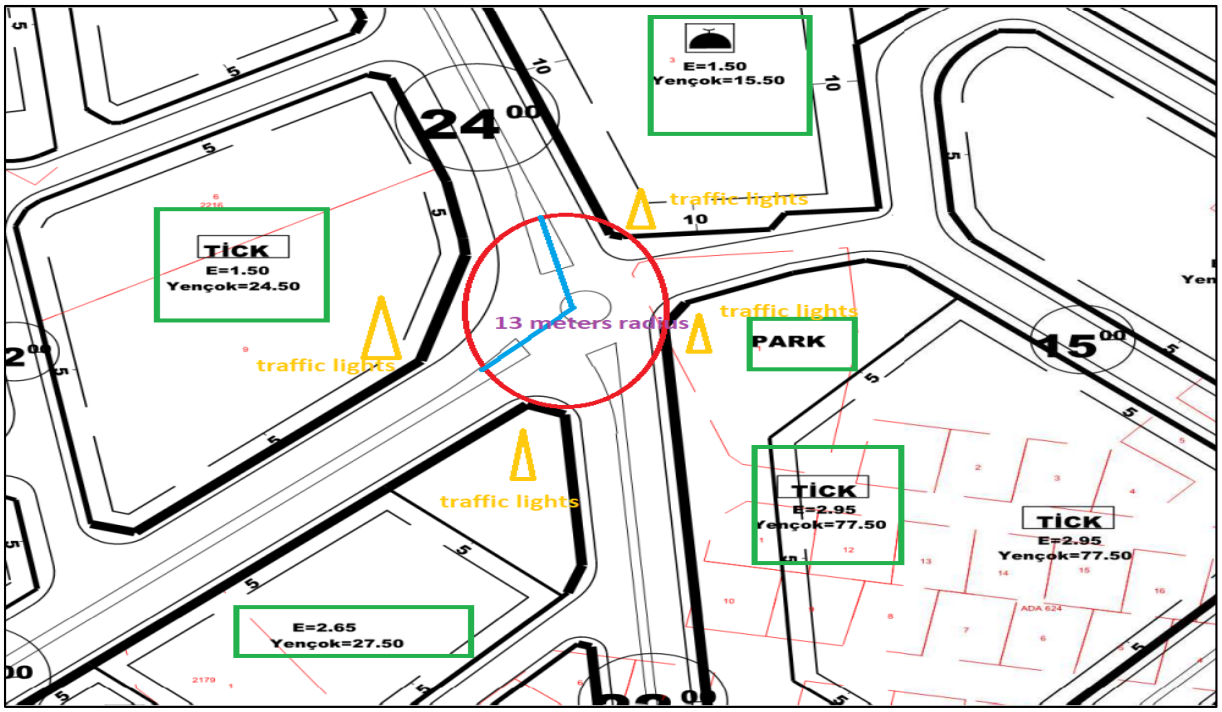


Figure 12. Layout of traffic lights at intersections with tick and equivalent values

In Figure 12, traffic lights are found by adding the intersection radius according to the total arithmetic average of the height and peer values in commercial residential areas, with a 24-meter 4-arm intersection point corresponding to a radius of approximately 13 meters. From equation 9, information was obtained about how to design the intersection geometry together with the connecting branches mathematically, about the derivative and integral expansions and their geometries.

$$\frac{a1+a2\ldots+an}{n} = \Sigma_{an} \quad (9) \text{ is found from.}$$

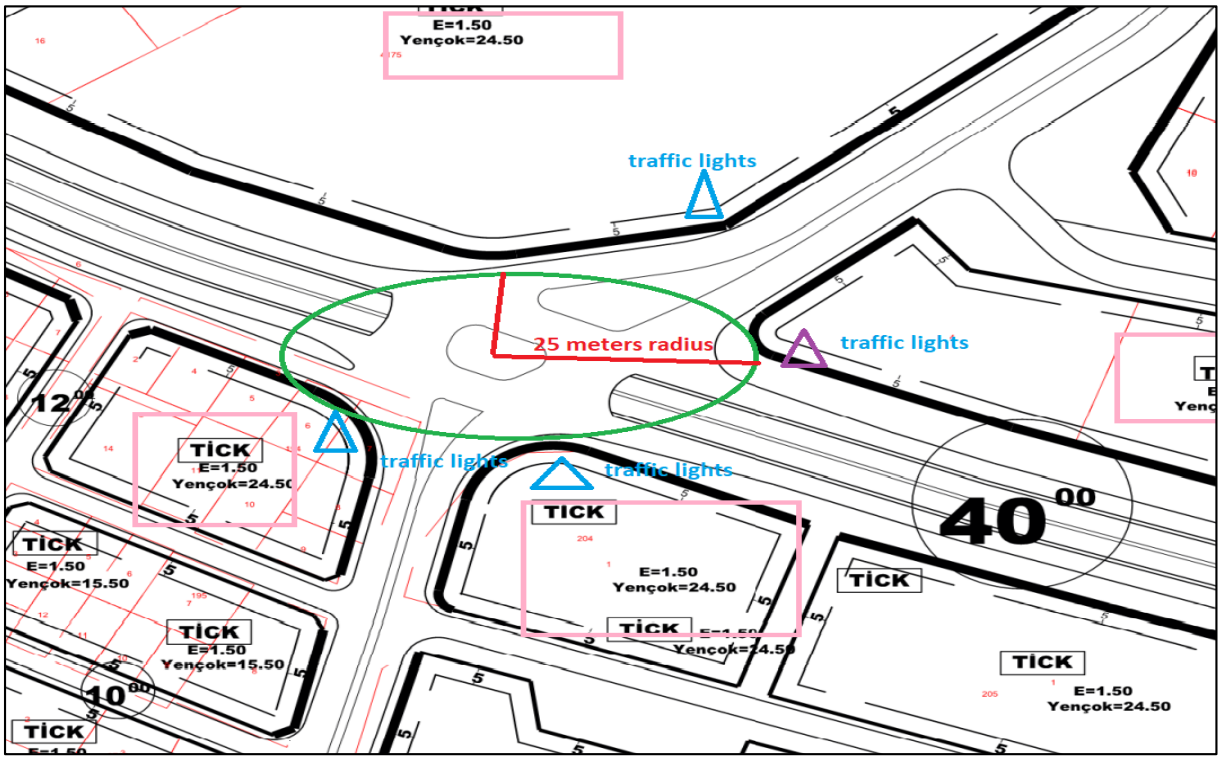


Figure 13. Demonstration of 40 meter port in hybrid form

In Figure 13, the distances of the traffic lights will be calculated by adding all the arithmetic plan island parameters to the radius of approximately 25 meters of the roundabout point, which consists of a 40-meter road width.

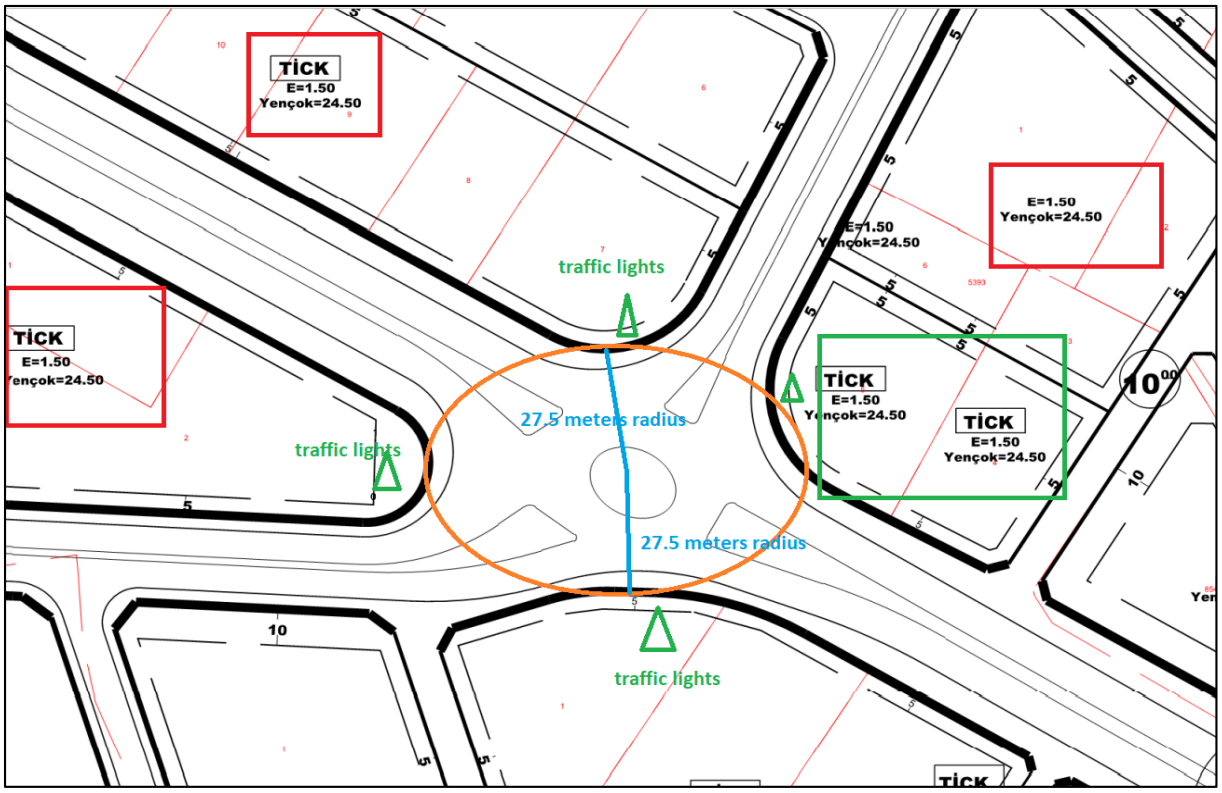


Figure 14. Tick zoning island intersection traffic lights layout display

As can be seen in Figure 14, the radius is determined on the basis of an average of 40 to 50 meters in the elastic, that is, undetermined binomial area where the road width is opened and narrowed. will be placed.

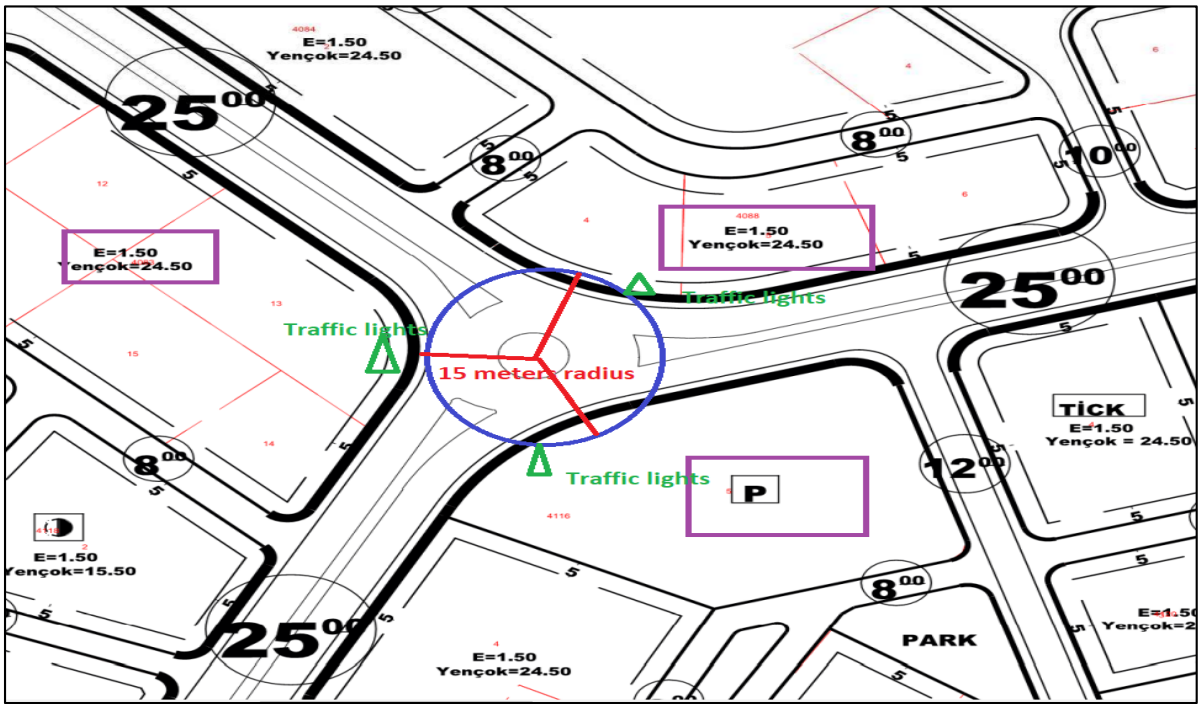


Figure 15. Traffic light placement at a mixed 3-leg intersection

In Figure 15, it is determined by adding at least 10 meters to the points where traffic lights will be placed on the turning circle, which will be located in the circle area of 15 meters radius, to the road width at the intersection at the intersection with the park, precedent and height value, as a result of the arithmetic average of the towing distances, which will correspond to the precedent and height values, like a compass.

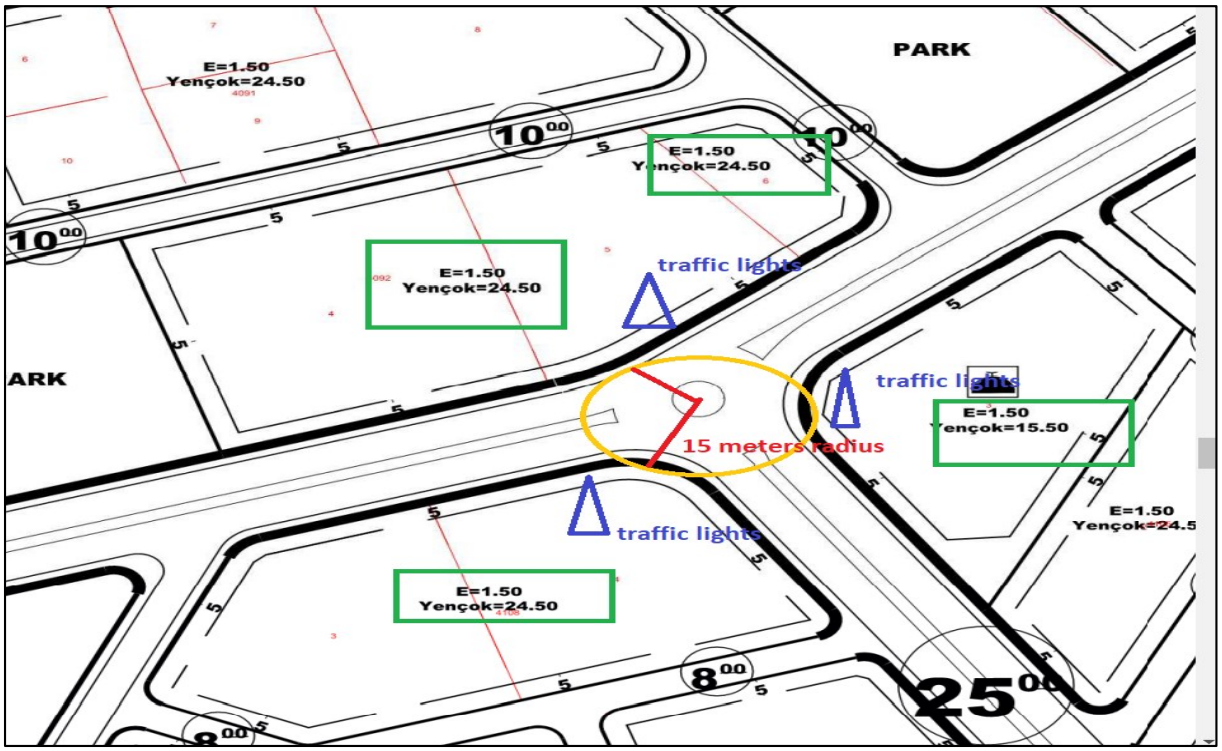


Figure 16. Light placement at the intersection according to the peer value

In Figure 16., since the precedent and height values of the zoning islands are determined only at the 3-arm connection point, the light settlement point can be determined by adding two arithmetic factors to the intersection radius.

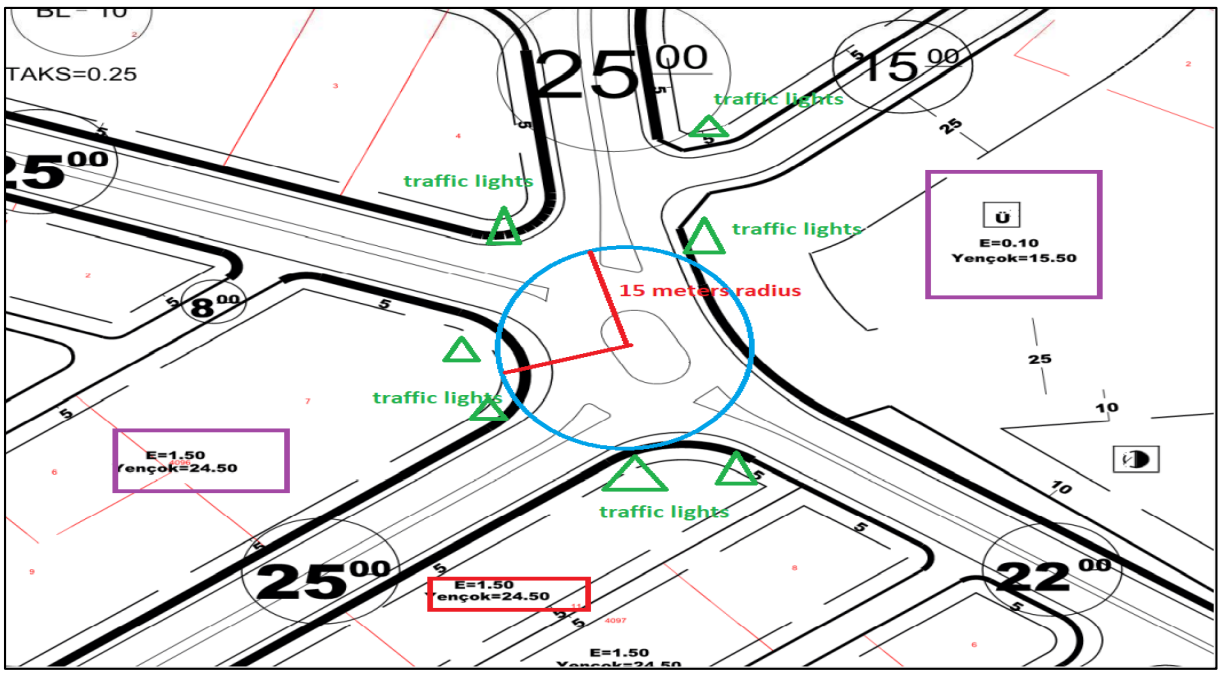


Figure 17. Light placement demonstration at the junction point in the hybrid structure

In Figure 17, traffic lights will be placed at the mixed connection plan points by taking the average of the values given in the tables in addition to the intersection radius, which is formed based on the road width at the intersection points of the official institution, that is, the university area and the zoning islands with normal precedent and height values.

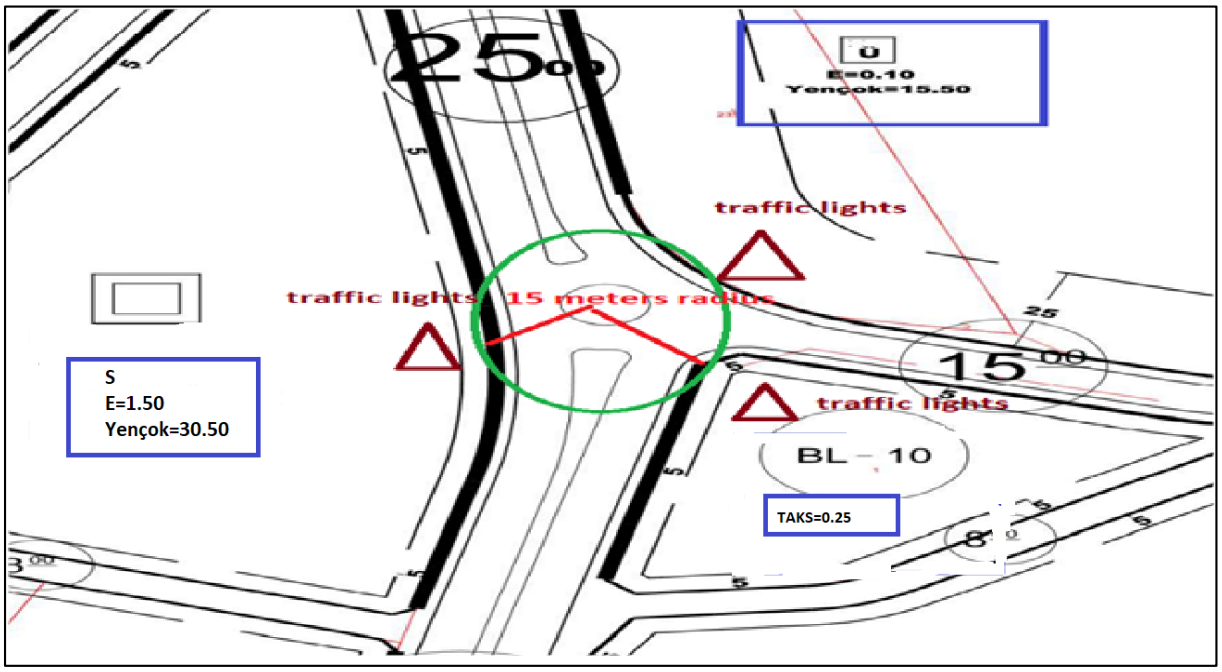


Figure 18. Mixed 3-arm port

In Figure 18, additions are made to the radius intersection distance, which is formed according to the 25-meter road width, according to the precedent, the building order and the average arithmetic value to be added in official institutions.

Table 6. Correlation by building order

Building order	Horizontal distance (m)
Separate	6
Block	6
Adjacent	4

In Table 6, it is found by adding to the intersection radius according to the discrete, block or adjacent building regulations as a parameter at the junction points where the building order shapes are known in the zoning blocks.

5. Conclusion and Recommendation

While creating a network of highways such as traffic lights and signs, the most important goal is to ensure the safety of the driver and pedestrians. Related institutions and organizations are clear. Generally, it may not be sufficient to consider only the road geometry when passing these signs and signs or lights. Especially when local governments make a zoning plan, a road network should be established in cooperation with the roads or highways under their control. Regardless of how many branches the connections of the main and intermediate roads are, the traffic lights must be passed according to the targeted 30-40 year minimum human population of the zoning islands while determining the topography cuts or fillings. In the study, it has been tried to explain with examples, which complex structure will be added to the intersection radius and which criteria should be paid attention to. According to the legends of the zoning islands, our suggestion is to ensure that the right

lights are placed at the points where human hours are intense or permanent, with planning that will take into account the traffic density in terms of security.
As the height values increase to 3 meters, the intersections increase proportionally from 12 meters to 12, 15, 18, 21, and 24, according to their width, and increase from 0.30 to 12, 15, 18, 20, 25, and 30 meters according to the equivalent values. While it is generally determined as 10 to 30 meters on municipal service roads according to population rates and island legends, this rate increases to around 15 to 200 meters at points connected to highways.
Traffic lights, based on the midpoint of the intersection,

- Due to the width of the road, it is necessary to place traffic lights on the 20-50 meter scale of the road, in addition to the radius of the intersection, around the circle as a radius of 12.5 meters and 30 meters from roundabouts,
- Placement of the zoning islands of the road around areas such as residences, commerce, official institutions, schools, mosques, hospitals, and fuel oil, by adding them in the range of 20-40 meters in addition to the radius distance,
- At the roundabout where the road passes, zoning blocks should be placed between 12 and 41 meters in the radius of the roundabout, starting with 0.30 precedent and corresponding to the number of construction floors that will emerge, corresponding to each 0.30 precedent increase,
- Between 15-43 meters in addition to the traffic light radius, which will correspond to the rate to be found only in H max in the zoning islands around the route where the road passes,
- Adding 10 meters to the fixed radius if there is only a school and official institution area at the roundabout where the road is located,
- At the junction where the road is located, the zoning island with different features, which allows a mixed structure, is added to the settled point with a radius of 25 meters,
- On the connection line, where the width of the road is 40-50 meters, by adding 27.5 meters around the commercial residential islands called TİCK,
- Adding a minimum of 15-25 meters to the radius of the intersection, depending on the intersection arms of the intersection, which is the intersection point of the road,
- By adding 4-6 meters to the fixed radius of 7.5-15 meters according to the separated, block, and adjacent situations of the zoning islands around the road,

The average values have emerged by finding from the mathematical diagonal matrices that the factors in the routes of the zoning plans are effective in the minimum conditions of placing the lights in the fixed regulation. In this way, the process of the correct application of zoning plans in safer, long-lasting road constructions for drivers and pedestrians has been revealed.

Statement of Support and Acknowledgment
There is no institution or organization to thank.

Conflict of Interest Statement
There is no conflict of interest with any person or institution within the scope of the study.

References

Aksoy, P. (2019). *Investigation of the Relationships between Drivers' Disobedience to the Rules at Illuminated Intersections, and Traffic Signs and Intersection Geometry*, ITU, Institute of Science and Technology, Department of Civil Engineering, Transportation Engineering Program, Master's Thesis, Istanbul.

Alemdar, K.D. (2019). *Evaluation of Intersection Designs by Decision Making Techniques, Atatürk University Institute of Science and Technology,* Department of Civil Engineering, Department of Transportation, Master's Thesis, Erzurum.

Anbari, M. (2020). *The Effect of Urban Design on Traffic Safety, Gazi University Institute of Science and Technology,* Department of Environmental and Technical Research on Accidents, PhD Thesis, Ankara.

Basa, H. (2016). What is a Junction? traffic.net.tr, https://trafik.net.tr/kavsak-nedir/ (28.06.2019).

Boz, C. (2019). *Simulation of Traffic Flow at Road Network Junctions and Investigation of the Effects of Change in Configuration,* Yıldız Technical University, Institute of Science and Technology, Department of Surveying Engineering, Remote Sensing and GIS program, Master Thesis, Istanbul.

Cakici, Z. (2014). *Investigation of Design Principles of Signalized Roundabout Interchanges,* Pamukkale University Institute of Science and Technology, Department of Civil Engineering, Master's Thesis, Denizli.

European Commission, Annual Accident Report, (2018). https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/statistics/dacota/asr2018.pdf, Accessed 10 October 2020.

FHWA. (2004). Signalized Intersections: *Informational Guide.*

Guncu, V. (2019). *Investigation of Existing Roundabouts on Highways in Turkey in terms of Traffic Safety by Taking Geometric Designs into Consideration,* Gazi University Institute of Science and Technology, Department of Civil Engineering, Master Thesis, Ankara.

Janssens, R. (1994). Evaluating the Performance of a Roundabout, CEEC's Training Seminar on Road Development and Safety for Managerial Staff from Central and Eastern *European Countries, Brussles-Belgium.*

Kaufmann, A. and Gupta, MM. (1991). Introduction to Fuzzy Arithmetic Theory and Applications, *Van Nostrand-Reinhold.*

Kaya, I. (2020). *Building and Zoning Sanctions in the Zoning Law in the Light of the Council of State Decisions,* Kırıkkale University, Institute of Social Sciences, Department of Public Law, Master's Thesis, Kırıkkale.

Kayacan, C. (2022). *Determination of Geometric Delay at Roundabouts in Izmir,* Dokuz Eylul University Institute of Science and Technology, Department of Civil Engineering, Transport Program, Master Thesis, Izmir.

KGM, Highway Traffic Safety Handbook, (2007). Traffic Branch Directorate, Ankara.

Kısa, M. (2022)). *Application of Fractional Derivatives and Integrals to Some Inequalities,* Fırat University, Institute of Science and Technology, Department of Mathematics, Master's Thesis, Elazig.

Kızolli, Beni. (2017). *New Approaches/UTY Strategies for Urban Traffic Problems and Solutions: Example of Pristina,* Gazi University Institute of Science and Technology, Department of Environmental and Technical Research on Accidents, Doctoral Thesis, Ankara.

Mohammed Ali, M.E. (2021). *Coordinated Adaptive Traffic Signaling Control for Smart Cities, Selcuk University,* Institute of Science and Technology, Department of Electrical and Electronics Engineering, PhD Thesis, Konya.

Molodtsov, D. (1999). *Soft set theory-first results, Computer and Mathematics with Applications*, 37, 19-31 pp.

Oluwole, A., Abdul Rani, M., & Mohd Rohani, J. (2013). *Integrating road safety indicators into performance road safety index. ARPN Journal of Engineering and Applied Sciences,* 8(9), 693-698.Orbay, K. (2014). On Fuzzy Soft Sets, Ege University Institute of Science and Technology, Department of Mathematics, M.Sc., İzmir.

Öğütveren, E. (2019). *Geometric Design of Modern Roundabouts and Capacity Relationship,* Pamukkale University Institute of Science and Technology, Department of Civil Engineering, Master's Thesis, Denizli.

Rasheed, F., Yau, K.-L. A., Noor, R. M., Wu, C., and Low, Y.-C. (2020). *Deep Reinforcement Learning for Traffic Signal Control:* A Review, IEEE Access.

Sarı, F.A. (2021). *The Use of Traffic Simulation Techniques at Junctions and Comparative Analysis of Simulation Programs,* Sakarya University Institute of Science and Technology, Civil Engineering, Department of Transportation, Master's Thesis, Sakarya.

Tanyel, S. (2001). *Capacity calculation method for roundabouts in Turkey*. Phd Thesis. I.T.U. Faculty of Engineering and Architecture, İstanbul.

Tunç, A. (2003). *Traffic engineering and applications,* Asil Yayın Dağıtım Ltd. Sti., Ankara, 655-783.

Umar, F. and Yayla, N. (1992). *Road Construction,* Istanbul: İ.T.Ü Civil Engineering Faculty Printing House.

Yayla, N. (2015). *Highway Engineering*. Birsen Publishing House, Istanbul, Turkey.

Yilmaz, E. (2006). *Highway Traffic Simulation,* Master Thesis, Karadeniz Technical University, Trabzon.

Yilmaz, Y.E. (2021). *A Composite Safety Index Development Study on Highway Traffic, Yıldız Technical University,* Institute of Science and Technology, Civil Engineering Department, Master Thesis, Istanbul.

Url 1:
https://www.kgm.gov.tr/SiteCollectionDocuments/KGMdocuments/Trafik/IsaretlerElKitabi/KarayoluTrafikIsaretlemeStandartlari1.pdf

Url 2:
https://www.kgm.gov.tr/SiteCollectionDocuments/KGMdocuments/Trafik/IsaretlerElKitabi/KarayoluTrafikIsaretlemeStandartlari2.pdf

Url 3:
https://www.kgm.gov.tr/SiteCollectionDocuments/KGMdocuments/Trafik/moderndonelkavsak.pdf

Url 4:
https://www.kgm.gov.tr/SiteCollectionDocuments/KGMdocuments/Trafik/UzmanRaporlari/KITGIUzmanRaporlari.pdf