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Determining Optimal Road Widths in Zoning Plans using the LSM: Evidence from Elazığ, Türkiye

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Zoning plans encompass areas where people reside and fulfill their essential functions. The formulation of these plans is governed by various criteria, encompassing population, topography, land slope, aspect, climatic conditions, transportation, and opportunities for health and education. In Türkiye, the zoning plan governed by Law No. 3194 is developed around zoning islands, incorporating various criteria during its formulation. Within such plans, transportation networks are established through primary and intermediate roads, which are designed not according to private property boundaries but in response to the configuration of zoning islands and site-specific land conditions. Consequently, this study investigates the necessity of determining road widths with varying characteristics—such as population, precedent, height, and construction coefficient—to optimize both traffic flow and pedestrian safety. By utilizing the Least Squares Method (LSM), main road widths are treated as correction coefficients; the constant width lengths, length coefficients, and all relevant criteria of zoning blocks are expressed separately as constants and unknowns, with their relations examined. The results provide an evaluation of road network design, emphasizing that the determination of ideal road width is a critical factor in enhancing the performance of zoning plans, offering place- and evidence-based guidance to strengthen long-term functional efficacy and urban resilience.

Keywords: Least squares method (LSM), Spatial planning optimization, Türkiye zoning regulation 3194, Urban road network design, Zoning islands

Introduction

The increasing emphasis on public space quality has elevated expectations for such spatial environments; examining the needs of diverse groups within metropolitan zoning plans can reveal underlying urban planning and design decisions.[1] It is thought that the deterioration observed in urban textures, which has recently been affected by various negatives, causes the preservation of durable spatial lives with various technological and planning designs required to provide solutions.[2] Urban morphology conceptualizes the city as a spatial configuration of buildings, streets, and open spaces—a product of ongoing socio-spatial transformation; this field encompasses processes of land subdivision, construction, and infrastructure development, with building and street patterns—collectively termed the "urban grain"—serving as fundamental analytical units.[3] Quantitative approaches, such as extracting street-network characteristics and simulating daylight conditions, have been used to capture road network morphology, block scale, and building scale.[4]

Further research has examined the morphological structure of urban edges, assessing both positive and negative impacts of discretionary peripheral development on transportation, road networks, utilities, and accessibility, often employing mapping analyses to observe urban boundaries and their evolution.[5] In fast-growing cities, transportation networks—spanning nearly the entire urban area—are critical to morphological coherence; poorly coordinated morphology can exacerbate traffic congestion and undermine sustainability objectives.[6] Moreover, increasing private vehicle use in emerging economies, coupled with urbanization and metropolitan expansion, presents significant challenges.[6] As seen globally, Türkiye has long prioritized motor vehicles in urban mobility, shaping urban and transportation planning around managing higher vehicular mobility.[6]

Spatial planning encompasses a wide range of decisions that govern the formation of land policy,

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including planned urbanization, environmental-nature-culture conservation, safe agriculture, transportation networks, and so on.[7] Regular road network planning, zoning schemes, and traffic design interact to produce order in spatial transportation layouts, with initial development phases relying on robust road infrastructure linked to economic, commercial, and social activities.[8] Roads thus symbolize civilization and modernization; however, rising vehicle ownership and population density now strain existing infrastructure, contributing to chronic congestion.[8,9] Accelerated urbanization drives migration from rural to urban areas, resulting in rapid population growth and diverse challenges in regional centers.[10,11] These pressures adversely affect urban traffic, prompting worldwide studies to regulate traffic and alleviate urban transportation burdens, as well as to explore optimization solutions for urban traffic management.[10,11]

In developing countries, transportation serves as a key driver of development, where well-balanced modes, high geometric standards, and adequate road networks are essential for growth; numerous legal regulations, zoning plans, and administrative procedures have been implemented to ensure zoning order, with violations subject to sanctions.[12] Nevertheless, in certain cases, road designs have prioritized vehicular movement, sometimes at the expense of pedestrian space, reflecting a historical emphasis within transportation engineering and urban planning.[13] Urban transportation and technical infrastructure increasingly struggle to meet growing demands, a situation exacerbated in Türkiye by a relative scarcity of place-based research, underscoring the urgency for targeted studies.[11,12]

Specifically, in Türkiye, the formation of the primary road network is intrinsically linked to zoning plans, with all processes governed by national zoning law; land use, acquisition, and tenure adjustments are conducted by public authorities within the legal framework.[12,14] Among land management tools, zoning plan applications represent one of the most comprehensive mechanisms for reorganizing land parcels; this process typically involves reallocating remaining portions of parcels after legally mandated deductions, creating new parcels, and distributing them to their rightful owners.[15] However, demographic shifts, economic fluctuations, and evolving societal needs often necessitate amendments to existing plans; in some cases, municipalities employ land adjustment methods to reserve public land—particularly for road expansion—to accommodate urban growth.[16]

Building upon this institutional and legal context, this study proposes an alternative analytical perspective by examining the quantitative relationship between zoning block parameters and road width, integrating building construction and road engineering viewpoints. The approach to be followed on the paving of roads is adjustable under minimum circumstances, depending on the topographic and demographic factors of the cities. Specifically, it investigates the effect of road width within the horizontal axis of the zoning plan, considering its mathematical implications on roads as influenced by plan parameters such as setback distances of zoning islands relative to adjacent roads. By evaluating zoning block setbacks and examining how existing roads can be proportionally adjusted—expanded or reduced—to meet sustainable urban needs, applying relevant criteria within a matrix-based mathematical model. The findings aim to provide empirically grounded recommendations for aligning road morphology with Türkiye's national zoning standards, thereby supporting sustainable and adaptable urban development.

Methodology

Description of the Study Area

Türkiye is a country that governs its surface area centrally, with 81 provinces. Elazığ (Merkez) is the capital of Elazığ Province, one of 81 provinces in Türkiye. Elazığ in Fig. 1 is chosen for the experimental study area of zoning plans because it is the center of a provincial administrative region with flat plain terrain, and the city is on the ground with very little elevation difference; there is no road going through the tunnel between the mountains when the elevation difference is extremely minor, and it is entirely suited for passing roads.[12,17]

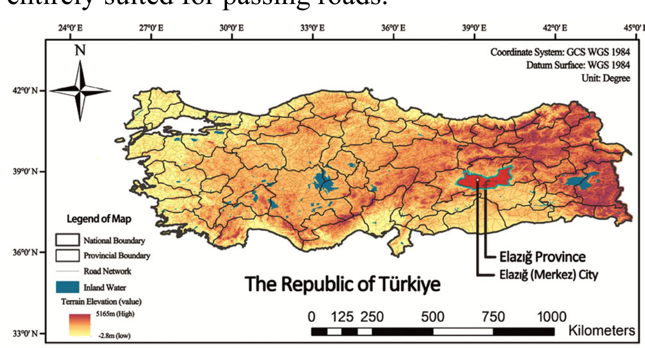

Fig. 1 — Locationmap of the study area: Elazığ, Türkiye [Note: the map is drawn based on the public geo-administrative information data (Source:https://www.diva-gis.org/)]

There is a single Zoning Law;it is known as Law No. 3194 in Türkiye, which specifies the requirements to be considered in construction, road, and land development in planned and unplanned areas.[18,19] The zoning plan law was enacted in 1985 and is documented in the Türkiye Legislative Information System (Türkiye Cumhuriyeti Cumhurbaşkanlığı Yasama Bilgi Sistemi), Number: 18749 (Source: https://www.mevzuat.gov.tr/mevzuatmetin/1.5.3194.pdf). The general minimum requirement for zoning roads in Zoning Law No. 3194 has been derived based on the facade and depth requirements of the zoning islands, where discrete, block, adjacent, and typically discrete blocks and adjacent are applied concurrently. Zoning islands within zoning plans include many features, such as homes, commercial spaces, parks, places of worship, and social and cultural spaces. However, as time has passed, some scholars have proposed a disconnect of urban planning in Türkiye by investigating the relationship between conceptual theory and practical applications, and the fact that planning in Türkiye is dominated by outdated laws and regulations is a significant contributor to this issue.[20]

Conceptual Framework and Scope

Urban development plans are fundamentally comprised of three integral components: conceptual, traffic, and city center plans; within this framework, the geometric design of roads constitutes a specialized field of road engineering, concerned with arranging physical road elements in accordance with established standards and constraints.[8,12,17] Geometric design is directly influenced by a multitude of site-specific factors, including the physical and geological characteristics of the terrain, climate, horizontal and vertical alignment considerations, cross-sectional requirements, and topographic profile—whether flat, rolling, or mountainous; its principal objectives are to optimize operational efficiency and safety while minimizing costs and environmental impact.[8]

Road traffic safety is inherently a complex, multi-factorial problem involving interactions between human, vehicle, road, and environmental elements.[21] Within the road factor, the design of the horizontal alignment—particularly horizontal curves (horizontal bends)—is critical; although accidents occur more frequently on curves than on straight sections, the inclusion of horizontal curves remains a practical necessity in road design due to terrain, land use, and alignment constraints.[22,23] It is widely concluded that accidents rarely stem from a single cause but rather from the combined effect of multiple factors (research indicates that specific design parameters on the horizontal axis—such as curve radius, superelevation, curve length, transition curves, and sight distance—significantly influence accident rates); consequently, each design parameter for highway horizontal curves must meet or exceed established design values to ensure safety.[22,23]

A transportation planning paradigm that prioritizes vehicular flow exclusively is inadequate for creating safe and efficient urban infrastructure; urban transportation design must instead be planned and implemented with a focus on social benefit, sustainability, and enhanced traffic safety. From a transportation perspective, key urban design principles include: accessibility; the provision of pedestrian-oriented areas; comprehensive and functional public transportation systems; seamless integration between different transport modes; the balanced distribution of moving and stationary traffic within the urban fabric; traffic calming measures; the creation of a safe traffic environment; the application of intelligent technologies; and sustainable planning.[24]

A major road network consists of interconnected or sequential intersections along primary flow directions within a single plane. The objective of signal control on such arterials is to minimize vehicle stops, ensure continuous progression (signal coordination), and increase average speeds; effectively, this aims to smooth traffic flow along main corridors, thereby reducing travel times, stops, and intersection delays.[25] Achieving this requires coordinated traffic signal control across the network, a method recognized since the 1960s as effective for mitigating urban congestion and a focus of sustained research interest.[26]

Lane width on major roads, particularly along primary routes, must be determined by synthesizing several factors: the designated road cross-section (number of lanes), traffic volume requirements, the width available after allocating space for pedestrian sidewalks at the narrowest point, and the resulting feasible platform width; where on-street parking is not permitted (if roadside parking is not arranged), a standard lane width should not exceed 3.0 meters in central areas and 3.5 meters elsewhere in Türkiye.[11] The lane configuration must accommodate the most restrictive of these constraints.[11] Accordingly, building upon the above framework, this study is achieved by matrix-based analysis of the interrelationships between all zoning island characteristics within the study scope. The baseline configuration assumes a two-lane road with a total width of 7 meters. The model assesses how these zoning parameters interact and determines the necessary adjustments to this 7-meter width standard.

Zoning plans universally serve as instruments of urban order. While each country's planning process adheres to its own legal and cultural criteria—incorporating factors like population, topography, and socio-economic structure—the design of the road network remains intrinsically linked to zoning configuration and planning standards. The road network is shaped not only by the physical totality of the land but also by the correlative relationships between zoning islands, which are themselves defined by the planning criteria applied. This study employs a coefficient matrix as its methodological core; it conceptually integrates, beyond the standard plan legends dictating island placement, the contribution of each island's specific criteria—through parameters such as minimum setback distances and zoning diameter—into the determination of road network dimensions, aiming to quantify how these factors collectively influence pedestrian and traffic regulation within the plan.

Study Methods and Design

Even if a quantity is measured many times under the same conditions, it is always measured differently from each other.[27] It has been accepted that measurements are never exact and always contain errors, no matter how carefully they are made; for this reason, data should be processed and analyzed before and after use.[27,28]

When the number of measurements (n) exceeds the number of unknown parameters (u) in a system, a unique solution can be obtained via a balancing adjustment calculation; among various adjustment methods, the Least Squares Method (LSM) is most widely employed.[27] Its origins trace to Legendre (1805) and Gauss (1809), who used it to determine celestial orbits from astronomical observations.[28] Subsequently adapted for solving diverse technical problems, the method's properties have been extensively studied, leading to specialized numerical algorithms and tailored formulations.[29]In geodetic and statistical contexts, LSM determines unique parameter values by minimizing the sum of the squares of the weighted residuals—the differences between observed and adjusted values.[27,30–33] As a foundational statistical tool for modeling relationships within data, LSM occupies a central role across countless research areas, with countless varieties and applications.[34] Nevertheless, its sensitivity to outlying measurements—especially those following non-normal distributions—has spurred the development of alternative robust statistical techniques over time.[35,36] Despite this, LSM remains prevalent due to its computational simplicity and established theoretical framework.[37,38] The general linear LSM model is expressed as follows:

$$V = A \cdot X - L \quad \dots (1)$$

where, V is the vector of residuals, A is the design (or coefficient) matrix, X is the vector of unknown parameters to be estimated, and L is the vector of observedvalues.[27] The weight matrix P_{LL} of observations is defined as the inverse of the variance-covariance matrix Q_{LL}, scaled by the variance factorK_U/S_0^2:

$$P_{LL} = Q_{LL}{}^{-1} \cdot \frac{K_U}{S_0{}^2} \quad \dots (2)$$

The optimal estimate of X is derived by solving the normal equations,

$$A^T \cdot P_{LL} \cdot A \cdot X - A^T \cdot P_{LL} \cdot L = 0 \quad \dots (3)$$

which yields the following least-squares estimator:

$$\hat{X} = (A^T \cdot P_{LL} \cdot A)^{-1} \cdot A^T \cdot P_{LL} \cdot L \quad \dots (4)$$

The full model (Eq. 1-4) accounts for the variability and correlations among observations through the weight matrixP_{LL}. However, in the specific context of applying this framework to the zoning plan parameters in our study area, we adopt a standard least-squares simplification. This is achieved by assuming that all observations (i.e., the baseline road width criteria associated with each zoning block) are of equal reliability and mutually uncorrelated. Under this condition, the variance-covariance matrix Q_{LL} becomes proportional to an identity matrix, and the weight matrix P_{LL} reduces to a scalar multiple of the identity matrix. Consequently, P_{LL} can be omitted from the calculation without affecting the relative weighting of the parameters, leading to the simplified and widely used estimator for the unknown coefficients X:

$$X = (A^T \cdot A)^{-1} \cdot A^T \cdot L \quad \dots (5)$$

This formulation (Eq. 5) is used in the subsequent empirical analysis to compute the specific adjustment coefficients that link zoning island characteristics to optimal road widths. It provides a computationally straightforward yet robust means of quantifying the relationship prescribed by the planning framework. Here, it is employed to quantify the link between zoning block parameters and the requisite road widths in both greenfield planning and urban renewal contexts. The method, implementable via peripheral-to-central clustering or inverse computational schemes, offers statistical stability coupled with direct physical interpretability—making it particularly suitable for generating policy-relevant urban planning guidance.

Therefore, this method emphasizes objectivity, accuracy, and reliability, recognizing that sound urban planning must rely on measurable parameters to minimize subjective bias and support evidence-based decision-making.[39,40] Through LSM-based detection and interpretation of key indicators, the analysis ensures conclusions that are both verifiable and robust.

Findings and Discussion

Zoning plans are based on two concepts: the zoning island and the road, particularly in implementation. The two concepts are inseparable. The criteria for the zoning islands, that is, the criteria affecting the road, are five in number, as stated below.

- Total area of construction called precedent
- Height coefficient
- Tensile applied according to the split type
- Tensile applied according to block formation
- Tensile applied according to its adjacent formation

Along the main roads, the effects of the essential 5 characteristics of the zoning islands on road formation have been investigated, as the population ratios affecting the zoning islands will also affect the widths of road connections and roads.

All features specified on a zoning block in a zoning plan, such as identity, facilitate controlled correlation. For example, multiplying the total construction area by the floor height by the base construction footprint yields the same result. Or, for example, drawing garden distances using a yardstick, determining the height by the number of floors, or determining the road widths that should be used as side yards to define the garden distance. All these correlations facilitate controlled calculations.

An examination of the relationship with the first criterion, the precedent value, reveals its characteristics.

In Table 1, the characteristics of parcels within a zoning island are determined primarily by the relationship between the precedent and the number of floors. The expression defined with E in the plan corresponds to the maximum construction area that a parcel can use in total. In determining the total construction area of the average title deed areas, it will be taken as 0.30 in single-story parcels. This ratio will increase by placing it above 0.30 when the number of floors increases consecutively.

In Fig. 2, the projections with a road between them, which are enclosed by the black line, are the zoning islands. Suppose only the E symbol is used at the points where the zoning islands occur along the main road route. In that case, the relationship between them will determine the width of the main road by adding 7 meters to a single-lane round trip, together with an increase of 3n due to the X matrix.

The effect of the unknown coefficient matrix from X on the width of the matrix increases by an equivalent of 0.30, depending on the number of floors.

$$\left(\begin{bmatrix} 1 & 0.30 \\ 0.30 & 1 \end{bmatrix}^T * \begin{bmatrix} 1 & 0.30 \\ 0.30 & 1 \end{bmatrix}\right)^{-1} \times \left(\begin{bmatrix} 1 & 0.30 \\ 0.30 & 1 \end{bmatrix}^T * \begin{bmatrix} 7 \\ 1 \end{bmatrix}\right) \quad \ldots (6)$$

The amount corresponding to approximately 2.87 meters from the unknown matrix X will correspond to the same ratio as the peer rate increases per floor. If the amount to be added to the road width is taken as approximately 3 meters, and n denotes the number of floors, the increase will be 3 meters. For example, the ratio of 1.50 corresponds to a 5-fold equivalent.

$$\left(\begin{bmatrix} 1 & 1.50 & . & . & . & . \\ 1.50 & 1 & . & . & . & . \\ . & . & 1 & . & . & . \\ . & . & . & 1 & . & . \\ . & . & . & . & 1 & . \\ . & . & . & . & . & 1 \end{bmatrix}^T * \begin{bmatrix} 1 & 1.50 & . & . & . & . \\ 1.50 & 1 & . & . & . & . \\ . & . & 1 & . & . & . \\ . & . & . & 1 & . & . \\ . & . & . & . & 1 & . \\ . & . & . & . & . & 1 \end{bmatrix}\right)^{-1} \times \left(\begin{bmatrix} 1 & 1.50 & . & . & . & . \\ 1.50 & 1 & . & . & . & . \\ . & . & 1 & . & . & . \\ . & . & . & 1 & . & . \\ . & . & . & . & 1 & . \\ . & . & . & . & . & 1 \end{bmatrix}^T * \begin{bmatrix} 7 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}\right) \quad \ldots (7)$$

Table 1 — The relationship between the equivalent value and the number of floors (corresponding to 9 floors)

Equivalent value	Number of floors
0.30	1
0.60	2
0.90	3
1.20	4
1.50	5
1.80	6
2.10	7
2.40	8
2.70	9

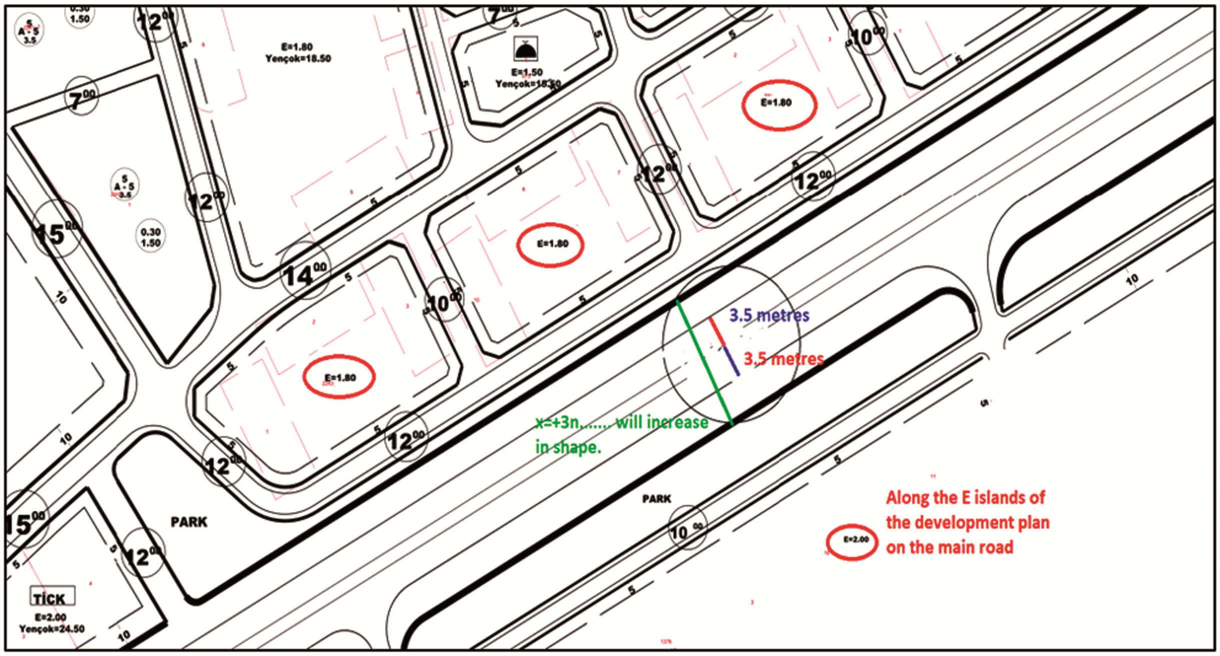

Fig. 2 — Display of the island route, which is only in the plan as a precedent

If the matrix of X coefficients is equivalent to 1.50, 5 floors, it will be approximately 2.88 with the least squares calculation, and the width of the road will increase by 3 meters. L coefficients matrix, on the other hand, represents the unit matrix of the width of the fixed 7-meter double-lane road.

In Table 2, according to the peer values, the unknown coefficient matrix X and the fixed path width coefficient matrix are 2.87, 2.88, etc. Based on the results, the part to be added to the road width is shown as 3 shards per rate.

According to the benchmark value criterion, one of the island legends in the zoning plan, the value to be added for each value is shown as a result of the correlation between the main roads and the front of the islands, with a fixed 7-meter width. It shows how to calculate based on a precedent value, and the results for each value are indicated in the table. In the zoning plans, it is estimated that the towing distances and the width of the main road lines will positively affect both pedestrian and vehicle traffic.

An examination of the relationship with the second criterion, the height coefficient, reveals its characteristics.

In Table 3, the height coefficient for single-story parcels is shown as 3.50 meters in the zoning plan. Therefore, as the number of floors increases, the height coefficient will increase by 3 meters. In this way, the unknown of X meters, which will be added to the fixed 7 meters along the main road route, will be calculated from the coefficient matrix.

In Fig. 3, when the fixed double lane road width is taken as 7 meters at the point where the main road passes along the route of certain zoning islands with only the height coefficients, the width of the road will

Table 2 — The width of the road increases the display of the names with equivalent values (corresponding to 9 floors)

Precedent value	Amount to be added to the width of the road (m)
0.30	3
0.60	6
0.90	9
1.20	12
1.50	15
1.80	18
2.10	21
2.40	24
2.70	27

Table 3 — The relationship between the height coefficient and the number of floors (corresponding to 9 floors)

H-max (m)	Number of floors
3.50	1
6.50	2
9.50	3
12.50	4
15.50	5
18.50	6
21.50	7
24.50	8
27.50	9

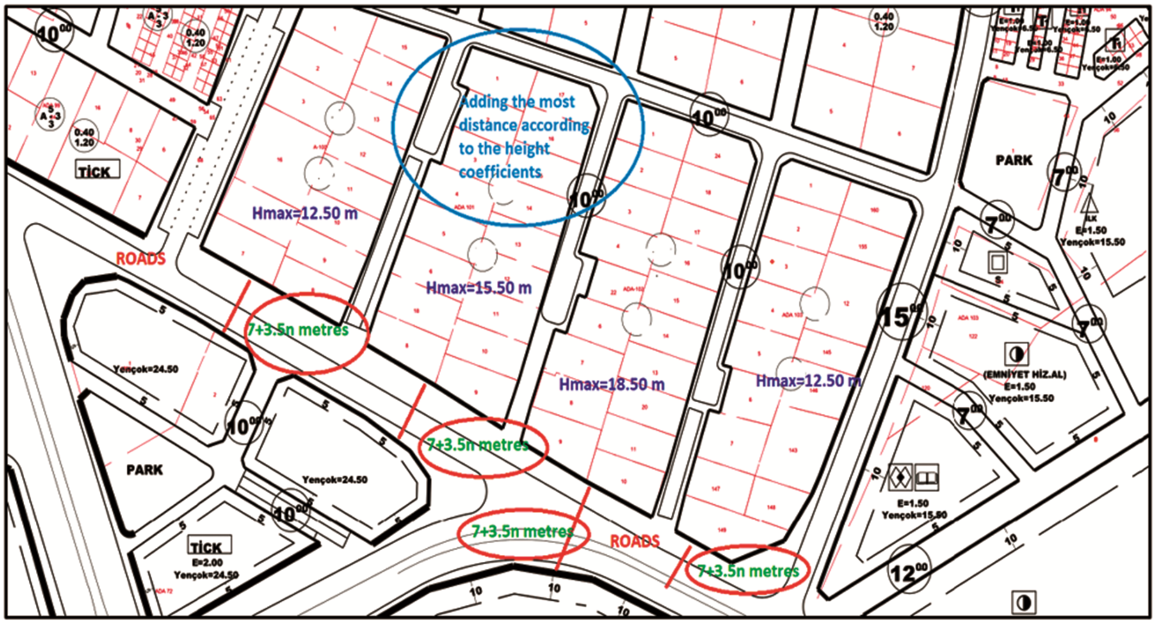

Fig. 3 — Representation of the relationship of the road with certain islands with altitude coefficients

be determined by the following calculation, with an increase of 3.5n from its relationship with the X coefficients matrix.

From the main formula of X desired unknown coefficients to unknown points, because of the relationship between height coefficients and L constant coefficients matrix, the ratio will be calculated between 3.4 and 3.5 meters, corresponding to the number of floors.

$$\left(\begin{bmatrix} 1 & 15.50 & . & . & . & . \\ 15.50 & 1 & . & . & . & . \\ . & . & 1 & . & . & . \\ . & . & . & 1 & . & . \\ . & . & . & . & 1 & . \\ . & . & . & . & . & 1 \end{bmatrix}^T * \begin{bmatrix} 1 & 15.50 & . & . & . & . \\ 15.50 & 1 & . & . & . & . \\ . & . & 1 & . & . & . \\ . & . & . & 1 & . & . \\ . & . & . & . & 1 & . \\ . & . & . & . & . & 1 \end{bmatrix}\right)^{-1} \times \left(\begin{bmatrix} 1 & 15.50 & . & . & . & . \\ 15.50 & 1 & . & . & . & . \\ . & . & 1 & . & . & . \\ . & . & . & 1 & . & . \\ . & . & . & . & 1 & . \\ . & . & . & . & . & 1 \end{bmatrix}^T * \begin{bmatrix} 7 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}\right) \quad \ldots (8)$$

From the illustration in Table 3, for example, when calculated from the matrix of 15.50 meters X coefficients, corresponding to 5 floors, the ratio of 3.4 meters is obtained. Since the other floors will approximate this ratio, the results below are shown in Table 4.

In Table 4, the relationship between the unknown coefficient matrix X and the height coefficients in the plan is added to the 7 fixed amounts according to the number of 3.5 meters.

It is another criterion for determining the zoning plan's height coefficients and the number of floors.

Table 4 — Display of the amount to be added to the main roads with the height coefficients (corresponding to 9 floors)

Height coefficient (m)	Amount to be added (m)
3.50	3.50
6.50	7.00
9.50	10.50
12.50	14.00
15.50	17.50
18.50	21.00
21.50	24.50
24.50	28.00
27.50	31.50

Due to the number of floors according to the corresponding value of this criterion, X unknown will be approximately the same over a sample of 15.50 meters. As a result, the necessary values to be added to the fixed path width were calculated successively.

Based on the 3rd and 4th criteria of the zoning plan's island regulations—specifically the setback requirements—the number of floors permitted in subdivision and block applications is determined using the side and rear yard distances together with the associated road width.

The islands are shown in Table 5. Split and block structures will be allowed, and the road width will be determined based on the number of floors for side and rear hauling, according to the ownership status.

In Fig. 4, if the property is processed based on the separate and block-drawn islands, the number of floors can be determined, especially from the side and backyard distances, just like the height coefficients. Since the difference with only the height coefficient will arise from the relationship with the traction application along the islands up to 4 floors, the distance to be added per floor will be added to the road width as a consecutive amount.

$$\left(\begin{bmatrix}1&3&.&.&.\\3&1&.&.&.\\.&.&1&.&.\\.&.&.&1&.\\.&.&.&.&1\end{bmatrix}^T * \begin{bmatrix}1&3&.&.&.\\3&1&.&.&.\\.&.&1&.&.\\.&.&.&1&.\\.&.&.&.&1\end{bmatrix}\right)^{-1} \times \left(\begin{bmatrix}1&3&.&.&.\\3&1&.&.&.\\.&.&1&.&.\\.&.&.&1&.\\.&.&.&.&1\end{bmatrix}^T * \begin{bmatrix}7\\1\\1\\1\\1\end{bmatrix}\right) \quad \ldots (9)$$

In the names from the matrix representation for the 4 floors, the relation matrix element 4, which is the side and backyard drawing application, will be taken. The amount of the result will be added to the width of the road by adding the corresponding floor equivalent in the unit matrix according to the number of floors.

Table 5 — Display of said kata in the application with split and block criteria (corresponding to 9 floors)

Split and block side / Rear distance (m)	Number of floors
3	1
3	2
3	3
3	4
3.5	5
4	6
4.5	7
5	8
5.5	9

$$\left(\begin{bmatrix}1&3.50&.&.&.&.\\3.50&1&.&.&.&.\\.&.&1&.&.&.\\.&.&.&1&.&.\\.&.&.&.&1&.\\.&.&.&.&.&1\end{bmatrix}^T * \begin{bmatrix}1&3.50&.&.&.&.\\3.50&1&.&.&.&.\\.&.&1&.&.&.\\.&.&.&1&.&.\\.&.&.&.&1&.\\.&.&.&.&.&1\end{bmatrix}\right)^{-1} \times \left(\begin{bmatrix}1&3.50&.&.&.&.\\3.50&1&.&.&.&.\\.&.&1&.&.&.\\.&.&.&1&.&.\\.&.&.&.&1&.\\.&.&.&.&.&1\end{bmatrix}^T * \begin{bmatrix}7\\1\\1\\1\\1\\1\end{bmatrix}\right) \quad \ldots (10)$$

As seen from the matrix, the relationship factor in the unit matrix will be calculated as 3.5 meters, and will increase from 5 floors. Since the calculations will give an average of X desired matrix between 2.8 and 3.00 meters, an average of 3 meters up to 4 floors, and between 3.2 and 3.5 after 4 floors, an increase of 3.5 meters will be added.

When Table 6 is considered, the amount to be added to the width of the main roads is calculated to correspond to the number of floors, equal to the value of the side and rear tractions on the islands where traction is applied on split and block ground.

The 5th criterion, which is effective in zoning planning, is that, since the relevant parcels will be applied to the road in the adjacent zoning islands, zero traction will be applied so that the separated and block front drawing distances will be 5 meters from the applied matrix by increasing one meter per floor, which will come out of the applied coefficients of shrinkage.

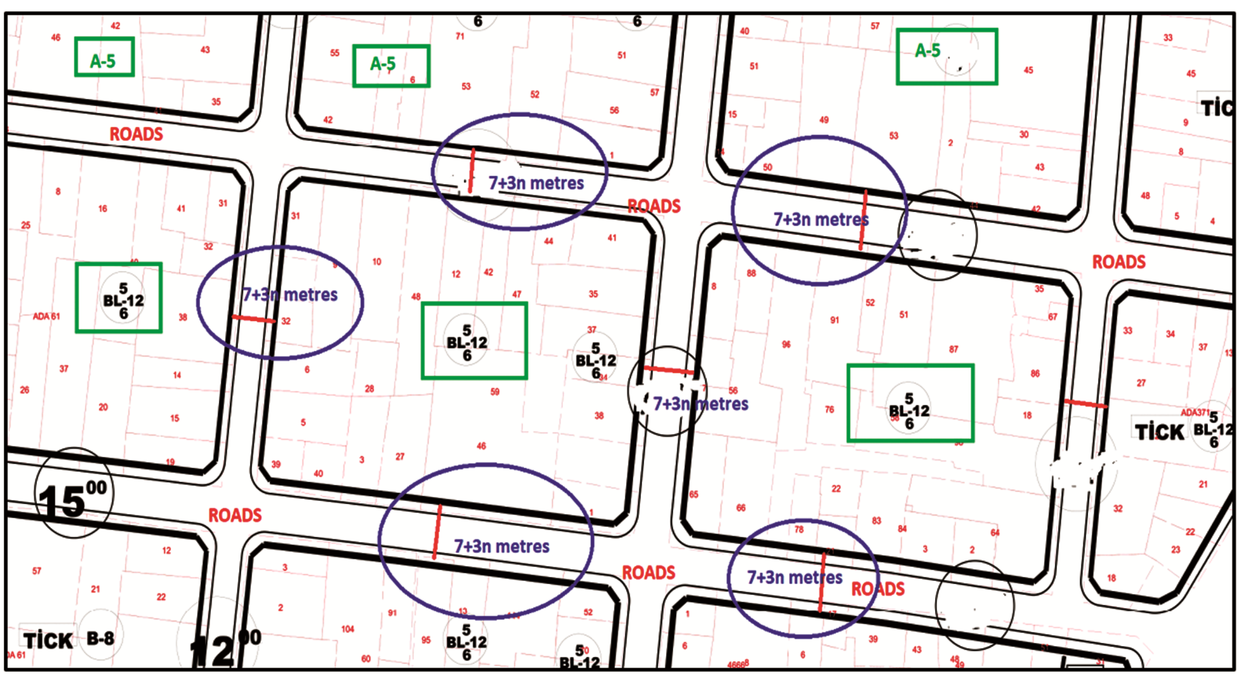

Fig. 4 — Representation in connection with the main road on islands with split and block drawing applications

In Table 7, the width of the road is calculated as 5 plus one over the constant, considering the width of the road as if it were separate and as a block, since there is no forward traction on the adjacent islands.

Table 6 — Display between the split and block drawing application and the carriage addition amount

Number of split and block floors	Amount to add road width (m)
1	3.0
2	3.0
3	3.0
4	3.0
5	3.5
6	4.0
7	4.5
8	5.0
9	5.5

Table 7 — A coefficient matrix representation to be applied per floor in adjacent islands (corresponding to 9 floors)

Number of adjacent building floors	An insertion factor (m)
1	5
2	6
3	7
4	8
5	9
6	10
7	11
8	12
9	13

In Fig. 5, the average value is obtained by adding the coefficients in Table 7 from the coefficients matrix calculation by adding a plus to the number of floors with 5 meters, assuming the main road additions as the split and the front pulling distance in the blocks, since the front drawing distance in the islands in the form of adjacent buildings is not used in the buildings on the ground.

$$\begin{bmatrix}1&9&.&.&.&.\\9&1&.&.&.&.\\.&.&1&.&.&.\\.&.&.&1&.&.\\.&.&.&.&1&.\\.&.&.&.&.&1\end{bmatrix}^T * \begin{bmatrix}1&9&.&.&.&.\\9&1&.&.&.&.\\.&.&1&.&.&.\\.&.&.&1&.&.\\.&.&.&.&1&.\\.&.&.&.&.&1\end{bmatrix})^{-1} \times (\begin{bmatrix}1&9&.&.&.&.\\9&1&.&.&.&.\\.&.&1&.&.&.\\.&.&.&1&.&.\\.&.&.&.&1&.\\.&.&.&.&.&1\end{bmatrix}^T * \begin{bmatrix}7\\1\\1\\1\\1\\1\end{bmatrix}) \quad \ldots (11)$$

Adding 5 floors from the matrix will result in an average of 0.8, so it will be close to 1 meter in other values. Therefore, the amount of distance to be added to the main road in adjacent buildings will correspond to 5+1n when n floors are taken.

In Table 8, the amount to be added to the road width, which is a fixed 7 meters according to the number of floors, will be calculated from the desired matrix where X is unknown in the islands in the form of adjacent structures.

Notably, some of the islands, or their mutual characteristics, may differ between the road line in the north and south, or along the main road route in the east-west direction. When the calculations are made in the direction of the facing sides of the islands, it will be seen that the width of the road along the road

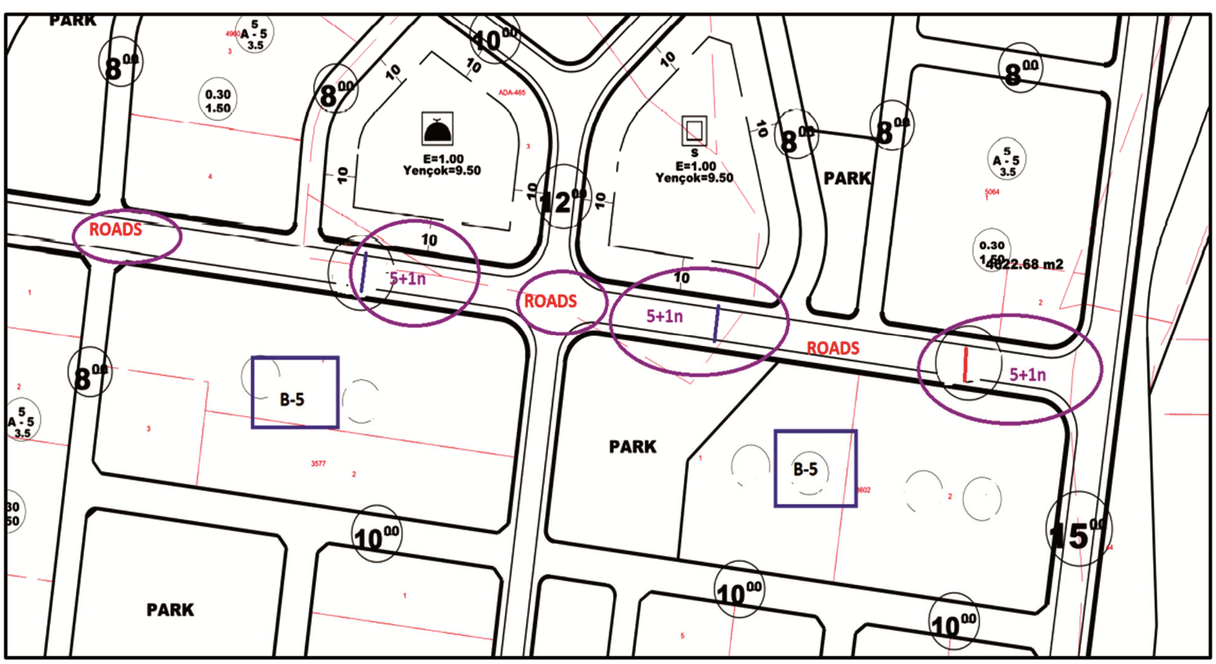

Fig. 5 — The width of the main road on the route of the islands in the form of adjacent structures

Table 8 — Display the number of adjacent building floors and the distance to be added

Number of adjacent building floors	Amount to be added (m)
1	5
2	6
3	7
4	8
5	9
6	10
7	11
8	12
9	13

line will differ in the parts of the road facing different islands.

Separate, block, and adjacent zoning islands are the most commonly used types for island formation in zoning plans. This type of zoning is used as the basis for regional planning to respond to future population needs over a given period. The towing distances of these islands, according to which ratio, to which number of floors, etc., the future is created according to the planned areas or the character of the unplanned areas. Just as the island is determined according to the population ratio, while the zoning road network is also being passed, it is expressed with these three most used types of island criteria to look at the road correlation with the island to ensure that the long-term function of both pedestrian and vehicle traffic is good in the plan.

Because this sample area will be subject to a zoning plan renewal, the width of the zoning roads and the zoning block parameters are already included in the plan; they are based on the criteria in the zoning regulations. In areas where new zoning plans are prepared, road widths are recalculated based on topography, population density, and zoning block characteristics; scaling and weighting coefficients are taken and related in this way.

Conclusions

The two most essential criteria in zoning planning are the characteristics of zoning islands and the smooth functioning of the road network that will be formed. Although each country regulates dimensional standards of primary and secondary roads, Türkiye's dominant configuration—double-lane corridors of roughly 7 meters—provides a consistent baseline for examining how different block-level attributes interact with mandated road widths. The study's contribution lies in advancing planning logic from standardized provision toward demand-responsive thinking—road network hierarchies should be calibrated to the actual situation rather than merely mechanically applied classification standards. While limited to static parameters, the framework offers practical value for urban form; other countries could adapt similar transformations for road-planning regimes, translating abstract sustainability goals into tangible spatial parameters. Despite simplifications, this methodology provides a transferable basis for adapting road-width standards to the spatial realities, supporting more resilient urban development through evidence-based infrastructure scaling.

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