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Parking Availability, On-Street Parking Behaviour, and Residential Road Capacity: Evidence from a Household Survey and Correlation Analysis

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Abstract: In residential neighbourhoods, the provision of parking often fails to keep pace with increasing levels of private vehicle ownership. As a result, on-street parking becomes common practice, gradually affecting the functioning of local roads. This study looks at how parking availability and on-street parking behaviour are related to changes in residential road capacity. The analysis is based on a household survey of 215 residents, combined with direct observations of parking conditions and street layouts. Correlation analysis was applied to examine the links between parking supply, vehicle ownership, and actual parking practices. The findings indicate that limited parking provision is closely associated with a higher dependence on on-street parking, especially in areas characterised by smaller housing units with restricted garage space. In many cases, vehicles are parked for extended periods, and parking configurations such as perpendicular or irregular arrangements further reduce the usable width of the carriageway. This, in turn, makes vehicle manoeuvring more difficult and increases the likelihood of localised congestion and access-related conflicts. Differences in parking behaviour are also observed across households, with income level, housing type, and vehicle ownership shaping both parking demand and parking location choices. Taken together, the results suggest that parking conditions in residential areas should be understood as part of everyday transport performance rather than treated solely as a matter of spatial provision. Measures aimed at improving parking supply, managing on-street parking practices, and aligning residential design with actual patterns of vehicle ownership may help to ease pressure on local roads and improve overall traffic conditions at the neighbourhood scale.

Keywords: Parking availability; Road capacity; Parking behavior; Socioeconomic factors; Spatial planning; BTN Minasa Upa

1 Introduction

Private vehicle ownership, particularly cars, is now regarded as an indicator of economic status. According to the Makassar statistical board [1], Indonesia's per capita income in 2022 reached IDR 71 million per year, or approximately IDR 5.9 million per month, an increase of 13.96% compared to the previous year. This growth parallels the rise in the number of motor vehicles, especially in urban areas.

Makassar, as the largest metropolitan city in eastern Indonesia, has experienced a population growth rate of 9% annually. With a population of 1,474,393 people in 2023 and a density of 8,119 people per square kilometre, transportation and parking space issues have become critical—especially in densely populated residential areas such as the Minasa Upa Housing in Rappocini District. This district ranks fourth in population size out of 15 districts in Makassar [2].

The increase in private vehicle ownership without a proportionate infrastructure development—particularly the provision of adequate parking spaces—has led to various traffic problems in residential areas. These issues arise from insufficient garages or parking areas, driven by the addition or change in residents' vehicles as a result of rising household income and social status. Based on field observations, current housing developments that provide a garage for each household are no longer able to meet residents' parking needs over time. In many residential areas, vehicles are parked on roadways, sidewalks, and other open spaces, contributing to traffic congestion. This

situation highlights the growing disparity between the rapid increase in vehicle ownership and the limited availability of adequate parking facilities within housing areas.

In the Minasa Upa housing area, the current public facility parking capacity has proven insufficient to accommodate the growing number of residents' and visitors' vehicles. This has led to several negative impacts, such as limited space for traffic flow, obstruction of pedestrian access, and increased risks of traffic accidents and congestion.

The aims of this study are (1) to examine the parking characteristics related to its availability and road capacity within the residential area, and (2) to analyse how socioeconomic characteristics influence parking behaviour and how parking policies should be adapted for future housing development. It also seeks to examine the extent to which the available parking space can accommodate the rising number of private vehicle owners. Furthermore, this study will formulate recommendations for future housing development and its associated parking needs, as well as propose standardized street dimensions.

2 Theoretical Framework

Some literature has been reviewed to support this study aims. The reviewed literature is categorized into sub-sections as follows.

2.1 Parking Behaviour Theory

Parking is a crucial element of the transportation system, serving as both the starting and ending points of every motor vehicle journey. Parking facilities are not merely static spaces to store vehicles but play a strategic role in supporting traffic flow and efficient use of road space, as emphasized by Litman [3]. In transportation planning, the demand for parking space must be balanced with road capacity, residential density, and the community's activity patterns. A mismatch between the number of vehicles and available parking spaces can lead to illegal parking, which directly reduces effective road capacity, increases congestion, and lowers the safety and comfort of other road users.

According to Raju et al. [4], parking refers to the stationary condition of a vehicle left temporarily by its driver. Drivers tend to seek parking spots closest to their destinations, which, without proper planning, encourages on-street parking, especially in residential areas, shopping centers, public facilities, and high-activity zones. On-street parking often compromises the function of main roads, as part of the roadway is repurposed for parking, reducing the effective traffic width and increasing the likelihood of vehicle conflict. This condition is frequently observed in densely populated areas and major cities experiencing rapid vehicle growth without proportional increases in parking infrastructure.

According to the Guidelines for the Planning and Operation of Parking Facilities [5], parking involves the temporary stopping of a vehicle in a particular location, not merely for dropping off or picking up passengers or goods. Thus, parking encompasses spatial and temporal dimensions that require serious consideration in transport planning. Key terms in the parking system include parking capacity, parking duration, parking index, parking space demand, and turnover rate. These indicators describe how effectively and efficiently the parking system supports public mobility.

As noted in Institute for Transportation and Development Policy [6], in a sustainable transportation system, parking cannot be separated from land use, urban planning, and public transport policy. Well-integrated and well-managed parking contributes to space efficiency, reduced traffic burdens, and improved overall urban environmental quality.

In addition, parking issues in residential areas have become increasingly complex due to rising private vehicle ownership and limited available parking land. In residential contexts, vehicles are not only used for daily mobility but also stored for extended periods, especially overnight. The mismatch between parking space capacity and the number of vehicles leads many residents to use roadways as alternative parking areas. This results in reduced road width, restricted access for emergency vehicles, and a decline in the visual quality and comfort of the residential environment [7].

Unfortunately, parking space supply in residential areas has not kept pace with this growth, especially in densely populated neighbourhoods. In some urban areas, the number of vehicles per hectare is very high, even though the household vehicle ownership ratio is not necessarily excessive. This indicates a dense concentration of vehicles within a limited area, placing intense pressure on parking facilities [8, 9].

A 2001 study in Auckland identified that on-street parking causes significant traffic safety disruptions, particularly at intersections and pedestrian crossings, as it reduces visibility and narrows lanes for large vehicles such as fire trucks and ambulances [10]. In addition, local traffic congestion often occurs during peak hours, such as school drop-off and pick-up times, due to the lack of adequate parking around educational facilities within residential areas.

Parking management in residential neighbourhoods must be viewed as an integral component of area planning, encompassing spatial aspects, social behaviour, and mobility need. Efforts to manage parking spaces efficiently require a multidimensional approach that considers population dynamics, socio-economic factors, and the physical structure of the residential environment itself [7].

Most parking issues in residential areas arise from the lack of transportation planning during the development of new housing estates. Many housing developments focus solely on building residential units without considering the need for parking spaces, especially in lower-middle-income residential areas. In such cases, residential roads that are intended for vehicle movement are instead transformed into permanent parking zones [11].

According to fundamental principles of urban planning, streets are not only meant to serve as traffic corridors but also function as social spaces and routes for emergency services. When these roads are filled with illegally parked vehicles, these essential functions are disrupted or even lost. This poses a serious problem, particularly in emergencies when quick access for ambulances or fire trucks is critically needed [11, 12].

Additionally, the phenomenon of multiple vehicle ownership within a single household contributes to the parking space crisis. A single home may own two or even three vehicles, while the available land can only accommodate one. This mismatch between parking capacity and vehicle ownership forces residents to occupy sidewalks, green spaces, and even neighbours' front areas to park their vehicles. On the other hand, local regulations regarding residential parking are often not enforced consistently, leading to a normalization of such violations. Addressing this issue requires collaboration between local government, housing developers, and active community participation to enforce regulations and foster a culture of orderly and responsible parking behaviour [11–13].

2.2 Parking Policy and Management Framework

Parking space issues in residential neighbourhoods often arise from an imbalance between the growing number of vehicles and the availability of parking areas, as highlighted by the Auckland Council in its Residential Parking Policy [10]. In this context, having clear guidelines for parking space requirements is crucial to prevent conflicts among residents and to maintain smooth traffic flow within residential environments. According to Munawar [14], one applicable approach is to establish explicit regulations regarding which streets allow parking, including specific parking patterns that are designed not to disrupt traffic flow. For example, parking on only one side of the street in a parallel configuration can preserve circulation space for four-wheeled and emergency vehicles. Such arrangements must be accompanied by supervision, enforcement, and community education to avoid social resistance.

In Jakarta, local policy requires that residents who own a vehicle must also have a designated garage for that vehicle. Unfortunately, poor enforcement has caused the problem of parking in residential areas [15].

Optimizing the use of existing parking spaces is also an essential part of effective parking management. Governments and housing developers should provide off-street parking facilities, especially in areas with high activity such as commercial centres, service hubs, office zones, and entertainment venues. In construction permits like the Building Permit (IMB), requirements should be included to provide a minimum number of parking spaces according to the housing type and capacity. For instance, each residential unit should at least have a garage or carport that does not encroach upon public road space. Without such planning, public spaces in residential areas will continue to be displaced by unregulated parking activity [11, 16, 17].

Beyond physical considerations, parking space management must also account for the socio-economic characteristics of residents. Many residents in lower-middle-income housing areas may not be able to afford the cost of renting or constructing additional parking facilities. Therefore, a phased approach becomes a more realistic solution. In the short term, existing parking patterns can be maintained while implementing community guidance, such as establishing parking zones and regulating unauthorized vehicles. In the long term, the development of collective parking facilities or shared parking structures can be planned at strategic locations in the neighbourhood. This incremental strategy may also reduce social friction in communities where residents are often resistant to sudden new rules or financial burdens [18].

According to Panggabean et al. [13] and Kong et al. [19], residential parking solutions must consider three main aspects: regulatory frameworks, security of parking spaces, and residents' financial capability. These considerations are critical to ensure that policies are not merely formal instruments but are genuinely accepted and implemented by the community. Every residential zone has distinct characteristics; therefore, parking management strategies must be context-specific. For example, in densely populated areas with narrow streets, policies restricting vehicle ownership per household or banning on-street parking must be supported by the provision of alternative parking spaces. Hence, parking space guidelines should not only be based on technical standards but should also balance mobility needs, residential comfort, and the preservation of public space in residential areas.

In addition, the road classification should also be considered. According to Indonesian National Standard (SNI) [20], roads in residential zones are categorized based on their function, traffic volume, and connectivity between sections of housing and surrounding areas. This classification forms the basis for establishing technical policies related to road width, speed limits, vehicle circulation, and the legal feasibility of on-street parking.

According to Sari et al. [11], the road classification is not only technically relevant but also directly impacts the quality of residential environments. Roads that are overly narrow due to excessive parked vehicles reduce liveability, increase the risk of accidents, and heighten the potential for conflict among residents. For this reason, road classification serves as a primary reference in planning and policy decisions regarding whether a street is suitable

for parking, and if so, under what standards and monitoring systems. Furthermore, it is essential for developers and local governments to use road classifications as a foundation when preparing spatial planning documents and when establishing regulations for new housing developments. For example, houses located along Secondary Local Road III should be designed with private carports or garages to avoid relying on public roads for parking. In this way, road classification becomes not merely an administrative procedure but a foundational pillar in developing safe, comfortable, and efficient residential spatial planning.

Ultimately, the determination of the number of parking spaces in a residential area depends on various interrelated factors. It is not merely about counting the number of vehicles but also involves spatial planning, community mobility patterns, and projections of future population growth and vehicle ownership. Parking allocation must follow a systematic and rational approach to meet current demands while anticipating future changes. One of the primary factors influencing parking needs is the level of activity generation within the area. The higher the intensity of activity, the greater the demand for parking. For instance, residential areas equipped with facilities such as places of worship, minimarkets, clinics, or tutoring centres tend to attract both residents and non-residents. These activities lead to spikes in parking demand, particularly during peak hours such as weekends or after work [7].

Another significant factor is the rate of private vehicle ownership. Higher household income and purchasing power increase the likelihood of owning multiple vehicles. This poses a considerable challenge for densely populated residential areas with limited land. Many residents rely on street parking due to the absence of proper garages or carports. Without adequate planning and regulation, this condition may lead to overcrowding, social conflicts among residents, and internal traffic congestion within the neighbourhood. Therefore, a strict regulation that enforces vehicle owners to also own a garage [15, 21].

To determine the ideal number of parking spaces, a parking demand analysis approach is required. This involves daily surveys on parking duration, vehicle volume, accumulation during peak hours, and the parking index. The use of standard formulas, such as the provision of one parking lot per 36 m^2 of residential floor area, is common in technical planning. However, these formulas must still be adapted to the socio-economic conditions and mobility characteristics of the local community [22].

Parking allocation should also consider service and comfort factors, including security, ease of access, nighttime lighting, and clear markings. Without these supporting elements, users tend to choose informal or illegal parking spots, which ultimately disrupts the residential environment. Therefore, technical calculations must be aligned with spatial management strategies and community education to promote more responsible parking behavior [23].

According to Shoup [7], parking policy constitutes an integral component of transportation management and spatial planning. Its primary objectives are to regulate private vehicle usage, improve traffic efficiency, and create safe and orderly environment for road users. In both urban and residential contexts, parking policy encompasses not only technical dimensions but also social, economic, and ecological interests. Thus, policy formulation must balance the provision of space with the control of vehicle demand.

A prevalent strategy adopted by many urban planners is the restriction of on-street parking. Unregulated parking on public roads can lead to reduced traffic flow, congestion, and limited access for emergency services. Consequently, many city governments have implemented controlled parking systems that designate specific streets, apply hourly fees, or even enforce outright bans. Such measures encourage the use of off-street parking facilities and promote alternatives such as public transport, cycling, and walking [24].

Strategic parking policies, as outlined by Basri [25], include:

• Progressive parking fees, Parking charges increase with duration to discourage long-term parking and encourage turnover.

• Parking zoning, Areas are categorized based on traffic density and activity levels. Commercial zones are subject to stricter regulation and higher fees than residential areas.

• Incentives and disincentives, Incentives are offered to residents who do not use private vehicles, while penalties are applied to those who park illegally or misuse public space.

• Integration with spatial policies Parking requirements are mandated in building permits (e.g., for homes, shophouses, or businesses), ensuring the inclusion of adequate parking space.

• Community or private sector management Parking operations may be delegated to private entities or community organizations under government supervision to ensure accountability and equitable pricing.

Parking policy plays a critical role in enhancing urban safety and livability, especially within residential zones. As argued by Litman [26], effective parking management must prioritize accessibility for pedestrians, emergency responders, and essential services, thereby avoiding congestion and potential risks. This view aligns with sustainable mobility frameworks that advocate reducing dependence on private vehicles while promoting public transport alternatives [7]. Thus, parking policy must not be treated as an isolated urban element but rather as part of an integrated transportation and environmental strategy.

In residential planning, parking regulations can serve as a lever to influence developer behavior. For instance, zoning ordinances may require each housing unit to include a designated garage or carport, which not only ensures

parking availability but also minimizes street clutter [27]. In densely populated areas, a community-driven model, such as parking spaces managed by local neighborhood units (RT/RW), can be effective. This approach, supported by collaborative governance theory, fosters both spatial order and a sense of ownership among residents [28].

Successful implementation, however, demands a participatory process. Community involvement in drafting rules, educational outreach on the consequences of illegal parking, and the provision of viable parking alternatives are essential precursors to regulatory enforcement. As noted by Barter [29], parking policies without adequate public backing often result in resistance and widespread non-compliance, undermining their intended impact.

According to Litman [30], ideal parking systems also consider efficiency and user convenience. Five commonly used service indicators for parking quality include:

- Safety—ensuring protection against theft or damage.
- Accessibility—ease of reaching and using the parking facility.
- Reliability—the facility's consistent ability to accommodate vehicles under various conditions.
- Cost-comparative—affordable fees that align with user purchasing power.
- Operational efficiency—smooth circulation and positioning of vehicles without disrupting surrounding traffic flow.

When these five indicators are adequately addressed, parking functions not only as a transportation support facility but also as a vital component in shaping a high-quality living environment. Thus, the calculation and design of parking spaces must integrate functional, social, economic, and technical considerations in a holistic manner.

3 Methods

This study employs a qualitative descriptive method, an approach aimed at systematically, factually, and accurately describing specific characteristics and facts within a population. The method emphasizes the depth of data over sample size. In this context, the qualitative approach is used to understand the parking phenomenon in residential areas from the perspective of residents who directly experience the problem. According to Kriyantono [31], qualitative research focuses more on meaning and process rather than merely producing numerical output. The analytical technique used is interpretative, where the researcher explores the meaning of the data collected through field observation, in-depth interviews, and document analysis.

3.1 Research Location and Time

This research was conducted in Makassar, Indonesia. Particularly in the housing residence of BTN Minasaupa (Rappocini District). This location was selected based on the consideration that Minasa Upa represents a densely populated residential area facing classic issues related to limited parking spaces and the high volume of private vehicles owned by residents (Figure 1).

The selection was also based on the area's characteristics, which reflect a typical mid-level urban settlement with various public facilities, educational institutions, offices, and small businesses. The location is considered representative of the parking space management problems found in rapidly developing residential areas that lack proper transportation planning. The Data collection was conducted from December 2024 to March 2025.

3.2 Population and Samples

The population in this study refers to all individuals or groups that possess specific characteristics relevant to the research problem, namely, residents who use parking spaces in the Minasa Upa Housing Area, Rappocini District, Makassar City. According to Sugiyono [32], a population is a generalization region consisting of objects or subjects that meet certain qualities and characteristics defined by the researcher for the purpose of study and conclusions.

Thus, the research population comprises Minasa Upa residents who own private vehicles and utilize either public or private spaces for parking. Sampling was conducted using a purposive sampling technique, in which respondents were selected based on specific criteria relevant to the research objectives. This method was chosen because not all residents own private vehicles, nor do all vehicle owners face the same parking challenges. The inclusion criteria for sample selection include: (1) permanent residents of Minasa Upa Housing Area, (2) users of private four-wheeled or two-wheeled vehicles, and (3) individuals who directly experience difficulties in finding parking near their homes.

The sample location is distributed in 5 blocks as presented in Figure 1. The number of samples used in this study is 215 respondents (representation of the head of household in the housing area). The number of samples was determined to ensure the collection of in-depth and diverse information while remaining within the study's time and resource constraints. With this sample size, it is expected that data saturation can be achieved to provide a comprehensive picture of parking behaviour, residents' perceptions of parking availability, and the actual need for ideal parking facilities in the area. Data collection utilizes interviews with structured questionnaires and is supported by field observation.

This study employs a mixed-methods approach by integrating quantitative and qualitative analyses. The quantitative component is based on a structured questionnaire distributed to residents of Minasa Upa Housing.

Correlation analysis was conducted using Pearson's correlation coefficient to examine the relationship between parking requirements and housing development intensity. The significance of the correlation was tested at a 95% confidence level ($p < 0.05$). To ensure the reliability of the survey instrument, internal consistency was assessed using Cronbach's alpha, with values exceeding 0.70 indicating acceptable reliability. Qualitative data were obtained through field observations and semi-structured interviews, which were used to support and contextualize the quantitative findings.

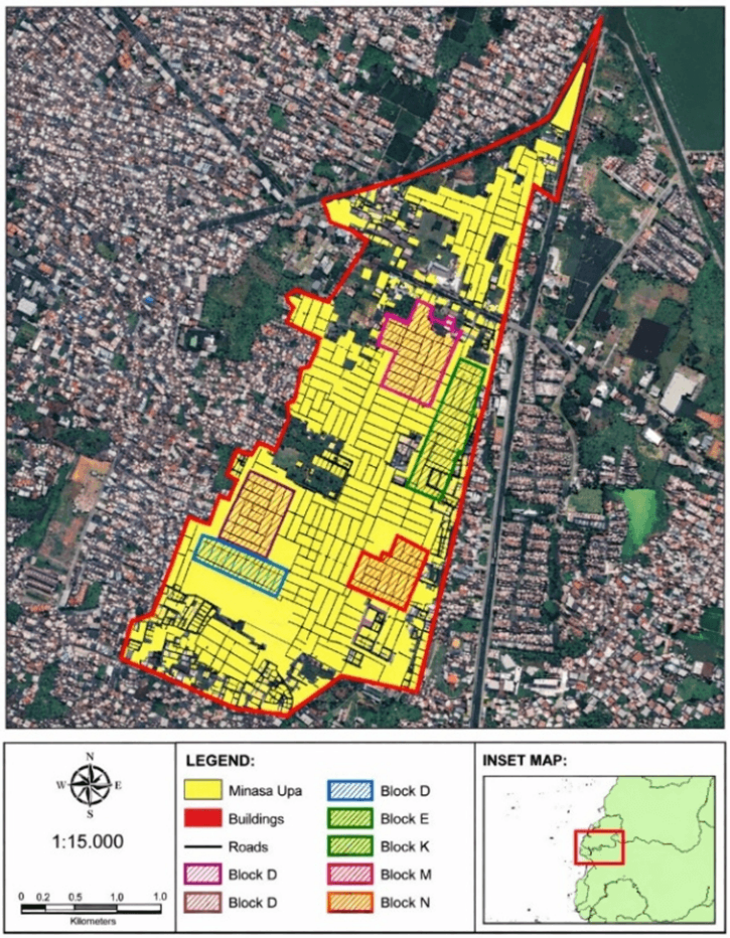

Figure 1. Location map of BTN Minasa Upa, Rappocini District, Makassar City

4 Results and Discussion

Makassar City, the capital of South Sulawesi Province, is the largest city in Eastern Indonesia and serves as a hub for trade, services, education, and industry. One of the prominent residential areas in Makassar is BTN Minasa Upa Housing Complex, located in Rappocini District. Developed by PT Timurama between 1980 and 1994, this housing complex was constructed in stages across 15 development phases. It offers a variety of house types, ranging from Type 21 to Type 54, initially designed to cater to the housing needs of lower-middle-class communities.

Over time, the area has experienced significant development, both in terms of infrastructure and demographics. Strategically located near public facilities such as Bahagia Hospital and Jipang Market, the BTN Minasa Upa Housing Complex has become a dense urban settlement. However, rapid population growth and the conversion of residential units into business premises or rental housing have led to increased density and a severe parking crisis. Due to limited private garages and the absence of designated public parking areas, many residents resort to parking their vehicles along the roadside, further exacerbating congestion and reducing road functionality.

4.1 Parking Characteristics Toward Its Availability and Road Capacity Within the Residential Area

Data indicate that approximately 90% of residents park their vehicles on the roadside (Table 1) despite having home garages (Table 2). The primary reason is that most residents' cars are too large to fit into the available garage space (Table 3)

Table 1. Observation results in btn minasa upa area

Area	Housing with Garage (%)	Average Garage Capacity	Additional Parking Space
Block E	±90	1–2 Cars	Roadside
Block M	±90	1 Car	Roadside
Block K	±90	1–2 Cars	Roadside
Block N	±90	1 Car	Roadside

The average road width of 5 to 6 meters, with shoulders ranging from 0.5 to 1.5 meters, makes vehicle maneuvering difficult. This situation contributes to frequent congestion and safety hazards, particularly during peak traffic hours or in emergency situations.

As mentioned, most of the houses own a garage. The detail can be seen in Table 2. Data presents that the larger the house type, the greater the likelihood of having a garage.

Table 2. Garage availability by lot

Housing Type	With Garage	Without Garage
Type 21	85	37
Type 27	40	20
Type 36	15	6
Type 45	12	-
Total	152	63

Some houses do not have parking garages, even though the residents own private vehicles (cars or motorcycles).

With the current trend of vehicle ownership, some households own more than one vehicle. Based on the size of the garages (Table 3), they can only accommodate small cars (4 passengers). The garages cannot fit a car together with a motorcycle or a larger 7 passenger vehicle. As presented in the table, Housing Types 21 and 27 are inadequate for large vehicles, leading to street parking.

Table 3. Garage dimensions by house type

Housing Type	Average Length (m)	Average Width (m)	Average Size (m^2)
Type 21	2.31	1.63	3.76
Type 27	2.61	2.02	5.27
Type 36	3.39	2.51	8.51
Type 45	5.73	4.00	22.92

Public parking is not available within the residential area. Some residents consider mosque yards, school yards, or road shoulders as “public parking areas”.

Considering the road capacity, data shows that the average road is 5 meters wide. Figure 2 presents the cross-section of the road to provide a clearer picture of the physical conditions of residential roads. The picture provides cross-sectional sketches showing road and shoulder widths at three points.

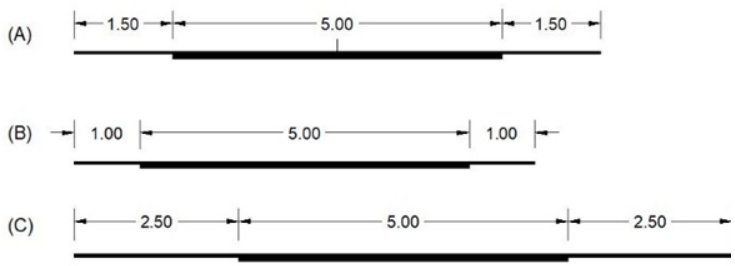

Figure 2. Cross-section sketches at points A, B, and C

Cross-section A shows that each shoulder is 1.50 meters wide; cross-section B has narrower shoulders at 1.00 meters each; and cross-section C has the widest shoulders at 2.50 meters each.

Traffic volume was categorized into three time periods: morning (06:00–09:00), afternoon (12:00–14:00), and evening (16:00–19:00). Most analysed blocks experienced medium to high traffic volumes during at least one of these periods, indicating dynamic vehicle activity throughout the day.

4.2 Socioeconomic Characteristics

This data provides a comprehensive view of the socioeconomic conditions of BTN Minasa Upa residents. Variables analyzed include vehicle ownership, occupation, house type, and household size.

Data shows that 94.4% residents owned at least one motorcycle, making it the dominant transport mode. Data present that ±48.8% do not own a car, 34.9% own one, and only 10.2% own two. Ownership of more than two cars is rare, and combined ownership data shows many households have one motorcycle and no car (54 households). Some higher-income households own multiple two- and four-wheeled vehicles. This places high pressure on parking spaces, especially as most homes are small and lack proper garages, leading to common use of road shoulders for parking and potential resident conflict (Table 4).

Table 4. Garage dimensions by house type

		Car Ownership					
		None	**1**	**2**	**3**	**4**	**Total**
Motorcycle Ownership	**None**	11	1	0	0	0	12
	1	54	36	3	1	2	96
	2	24	29	7	4	1	65
	3	11	7	8	1	0	27
	4	5	2	4	2	2	15
	Total	105	75	22	8	5	215

Table 5 shows that the occupational distribution reflects the social structure and income levels of respondents.

Table 5. Occupation types

Occupation	Frequency	Percentage (%)
Badan Usaha Milik Negara (BUMN)	1	0.4
Contract worker	1	0.4
Housewife	6	2.8
Entrepreneur	27	12.6
Student	126	58.7
Civil servant	26	12.2
Sailor	2	0.9
Retiree	1	0.4
Farmer	1	0.4
Military personnel	1	0.4
Small business owner	23	10.8
Total	215	100.0

Most respondents are students (58.7%), indicating they are mostly rented by students to pursue their education within the city of Makassar. Entrepreneurs and civil servants follow as the largest income-generating groups. Traditional occupations like farming and fishing are nearly absent, reflecting an urban shift towards services and education sectors.

Furthermore, house type (Table 6) distribution indicates housing capacity and potential for private parking space.

Table 6. Housing type profile

Housing Type	Frequency	Percentage (%)
Type 21	124	56.1
Type 27	62	28.1
Type 36	22	10.0
Type 45	13	5.9
Total	215	100

A total of 186 homes (86.5%) are small types (Type 21 and 27), which typically lack adequate space for garages or carports. This explains the widespread use of road shoulders as alternative parking.

In addition, household size (Table 7) influences both vehicle ownership and parking space requirements, as some families own more than one vehicle to meet the mobility needs of their members.

Table 7. Profile type household size

Household Members	Frequency	Percentage (%)
1–3 People	14	6.5
4–6 People	171	79.5
7–9 People	24	11.2
≥10 People	6	2.8
Total	215	100.0

4.3 Parking Behaviour

Parking behaviour is a key aspect closely linked to limited space and high vehicle ownership in BTN Minasa Upa. Three main indicators are used to assess parking behaviour: parking duration, parking angle, and parking location. Together, these reflect the interaction between vehicles, space, and residents' habits in utilizing open spaces.

Parking duration refers to the length of time a vehicle is parked in a particular location. In this study, duration is categorized into three groups: less than 1 hour, between 1–4 hours, and more than 4 hours.

Table 8. Parking duration

Block	<1 Hour	1–4 Hours	>4 Hours
A	33.3%	66.7%	-
B	-	-	100%
E	-	100%	-
F	-	50%	50%
H	20%	60%	20%
J	-	100%	-
K	-	37.5%	62.5%
L	-	50%	50%
M	-	50%	50%
N	-	66.7%	33.3%

The data in Table 8 indicates that most vehicles are parked for medium to long durations. In some blocks, such as B and E, 100% of vehicles are parked for more than 4 hours, suggesting that these vehicles are primarily household vehicles and remain parked when not in use. The number of vehicles that park for a longer duration means that the owner does not have a parking garage at their house.

Furthermore, this study also observes the parking orientation, which refers to the angle at which vehicles are positioned in relation to the road when parked. It is commonly classified into parallel, diagonal, and perpendicular types (Table 9).

Table 9. Parking angle

Block	Parallel	Diagonal	Perpendicular	% Road Used
A	33.3%	-	66.7%	50%
B	50%	-	50%	55–60%
E	50%	-	50%	55–60%
F	50%	-	50%	55–60%
H	100%	-	-	30%
J	-	-	100%	70%
K	62.5%	12.5%	25%	50%
L	100%	-	-	30%
M	66.7%	-	33.3%	55%
N	100%	-	-	30%

Most blocks use parallel parking, particularly blocks H, L, and N, where 100% of vehicles are parked parallel to the road. This indicates limited space or road widths that do not support other parking configurations.

Perpendicular parking is dominant in block J and significantly present in blocks A, B, E, and F, suggesting that parking space is more feasible in those areas.

Diagonal parking only appears in block K (12.5%) and may represent local adaptation or user experimentation in response to spatial conditions.

4.4 Parking Space Arrangement Recommendations

Based on field findings and the socio-economic characteristics of residents in BTN Minasa Upa, several technical and social recommendations for parking space management are proposed as follows:

a. Adjustment based on road dimensions

1. Main roads $<$ 6 meters: parking should only be allowed on one side (to avoid traffic congestion).
2. Road shoulders $\geq$ 2.5 meters: parallel parking on both sides may be possible with proper markings and signage

b. Development of shared parking facilities

1. Vacant land around small-type houses (Types 21 & 27) can be utilized as community parking zones.
2. These should be regulated in coordination with neighborhood units (RT/RW) and supported by local spatial planning.

c. Legalization of informal parking zones

Mosque yards, schools, or public fields may be designated as controlled parking zones with time limits, paved surfaces, and community oversight.

d. Redesign of residential units

1. Future housing developments are advised to include at least one carport of 2.5 $\times$ 5 meters.
2. Mid-to-upper housing types ($\geq$Type 54) should provide tandem or two-car garages.

e. Utilization of setback roads

In blocks such as Block E, where traffic circulation is minimal, diagonal parking (30–45°) can be implemented for capacity efficiency.

f. Community-based regulation and socialization

1. Restrictions on parking zones, prohibitions at intersections or sharp turns, and fair allocation of parking per household should be implemented.
2. A neighborhood parking coordinator (RT/RW) should be appointed to mediate disputes and oversee compliance.

g. Development of alternative mobility modes

1. Develop pedestrian and bicycle routes along with public bicycle racks.
2. Support shared transport options (e.g., school shuttles, local motorcycle taxis) to reduce dependency on private vehicles.

These recommendations address not only physical aspects but also behavioral and social dimensions, aiming to create a fair, efficient, and infrastructure-appropriate parking system.

4.5 Implications of Parking Availability on Residents' Quality of Life

This study finds that parking availability significantly impacts the quality of life for BTN Minasa Upa residents. Quality of life encompasses not only physical aspects such as comfort and safety, but also social and psychological factors, including orderliness, social interaction, and tensions or conflicts among residents.

The lack of adequate parking pushes residents to park haphazardly on the roadside, in front of neighbors' homes, or even in public facilities such as mosques and schools. This often leads to disputes among residents due to obstructed access or compromised privacy and peace. Some residents also report increased stress from daily struggles to find parking, especially at night or on weekends.

As Paulley [33] pointed out, local transport conditions such as parking ease and vehicle circulation directly influence residential satisfaction. Conversely, parking shortages can worsen negative perceptions of the area, accelerate social degradation, and even reduce property values.

Proper parking space management can enhance safety, strengthen social bonds among residents, and foster a stronger sense of community. Thus, parking interventions—though seemingly technical and minor—have far-reaching implications for social development in residential areas.

4.6 Policy Implications

To resolve parking space issues sustainably, a collaborative approach involving the government, housing developers, and the community is required. Local governments must enforce stricter technical regulations and zoning

for new developments, including minimum parking space requirements based on household size and projected vehicle ownership.

However, top-down policies alone are insufficient. Community involvement in planning and managing parking is essential. Initiatives such as neighborhood meetings (RT/RW forums), engaging the community in drafting internal regulations, and establishing residential parking task forces can be key to long-term success. This involvement fosters a sense of shared responsibility and strengthens the social legitimacy of the policies implemented.

Barter [24] emphasized that parking solutions in residential areas cannot be uniformly imposed but must be adapted to local culture, economic capacity, and community preferences. Therefore, a hybrid model—combining government technical interventions with community-based management—can be the most effective approach for areas like BTN Minasa Upa.

Sustainable parking management faces various challenges, especially in mid-level residential areas like BTN Minasa Upa. Key challenges include limited physical space, high vehicle ownership rates, and funding constraints for shared parking infrastructure. Additionally, social resistance to spatial changes or new regulations may hinder implementation, particularly if not accompanied by proper socialization and education.

On the other hand, significant opportunities exist. Residents' willingness to seek joint solutions—as reflected in the use of informal parking zones—demonstrates collective awareness of the issue. Technology also offers new possibilities, such as implementing digital parking reservation systems, app-based parking rotation management, or using community CCTV to regulate orderliness.

Another opportunity lies in engaging the private sector, such as property developers or microfinance institutions, to help fund modular carport construction through affordable instalment schemes for residents. Thus, parking management is not merely a technical issue but also part of economic empowerment and social development in the neighbourhood.

5 Conclusion

Based on the analysis, several conclusions can be drawn as follows:

• The availability of parking spaces significantly affects road capacity in BTN Minasa Upa. The limited number of private garages causes many residents to park their vehicles along the roadside, reducing the effective road width and triggering congestion as well as obstructions for larger or emergency vehicles.

• Residents' parking behavior is influenced by vehicle ownership, housing type, and economic status. Small-type houses (Types 21 and 36), typically occupied by lower-income families, tend to rely on roadside parking. Meanwhile, households with higher incomes and larger houses tend to have more organized parking patterns, although owning more than one vehicle still creates competition for limited parking space.

• Parking management must be adapted to the physical condition of the roads and the socio-economic characteristics of the residents. Roads less than 6 meters wide should implement single-side parking rules. In densely populated areas, the use of community-shared parking, modular carports, or tandem parking is recommended. These physical interventions should be supported by community regulations, signage, and improved pedestrian access to create an orderly environment and promote efficient mobility.

Author Contributions

Conceptualization, A.A., V.V.N., and S.W.; methodology, A.A., V.V.N., and S.W.; formal analysis, A.A., V.V.N., and S.W.; investigation, A.A., V.V.N., and S.W., X.X.; writing—original draft preparation, A.A., V.V.N., and S.W.; writing—review and editing, V.V.N. and S.W. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] Makassar Statistical Board, "Makassar City in Figures," 2021. https://makassarkota.bps.go.id/id/publication/2021/02/26/be312e3f776bcfd005978bda/kota-makassar-dalam-angka-2021.html

[2] Makassar Statistical Board, "Makassar City in Figures," 2023. https://makassarkota.bps.go.id/id/publication/2023/02/28/b51bbd208d15ce2626a75efb/kota-makassar-dalam-angka-2023.html

[3] T. Litman, *Parking Management Best Practices (2nd)*. Routledge, 2006.

[4] S. Raju, J. Joseph, T. Joseph, M. Midhun, and P. Swaminathan, "Study on parking system and its analysis," *Int. J. Eng. Res. Technol.*, vol. 11, no. 2, 2023. https://doi.org/10.17577/IJERTCONV11IS02047

[5] Direktorat Jenderal Perhubungan Darat, "Keputusan Direktur Jenderal Perhubungan Darat (nomor: 272/HK.105/DRJD/96) tentang pedoman teknis penyelenggaraan fasilitas parkir," 1996. https://drive.google.com/file/d/0B79tMYph7q2WQ2ZrR2tYU2ZVMk0/view?resourcekey=0-FDgz-jglsn6QX0sP0-8TXA

[6] Institute for Transportation and Development Policy, "Reforming Off-Street Parking is the Key to Fewer Emissions and More Livable Cities," 2023. https://itdp.org/2023/09/12/reforming-off-street-parking-fewer-emissions-livable-cities/

[7] D. Shoup, *The High Cost of Free Parking*. Routledge, 2017.

[8] R. Ruslan, S. M. Saleh, R. Anggraini, and S. Sugiarto, "Exploring contributing factors to household vehicle ownership in developing countries: A case of Banda Aceh, Indonesia," *Commun.-Sci. Lett. Univ. Zilina*, vol. 27, no. 1, pp. D13–D24, 2025. https://doi.org/10.26552/com.C.2025.009

[9] I. Sefriyadi, I. G. A. Andani, A. Raditya, P. F. Belgiawan, and N. A. Windasari, "Private car ownership in Indonesia: Affecting factors and policy strategies," *Transp. Res. Interdiscip. Perspect.*, vol. 19, p. 100796, 2023. https://doi.org/10.1016/j.trip.2023.100796

[10] Auckland Council, "Vehicle Use and Parking," 2025. https://www.aucklandcouncil.govt.nz/content/dam/ac/docs/plans-projects-policies-reports-bylaws/misc/vehicle-use-and-parking-bylaw-2025.pdf

[11] Y. A. Sari, A. I. Rifai, and K. Wiliansyah, "The phenomenon of on-street parking in a residential area in Batam City," *Rekayasa Sipil*, vol. 10, no. 1, pp. 26–33, 2021. https://doi.org/10.22441/jrs.2021.v10.i1.04

[12] I. P. Wangi, Lenggogeni, R. B. Yasinta, and D. N. Fajriah, "Parking policy and its challenges in metropolitan cities in Indonesia," *AIP Conf. Proc.*, vol. 3222, p. 020002, 2024. https://doi.org/10.1063/5.0231124

[13] I. P. T. Panggabean, S. Sirojuzilam, S. Lubis, and A. Purwoko, "Parking management in supporting sustainable development: A systematic literature review," *Proc. Int. Conf. Commun. Sci.*, vol. 2, pp. 11–16, 2022. https://doi.org/10.29303/iccsproceeding.v2i1.51

[14] A. Munawar, *Manajemen Lalu Lintas Perkotaan*. Beta Offset, 2006. https://www.scribd.com/doc/241241178/Ahmad-Munawar-Manajemen-Lalulintas-Perkotaan

[15] W. P. Retnaningtyas and I. R. Maksum, "Analysis of the implementation of garage ownership or control policy for motor vehicle owners: A case study in the DKI Jakarta Province," *Eduvest J. Univers. Stud.*, vol. 4, no. 2, pp. 584–592, 2024. https://doi.org/10.59188/eduvest.v4i2.1044

[16] Indonesia Government, "Regulation No. 16/2021 on buildings (Peraturan Pemerintah (PP) nomor 16 tahun 2021 tentang peraturan pelaksanaan undang-undang nomor 28 tahun 2002 tentang bangunan gedung)." https://peraturan.bpk.go.id/Details/161846/pp-no-16-tahun-2021

[17] Institute for Transportation and Development Policy (ITDP), "Jakarta Parking Reform Guidelines," 2024. https://itdp-indonesia.org/wp-content/uploads/2024/07/Executive-Summary-Jakarta-Parking-Reform-Guidelines.pdf

[18] T. Litman, "Parking requirement impacts on housing affordability: The costs of residential parking mandates and benefits of reforms," *Victoria Transport Policy Institute*, 2025. https://vtpi.org/park-hou.pdf

[19] W. Kong, D. Pojani, J. Corcoran, and N. Sipe, "Parking policies in six continents: Mixed outcomes and multifaceted barriers to reform," *Policy Des. Pract.*, vol. 7, no. 3, pp. 343–360, 2024. https://doi.org/10.1080/25741292.2024.2333602

[20] Badan Standardisasi Nasional (BSN), "Persyaratan umum sistem jaringan dan geometrik jalan perumahan," Indonesian National Standard (SNI) 03-6967-2003. https://dn721806.ca.archive.org/0/items/9747-sni-2847-2019-persyaratan-beton-struktural-untuk-bangunan-gedung-dan-penjel/2691-SNI%2003-6967-2003-Persyaratan%20umum%20sistem%20jaringan%20dan%20geometrik%20jalan%20perumahan.pdf

[21] D. P. Rachmi, M. Z. Irawan, and D. Dewanti, "Do household characteristics influence private car and motorcycle ownership? Evidence from a case study in Yogyakarta urban area, Indonesia," *INERSIA: lNformasi dan Ekspose Has. Ris. Tek. Sipil dan Arsit.*, vol. 18, no. 2, pp. 157–166, 2022. https://doi.org/10.21831/inersia.v18i2.55411

[22] Direktorat Jenderal Perhubungan Darat, "Pedoman Teknis Penyelenggaraan Fasilitas Parkir," 1996, No. 272/HK.105/DRJD/96. https://drive.google.com/file/d/0B79tMYph7q2WQ2ZrR2tYU2ZVMk0/view?resourcekey=0-FDgz-jglsn6QX0sP0-8TXA

[23] G. R. Marsden, "The evidence base for parking policies: A review," *Transp. Policy*, vol. 13, no. 6, pp. 447–457, 2006. https://doi.org/10.1016/j.tranpol.2006.05.009

[24] P. A. Barter, "Off-street parking policy without parking requirements: A need for market fostering and regulation," *Transp. Rev.*, vol. 30, no. 5, pp. 571–588, 2010. https://doi.org/10.1080/01441640903216958

[25] A. Basri, "Analisis dampak parkir terhadap kinerja lalu lintas di ruas jalan sekitar Mall Panakkukang Kota Makassar," 2017.

[26] T. Litman, *Parking Management Best Practices*. Routledge, 2017.

[27] G. Marsden, "Parking policy," in *Parking Issues and Policies*. Emerald Group Publishing Limited, 2014, pp.

11–32. https://doi.org/10.1108/S2044-994120140000005016

[28] J. Gehl, *Cities for People*. Island Press, 2010.

[29] P. A. Barter, "Off-street parking policy surprises in asian cities," *Cities*, vol. 29, no. 1, pp. 23–31, 2012. https://doi.org/10.1016/j.cities.2011.06.007

[30] T. Litman, *Parking Management: Comprehensive Implementation Guide*. Victoria Transport Policy Institute, 2025.

[31] R. Kriyantono, S. Sos., and M. Si., *Teknik Praktis Riset Komunikasi*. Jakarta: Kencana Prenada Media Group, 2006.

[32] A. Rachman, E. Yochanan, A. I. Samanlangi, and H. Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D*. Saba Jaya Publisher, 2024.

[33] N. Paulley, R. Balcombe, R. Mackett, H. Titheridge, J. Preston, M. Wardman, J. Shires, and P. White, "The demand for public transport: The effects of fares, quality of service, income and car ownership," *Transp. Policy*, vol. 13, no. 4, pp. 295–306, 2006. https://doi.org/10.1016/j.tranpol.2005.12.004