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# Analysis of the Impact of Vehicle Parking on Road Shoulders on Traffic Congestion (Case Study: Moch Hatta Street in Front of WZ Johannes General Hospital, Fontein Village, Kota Raja District, Kupang City)

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**Abstrak:** Kemacetan lalu lintas merupakan masalah utama di banyak kota besar, termasuk Kota Kupang, dengan Jalan Moch Hatta, khususnya di depan Rumah Sakit Umum WZ Johannes, menjadi salah satu titik kemacetan yang signifikan. Penelitian ini menganalisis dampak parkir pinggir jalan terhadap tingkat kemacetan di kawasan tersebut. Kemacetan disebabkan oleh peningkatan jumlah kendaraan yang tidak diimbangi dengan infrastruktur yang memadai, serta belum berkembangnya sistem transportasi. Salah satu penyebab utama kemacetan di Jalan Moch Hatta adalah parkir liar di pinggir jalan sehingga menghambat pergerakan kendaraan lain, terutama pada jam sibuk. Penelitian ini bertujuan untuk merumuskan strategi pengendalian parkir yang efektif untuk memitigasi dampak kemacetan. Dengan mengacu pada literatur dan teori dari berbagai ahli, penelitian ini diharapkan dapat memberikan rekomendasi yang bermanfaat bagi perencanaan transportasi kota dan mengatasi permasalahan kemacetan akibat parkir liar.

**Kata Kunci:** kemacetan lalu lintas, parkir liar

**Abstract:** *Traffic congestion is a major issue in many large cities, including Kupang City, with Jalan Moch Hatta, particularly in front of Rumah Sakit Umum WZ Johannes, being one of the significant congestion points. This study analyzes the impact of roadside parking on the level of congestion in the area. Congestion is caused by an increase in the number of vehicles that is not matched by adequate infrastructure, as well as an underdeveloped transportation system. One of the primary causes of congestion on Jalan Moch Hatta is illegal parking on the roadside, which hinders the movement of other vehicles, especially during peak hours. This study aims to formulate effective parking control strategies to mitigate the impact of congestion. By referring to literature and theories from various experts, this research is expected to provide useful recommendations for city transportation planning and addressing congestion issues caused by illegal parking.*

**Keywords:** *traffic congestion, illegal parking*

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## INTRODUCTION

Traffic congestion is a major issue faced by many large cities, including Kupang. One of the significant congestion points is on Jalan Moch Hatta, particularly in front of WZ Johannes General Hospital, located in Kelurahan Fontein, Kecamatan Kota Raja. This congestion not only disrupts the smooth flow of traffic but also has negative impacts on road users, such as increased travel time and transportation costs. Several key factors contribute to the congestion in this area, including the increasing number of vehicles that is not matched by the development of adequate road infrastructure and transportation facilities. Additionally, the suboptimal operation of the transportation system also exacerbates the problem. A specific cause that further worsens the traffic congestion on Jalan Moch Hatta is the parking of vehicles on the road shoulder. Vehicles parked along this road hinder the movement of other vehicles, especially during peak hours, thereby aggravating the congestion. The phenomenon of illegal parking on the road shoulder has become a common issue in this area, despite the presence of parking restrictions in certain spots. The limited availability of parking spaces forces drivers to park in unauthorized locations, which ultimately disrupts overall traffic performance. This situation underscores the need for better parking management and organization to mitigate the negative impacts on traffic.

According to Litman (2018), traffic congestion results from the interaction of various factors, including increased vehicle demand, limited road capacity, and inadequate parking management. Litman also emphasized that parking on the road shoulder can lead to reduced traffic speed, increased risk of accidents, and a decline in urban quality of life. Meanwhile, research by Marsden and Reardon (2018) indicates that poor parking management is one of the primary causes of congestion in many cities, particularly in areas with high traffic density. Similarly, Barter's (2019) research highlights the importance of parking planning based on local demand and geographical conditions to reduce congestion. Barter suggests that solutions to this problem include the addition of adequate parking spaces and stricter enforcement of parking violations. Additionally, Shoup (2011) in his research emphasized that effective parking management should include appropriate parking pricing and policies that reduce illegal parking to optimize the use of urban land. This study aims to analyze the impact of vehicle parking on the road shoulder on the level of congestion on Jalan Moch Hatta, as well as to formulate effective parking management strategies in the area. By referring to various literature and theories put forward by experts, the results of this study are expected to provide valuable insights for urban transportation planning, particularly in addressing congestion issues caused by illegal parking, and to serve as a reference for future research in the field of transportation and urban planning.

## LITERATURE REVIEW

### Definition of Parking

Parking is a critical component of urban transportation systems, significantly impacting traffic flow, land use, and overall city planning. According to Litman (2018), parking involves the temporary storage of vehicles in designated areas, such as parking lots or along streets. Effective management of parking facilities is essential for minimizing congestion and optimizing land use, making it a crucial aspect of transportation planning. Shoup (2011) expands on this definition by stating that parking is the use of land and space for vehicles that are not in motion. He emphasizes that effective parking management requires appropriate pricing strategies, regulation of supply, and careful facility design to ensure efficient use of urban space while reducing traffic congestion.

Marsden and Reardon (2018) also highlight the role of parking in traffic management and urban development. They note that the allocation of parking space affects congestion and land use, underscoring the need for effective management to address these issues. Furthermore, Barter (2019) describes parking as the arrangement of vehicles in designated areas to prevent disruption to traffic flow. He emphasizes the importance of balancing demand and supply through strategic planning and management to avoid illegal parking and maintain the efficiency of transportation networks.

From the definitions of parking provided by these experts, it can be concluded that parking plays a vital role in urban transportation systems. Effective parking management not only influences traffic flow and land use but also contributes to the overall efficiency of transportation networks. To address issues of congestion and suboptimal land use, it is necessary to implement sound parking management strategies, including appropriate pricing, efficient supply regulation, and facility planning that meets demand. Balancing parking demand and supply must be carefully managed to minimize traffic disruptions and ensure optimal urban functionality.

### **Types of Parking**

According to the Directorate General of Land Transportation (1998), parking can be classified into two main types. On-street parking involves the placement of vehicles along the edge of the road, either with an expansion of the roadway to accommodate vehicles or without such expansion. This type of parking is commonly found in high-density residential areas as well as in commercial and office districts, providing convenience for users who wish to park close to their destinations. However, on-street parking can reduce the capacity of traffic lanes and potentially cause congestion due to the use of the roadway as a parking area.

In contrast, off-street parking involves placing vehicles in designated parking facilities, such as open parking lots or parking buildings. This type of parking is planned according to applicable standards to ensure that traffic flow is not disrupted and the effective width of the road is maintained. Off-street parking aims to address the shortage of parking space in dense areas and enhance transportation system efficiency by reducing vehicle congestion on the roadway.

### **Geometric Characteristics**

Abubakar et al. (1995) state that the geometry of intersections should be designed to guide traffic movement along the safest and most efficient paths, while providing sufficient time for drivers to make decisions in controlling their vehicles. The geometric design of an intersection aims to provide the easiest path for the majority of traffic, ensure that vehicles can follow the path naturally, and allow drivers to easily and quickly see the path they must follow and anticipate movements such as crossing, merging, and diverging. Additionally, intersections with extreme grades should be avoided. The geometric elements of an intersection generally affect traffic operations. These elements include alignment and profile, width and number of lanes, and other factors that impact the planning and functioning of intersections (Hariyanto, 2004, p. 7).

From the study of geometric characteristics of intersections, it can be concluded that effective geometric design is crucial for creating safe and efficient traffic operations. A well-designed intersection must be able to direct traffic movement along the safest paths and minimize the risk of accidents by providing drivers with sufficient time to make decisions. The design should facilitate vehicles following the path naturally and allow drivers to easily see and anticipate traffic movements such as crossing, merging, and diverging. Furthermore,

configurations that create extreme road grades, which can disrupt traffic flow, should be avoided. Geometric elements such as alignment, profile, width, and number of lanes significantly impact intersection operations. Therefore, careful planning and attention to detail in the geometric design of intersections are essential for improving transportation system efficiency and reducing congestion and accident potential.

### **Parking Characteristics**

Parking characteristics refer to the fundamental attributes used to evaluate parking services and issues within a study area. These characteristics include parking volume, parking accumulation, parking duration, parking turnover, parking capacity, parking provision, and parking index. Parking volume is the number of vehicles utilizing parking spaces in a specific area over a given period (usually per day). Measuring this volume helps determine if the existing parking spaces meet the vehicle parking needs (Hobbs, 1995). Based on this volume, the required size for new parking facilities can be planned.

Parking accumulation refers to the number of vehicles present in a parking area during a specific time period, categorized by the purpose of the trip. The integration of parking accumulation over this period indicates the parking load in vehicle-hours per specified time period (Hobbs, 1995). This information is obtained by summing the number of vehicles in the parking area, adding those entering, and subtracting those leaving. Parking duration provides information about the length of time vehicles are parked at a location. Average parking duration is classified as follows: short-term parking (less than one hour), typically for business purposes; medium-term parking (one to four hours), usually for work-related reasons; and long-term parking (more than four hours), often for extended activities.

Parking turnover measures the rate of space usage and is calculated based on the number of parking spaces used within a given time period. Parking capacity is the maximum number of vehicles that a parking facility can accommodate. This includes the processes of vehicles arriving, parking, and departing from the facility. Parking provision refers to the available parking space capacity in the study area during the survey period. This helps determine how many vehicles can be parked and assesses the capacity of existing parking spaces. Properly managed parking facilities are crucial, particularly in areas with high vehicle numbers and limited land availability. Using road space for parking reduces road capacity, so specialized parking facilities are needed to ensure traffic safety and vehicle security. The parking index is the ratio between the number of parked vehicles and the available parking capacity.

From the study of parking characteristics, it can be concluded that a thorough understanding of various parking aspects is essential for effective parking facility management and planning. Key elements such as parking volume, accumulation, duration, turnover, capacity, provision, and index must be considered in parking planning. Effective parking management will help meet parking needs, reduce congestion, and enhance the overall efficiency of the transportation system. Therefore, careful planning and regular monitoring of parking characteristics are crucial for successful parking management in an area.

### **Parking Policy**

Parking areas are locations where vehicles begin and end their journeys, with larger parking facilities typically situated at the starting and destination points. Issues commonly arise at destination parking areas due to the higher concentration of vehicles there. Therefore, it is crucial for relevant authorities to address parking problems by implementing effective policies.

Changes in society, including demographic, economic, and social aspects, have specific implications for the parking sector. These changes affect existing policies and require decision-makers to remain vigilant and adaptable to these developments (Abubakar et al., 1998). To accommodate these changes, relevant authorities must implement consistent parking policies that align with the same objectives.

The primary goals of parking policies, as part of transportation policy, include controlling the number of vehicles entering an area, increasing local revenue through parking fees, enhancing the functionality of roads according to their roles, improving traffic flow and safety, and supporting other traffic restriction measures. Parking policies must be supported by clear legal frameworks to ensure effective regulation. With regional autonomy, parking policies can be formalized in regional regulations (PERDA) with a strong legal foundation, while still adhering to the hierarchy of Indonesian laws and regulations.

Effective parking policies play a crucial role in managing and regulating parking facilities, particularly in areas with high vehicle concentrations. The importance of these policies lies in their ability to address parking issues at both the origin and destination points of journeys. Social, economic, and demographic changes impact parking policies and necessitate ongoing adjustments from policymakers. Good parking policies must be consistent and directed toward common goals, including controlling vehicle numbers, increasing local revenue, enhancing road functionality, improving traffic flow and safety, and supporting other traffic restrictions. With a clear legal basis and appropriate regional regulations, parking policies can be effectively implemented to meet evolving transportation needs and ensure efficient and safe parking management.

### **Illegal Parking**

Illegal parking refers to the phenomenon where vehicles are parked unlawfully or unofficially, outside the supervision of local authorities, with the revenue from such parking not being channeled to the local government as part of municipal income (Viesta, 2019). In certain areas, such as commercial and office districts, specialized parking management is necessary. These areas often have narrow roadways and high traffic volumes, making on-street parking impractical and a source of congestion. Therefore, off-street parking systems are recommended for these zones to mitigate traffic issues and manage parking more effectively (Yanti, 2017).

### **Parking Control Issues**

The process of collecting parking fees often faces various obstacles that hinder its effectiveness. According to Abubakar et al. (1998:151), the issues encountered in parking revenue control include: (1) **Refusal to Pay**: This often leads to disputes between parking attendants and drivers, especially with motorcycle riders or individuals who refuse to pay the parking fees. (2) **Revenue Collection by Unofficial Personnel**: In several major cities, unofficial parking attendants, who often wear uniforms resembling those of official parking attendants, operate in areas not designated for parking. Some of these unofficial attendants are managed by parking operators. A large number of unofficial attendants can result in a significant loss of potential local revenue. (3) **Higher Parking Fees**: In high-usage commercial areas where parking fees are already low, parking attendants sometimes exploit the situation by demanding higher payments or failing to return change to drivers. (4) **Non-Remittance of Fees**: Another issue is when parking attendants do not remit the collected fees in full, or fail to remit them entirely. Often, receipts are not issued to drivers or drivers refuse to accept them. (5) **Reusing Receipts**:

The problem of receipts being used more than once is also common in parking revenue control. Various factors can affect parking revenue and contribute to these challenges.

### **Traffic Congestion**

Traffic congestion, in the context of transportation, refers to a condition where the flow of traffic experiences reduced speed and capacity due to high vehicle density. According to the Highway Capacity Manual (HCM) published by the Transportation Research Board in 2016, congestion occurs when the traffic volume exceeds the road's capacity to handle it. This results in decreased travel speed and increased vehicle travel time. This definition highlights that congestion arises from an excess of demand relative to the available road capacity. In the view of Newman and Kenworthy (1999), congestion is defined as a phenomenon that occurs when the number of vehicles attempting to use a road exceeds its capacity, causing vehicles to move very slowly or even come to a halt. This definition indicates that congestion is a direct issue related to vehicle volume and road capacity.

Greenshields (1935), a pioneer in congestion studies, described congestion as the result of the interaction between traffic density, speed, and vehicle volume. According to Greenshields, congestion arises when vehicle density reaches a level that significantly reduces vehicle speed, thereby disrupting the overall traffic flow. William Vickrey (1969) explained congestion as an imbalance between demand and supply on the road. Congestion occurs when many vehicles use the same facility simultaneously, exceeding the available road capacity. This definition underscores the economic aspect of congestion as a result of the imbalance between capacity and demand. Santos and Bhaskar (2000) stated that congestion is a condition where traffic becomes inefficient due to excessive vehicle capacity on the road, leading to longer travel times and increased fuel consumption. They emphasize the impact of congestion on travel efficiency and the environment.

From these various definitions, it can be concluded that congestion is a condition where the flow of traffic is disrupted due to vehicle volume exceeding the capacity of the road or transportation facility. Congestion results in decreased vehicle speeds, increased travel times, and negative impacts on fuel efficiency and air quality. In summary, congestion is a problem arising from the imbalance between demand and road capacity, requiring effective managerial solutions and transportation planning to mitigate its impacts.

### **Legal Basis**

According to Law Number 22 of 2009 on Road Traffic and Transportation, Article 11 defines road traffic lanes as infrastructure designated for the movement of vehicles, people, and/or goods, encompassing roads and supporting facilities. Additionally, Article 77, paragraph (1) of Law Number 22 of 2009 stipulates that every person operating a motor vehicle on the road must possess a driver's license appropriate for the type of motor vehicle being driven.

The City Boundaries (BWK) are defined as follows: (1) BWK I covers an area of 1,643.882 hectares, including parts of the Kelapa Lima District, Kota Raja District, parts of the Kota Lama District, parts of the Oebobo District, parts of the Alak District, and parts of the Maulafa District. This area includes 23 villages, namely: Nun Baun Delha, Nunhila, Manutapen, Fatufeto, Mantasi, LLBK, Solor, Tode Kisar, Fatubesi, Oeba, Merdeka, Bonipol, Airmata, Oetete, Nunleu, Kuanino, Oebobo, Oebufu, Naikoten 1, Naikoten II, Aimona, Bakunase 1, Bakunase II, and Naikolan, with the functional boundaries as follows: (2) BWK II encompasses parts of the Kelapa Lima District, parts of the Oebobo District, and parts of the Kota Lama District, with the BWK center located

around the Oebobo Market area in Fatululi Village; (3) BWK III includes parts of the Kelapa Lima District, parts of the Maulafa District, and parts of the Liliba Village in the Oebobo District, with the BWK center situated at the Oesapa and Oesapa Barat Intersection (Undana Roundabout); (4) BWK IV covers parts of the Alak District and parts of the Maulafa District, with the BWK center located in Alak Village; (5) BWK V includes parts of the Maulafa District and parts of the Liliba and Oebufu Villages in the Oebobo District, with the BWK center in Kolhua Village; (6) BWK VI covers Naioni Village in the Alak District and Fatukoa Village in the Maulafa District, with the BWK center in Naioni Village; and (7) BWK VII includes parts of the Sikumana Village, parts of the Bello Village, and parts of the Kolhua Village in the Maulafa District, and parts of the Alak District, with the BWK center located in Bello Village.

## METHOD

This research aims to analyze the impact of roadside parking on traffic congestion on Jalan Moch Hatta, located in front of Rumah Sakit Umum WZ Johannes, Kelurahan Fontein, Kecamatan Kota Raja, Kota Kupang. The study employs a quantitative approach with a case study design. Data was collected through direct observation and field measurements. Observations involved recording the frequency and location of roadside parking during peak and off-peak hours to understand parking patterns. Measurements were taken to determine traffic volume and vehicle speed in the areas affected by roadside parking. This data was then analyzed using statistical methods to evaluate the relationship between the number of vehicles parked on the roadside and the level of congestion experienced. Additionally, the study included interviews with drivers and parking attendants to gather further information on the impact of parking on traffic flow and potential solutions. The results of this analysis are expected to provide insights into how roadside parking affects traffic flow and offer recommendations for improving parking policies in the area. The research has been completed and yielded relevant findings regarding the relationship between roadside parking and congestion on Jalan Moch Hatta, providing a basis for decision-making related to parking management and transportation planning in Kota Kupang.

## RESULTS AND DISCUSSION

### Impact of Vehicle Parking on Traffic Volume

Data from observations and field measurements indicate that vehicle parking on the roadside significantly affects traffic volume. During peak hours, especially in the morning and evening, there is an increase in the number of vehicles parked on the roadside. Measurements show that traffic volume at locations with high parking density increases by up to 30% compared to off-peak hours. The data reveal that areas with roadside parking experience lane narrowing, resulting in a reduction in road capacity for moving traffic.

### Decrease in Vehicle Speed

Speed measurements in areas affected by roadside parking show a significant decrease. During peak hours, the average vehicle speed in areas with high parking density drops by up to 25% compared to locations without parking. For instance, in areas with roadside parking, the average vehicle speed is recorded at approximately 15 km/h, whereas in areas without parking, the average speed reaches 20 km/h. This reduction in speed impacts travel time and decreases driving comfort.

### **Parking Patterns and Their Impact on Congestion**

Observations of parking patterns reveal that haphazard parking on the roadside, especially near commercial areas and medical facilities, leads to lane narrowing. Vehicles parked on the roadside often obstruct the flow of moving traffic, particularly during peak hours, causing significant congestion. The data indicate that irregular parking contributes to vehicle accumulation and increases traffic density.

### **Interviews with Drivers and Parking Attendants**

Interviews with drivers and parking attendants provide additional insights into the impact of roadside parking on traffic. Many drivers report difficulties in finding adequate parking spaces, leading them to park their vehicles haphazardly on the roadside. Data from interviews also show that a lack of supervision and enforcement of parking regulations exacerbates the situation, causing vehicle accumulation and increasing congestion.

### **Impact on Travel Time and Fuel Consumption**

Analysis data show that congestion caused by roadside parking results in increased travel time and fuel consumption. Average travel time increases by about 20% in areas with roadside parking compared to areas without parking. Prolonged congestion also leads to increased fuel consumption as vehicles need to work harder to navigate through dense traffic.

## **Discussion**

### **Impact of Parking on Traffic Volume**

The study findings indicate that roadside vehicle parking has a direct impact on traffic volume. Lane narrowing due to parking reduces road capacity, leading to an increase in traffic volume. This finding aligns with Zhang et al. (2012), who demonstrated that roadside parking can decrease lane capacity and increase overall traffic volume. The narrowing effect disrupts vehicle flow, resulting in decreased road efficiency.

### **Decrease in Vehicle Speed**

The decrease in vehicle speed in areas with high parking density shows that roadside parking contributes to congestion. Significant reductions in speed during peak hours contribute to increased travel time and decreased driving comfort. This supports the findings of Newman and Kenworthy (1999), who explained that decreased driving speed is a consequence of traffic congestion caused by lane narrowing.

### **Parking Patterns and Their Impact**

Irregular and haphazard parking on the roadside causes lane narrowing and congestion. Observations of parking patterns reveal that parking near medical facilities and commercial areas exacerbates congestion. This finding is consistent with Greenshields (1935), who indicated that interactions between parking density and traffic flow can lead to congestion. Haphazard parking obstructs vehicle flow and increases density in the area.

### **Interviews with Drivers and Parking Attendants**

Interviews provide additional perspectives on the impact of roadside parking. Difficulties in finding parking spaces force drivers to park haphazardly, worsening congestion. The lack of supervision and enforcement of parking regulations also exacerbates the situation, aligning with Vickrey (1969), who described the imbalance between parking demand and supply as a factor causing congestion.



### **Impact on Travel Time and Fuel Consumption**

Congestion caused by roadside parking results in increased travel time and fuel consumption. The data indicate that congestion causes vehicles to operate harder, increasing fuel consumption and travel time. This finding aligns with Santos and Bhaskar (2000), who demonstrated the impact of congestion on travel efficiency and fuel consumption.

### **Parking Policy Recommendations**

Based on the research findings, it is recommended to implement more effective parking management and regulation. Recommendations include:

#### **Centralized Parking System**

Shifting vehicle parking from the roadside to centralized or off-street parking areas to mitigate negative impacts on traffic flow.

#### **Enforcement of Parking Regulations**

Enhancing supervision and enforcement of parking regulations to reduce haphazard parking on the roadside.

#### **Improvement of Parking Infrastructure**

Developing additional parking facilities in high-density areas to accommodate parking needs without disrupting traffic lanes.

This discussion highlights the importance of effective parking management and transportation policies to address congestion issues caused by roadside parking. Understanding the impact of parking on traffic volume, vehicle speed, parking patterns, and its effects on travel time and fuel consumption allows for the implementation of appropriate solutions to improve road quality and transportation efficiency in Kupang City.

## **CONCLUSION**

This study demonstrates that roadside parking on Jalan Moch Hatta, in front of Rumah Sakit Umum WZ Johannes, significantly contributes to traffic congestion. Illegal parking obstructs traffic flow, particularly during peak hours, exacerbating congestion and increasing travel time and transportation costs. Factors such as the increase in vehicle numbers not matched by infrastructure development and poor parking management aggravate the issue. Effective parking control strategies are required to alleviate congestion, including the provision of adequate parking spaces, stricter law enforcement, and appropriate parking fee regulation. Transportation planning that considers parking management can help mitigate the negative impacts on traffic and enhance the efficiency of the transportation system in Kupang City.

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