

Evaluation of Parking characteristic on International Ferry Port and shopping mall Integrated Area

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ABSTRACT: Limited land and space efficiency are the main reasons for organizing integrated activities. Parking areas are things that can be integrated for several facilities located in one area. The construction of the International Ferry Port and the adjacent shopping mall can be used as a good integration pattern. This paper is prepared to analyze the characteristics of parking in the international ferry port area. The case study was selected in the Batam Center International Ferry Port and Shopping Mall area. Characteristics are analyzed through volume, cumulative, turnover, index, and performance index. The study results show that the Batam Center International ferry port parking area that is integrated with the shopping mall has exceeded its performance limit. On weekdays the volume and accumulated number of parking vehicles can still be accommodated by the available parking facilities. However, on weekends, the available capacity is not sufficient for existing needs. The performance index for the average vehicle is below 1.00, so it must be increased again. One of the steps that can be taken is to encourage parking spaces in the shopping mall area that has been integrated.

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I. INTRODUCTION

Ease of mobility in public facilities is one indicator of the success of managers in serving the community. The integration of various services in an area is a feature of modern development. Limited land and space efficiency are the main reasons for organizing integrated activities. Modern society prefers to carry out various activities in one area at the same time [1]. In some developed countries, the concept of transit-oriented development has become the standard of development [2].

Indonesia is a developed country that continues to develop modern areas. Therefore, service centers must be able to meet the needs of local and international communities well. Batam is one of the main gates of Indonesia in the western part is an area that receives special attention. The determination of Batam as a special economic zone makes this area very busy and bustling with various community activities [3]. so that the government and other stakeholders are expected to be able to provide various public service facilities needed.

Batam is designated as a special economic zone because it is directly adjacent to Singapore and international waters. So, this opportunity must be used optimally [4]. Therefore, providing facilities for entry and exit between countries is the main requirement in maintaining investment value. One thing that must be a concern is the international sea-port service facility which is the direct access to enter Batam. Batam Center International Ferry Port is the main passenger port because it goes directly to the Batam City government center and Batam Indonesia Free Zone Authority (BIFZA).

Batam Center International Ferry Port, designed by BIFZA, has good connectivity with various other supporting facilities. Besides being located in the central government area of Batam City, this Ferry port is integrated with Batam Center Mall. The integration of these main facilities makes it easier for Singaporeans and Malaysians to shop in Indonesia. In addition, the existence of the mall makes it easier for other passengers just to buy various necessities or eat before and after traveling through this ferry port. This integration is designed the mobility of facility users does not interfere with the transportation system in the area.

Batam Center International Ferry Port only serves international routes to Singapore and Malaysia with a steadily growing number of passengers. The increase in the number of passengers encourages all facilities at the service center to be well developed. One of them is supporting infrastructure in the form of a regional parking area. Parking facilities and areas at the port are essential, so an adequate parking area is needed. The fulfillment of parking infrastructure can facilitate the mobility of users of port services and shopping malls. The provision of parking areas is usually adjusted to the needs of existing parking spaces.

The movement of transportation facilities and the ability of people's purchasing power to vehicles is increasing from year to year, causing the need for parking spaces to be urgently needed. Lay-out planning and

vehicle circulation must be carried out correctly not to cause congestion that can hinder the flow of vehicles around the port. The significant increase in Batam Center Ferry Port and Shopping Mall vehicles must be balanced with an increase in the parking area. If the two are not balanced, transportation problems will occur, such as decreased vehicle mobility performance. In addition, the density of parking areas that cannot accommodate vehicles can affect the service level of ports and shopping malls.

This paper aims to analyze parking characteristics in the area, which consists of a ferry port and a shopping mall located in Batam Center. The evaluation begins by measuring parking performance and assigning a service value. Furthermore, an overview will be given in the future, so that there are no more vehicles that do not get parking spaces.

II. LITERATURE REVIEW

Parking is part of the transportation system that cannot be separated from other subsystems. Parking is the final movement or transit for vehicle traffic looking for a stopping place. Some stop or put the type of vehicle for a specific time in a place that has been provided. Success in processing and operating parking areas reflects success in planning transportation [5]. In a general sense, parking is defined as a vehicle that stops at certain places regulated by signs.

Parking Characteristic

Parking facilities in public service areas are generally built and prepare separate parking spaces in the area. Moving vehicles must stop and look for a parking space. Parking facilities are part of the transportation system whose function is to stop vehicles. In addition to vehicles parked in a unique building or place, parking can also be done on public roads where possible. This type of parking utilizes the existing road area without increasing the existing road's capacity [6]. Parking with a system like this is generally in demand by motorists because they want to park closer to their destination and are considered practical. Parking lots like this are generally located in densely populated residential areas and in central office areas, trade, and ports, which are unable to accommodate the number of parked vehicles [7]. This kind of parking can cause losses because it reduces the capacity of the traffic lane that is being passed by the vehicle, resulting in the road body not functioning correctly [8].

Parking characteristics are essential properties that can provide an assessment of parking problems. Therefore, parking characteristics are used as parameters that can be used to design the optimal parking facility concept [9]. One of the most dominant influencing characteristics of parking is parking capacity. Parking capacity is the maximum total vehicle that can be accommodated by an available parking area based on the type of vehicle [10]. At the same time, the accumulation of parking is the total number of vehicles parked in the parking area for a particular time. Calculating the accumulation is usually by adding up the vehicles that have used the parking lot with the vehicles entering, then subtracting the vehicles that have left the parking area [11].

Furthermore, the parking volume also affects the characteristics of parking facilities. Parking volume is the total number of vehicles using parking facilities. Meanwhile, parking turnover, which is the turnover rate, is obtained from the total number of vehicles at a particular time divided by the existing parking space [12]. The use is obtained by accumulating vehicles in a specific time interval divided by the existing parking space. The amount of parking turnover is influenced by the parking index, which is a percentage of the number of vehicles parked in the parking area [13]. This characteristic is one way to determine the level of parking demand.

The maximum parking requirement that is taken into account is the number of available parking lots compared to the accumulated maximum number of vehicles. Therefore, parking needs analysis is needed to plan parking facilities, initial planning, and planning to develop parking lots [14]. There are three methods commonly used in determining parking requirements. The first is the method based on the floor area of the building. This method is used to estimate the development of parking spaces needed in existing parking lots. The floor area of a building will affect the total number of vehicles parked around the building [15]. The criteria for applying the floor area of the building can be done in shopping areas or offices.

Next is a method that assumes a relationship with the parking area with the number of vehicles registered in the city center [16]. As the population increases, the need for parking space is increasing because vehicle ownership is increasing. Therefore, the third method is based on the most significant difference between the departure and arrival of the vehicle. This method calculates the most significant accumulation in observation intervals [17]. Parking accumulation is the number of vehicles parked in a particular place, where the number of parked vehicles must vary in other places from time to time.

Parking Management System

Management is a process that occurs from planning, organizing, actuating, and controlling activities. Good parking management can support parking traffic to run well, safely, comfortably, and economically [18]. In addition, the parking management system is vital in traffic control to anticipate problems due to congestion,

noise levels, and environmental standards [19]. Therefore, another effort in parking management is to determine the cost of parking management and the use of parking management technology.

Traffic management, in general, is the process of setting up and using an existing road system. This management aims to fulfill specific interests without adding and creating new infrastructure [20]. Activities can be carried out through a series of businesses that include planning, procurement, installation, maintenance of road facilities. Traffic management concerning parking can be divided into two types. The first is the management outside the parking space, which is based on policy input to the planning and control process. The process of planning traffic outside the parking space regularly, including the regulation of land use control consisting of service, residential, industrial, and agricultural activities. The relationship with parking controls the amount and activities covering office buildings, government, trade, ports, airports, schools, universities, malls, hospitals, stadiums, hotels, and tourist attractions.

The following management step is inside the parking space. This type of management is a necessary factor in the transportation system in urban areas because the growth of road capacity is smaller than the growth of vehicle mobilization and transportation modes. This causes many vehicles to park on the side of the road, thus disrupting traffic flow on the road, which can cause congestion [21]. In this regard, activity centers are required to provide sufficient parking space to reduce traffic disturbances on the highway.

Reducing traffic jams by applying off-street parking is not easy. The land use condition is minimal while the number of vehicles is continuously increasing rapidly, it is necessary to carry out traffic management both in city centers and on integrated roads. The goal obtained from the implementation of the traffic management system is to get the overall level of vehicle efficiency and traffic movement with increased accessibility [22]. In addition, it can balance the movement and existing facilities. Furthermore, it can increase user safety and, at the same time, improve environmental conditions by promoting the efficient use of energy.

III. RESEARCH METHOD

The research was conducted in the Batam Center Ferry port and shopping mall integrated area on weekdays and weekends. Primary data is obtained by meeting relevant agencies to obtain parking data, parking plans, parking area, and parking capacity. The data obtained from the survey results are then analyzed and calculated based on a standard formula. Furthermore, the data is described with several related literature and journals. Data analysis is expected to present meaning and be arranged systematically and easily understood by the reader.

The data obtained from the interviews were examined and compared with the informants' answers about parking performance. All the answers obtained are then grouped according to the summarized questions so that they have meaning and meaning in conducting this research. The calculation results can be seen at certain time intervals regarding the number of vehicles using the parking area. Furthermore, data processing will produce parking characteristics such as parking accumulation, parking capacity, parking area, parking volume, parking index, parking performance, parking space units, and parking management.

IV. CASE STUDY AND DISCUSSION

The parking area provided at the Batam Center International Ferry Port is based on data obtained from the company. Namely parking at points A to point D, which is located on the right side of the port which is a four-wheeled vehicle parking area with a parking area of 5004.7 m², the left side of the port with a point E to point H the parking area is 5891.5 m², four-wheeled vehicles for director's employees are located on the right side, which is 353 m², bus vehicles are 943.4 m², and motorcycles are 1193.2 m².

The four-wheel parking position has three parking positions with different capacities, namely parking angles of 60° degrees totaling 175 vehicles, 90° degrees totaling 11 vehicles, and parallel parking totaling 64 vehicles located on the right and left of the port building. The parking position for two-wheeled vehicles uses a 90° degree parking angle with a total capacity of 400 motorcycles located in the back corner of the left side of the port building. The parking positions for large, medium and small buses are parallel parking positions, with ten bus vehicles located on the left side of the Batam Center International Ferry Port building.

The width of the parking area at the Batam Center International Ferry Port is 5 meters in each parking aisle for four-wheeled vehicles and bus vehicles. The width of the main road is 7 to 8.5 meters at the entrance and exit of the parking area, and the width of the road for motorbikes is 1.5 meters per parking aisle. Parking facilities at Batam Center International Ferry Port are equipped with adequate parking signs, pedestrian crossing facilities (Zebra Cross) with a width of 2 meters, spacing between lines of 30 centimeters. Other existing facilities are a unique path for pedestrians (pedestrians) with a lane width of 1.3 meters and a suggestion input box made to improve infrastructure, located in the four-wheeled vehicle parking area at the Batam Center International Ferry Port. There are three parking guard posts at the port, each of which is spread out at various parking corner points. Post 1 is near the port one entrance, post 2 is in the employee parking area, and post 3 is in the bus and motorcycle parking area.

Data from observations at the study site were then analyzed and processed based on the formulation of this research. Based on the results of observations of the parking system applied in regulating the entry and exit of vehicle flow at the Batam Center Ferry Port using a ticket system with gate details as in table 1. automatic door for motorcycle.

Table 1. Number of the parking gate

Vehicle	Gate-in	Gate-out
Bus/Car	2	2
Motorcycle	1	1

The exit from the parking area at Batam Center International Ferry Port has two payment posts for parking for four-wheeled vehicles or buses. Two-wheeled vehicles such as motorcycles only have one exit post. Therefore, the total access that can be passed by vehicles to park at the port is three entrances and three exits. Payments received are pretty flexible, which can be cash and cashless.

Parking Characteristic

The vehicle data that has been obtained is then analyzed to determine the maximum vehicle accumulation that occurs on weekdays and weekends. Next, the maximum accumulation rate is calculated based on the formula and the type of vehicle that has been determined. Finally, the sample data is processed and displayed in graphical form by counting vehicles entering and leaving based on 15-minute intervals. The results of the accumulation calculation can be seen in figure 1.

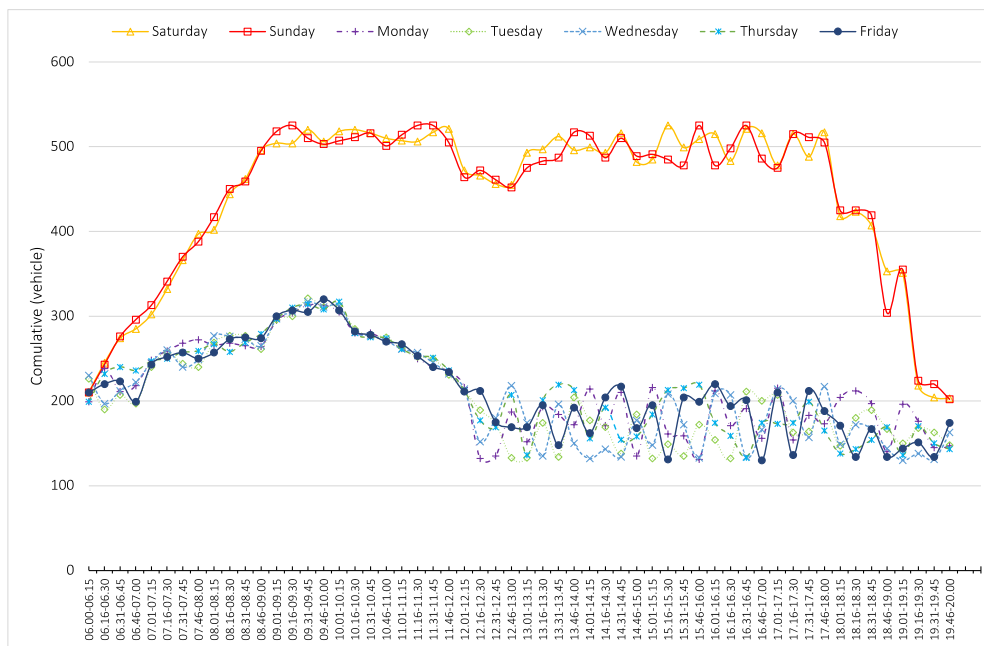


Fig. 1. Cumulative of vehicle

Figure 1 shows the maximum vehicle accumulation data on Sundays at 10.01-10.15 as many as 523 vehicles. The movement of the accumulation of parked vehicles in the ferry port area has two types of patterns. The first is a pattern formed on weekdays, and the second is a weekend pattern. During weekdays, the maximum accumulation only reached 317 vehicles at 10.01-10.15, then decreased and fluctuated. While on weekends, after reaching the maximum accumulation, the number of vehicles lasts until 17.00. This shows that the ferry port facility users are likely to vacation in Malaysia or Singapore during the weekend.

Furthermore, in figure 2, the volume of parking that occurs—analysis of vehicle volume divided by types of cars and motorcycles. The volume of vehicle parking is sampled on weekdays and weekends. The increase in the volume of four-wheeled vehicles in the parking area was highest on weekends, namely 3371 vehicles. Meanwhile, the volume of four-wheeled vehicles in the parking area is highest on weekdays, with 3087 vehicles. Thus, when studying the picture, the volume of vehicles is divided into two patterns, namely the pattern during weekdays and the pattern on weekends.

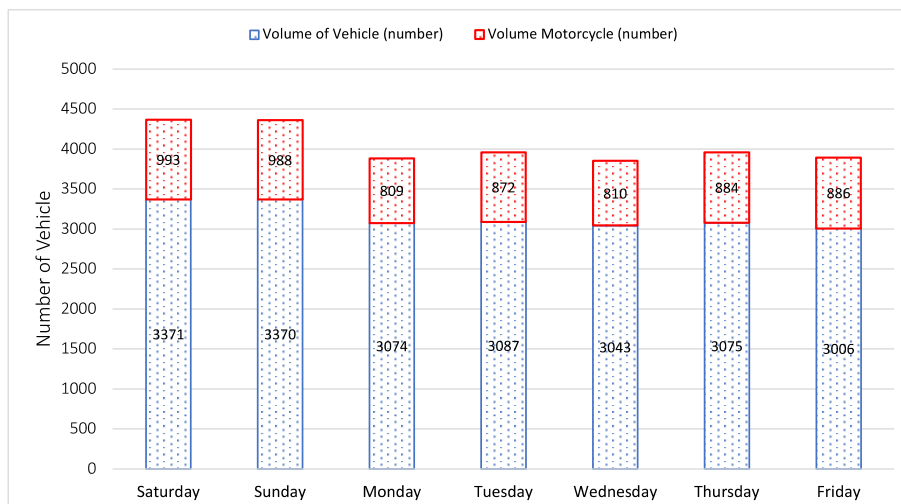


Fig 2. Number of vehicles

In table 2 can be explained about the volume, index, turnover, and parking performance number. The parking volume that occurs is calculated based on the applicable formula—analyzing the volume of vehicles divided by the type of vehicles entering the port, namely cars and motorcycles. The volume of vehicle parking is sampled on weekdays and weekends. The increase in the volume of four-wheeled vehicles in the parking area occurred on weekends of 3360 vehicles while on weekdays of 3095 vehicles. From the results of the calculation of the volume of vehicles, it shows that the condition of the parking area at the port is very crowded on working holidays.

Table 2. Parking characteristic

	Sat	Sun	Mon	Tues	Wed	Thu	Fri
Volume of car (number)	3371	3370	3074	3087	3043	3075	3006
Volume Motorcycle (number)	993	988	809	872	810	884	886
Turn-over car (ratio)	16,86	16,85	15,37	15,44	15,22	15,38	15,03
Turn-over motorcycle (ratio)	2,48	2,47	2,02	2,18	2,03	2,21	2,22
Car index (%)	210,00	210,00	125,20	128,40	126,80	126,80	128,00
Motorcycle Index (%)	97,25	78,75	83,25	75,00	79,75	87,50	84,75
Performance Index car (ratio)	0,48	0,48	0,80	0,78	0,79	0,79	0,78
Performance Index Motorcycle (ratio)	1,03	1,27	1,20	1,33	1,25	1,14	1,18

Table 2 above also describes the turnover that occurs in the ferry port area. It can be seen that for vehicles, the most significant turnover is 16.86 and 2.48 for motorcycles. In comparison, the parking index that occurs is 210% for vehicles and 97.25% for motorcycles. The parking index at the Batam Center International Ferry Port turned out to be more than 100%, which means the parking area exceeds its capacity. Therefore, the parking index that occurs should be lowered. One of the steps that can be done is by adding a parking area.

Furthermore, the parking performance index obtained at the parking facility is 0.48 for vehicles and 1.03 for motorcycles. Therefore, parking performance in vehicles on average is less than one, meaning that parking performance at the Batam Center International Ferry Port is experiencing a shortage of parking space, so parking performance is not optimal and must be added for vehicles. While the performance index for motorcycles still meets the needs.

V. CONCLUSION

The Batam Center International ferry port parking area, integrated with the shopping mall, has exceeded its performance limit. On weekdays the volume and accumulated number of parking vehicles can still be accommodated by the available parking facilities. However, on weekends, the available capacity is not sufficient for existing needs. The performance index for the average vehicle is below 1.00, so it must be increased again. One of the steps that can be taken is to encourage parking spaces in the shopping mall area that has been integrated.

REFERENCES

- [1]. Akib, H., & Ihsan, A. (2017). Bureaucratic reform in public service: A case study on the one stop-integrated service. *Mediterranean Journal of Social Sciences*, 8(2), 253-253.
- [2]. Li, Z., Han, Z., Xin, J., Luo, X., Su, S., & Weng, M. (2019). Transit oriented development among metro station areas in Shanghai, China: Variations, typology, optimization and implications for land use planning. *Land use policy*, 82, 269-282.
- [3]. Aritenang, A. F., & Chandramidi, A. N. (2020). The impact of special economic zones and government intervention on firm productivity: The case of Batam, Indonesia. *Bulletin of Indonesian Economic Studies*, 56(2), 225-249.
- [4]. Anggraeny, I., & Ayu, I. K. (2020). Development of Indonesian Free Trade and Port Zone: Analysis of Historical in Batam Island. *JL Pol'y & Globalization*, 99, 19.
- [5]. Shaaban, K., & Adalbi, M. A. (2021). Smart City Transportation System in Developing Countries: The Case of Lusail City, Qatar. . In *International Conference on Applied Human Factors and Ergonomics* (pp. 445-452). Springer, Cham.
- [6]. Bock, F., Di Martino, S., & Origlia, A. (2019). Smart parking: Using a crowd of taxis to sense on-street parking space availability. *IEEE Transactions on Intelligent Transportation Systems*, 21(2), 496-508.
- [7]. Scheiner, J., Faust, N., Helmer, J., Straub, M., & Holz-Rau, C. (2020). What's that garage for? Private parking and on-street parking in a high-density urban residential neighbourhood. *Journal of Transport Geography*, 85, 102714.
- [8]. Mo, B., Kong, H., Wang, H., Wang, X. C., & Li, R. (2021). Impact of pricing policy change on on-street parking demand and user satisfaction: A case study in Nanning, China. . *Transportation Research Part A: Policy and Practice*, 148, 445-469.
- [9]. Fu, C., & Huang, M. (2018). Urban Parking Characteristic Investigation and Parking System Evaluation: A Case Study in Xi'an. . In *CICTP 2017: Transportation Reform and Change—Equity, Inclusiveness, Sharing, and Innovation* (pp. 2399-2410). Reston, VA: American Society of Civil Engineers.
- [10]. Sweet, M. N., & Ferguson, M. R. (2019). Parking demand management in a relatively uncongested university setting. *Case Studies on Transport Policy*, 7(2), 453-462.
- [11]. Rifai, A. I., & Hafis, K. (2021). Analysis of Road Performance and Vehicle Parking Characteristics in the Halim Perdanakusuma International Airport Area. *Journal of World Conference (JWC)* (Vol. 3, No. 1), 89-98.
- [12]. Wang, H., Li, R., Wang, X. C., & Shang, P. (2020). (2020). Effect of on-street parking pricing policies on parking characteristics: A case study of Nanning. *Transportation Research Part A: Policy and Practice*, 137, 65-78.
- [13]. Parmar, J. D., Azad, F., Dave, S., & Kumar, R. (2020). Evaluation of Parking Characteristics: A case study of Delhi. *Transportation Research Procedia*, 48, 2744-2756.
- [14]. Al Hawarneh, A., Bendak, S., & Ghanim, F. (2019). Dynamic facilities planning model for large scale construction projects. *Automation in Construction*, 98, 72-89.
- [15]. Wei, X. P., Wang, Y. G., Cheng, Y. Q., & Zhu, G. X. (2017). Study on Parking Mechanism Based on Parking Spaces Time Series. *International Conference on Green Intelligent Transportation System and Safety* (pp. 53-59). Singapore: Springer.
- [16]. Christiansen, P., Fearnley, N., Hanssen, J. U., & Skollerud, K. (2017). Household parking facilities: relationship to travel behaviour and car ownership. *Transportation research procedia*, 25, 4185-4195.
- [17]. Parmar, J., Das, P., & Dave, S. M. (2020). Study on demand and characteristics of parking system in urban areas: A review. *Journal of Traffic and Transportation Engineering (English Edition)*, 7(1), 111-124.
- [18]. Melnyk, P., Djahel, S., & Nait-Abdesselam, F. (2019). Towards a Smart Parking Management System for Smart Cities. . *IEEE International Smart Cities Conference (ISC2)* (pp. 542-546). IEEE.
- [19]. Yin, C., Shao, C., & Wang, X. (2018). Built environment and parking availability: Impacts on car ownership and use. *Sustainability*, 10(7), 2285.
- [20]. Chai, H., Ma, R., & Zhang, H. M. (2019). Search for parking: A dynamic parking and route guidance system for efficient parking and traffic management. *Journal of Intelligent Transportation Systems*, 23(6), 541-556.
- [21]. Akbar, M., Paresa, J., & Pamuttu, D. L. (2021). Analysis of the Effect of Parking on Road Bodies on Road Service Levels. *IOP Conference Series: Materials Science and Engineering* (Vol. 1125, No. 1) (p. 012014). IOP Publishing.
- [22]. Cao, Y., Yang, Z. Z., & Zuo, Z. Y. (2017). The effect of curb parking on road capacity and traffic safety. *European transport research review*, 9(1), 4.