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An evaluation on Dr. M. Djamil Hospital Padang parking lot capacity

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Abstract. Parking is an element that cannot be separated from a facility, including hospitals. Dr. M. Djamil General Hospital, one of the health facilities located in Padang, should have an adequate parking space according to the standard designed for parking facilities. This research is conducted to evaluate the condition of the hospital parking facilities, started by calculating the existing capacity of the parking facility for motorcycles and cars. The next step is estimating the demand for parking spaces based on a one-week observation. Finally, the capacity is compared to the demand for parking areas. It was found 319 and 551 parking spaces available for cars and motorcycles. While based on the observation, it is also known that the maximum demands are 453 and 1038 spaces for cars and motorcycles, respectively. Furthermore, the current parking layout condition has not met the standard yet. This study proposes two kinds of improvement. First, additional parking lots are required, and it is designed based on the demand-capacity comparison. Second, the management of the hospital is suggested to regulate the number of vehicles that can park in the hospital parking area. The main contribution of this paper is on the parking lot design alternatives provided to the hospital.

1. Introduction

The issue of parking space is one of the most expensive problems and requires more space than ever [1]. According to Chrest, et al. [2] the parking arrangement has its own characteristics, so it requires a specific focus compared to other construction of facilities in a building. The design of the parking lot should consider some aspects such as traffic around both inside and outside parking areas, exits and entrances, pedestrian areas, security, structural durability, and signs [2]. There have been abundant literature and standards that can be used in designing parking lot facilities. Milošević et al. [3] explored the effects of changing trees positions on the comfort of the parking lot users. Rea et al. [4] proposed a model to recommend parking lot lighting brightness by considering users' perception of security. Due to the growth of electric vehicle usage, Zhang and Li [5] applied an optimization approach to managing a parking lot used for electric vehicle charging.

Hospital is one of the public facilities people mostly use. The services and facilities provided by a hospital become one of the satisfaction aspects of the visitors. The availability of adequate parking lots which does not disrupt the surrounding traffic becomes very important. The absence of adequate parking space will end up to a possibility of visitors parking their vehicles on the roadside or in any improper places; this can lead to the obstruction of traffic to the hospital which is supposed to be minimal barriers.

Dr. M. Djamil General Hospital is located in Padang, West Sumatra. As a public hospital, Dr. M Djamil Hospital has excessive visitors. However, parking service facilities are seen as insufficient to accommodate all vehicles belonging to visitors or hospital personnel, particularly during rush hour times. This problem can be seen as of vehicles parked outside the parking area, no parking signs, and the arrangement is barely proper. In addition to the unavailability of standardized parking facilities, visitors parked vehicles in an improper way. Not only motorcycles, but cars were also parked carelessly and disrupt the traffic. Meanwhile, the road that is being used as a parking area should not be a parking area, because it is the main road to the Emergency Installation passed by the ambulance. Based on those problems as well as observations and short interviews conducted on hospital visitors, it is necessary to evaluate the parking facilities at Dr. M. Djamil Hospital Padang, in order to know the comparison between the needs of parking space and the capacity of available parking space around the hospital. Furthermore, this article will provide several improvement opportunities by providing creative design solutions for the hospital parking lot. The solutions consider parking lot standards that are applicable in Indonesia.

2. Evaluation of the condition of parking facilities

2.1. Calculation of existing parking capacity

The data required in this research included daily observation data of one-week parking observation, the number of active employee in Dr. M. Djamil Hospital, the number of bed, the number of visitors in outpatient installation, and layout of Dr. M. Djamil Hospital. The condition for car and motorcycle parking lot is considerably different. Car parking lot has parking line while motorcycle parking lot doesn't. This made the calculation for existing capacity in car parking lot was based on direct counting on the line, while for motorcycle parking lot, there was no parking line, so the calculation was based on the standard size. Based on the observation, it is shown in Table 1 the existing parking capacity of the motorcycle in six parking lots. Parking lot 4 and parking lot 5 does not require an alley because it only consists of one layer of parking.

Table 1. Recapitulation of parking space capacity for motorcycle

No.	Parking lot	Area		One parking space size [c]	Alley width [d]	Parking area width [e] e=(axb)-(axd)	Capacity (parking unit) [f] f = e/c
		Length (m) [a]	Width (m) [b]				
1	Parking lot 1	60	8.2	0.75 x 2m	4.2	240	160
2	Parking lot 2	55	7.5	0.75 x 2m	3.5	220	146
3	Parking lot 3	21	5.4	0.75 x 2m	1.4	84	56
4	Parking lot 4	21.7	2	0.75 x 2m	0	43.4	28
5	Parking lot 5	20	2	0.75 x 2m	0	40	26
6	Parking lot 6	35	10.6	0.75 x 2m	4.8	203	135
			Total				551

While in Table 2 shows the information on the capacity of car parking in the parking lot at Dr. M. Djamil Hospital.

Table 2. Recapitulation of parking space capacity for car

No	Parking lot	Capacity (Parking units)
1	Parking lot 7	130
2	Parking lot 8	98
3	Parking lot 9	45
4	Parking lot 10	16
5	Parking lot 11	30
	Total	319

2.2. Parking demand calculation

Parking demand calculation was done hourly for one week, starting at 7:00 a.m. to 5:00 p.m. The number of vehicles parked at night was not observed directly, but the accumulation amount was calculated in the morning before the observation begins. Based on a one-week observation, the average number of vehicles and the maximum accumulation of vehicles for each day was calculated and shown in Table 3.

Table 3. Recapitulation of number of vehicles

No	Day	Average		Maximum accumulation	
		Car	Motorcycle	Car	Motorcycle
1	Saturday	249.9	586.0	347	770
2	Sunday	184.6	553.1	248	741
3	Monday	399.1	760.6	453	916
4	Tuesday	304.9	870.4	336	1038
5	Wednesday	273.1	759.2	325	826
6	Thursday	356.1	858.4	389	968
7	Friday	246.6	783.8	296	887

In table 3, it can be seen that the largest value of average for parking cars is 399.1 units, while for motorcycles is 870.4 units. If parking lot capacity takes into account the maximum accumulation of vehicles parked at a time, then the demand for the parking lot for cars is 453 spaces, while for motorcycles is 1038 spaces. Table 4.4 shows the comparison for demand and capacity of the parking lot.

Table 4. Demand and capacity comparison

	Car (Units)	Motorcycle (Units)
Demand observation	453	1038
Existing capacity	319	551
Deficiency	134	487

3. The proposed design of parking layout

3.1. Design of standardized parking layout

The next step is to design the parking layout based on the Technical Guidelines for Designing Parking Facilities by the Directorate General of Land Transportation [6] and refers to the value of existing capacity and demand based on direct observation. In this design, the parking pattern used for motorcycle parking lot is a pattern with 90^o angle. As for the car parking lots are designed using all angles; 90^o, 60^o, 45^o, and 30^o, except for parking lot 10 which is designed in the parallel pattern. The calculation for the motorcycle has no difference with the previous calculation, which is 551 spaces because the calculation was already based on the standard. But for the car, there were four

recommendation designs. All parking pattern was tried and calculated how much it could accommodate by using the pattern. The results are shown in Table 5.

Table 5. Recapitulation of parking pattern trial

Parking Lot	Available Length (m)	Parking Pattern									
		90°		60°		45°		30°		0°	
		Std. Width (m)	Parking Units	Std. Width (m)	Parking Units	Std. Width (m)	Parking Units	Std. Width (m)	Parking Units	Std. Width (m)	Parking Units
Parking Lot 7	300	2.3	130	3	98	3.7	79	5	58		
Parking Lot 8	184		78		57		44		32		
Parking Lot 9	69		30		21		17		12		
Parking Lot 11	45		19		13		10		7		
Parking Lot 10	48	-	-	-	-	-	-	-	-	6	8
Total (Parking Units)		265		197		158		117			

Std. Width = Standard Width

3.2. The alternative act of improvement

The next stage is to propose some alternatives acts of improvement to make a better parking facility at Dr. M. Djamil Hospital. Here are the two alternatives:

3.2.1. Additional Parking Lot(s)

The calculations showed that the maximum demand for the car is 453 spaces and for a motorcycle is 1038 spaces. To meet the parking demand, the hospital needs to provide additional land with the following details

1. Motorcycle
   The number of parking capacity for the motorcycle was attained based on standardized parking calculation because motorcycle parking lots have not had the parking line yet. See Table 4; there is a deficiency of motorcycle parking lots, which are 487 spaces. One parking space with the 90° angle, a length of 2 m and a width of 0.75 m, will get a parking area of 1.5 m2. If it takes 487 spaces to meet the demand, then the total area of additional land would be equal to 730.5 m2.
2. Car
   Unlike the motorcycle, there are four scenarios for car parking lots. Each scenario will make different additional parking area if applied. Table 6 shows the space deficiency of each parking pattern.

Table 6. Demand and capacity comparison for car

Parking Pattern	Capacity (Parking Units)	Demand (Parking Units)	Deficiency (Parking Units)
90°	265	453	188
60°	197	453	256
45°	158	453	295
30°	117	453	336

Based on the space deficiency shown in Table 6, here are the additional parking area widths that should be provided according to the chosen parking pattern refers to the standard parking guidelines by Directorate General of Land Transportation [6]:

a. One parking space with the 90^o angle, the standard length and width are 5.4 m x 2.3 m, it will be obtained the parking space equal to 12.42 m^2. It takes 188 spaces to meet the demand, so the total area of additional land would be equal to 2,334.96 m^2.
b. One parking space with 60^o angle, the standard length and width are 5.95 m x 3 m, so the parking space would be equal to 17.85 m^2, in Table 6, it is known that deficiency of parking lot for car with 60^o angle is 256 spaces, so the total area of additional land would be 4,569.6 m^2.
c. If the 45^o angle is used in designing a parking space, it will use the standard length and width are 5.65 m x 3.7 m, so the wide of parking space equal to 20.91 m^2, because the demand deficiency is 295 spaces, then total area of additional land would be 6,168.45 m^2.
d. The standard length and width for parking pattern 30^o are 5 m x 4.85 m, so the wide of parking space equal to 24.25 m^2. It takes 336 spaces to meet the demand, so the total area of additional land would be 336 x 24.25 m^2 or equal to 8,148 m^2.

3.2.2. Restrictions on the number of vehicles

There are some managerial alternatives that the hospital could consider. First is the restriction on the number of vehicles by considering mass transportation for the employee; the second is the escalation on parking price

1. Restricting the number of vehicles. Employee and medical staff arguably has a significant portion into the parking ratio. Based on calculation with two approaches Chrest et al. [1] and Directorate General of Land Transportation [6], employees take up to 62% of the current parking area. This can be a reference for the hospital to consider a regulation that employees are not allowed to bring their vehicle if they work at first and second shift because which of them are usually the shift where the peak time happens, therefore, the hospital would provide mass transportation to and from hospital that will accommodate all employees. If this plan is applied, about 60% of the parking area would be available for other users.
2. Escalating parking price. Parking rates at the hospital are Rp. 3,000 for car vehicles and Rp. 2,000 for motorcycle vehicles. The rate does not increase based on the time but remains per visit. So, an hour's parking will be as costly as a day of parking. Increasing parking rates after a few hours can be an alternative to discourage visitors to park their vehicle in a long-term. According to the US Department of Transportation [7], escalating price often used in off-street parking, escalating rates increase the longer a vehicle is parked at a location. The rate structure is designed to discourage long-term parking, thereby increasing parking turnover and availability. To determine how much parking rate for the first hour and the price change for the following hour(s), the value of ATP (Ability to Pay) and WTP (Willingness to Pay) with reference to Tamin [8], can be used.

4. Conclusion

This article discusses about evaluation of parking lot capacity of Dr. M. Djamil Hospital. The evaluation tasks were started by calculating the existing capacity of parking facility for motorcycle and car, and then calculating the demand based on a one week observation. Finally, the capacity was compared to the demand on parking area. The conclusions that can be obtained from this study are: 1) The condition of motorcycle parking is not based on standard yet, because there is no parking line so it is difficult for the service providers to know the capacity of available parking space; 2) The amount of parking space that can accommodate motorcycle according to the standard of the available land area is 551 spaces, while the maximum demand is 1038 spaces; 3) The condition of the car parking lot already has a parking line, however, during busy times, parking area that should be only one layer made into two layers, thereby it will be reducing the width of the road/alley; 4) The number of parking spaces that can accommodate car according to the existing condition is as much as 319 spaces, while the maximum demand is 453 spaces; 5) According to standard-based layout arrangement for car, it can be concluded that the wider the parking angle, the more convenient the driver would be, but it also gave the less parking space, vice versa. There are four scenarios that this study built for the hospital to choose the parking pattern they want to apply. These scenarios are based on the parking angle. For the

same parking land size, 90^{o} angle would make up to 265 parking spaces, 60^{o} would make 197 parking spaces, 45^{o} would make 158 parking spaces, and 30^{o} would make 117 parking spaces; 6) Planning on the proposed layout improvement is done by referring to the Directorate General of Land Transportation regulation (1996), after evaluating the current condition of parking lot, there are no space elimination for parking area of motorcycle. But for car, there is a reduction in parking spaces caused by adjustments to standard sizes. The reduction of parking space for car is varied based on the applied parking pattern; 7) This study proposes some alternatives of additional areas for parking lot according to the standards of Directorate General of Land Transportation (1996), with various parking pattern for car. This proposed improvement would give different parking space and different total area needed, and 8) This study also proposes managerial alternatives which are vehicle regulation for employee and escalating parking price to discourage long-term parking. The main contribution of this paper is on the several creative design solutions provided for the hospital parking lot.

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