Journal of Global Business and Social Entrepreneurship (GBSE)
Vol. 3: no. 5 (2016) page 174–186 | gbse.com.my | eISSN 24621714 |

APPLICATION QUALITY FUNCTION DEPLOYMENT PRINCIPAL FOR PARKING SYSTEM IMPROVEMENT: CASE STUDY KAMPUS KOTA UMK KELANTAN MALAYSIA

Md Ashlyzan Razik[1]
Suhaila Abdul Kadir[2]
Rooshihan Merican Abdul Rahim Merican[3]
Norlinda Mohd Rozar[4]

Abstract

Parking demand is a very critical issue in campus planning and developing especially to the campus that built in urban or town area which congestion is other issues that need to be take care of. With the increasing number of students each year has worsen this problem which has contribute to the increasing number of student with vehicles and the parking facilities definitely not enough to occupy each student attending the campus. In this paper proposed the design based on quality function deployment (QFD) method. Its translates car park location issue into new product design problem, then builds a QFD-based decision-making model of car park location by considering all participators' (including the user, the investor and the local authority) requirements, to find out the optimum location of car parks in the urban environment and also assist drivers to find vacant spaces in a car park in a shorter time.

Keywords: Quality Function Deployment, House of Quality, Decision Making Model

[1] Pensyarah, Fakulti Keusahawanan dan Perniagaan, Universiti Malaysia Kelantan, 16100, Kelantan, Tel: +60139226717 E-mail: ashlyzan@umk.edu.my
[2] Pensyarah, Malaysian Graduate School of Entrepreneurship and Business, Universiti Malaysia Kelantan, 16100, Kelantan, Tel: +60192514394 E-mail: suhaila.ak@umk.edu.my
[3] Pensyarah, Fakulti Keusahawanan dan Perniagaan, Universiti Malaysia Kelantan, 16100, Kelantan, Tel: +60199988888 E-mail: rooshihan@umk.edu.my

Introduction

Space is the amount of an area, room or surface that is empty or available to use or can be consider as an area that used for specific purpose. Shape and space was inseparable and a have a powerful and complementary relationship. Space can either be a flat area or have volume. Shape was called as an enclosed space while space was an unenclosed space. Therefore, space or empty space can be called as open, unbroken, plain or blank place. Parking lot can be refer as a space for a vehicle to stop and place for a certain time. Normally, building development and construction would consider space for parking lot because it is one of the necessary facilities. Car's owner would need proper car parks to be provided either inside or outside the building. A development without parking area reflection can be consider as failure project. Therefore, parking was important and a requirement in Town and Country. Either in shopping area, resident area or even restaurant area would provide parking lot for users. As the trend changing, demand for parking space has growths by year this is because of automobile business doing well and it is a standard to see a family owns more than 2 cars. (Malek, 2012)

Currently, private car has become an important and prevailing mode of transport. The aggregate ascendancy of the private car as a mode of transport is due to intrinsic advantages associated with its use. The unhindered authorization that car users enjoy is one central reason why many people wish to own a car. (Almeslati, Rahmat, Jaafar, & Abuhamoud, 2011) Besides, according to the figure 1.0 it shows that residents in San Francisco have a great discrepancy by owning a house with car parks and without car parks. As the survey happen, it can be knew that parking lots had become a necessary facilities for residents.

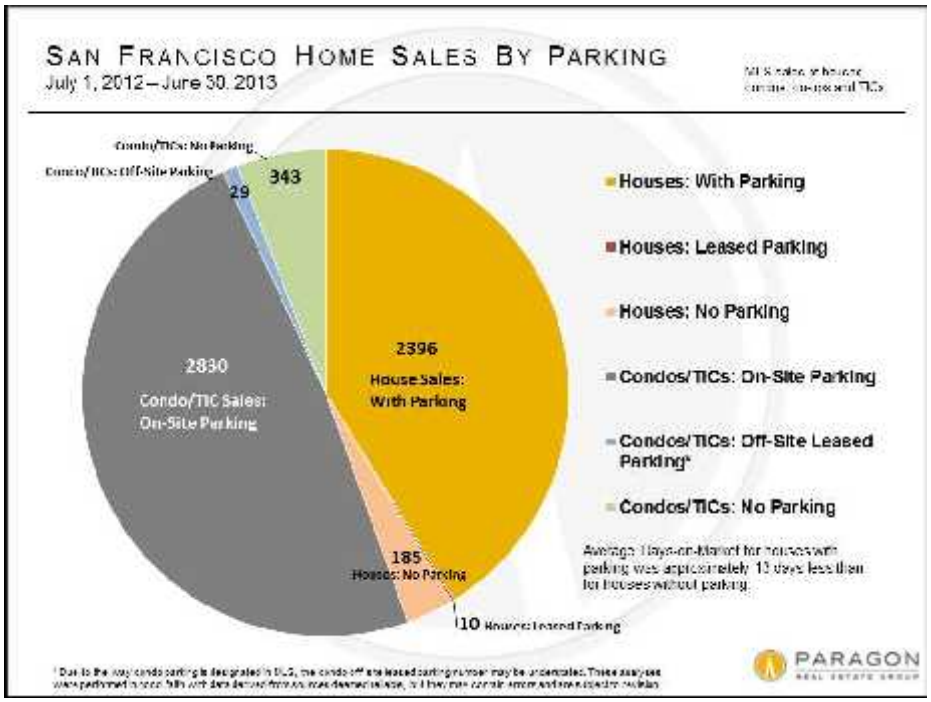


Figure 1.0 Research of San Francisco Home Sales by Parking

In Malaysia, Road Transport Department Malaysia report that "Car Registrations increased to 109255 Cars in December from 93578 Cars in November of 2015. Car Registrations in Malaysia averaged 65099.08 Cars from 1988 until 2015, reaching an all the time high of 138727 Cars in March of 2015 and a record low of 9732 Cars in May of 1988." The aforesaid statistics provided by the Malaysian ministry of transportation the current transportation infrastructure and car park facilities are deemed insufficient in sustaining the influx of vehicles on the road. According to table 1.0, it shows that the number of new passenger and vehicles registered in Malaysia increasingly from 1980 to 2015. With the increases of vehicle registered, it mean to be the increases of the use of vehicles. This could mean that parking lot would need more to fit every car within year by year in order to avoid the serious congestion happen. Besides, a better parking lot would also needed to create according the standard to meet the efficiency of used.

Problem Statement and Study Objectives

In University, parking system is one of the crucial facility for student and staff. If unable to handle the operations of parking spot will leads the parking spot to be congested. Moreover inefficiency of parking system will also cause dissatisfaction among student and staff. Obviously overwhelming numbers of cars and motorcycles leads congestion during "in and out" of cars and motorcycles at parking spot. Thus increasing in number of students and staff cannot meet up the demand of parking system. Therefore the University Malaysia Kelantan need to design a layout for specific parking spot for students as well staff with appropriate parking standard. In particular, this study has two main objectives; to investigate the factors that affected the parking system improvement in UMK City Campus and to determine the Parking System Improvement by using the Quality Function Deployment (QFD).

Literature Review

Car park planning standards is the standard that is used as the guideline in the provision of parking area in city centre. The standards can be either fixed standards or unfixed standard that can be change to suit the situation. In Malaysia, provision of parking space is referred to the car planning standards manual that have been adapted by the Department of Town and Country Planning throughout the country. However, there are some standards or policies that used by local authorities in the provision of sufficient parking space either for shop units, offices and many more which the use of the standards are depends on the suitability of the standard towards the location (Mohd Noor Awang, 2003).

There are two elements that a responsible person whether it is the developer or local authorities need to concern when planning on parking space. Parking space demand and layout of the parking space need to take into the consideration before further planning and investment. Each planning should provide sufficient parking spaces to meet their parking demand and they need to ensures the provision of safe and functional parking space design for convenience of users and smooth traffic flow of the parking space (Lta,2011).

Parking Standards

Car park planning standards is the standard that is used as the guideline in the provision of parking area in city centre. The standards can be either fixed standards or unfixed standard that can be change to suit the situation. In Malaysia, provision of parking space is referred to the car planning standards manual that have been adapted by the Department of Town and Country Planning throughout the country. However, there are some standards or policies that used by local authorities in the provision of sufficient parking space either for shop units, offices and many more which the use of the standards are depends on the suitability of the standard towards the location Mohd Noor Awang, (2003).

There are two elements that a responsible person whether it is the developer or local authorities need to concern when planning on parking space. Parking space demand and layout of the parking space need to take into the consideration before further planning and investment. Each planning should provide sufficient parking spaces to meet their parking demand and they need to ensures the provision of safe and functional parking space design for convenience of users and smooth traffic flow of the parking space (Lta,2011).

As stated by Barter,(2010), the objective of parking space standard is to meet demand and the minimum parking standards is the important instrument where each infrastructure need to have sufficient number of parking space to meet its forecasted maximum demand and also to avoid extra investment on unnecessary development.

There are two types of parking space which is fixed parking space and temporary parking space. Fixed parking space is the parking space that located around residential area and housing area which have lots of user that use the parking space permanently. While for temporary parking space it is provided for temporary moment for location for concert and stadium and there are no fix lots for the parking. For example, Shah Alam City Council has set the minimum standard for the provision of parking space in the area of offices, shopping centers, boutiques and galleries is one parking space for every 47 square meters of floor space and additional of 10% of parking space is required for visitors at the business office area.

Parking Standards for Wilayah Persekutuan Kuala Lumpur

Source from, Aliran & Dalaman, (2014)
a) Design standard for car park

- Dimension of stalls (parking box)

Minimum stall width : 2.4m
Minimum stall length : 4.8m
Minimum stall length for lateral parking : 6.0 m

- Dimension of Access Way

Minimum clear/effective width : 3.3m

- Aisle width :

Parking Angle	One Direction Traffic (Bay on one side or both side)	Two Direction Traffic (Bay on both side)
90˚	6.1m (20’0”)	7.3m (23’11”)
60˚	4.8m (15’9”)	6.7m (22’0”)
45˚	4.2m (13’9”)	6.7m (22’0”)
30˚	3.7m (12’2”)	6.1m (20’0”)
Lateral	3.7m (12’2”)	6.1m (20’0”)

- Headroom

For the car park that in a building either it is above or basement level, The minimum clear height of the part of the building should not be less than 2.3m (7’7’’). The underside of the beams, directional signs, sprinkler heads, fittings and other similar items may be allowed to project below this height provided under that under side of such items shall not be less than 2.0m (6’7’’) from the floor level.

- Stalls

The area between the stall (parking box) should be flat and free from columns, kerbs, raised pedestrian refuges and other encumbrances. Each stall should be marked on the surface of the parking area with thermoplastic paint or any other approved materials.

- Sign and floor markings

Direction signs and the floor marking to provide circulation are needed as reference for users to remember their vehicle location.

- Ventilation

For basement and underground parking area, ventilation system should be able to provide a minimum rate of six air changes per hour throughout the garage and the system applied should oblige with Building By Laws.

- Entrance and Exits

Design for the entrances and exits need to give good visibility at any changes of direction both horizontally and vertically. A car park that accommodate 500 cars and more need to have a minimum of 2 lanes and maximum number of cars for one point of access is only 600 cars. The entry and exit point need to be located in order to provide maximum storage space and maximum distance from intersection. Combined access need to be located at mid block which the entrance and exit need to be placed in the down streams portion of the block and the entrance is placed as far upstream as possible.

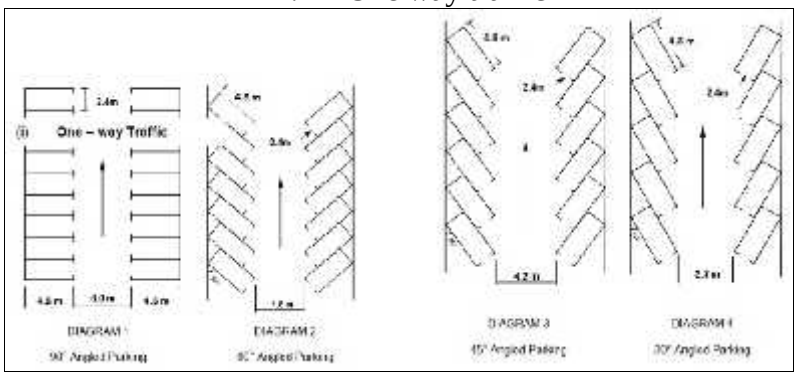
b) General Standards for Parking Area

- For every 50 parking bays or less should provide a minimum one parking space for disabled people (Disabled parking).
- Tandem parking spaces are not allowed and won’t be considered for commercial development such as offices and shopping complex.
- Tandem parking or detached parking can be considered for housing development such mid cost apartments, luxurious apartments and service apartments.
- Disabled parking for disable people cannot be sold or rented to the residents or to the public.
- Lighting must be provided at the car park area especially for basement car park and the brightness must be at least 120 LUX.

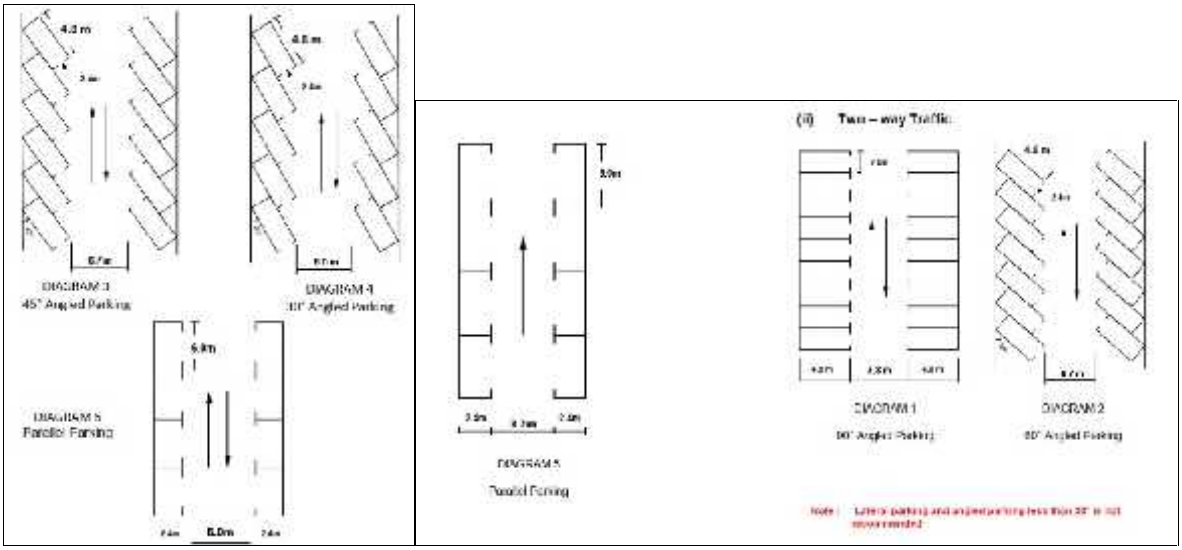
- Safety features such CCTV, safety mirrors, signboard directions, etc must be provided at the cap park area and it refer to standard plans JPIF/TLK.
- For multi storey car park, for each parking lots that facing to the outer wall need stopper.
- Parking bay at the end of road can be considered for two number of parking bay, it is only permitted if only the size of parking lot at minimum of 3.0m x 4.8m and vertically.
- 'Single Lady Driver' parking lots need to be provided for each parking level and located near to the lift for at least 7% of number of the total parking but this parking lot is especially for commercial development only.
- Parking lot at between of columns or wall and the columns or walls are within the 'barrier free zones area' should at least be size of 2.7m x 4.8m or 3.0m x 4.8m.

c) Dimension of Car Parking Stalls and Circulation Aisles

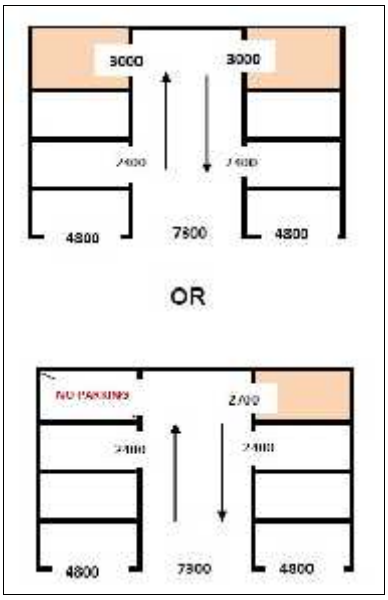
i. One way traffic



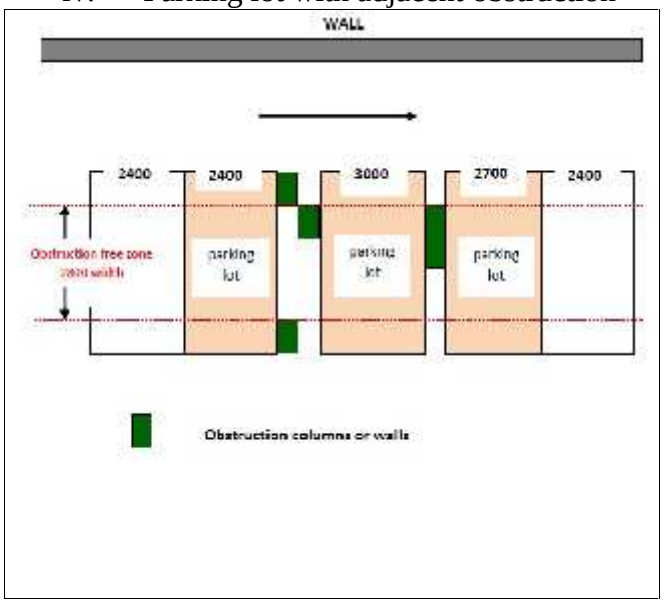
ii. Two way traffic



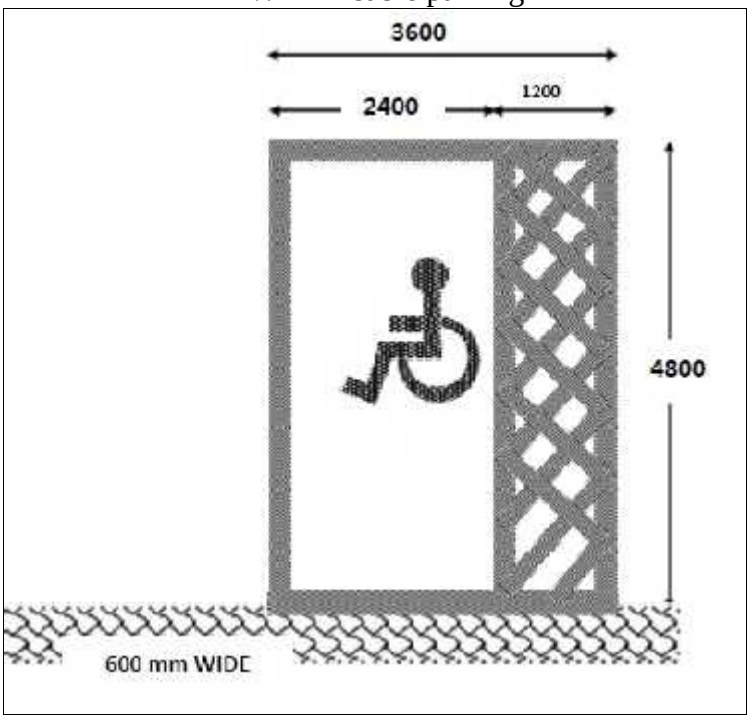
iii. Parking at the end of road



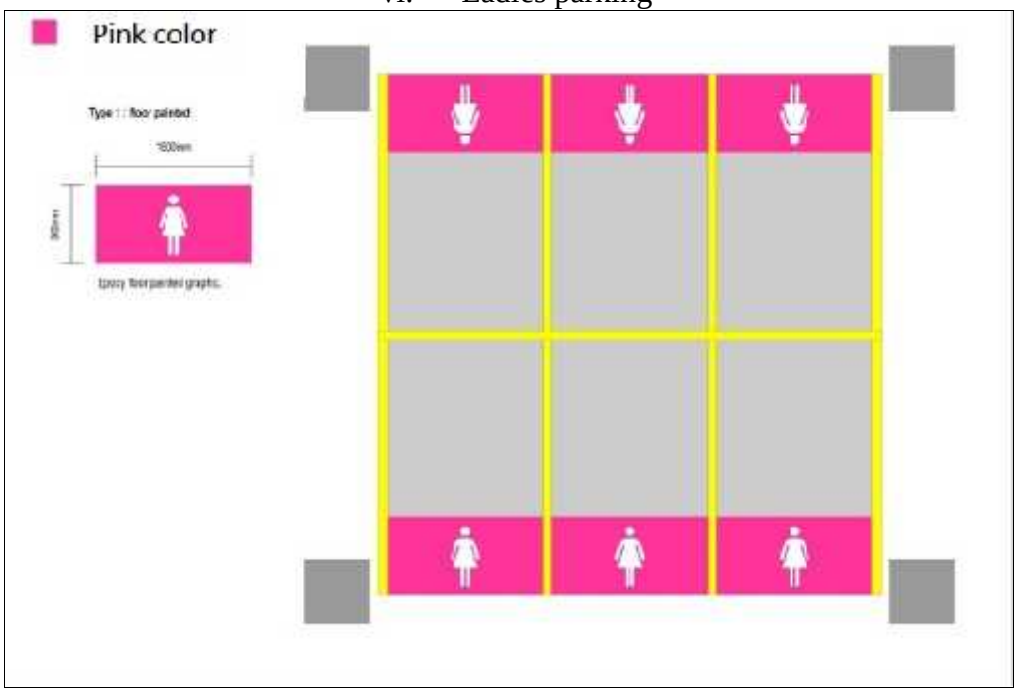
iv. Parking lot with adjacent obstruction



v. Disable parking



vi. Ladies parking



Comparisons of Parking Standards in Oversea

This part of the study will explain on the general view of the standards applied in well-developed places such Singapore. As for Singapore, they have limited lands therefore, they need to set a good standard, requirement for their parking provision in order to meet their demand parking.

- Parking standard in Singapore

Singapore is a country that has a very good parking space policies and standards especially in terms of determining the number of parking lots in their transportation system. The responsible party that involves in managing and determining the number of parking lots is Land Transportation Authority (LTA). A parking standard have been provided by the government through LTA which is called Parking Places (Provision of Parking Places and Parking Spaces Rules). Through this method, all kind of land use have been provided with standards to the respect of number of parking lots except for education location, culture institution, religious and related.

As for Singapore, the minimum measurement for their parking stall is the same as Wilayah Persekutuan Kuala Lumpur's requirement on parking in terms of width and length but not for the measurement for stall length for parallel parking which Singapore has shorter length for parallel parking.

Stall width	: 2.4m
Stall length	: 4.8m
Stall length for parallel parking	: 5.4m

The regular requirements for Singapore's parking standard are taken from Code of Practice on Vehicle Parking Provision in Development Proposals 2011 edition. The document stated that, if there is an obstacle or wall which adjacent to a stall and located within the middle 2.8m of the parking length, then the parking stall needs to be widened. If the wall is only on one side, the minimum of parking width shall be at least 2.7m but if the wall is on both side of the parking stall, the stall's width need to be at least 3.m. Any big element more than 0.175m such columns, walls or ducts create an obstacle.

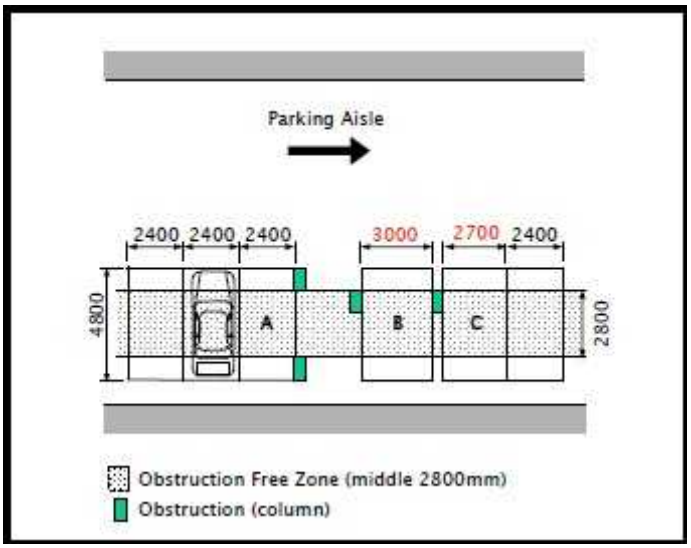


Figure: Parking Stalls with adjacent obstructions
Stall A : Without any obstacle within Obstruction Free Zone
Stall B : With obstacle on both sides
Stall C : With obstacle on one side

As for parallel parking which cars cannot park by reversing or where they are obstacle at its end, the minimum length need to be at least 7.2m

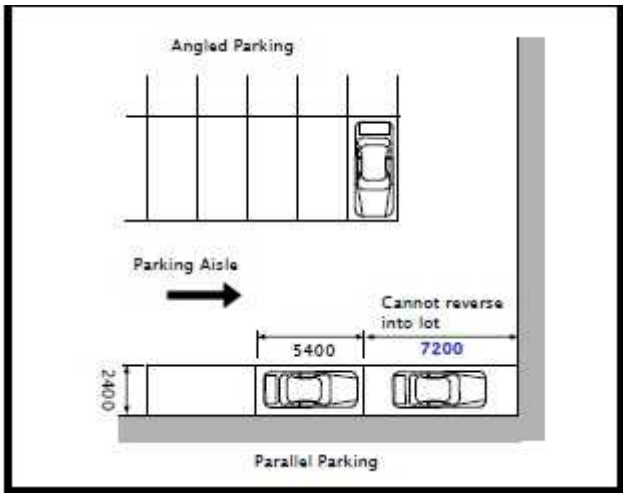


Figure: parking lot that cannot park by reversing

Follows are the minimum width of parking aisle for Singapore users:

Parking Angle	1-way Traffic Flow		2-way Traffic Flow
	Bays on 1 side	Bays on 2 sides	Bays on 1 or 2 sides
Parallel	3600mm	3600mm	6000mm
30°	3600mm	4200mm	6300mm
45°	4200mm	4800mm	6300mm
60°	4800mm	4800mm	6600mm
90°	6000mm	6000mm	6600mm

Code Practice for Vehicle Parking Provision in Development suggested that the need for parking provider to provide separate path for pedestrian to avoid problem such risk and relative speed and conflict among different users. It also said that clear sight distance such clear sight distance triangle or convex mirrors are the example of safety measures that need to place at sharp building edges and blind spot areas. For end lot parking stall should be at least 3.0m or it should be avoided as possible because it will cause difficulty for drivers. It also recommended that 0.3m gaps vertically and horizontally for perpendicular parking. Parking stall also need to be clearly demarcated within the parking space as a guideline for drivers. Proper signs, road markings should be provided such directional sign, colored or paving stones and no entry sign for the smooth traffic purpose.

Customer Requirements

CUSTOMER REQUIREMENT (INDEPENDENT VARIABLE)	AUTHOR	METHOD
AVAILABILITY	⁾ Christina C. Mendat and Michael **S.** Wogalter ⁾ Felix Caicedo ⁾ Caicedo, Blazquez, & Miranda	QUALITY FUNCTION DEPLOYMENT
LAYOUT AND DESIGN	⁾ Christina C. Mendat and Michael **S.** Wogalter ⁾ Abdul Azim Bin Abdul Malek	DESIGN IMPROVEMENT
SAFETY	⁾ Christina C. Mendat and Michael **S.** Wogalter ⁾ Chen	OPTIMUM STALL ANGLE
ACCESS POINT	⁾ Christina C. Mendat and Michael **S.** Wogalter ⁾ Phoo Ken Seng	EXPAND AREA

Table 2.0 Summary of literature review

Availability

According Mendat & Wogalter (2003), availability is one of the important customer requirement that needed to be concern such as provide enough parking lot to vehicle's user at any time. This author further explain that different places would needed to provide enough parking lot according the crowded level. Crowded places would always hard to find parking spaces. Therefore, the no of parking lot would needed to be sufficient in order to avoid congestion happen or negative issues. Besides, availability of parking lot can be knowledge by implemented parking facilities (Caicedo, 2009). Availability can be mean as reservation which mean that vehicle's user always want to have a reservation of parking lot before they arrive to the parking places (Caicedo, Blazquez, & Miranda, 2012). As a conclusion the availability of parking lot is one of the customer's requirement.

Layout and Design

A good design or layout of parking is able to fully utilize the space to provide an efficiently parking lots to users. As mention by Malek (2012), a bad layout or design of parking lot could lead to inadequate space to provide the maximum parking lot to vehicle's user. Besides congestion problem would exist if this incidents happen. Good design of parking lot is able to provide a clear information of parking lot to vehicle's user such as the availability of parking lot (Mendat & Wogalter, 2003). Moreover, satisfaction of user can be influence by the design of parking layout (Stubbs, 2002). A good design able to lead user to find parking lot easily and make it simple and convenient.

Safety

Generally the car which had parked in the parking lot can be rate as safe. But if the car will stay overnight at parking lot if would need to be considering based on the facilities that they

have. Normally in-door area parking lot will patrol by security guard to guarantee the safe (Chen, Hu, & Chang, 2011). Based on Mendat & Wogalter (2003) safety also one of the customer requirement that needed in parking lot. Theft of personal property and personal safety was occupy 16% and 29% respectively. Those issue always happen on the car that needed to stay overnight or parking during the night.

Access Point

Access point in parking lot can be mean as the entrance and exits from parking lot to street. According Mendat & Wogalter (2003), to exiting from the parking lot to street or vice versa can generate problem such as congestion, accident and more. Therefore access point also one of the requirement needed in parking system. Moreover, the author further said that too much handicap parking would cause accessibility problem too. As you can see, handicap parking is needed but not too many. But government doesn't provide any handicap parking for vehicle's users this could lead to a lot of inconvenience. Furthermore, pedestrian access is needed too. Pedestrian access is a path way for vehicle's user use to come out from parking to town or can be used by pedestrian to cross over there. Therefore an appropriate path needed to be build (P.Seng, 2011).

Conceptual Framework

Based on the literature review, a research model following figure 2.0 is developed in order to investigate the association between customer requirement and parking standard. PSRC will be the independent variables and PSTE will be the dependent variable.

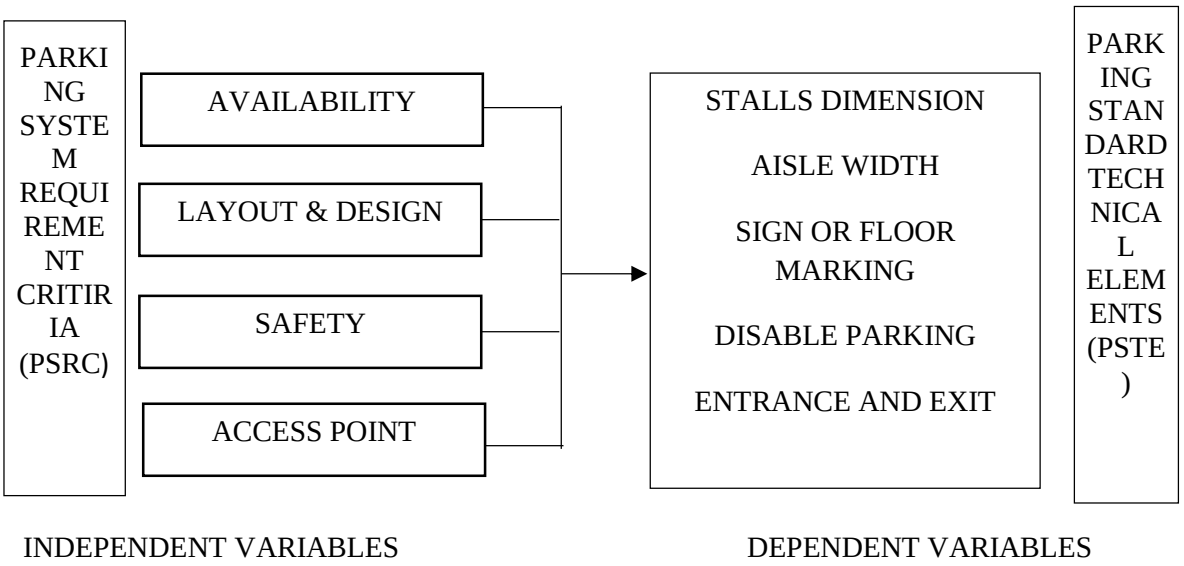


Figure 2.0 Conceptual Framework

Conclusion

This study provide proposed solutions to resolve on- campus parking. Vehicle stacking is a mechanical parking solution implemented to enables multiple vehicles parked in the footprint of a single vehicle. This solution considered as a potential method for increasing on-campus parking spaces and this type of technology is merely appropriate for use in parking decks. The parking structures could be designed to accommodate vehicle stackers, still technology required well trained operators to make it suit for valet parking.

Acknowledgements

I would like to thank the chief editor and anonymous reviewers for the helpful comments towards the fruition of this article.

References

Aliran, S., & Dalaman, T. (2014). Guidelines Internal Traffic Circulation, *1982*(Akta 267), 1–13.

Almeslati, A. I., Rahmat, R. A. O. K., Jaafar, O., & Abu Hamoud, M. A. (2011). The rise of the private car usage in Kajang, Malaysia: role of parking policy on reducing car usage. *Journal of Applied Sciences Research*, *7*, 1263–1268.

Barter, P. a. (2010). *Parking Policy in Asian Cities*. *SSRN Electronic Journal*.

Caicedo, F. (2009). The use of space availability information in “PARC” systems to reduce search times in parking facilities. *Transportation Research Part C: Emerging Technologies*, *17*(1), 56–68.

Caicedo, F., Blazquez, C., & Miranda, P. (2012). Prediction of parking space availability in real time. *Expert Systems with Applications*, *39*(8), 7281–7290.

Chen, M., Hu, C., & Chang, T. (2011). The research on optimal parking space choice model in parking lots. *ICCRD2011 - 2011 3rd International Conference on Computer Research and Development*, *2*, 93–97.

Lta. (2011). Code of Practice Vehicle Parking Provision in Development Proposals.

Malek, A. A. B. A. (2012). A Study of Parking Problems in Muar Town Case Study : Street on Muar Town (Jalan Salleh). *Uitm*, (September 2011), 24.

Mendat, C. C., & Wogalter, M. S. (2003). Perceptions of Parking Facilities: Factors to Consider in Design and Maintenance. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *47*(6), 918–921.

Mohd Noor Awang. (2003). Kereta Mengikut Jenis Guna Tanah Bandar-Bandar di Malaysia.

P.Seng. (2011). Parking effic. *Parking Efficient Parade Ump, Perpustakaan*, (May).

Stubbs, M. (2002). Car Parking and Residential Development: Sustainability, Design and Planning Policy, and Public Perceptions of Parking Provision. *Round Table, The*, *7*(2), 213–237.