PARKING GENERATION MODELLING OF GOVERNMENT HOSPITALS IN PENINSULAR MALAYSIA

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Parking has long been an issue in government hospital, especially the one which are located within urban environment. Scarcity of parking caused traffic issue, while over-providing would cost unnecessary expenditure on the infrastructures. There are few parking guidelines available, but none of these been established based on empirical data from actual site investigation. This study analyse the actual parking demand and develop a parking demand model for government hospitals in Malaysia. Quantitative study approach was carried out for the data collection via primary data survey at six (6) state hospitals from June 2016 to March 2017. Effective boundary for hospital compound were established and divided into zones which further assigned to the enumerators. Subsequently, Automated Traffic Counter (ATC) were installed for a week at each hospital to ascertain peak day which the parking survey shall be carried out. Then, license plate matching survey method was further carried out throughout a 12 hours period, from 7.00 a.m. to 7.00 p.m. where highest parking activity was anticipated. Parking information, including daily parking volume, hourly parking demand, average parking duration, parking turnover and parking index were captured from the survey and presented via descriptive statistical analysis. On the other hand, the independent variables for the modelling such as number of beds, professional staff, support staff, gross floor area, daily outpatient, and occupied bed were retrieved from Clinical Research Centre (CRC) or administration office from each hospital. Next, four type of predictive models based on regression modelling by utilising linear-, square-, inverse-, and natural logarithmic˘ based variable structures were developed which summed up to 60 different models been analysed. These models were evaluated based on the overall model F˘ test; coefficient of determination (R2); mean square error (MSE); root mean square error (RMSE) and mean absolute error (MAE). Inverse 6 from inverse based model has the lowest MSE, RMSE and MAE as well as the highest R2 among all models which represented by number of beds, number of total staff and number of daily outpatients as the root predictors. These three measurements are non˘ confidential data which obtainable from the hospitals and does not include sensitive information. Model validation was conducted by comparing the estimates of parking demand by the developed model with the estimates by other available guidelines as well as the actual parking demand. The developed model was proved to yield the least error, proving that it could better mimic the demand of parking spaces at hospitals in Malaysia. This model could benefit relevant stakeholder in establishment of parking facilities, especially town planner in way to instigate sustainable development approach.

ABSTRAK

Parkir telah lama menjadi isu di hospital kerajaan, terutamanya bagi yang terletak di kawasan bandar. Kekurangan parkir menyebabkan masalah trafik, manakala penyediaan yang berlebihan akan membebankan kos pembangunan infrastruktur. Terdapat beberapa garis panduan parkir sedia ada, namun tidak ada yang dibangunkan berdasarkan data empirikal dari penyiasatan tapak sebenar. Kajian ini menganalisis permintaan parkir sebenar dan membangunkan model permintaan parkir untuk hospital-hospital kerajaan di Malaysia. Pendekatan kajian kuantitatif dijalankan untuk pengumpulan data melalui cerapan data primer di enam (6) buah hospital negeri bermula Jun 2016 sehingga Mac 2017. Sempadan yang efektif di perkarangan hospital telah ditetapkan dan dibahagikan kepada zon-zon untuk ditugaskan kepada kumpulan penyelidik. Selanjutnya, Pembilang Lalu Lintas Automatik (PLLA) telah dipasang selama seminggu di setiap hospital untuk memastikan hari puncak di mana kajian parkir akan dijalankan. Kemudian, kaedah tinjauan pengecaman nombor pendaftaran kereta telah dijalankan sepanjang tempoh 12 jam, dari 7.00 pagi hingga 7.00 petang di mana aktiviti parkir tertinggi dijangkakan. Maklumat parkir, termasuk jumlah parkir harian, permintaan parkir setiap jam, purata tempoh parkir, pusingan balik parkir dan indeks parkir telah diperolehi daripada kajian tersebut dan dibentangkan melalui analisis statistik deskriptif. Selain daripada itu, pemboleh ubah bebas bagi permodelan, seperti bilangan katil, kakitangan profesional, kakitangan sokongan, luas lantai kasar, pesakit luar harian, dan bilangan katil dihuni telah diperoleh daripada Pusat Penyelidikan Klinikal (PPK) atau pejabat pentadbiran di setiap hospital. Seterusnya, empat jenis model ramalan berdasarkan pemodelan regresi dengan menggunakan struktur pembolehubah berasaskan „linear", „square", „reverse- „, dan „natural logarithmic" telah dibangunkan dengan jumlah sehingga 60 model berbeza yang telah dianalisis. Model-model ini dinilai berdasarkan model keseluruhan ujian-F; pekali penentuan (R2); ralat min kuasa dua (RMKD); ralat min punca kuasa dua (RMPKD) dan min ralat mutlak (MRM). Inverse 6 dari model berasaskan „inverse" mempunyai RMKD, RMPKD dan MRM terendah di samping mempunyai nilai R2 tertinggi di antara semua model, yang mana diwakili oleh bilangan katil, bilangan staf keseluruhan dan jumlah pesakit luar harian digunakan sebagai peramal punca. Ketiga-tiga pengukuran ini adalah bukan data sulit, dan dapat diperolehi dari hospital-hospital dan tidak termasuk dalam maklumat sensitif. Pengesahan model telah dijalankan dengan membandingkan anggaran permintaan parkir oleh model yang dibangunkan dengan anggaran garis panduan lain serta permintaan parkir yang sebenar. Model yang dibangunkan telah terbukti menghasilkan jurang kesilapan yang paling kecil, membuktikan bahawa model yang dibangunkan dapat mewakili permintaan parkir di hospitalˇ hospital di Malaysia. Model ini dapat memberi manfaat kepada pihak-pihak berkaitan yang relevan dalam pembangunan infrastruktur parkir, terutamanya perancang bandar bagi memupuk pendekatan pembangunan yang lestari.

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LIST OF ABBREVIATIONS

3D	–	Three-dimensional
ALOS	–	Average Length of Stay
APTA	–	American Physical Therapy Association
ATC	–	Automated Traffic Counter
BOR	–	Bed Occupancy Rate
CO_2	–	Carbon dioxide
CRC	–	Clinical Research Center
EEV	–	Energy Efficient Vehicle
EPU	–	Economic Planning Unit
GA	–	Genetic Algorithm
GDP	–	Gross Domestic Product
GFA	–	Gross Floor Area
HRPB	–	Hospital Raja Permaisuri Bainun
ICU	–	Intensive Care Unit
ITE	–	Institute of Transportation Engineers
JPBD	–	Jabatan Perancang Bandar dan Desa
JPJ	–	Jabatan Pengangkutan Jalan
KKM	–	Kementerian Kesihatan Malaysia
MAE	–	Mean Absolute Error
MLP	–	Multi-layered perception Neural Network
MLR	–	Multiple Linear Regression
MOH	–	Ministry of Health
MSE	–	Mean Square Error
MTE	–	Metrocount Traffic Executive Software
NAP	–	National Automotive Policy
NICU	–	Neonatal Intensive Care Unit
RMSE	–	Root Mean Square Error
RSU	–	Road Side Unit

SLR	–	Simple Linear Regression
SOV	–	Single Occupancy Vehicle
SPAD	–	Suruhanjaya Pengangkutan Awam dan Darat
Sq.ft	–	Square Feet
SUMP	–	Seattle Urban Mobility Plan
TDM	–	Transport Demand Management
TOD	–	Total Patient Days
TOI	–	Turn Over Interval
TSF	–	Thousand Square Foot
UAE	–	United Arab Emirates
US	–	United States of America
VIF	–	Variation Inflation Factor
VIP	–	Very Important Person

LIST OF SYMBOLS

R^2	-	Coefficient of Determination
Z	-	Z-score
df	-	Degree of freedom
Sig.	-	Significance probability
B	-	Regression coefficient
t	-	t-statistics
X1	-	Number of beds
X2	-	Number of professional staff
X3	-	Number of support staff
X4	-	Gross floor area
X5	-	Daily outpatients
X6	-	Number of Occupied Beds

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Availability of adequate parking spaces is a key to smooth traffic movement and operation of an area. Adequate parking spaces increase public safety since it potentially reduces illegal parking. Moreover, parking facilities is also an important element for the success of businesses. An adequate parking facility attracts more traffic and therefore increases business transactions in the area. However, parking facilities are also costly and space intensive. The question of what will be the optimum number of parking requirement has always been a topic of discussion among transport engineers and planners to minimize development costs and to provide sufficient parking spaces to the users.

In the United States, parking generation is determined by referring to the Parking Generation Report, 4th Edition by the Institute of Transportation Engineers (ITE). It provides statistical data on average, ranges and quality values that can help analyst to determine the general nature of parking demand for a given land use. There are 106 types of land use prescribed in the report. These land use types are divided into nine (9) categories such as Port and Terminal, Industrial, Residential, Lodging, Recreational, Institutional, Medical, Office, Retail and Services.

In Malaysia, parking requirements for any development are based on the guidelines provided by the Malaysian Town Planning Department (JPBD, 2011), which are based on six (6) different types of land use namely Residential, Commercial, Industrial, Recreational, Institutional and Disabled people. The independent variables are units of development, employees and gross floor area. A specific rate was applied on each type of land use which was categorized by the size

of population (more or less than 1 million) and the type of development (commercial or institutional area). The provision for visitors and motorcycle parking are also considered by the guidelines. These criteria had not been revised since the year 2000, a period of twenty years. Other parking guide referrable in Malaysian context are Garis Panduan Dan Peraturan Bagi Perancangan Bangunan Oleh Jawatankuasa Kecil Piawaian Dan Kos Bagi JPPN by Economic Planning Unit (EPU), and Ministry of Health very own parking norm by the internal Engineering Service Division.

There are 139 government hospitals enlisted in the Ministry of Health Website. These hospitals are situated in urban and sub-urban area. These hospitals are subdivided into two categories namely (i) specialist hospitals and institutions and (ii) non-specialist hospitals and district hospitals. The specialist hospitals provide minimum 15 resident specialist/sub-specialist while non-specialist only provide 5 minimum support services. There is a total of 40,158 patient beds in all of these hospitals. Specialist hospitals appear to have the greatest number of patient beds as compared to other hospitals with 27,756 patient beds. All of the specialist hospitals are located in urban area where serious traffic congestion issue exist related to insufficient number of available parking spaces, an issue that has been frequently highlighted. For instance, an article from online news portal Perak Today (2012) highlighted the worsening parking issue at Hospital Raja Perempuan Bainun (HRPB) Ipoh, which agreed and receive conforming responses from the fellow netizens. This trend of issues arises in nearly all major hospitals throughout Malaysia.

This issue of parking space scarcity should be dealt with appropriately because the consequences could threaten the security and smooth flow of medication process as well as those driving around the facilities. Learning about the needs of parking spaces and the future demand could assist the authorities to plan well ahead in resource allocation. A predictive model to estimate the parking needs at each hospital is crucial since it could guide the authorities to plan and develop ample parking spaces at optimum level. Globally, many researchers attempted to construct parking demand models based on different approaches including quantitative methods. These quantitative methods are based on statistical or non-statistical

concepts and they have their own advantages and disadvantages. In the end, what matters most is the accuracy of parking demand prediction.

1.2 Problem Statement

Parking spaces are vital especially in the areas related to some critical facilities such as hospitals. Critical facilities like hospitals tend to receive many visitors with desperate and extra needs. They are most probably having severe health problems and they require comfortable parking spaces to allow them to get appropriate in time medications. Having to search and park for illegal parking spaces which are normally far from the facilities could lead to the uneasiness of the visitors, especially the patients. This also could lead to unwanted events such as accidents, especially when visitors park in the shared facilities like roadsides. The cost of death would be increased and the tendency to disrupt the anticipated smooth flow of medical treatments could increase.

The parking issues is as highlighted in the background of study, where currently in Malaysian hospitals, no published study was done to evaluate the existing parking demand as well as performance of the existing parking norms and guidelines. It is of the utmost importance to understand the needs of parking spaces at each hospital. Without learning about the current parking demand at each hospital, it is possible to acquire incorrect picture of the overall parking needs. The process of studying the hospitals is also crucial to discover relevant and significant trends which could explain the variance in demand between all the sites. Henceforth, this research is in view to fill the gap of no statistical data or any numerical information regarding parking deficiency at hospitals.

While learning about the current parking demand is important, predicting the future trends of parking demand is equally important. In the current scenario, parking space estimations are conducted based on application of rates. By estimating and modelling the needs of future parking, resources could be better planned to overcome the scarcity in parking spaces as well as avoid unnecessary cost for unnecessary

parking spaces. Failing to correctly estimate the parking demand would also lead to late construction of parking spaces, hence, the same issue of scarce parking spaces could remain. Moreover, developing parking spaces based on the current needs could incur frequent ongoing costs as the developers would need to revise the demand periodically. Learning from the historical data of parking demand could yield an estimate of the future demand and this could be executed through some mathematical or statistical modelling.

A parking demand model based on quantitative methodologies could yield various levels of accuracy. The model that is totally based on the historical quantitative data depends largely on the accuracy of the data and the formulation of the model itself. While there are many available guidelines that are based on various foundations, it is best to compare the performance of the model with the available guidelines as an alternative to validate the model. This is to ensure that the model is relevant to the context of the geographically dependent parking demand. Without validating the model, the reliability of the model is highly dubious. Thus, validation through comparisons of the performance of the model with other parking generation guidelines is essential.

1.3 Aim and Objectives

The aim of the study is to investigate and formulate a mathematical model on parking generation for government hospitals in Malaysia. To achieve the aim of the study, some objectives were outlined as follows:

(a) To determine parking demand on public hospitals in urban area.
(b) To develop the best parking generation model for the selected land use type.
(c) To validate the goodness of the parking generation model by comparing its estimates with the available parking generation guidelines as well as the actual parking demand.

1.4 Scope of the study

The study involves states hospitals in Peninsular Malaysia which are believed to encounter the scarcity of legal parking spaces. In Ministry of Health, the medical facilities can be categorized to Specialist Hospitals and Institutions, Non-specialist hospitals, Special Medical Institution, Institution and College. In term of hierarchy, State Hospitals is the most visited of all facilities, provisioning up to 45 resident specialties and sub-specialties. It also makes up about 25% percent of total beds to accommodate in-patient. Detailed study was carried out on six hospitals, namely Hospital Sultanah Bahiyah, Hospital Tengku Ampuan Afzan, Hospital Tuanku Jaafar, Hospital Melaka, Hospital Raja Perempuan Zainab II and Hospital Tuanku Fauziah. These Specialist Hospitals were chosen due to their fit conditions to conduct the study, as they are located in urban area and make up the greatest number of patient beds comparable to other type of hospitals. The hospitals also have no potential data abnormality due to construction or major renovation. These conditions were believed to make a good representation of findings of the overall data population in terms of statistics. The study also does not cover the behavioural aspects of parking, focussing on the study objectives which to obtain the actual parking demand information at hospitals.

Apart from that, the data collected are only data from June 2016 to March 2017. It is believed that the parking demand model could be representative of other years because the data were collected in the best way possible to ensure the representation of data. Data collected were all quantitative in nature; parking demand, number of beds, number of staff, gross floor area, number of daily outpatients, and number of occupied beds, which can be further deliberated using both descriptive and inferential statistics.

In addition, this study employs some variable structure-based regression models due to the ease of interpretation of findings especially on the relationships and effects of the parking demand factors. The variable structures used are linear, squaring, inversion and natural logarithm-based, which the main variable structures in regression modelling.

1.5 Significance of the study

This study is expected to contribute to the body of knowledge in parking generation research. With the main contribution of mathematical modelling perspective, this study could act as a guide for other researchers to further contribute to the research area by utilising more mathematical models which are vital to predict future trends. This study could also catalyse more rigorous research works on parking generation, especially in Malaysia.

Moreover, this study is crucial for practitioners, especially the policy makers, to estimate the future demand of parking at hospitals and consequently prepare the necessary plans to ensure that parking space scarcity problem could be alleviated at present and avoided in the future. Since this model is generalisable to other hospitals, it is worth applying the model in predicting the actual parking demand at the remaining hospitals.

1.6 Structure of Thesis

This thesis is organised in five chapters which describe different aspects of the study. Chapter 1 presents the background of the study, the statement of problems, the aim and objectives of the study, the scope of the study, and the significance of the study. As the first chapter, Chapter 1 presents the general ideas of the whole thesis. Chapter 2 reviews all related works which are crucial to lay down the foundational concepts and some important studies which are believed to be useful as references of this thesis. This chapter outlines the concept of public and private transportation, its policies, parking policies, some related parking studies, and the government hospitals in Malaysia.

Chapter 3 describes the methodology of the study. The entire procedure, which includes the study site, the equipment used, data collection as well as data analysis steps, are explained in detail. The chapter plays an important role to validate the findings of the study which are then presented in the next chapter, Chapter 4. Chapter 4 displays and provides a thorough discussion of the findings systematically. The chapter primarily presents the findings on the preliminary study conducted, some individual subsequent studies executed, summary on the parking studies conducted, the development of parking demand model and its validation.

The final chapter, Chapter 5, is the chapter that summarises the whole thesis. With the main content consisting of the conclusion of the study, the contributions of the study, some limitations encountered as well as some recommendations for future works, this chapter reflects the overall significance of the study.

REFERENCES

Al-Masaeid, H., Al-Omari, B., Al-Harahsheh, A., (1999). Vehicle parking demand for different land uses in Jordan. ITE J. 69 (5), 79–84

Aderamo, A. J., & Salau, K. A. (2013). Parking patterns and problems in developing countries: A case from Ilorin, Nigeria. *African Journal of Engineering Research*, *1*(2), 40–48.

Ajeng, C., & Gim, T. (2018). Analyzing on-Street Parking Duration and Demand in a Metropolitan City of a Developing Country: A Case Study of Yogyakarta City, Indonesia. *Sustainability*, *10*, 591. https://doi.org/10.3390/su10030591

Al-Sahili, K., Eisheh, S. A., & Kobari, F. (2018). Estimation of new development trip impacts through trip generation rates for major land uses in Palestine. *Jordan Journal of Civil Engineering*, *12*(4), 669–682.

Askin, R. G. (1982). Multicollinearity in regression: Review and examples. *Journal of Forecasting*, *1*(3), 281–292. https://doi.org/10.1002/for.3980010307

American Public Transportation Association (2007). *Public Transportation: Benefits for the 21st Century*.

Badland, H. M., Garrett, N., & Schofield, G. M. (2010). How does car parking availability and public transport accessibility influence work-related travel behaviors? *Sustainability*, *2*(2), 576–590. https://doi.org/10.3390/su2020576

Bai, H., Liu, X., & Zhao, Y. (2011) Parking demand forecasting model based on principal component analysis and BP neural network. *11th International Conference of Chinese Transportation Professionals, Nanjing*. p. 2011

Barter, P. A. (2010) Parking Policy in Asian Cities. Lee Kuan Yew School of Public Policy Research Paper No. LKYSPP: 10-15 . Available at SSRN:https://ssrn.com/abstract=1780012

Barter, P. A. (2011). Parking Requirements in Some Major Asian Cities. Transportation Research Record, 2245(1), 79–86. https://doi.org/10.3141/2245-10

Borhan, M. N., Nazrul, A., & Ibrahim, H. (2019). *Why Public Bus is a Less Attractive Mode of.Transport : A Case Study of.*

Borhan, M. N., Syamsunur, D., Akhir, N.M., Yazid, M. R.M., Ismail, A., & Rahmat,

R. A. (2014). Predicting the use of public transportation: A case study from Putrajaya, malaysia. *Scientific World Journal*, *2014*. https://doi.org/10.1155/2014/784145

Breithaupt, M. (2011). *Sustainable Transport in Developing Cities - Examples of Success*.

Erin, M., & Sue, M. (1991). Statistical Models to Predict Commercial- and Parking-Space Occupancy. *Journal of Urban Planning and Development*, *117*(4), 129–139. https://doi.org/10.1061/(ASCE)0733-9488(1991)117:4(129)

Gakenheimer, R., & Zegras, C. (2004). Drivers of travel demand in cities of the developing world. In Mobility 2030: Meeting the Challenges to Sustainability (pp. 155-170).

George, D., & Mallery, M. (2010). *SPSS for Windows Step by Steps: A Simple Guide and Reference* (10a Ed.). Boston: Pearson.

Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: a guide for non-statisticians. International journal of endocrinology and metabolism, 10(2), 486–489. https://doi.org/10.5812/ijem.3505

Ghuzlan, K., Al-Omari, B., & Khasawneh, M. (2016). Parking Demand for Residential Apartment Buildings in Jordan. *Institute of Transportation Engineers*, *86*, 32–36.

Han, B., Xiao-xue, L., Yang-dong, Z., & Chun-hua, S. (2011). Parking Demand Forecasting Model Based on Principal Component Analysis and BP Neural Network. *ICCTP 2011*, 372–379. https://doi.org/doi:10.1061/41186(421)38

Hills, L., & Coomer-Smit, B. (1997). *Parking Demand Associated with Integrated Healthcare Services*. Retrieved from https://www.transportationgroup.nz/papers/2001/O1_Hills.pdf

Hilvert, O., Toledo, T., & Bekhor, S. (2012). Framework and Model for Parking Decisions. *Transportation Research Record: Journal of the Transportation Research Board*, *2319*, 30–38. https://doi.org/10.3141/2319-04

Hook, W. (1994). Role Of Nonmotorized Transportation And Public Transport In Japan's Economic Success. *Transportation Research Record 1441*. National Academy Press.

Ibeas, Á., Cordera, R., dell'Olio, L., & Moura, J. L. (2011). Modelling demand in restricted parking zones. *Transportation Research Part A: Policy and Practice*, *45*(6), 485–498.

https://doi.org/https://doi.org/10.1016/j.tra.2011.03.004

Institute of Transportation Engineers (ITE). (2010a). Manual of Transportation Engineering Studies, 2nd Edition. Washington DC, USA.

Institute of Transportation Engineers (ITE). (2010b). *Parking Generation, 4th Edition.* Washington DC, USA.

Institute of Transportation Engineers (ITE). (2019). *Parking Generation, 5th Edition.* Washington DC, USA.

Jabatan Perancang Bandar dan Desa, Semenanjung Malaysia. (2011). *Garis Panduan Tempat Letak Kereta, May 2011*. Malaysia.

Jingbo, Y., Tiexin, C., & Miaomiao, T. (2009). *Demand Forecasting of Parking Lot Based on Discrete Choice Model in Planned Special Events*. https://doi.org/10.1109/ICMSS.2009.5304335

Kamba, A. N., Rahmat, R. A. O. K., & Ismail, A. (2007). Why Do People Use Their Cars: A Case Study In Malaysia. *Journal of Social Sciences*, *3*(3), 117–122. https://doi.org/10.3844/jssp.2007.117.122

Kelly, A., & Pekol, A. (2013). *Transit Proximity and Car Parking Demand at Medium / High Density Residential Developments*. In Australasian Transport Research Forum, ATRF 2013-Proceedings (pp. 1-18).

Laffel, N. (2006). *Promoting Public Transportation for Sustainable Development.* The Woodrow Wilson School of Public and International Affairs Princeton University Task Force on Energy for Sustainable Development Spring, 124-149.

Lau, W., Poon, P., Tong, C., & Wong, S. (2005). The Hong Kong second parking demand study. *Proceedings of The Institution of Civil Engineers-Transport - Proc Inst Civil Eng-Transport*, *158*, 53–59. https://doi.org/10.1680/tran.2005.158.1.53

Lee, Y.W. (2015). Study on the Variables for On-street Parking Demand Estimation through Parking Survey. *Advanced Science and Technology Letters*, 100, 43-46. https://doi.org/10.14257/astl.2015.100.10

Lim, H., Williams, G. T., Abdelqader, D., Amagliani, J., Ling, Z., Priester, D. W., & Cherry, C. R. (2017). Alternative Approach for Forecasting Parking Volumes. *Transportation Research Procedia*, *25*, 4171–4184. https://doi.org/https://doi.org/10.1016/j.trpro.2017.05.360

Mytelka, L. K., & Boyle, G. (Eds.). (2008). Making choices about hydrogen:

transport issues for developing countries. IDRC.

Mathew, T.V. (2009). Lecture notes in Transportation Systems Engineering. Retrieved from https://www.civil.iitb.ac.in/~vmtom/1100_LnTse/535_lnTse/plain/

McGuiness, E., McNeil, S. (1991) Statistical models to predict commercial- and parking-space occupancy. Journal of Urban Planning and Development, 117 (4), pp. 129-139

McKnight, P.E., & Najab, J. (2010). Mann-Whitney U Test. The Corsini encyclopedia of psychology, 1-1.

Mela, C. F., & Kopalle, P. K. (2002). The impact of collinearity on regression analysis: The asymmetric effect of negative and positive correlations. *Applied Economics*, *34*(6), 667–677. https://doi.org/10.1080/00036840110058482

Millard-Ball, A. (2002). Putting on their parking caps. Planning, 68(4), 16-21. Miller, P., Barros, A. G. De, Kattan, L., & Wirasinghe, S. C. (2016). *Public Transportation and Sustainability : A Review*. *20*, 1076–1077. https://doi.org/10.1007/s12205-016-0705-0

Ministry of Health Malaysia (2013). Annual Report 2012. Malaysia .

Ministry of International Trade and Industry (2014). Press Statement National Automative Policy (NAP) 2014. https://www.miti.gov.my/miti/resources/fileupload/Press%20Statement%20NAP%202014.pdf

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. Ann Card Anaesth 2019;22:67-72

Naser, M., Qdais, S. A., & Faris, H. (2015). Developing trip generation rates for hospitals in Amman. *Jordan Journal of Civil Engineering*, *9*(1), 8–19.

Rosni, N.N.M., Jobli, A.F. & Neging, M. (2019). Driver Parking Behaviour: An Observational and Experimental Intervention Study. *IOP Conf Ser.: Mater. Sci. Eng.* **601** 012002

Okail, O., Mohamady, A., & El-Gamal, E. (2019). Parking Demand Rates for Some Selected Land Uses in Egyptian Cities. *International Journal of Engineering and Advanced Technology*, *8*(4), 259–262.

O'brien, R. M. (2007). A Caution Regarding Rules of Thumb for Variance Inflation Factors. *Quality & Quantity*, 41(5), 673–690. https://doi.org/10.1007/s11135-006-9018-6

Osborne, J., & Waters, E. (2002). Four Assumptions of Multiple Regression That Researchers Should Always Test. *Practical Assessment, Research & Evaluation*, *8*.

Perak Today. Masalah Parkir HRPB Semakin Meruncing (2012) Retrieved 2 August 2012 from http://peraktoday.com.my/2012/08/masalah-parkir-hrpb-semakin-meruncing/

Pojani, D., & Stead, D. (2015). Sustainable urban transport in the developing world: Beyond megacities. *Sustainability (Switzerland)*, *7*(6), 7784–7805. https://doi.org/10.3390/su7067784

Rahman, A., Ashikin, N., & Ayu, A. Y. (2016). *Theorizing the Concept of Urban Public Transportation Institutional Framework in Malaysia*. In *MATEC Web of Conferences (Vol. 66, p. 00043). EDP Sciences.*

Road Traffic Department Malaysia (2016). Total Motor Vehicles by Type and State, Malaysia, 2015. https://www.data.gov.my/data/ms_MY/dataset/jumlah-terkumpul-kenderaan-bermotor-mengikut-jenis-dan-negeri-total-motor-vehicles-by-type-and-state

Seattle Department of Transportation. (2008) Best Practices Transportation Demand Management (TDM) https://www.ctc-n.org/files/resources/07_seattle_best_practices_in_transportation_demand_management.pdf

Shen, T., Hua, K. & Liu, J. (2019) "Optimized Public Parking Location Modelling for Green Intelligent Transportation System Using Genetic Algorithms," in IEEE Access, vol. 7, pp. 176870-176883, 2019, doi: 10.1109/ACCESS.2019.2957803.

Shoup, D.C., 1999. The Trouble With Minimum Parking Requirements. Transportation Research Part A Vol. 33 (1999), pp. 549-574

Schuster, T., & Volz, R. (2019). *Predicting Parking Demand with Open Data BT - Digital Transformation for a Sustainable Society in the 21st Century* (I. O. Pappas, P. Mikalef, Y. K. Dwivedi, L. Jaccheri, J. Krogstie, & M. Mäntymäki, Eds.). Cham: Springer International Publishing.

Sen, S., Ahmed, M., & Das, D. (2016). A Case Study on On-Street Parking Demand

Estimation for 4-Wheelers in Urban CBD. *Journal of Basic and Applied Engineering Research*, *3*, 254–258.

Shapiro, S., & Wilk, M. (1965). An Analysis of Variance Test for Normality (Complete Samples). Biometrika, 52(3/4), 591-611. doi:10.2307/2333709

Suruhanjaya Pengangkutan Awam Darat (2012). *National land Public Transport Masterplan.* Malaysia.

Suthanaya, P. A. (2017). Development of Parking Demand Model for Private Hospital in Developing Country (Case Study of Denpasar City, Indonesia). *Journal of Sustainable Development*, 10(5), 52-60.

van Exel, N.J.A., de Graaf, G. & Rietveld, P. "I can do perfectly well without a car!" An exploration of stated preferences for middle-distance travel. Transportation 38, 383–407 (2011). https://doi.org/10.1007/s11116-010-9315-8

Wilcoxon, F. (1949). Some Rapid Approximate Statistical Procedures. American Cyanamid Co.. Stamford Research Laboratories.

Wong, S. C., Tong, C. O., Lam, W. C. H., & Fung, R. Y. C. (2000). Development of Parking Demand Models in Hong Kong. *Journal of Urban Planning and Development*, *126*(2), 55–74. https://doi.org/10.1061/(ASCE)0733-9488(2000)126:2(55)

Wu, Z., & Fan, Y. (2011). Model of the parking demand prediction for urban complex. In ICCTP 2011: Towards Sustainable Transportation Systems (pp. 519-526).

Yap, B. W., & Sim, C. H. (2011). Comparisons of various types of normality tests. *Journal of Statistical Computation and Simulation*, *81*(12), 2141–2155. https://doi.org/10.1080/00949655.2010.520163

Yue, J., Cheng, T., & Tai, M. (2009) Demand Forecasting of Parking Lot Based on Discrete Choice Model in Planned Special Events, *2009 International Conference on Management and Service Science, Beijing, China.*, pp. 1-4, doi: 10.1109/ICMSS.2009.5304335.

Zakaria, S. & Sufian, Z. (2009). Public Works Department Malaysia (Ensuring Road Quality In Malaysia).

Zegras, P. C., & Gakenheimer, R. (2006). Driving forces in developing cities' transportation systems: Insights from selected cases. Massachusetts Institute of Technology: Cambridge, 46.

Zhizhou, W., & Yujie, F. (2011). Model of the Parking Demand Prediction for Urban Complex. *ICCTP 2011*, 519–526. https://doi.org/doi:10.1061/41186(421)51

LIST OF PUBLICATIONS

Indexed Journal

1. **Ali, Abdul** & Hassan, Sitti. (2019). *Review of Malaysian current practice in supply/demand of parking in the hospital.* IOP Conference Series: Materials Science and Engineering. 512. 012057. 10.1088/1757-899X/512/1/012057.

Conference Proceedings

1. **Ali, Abdul** & Hassan, Sitti. (2019, December). *Parking Characteristics in Malaysia Public Hospitals.* Paper presented at the Sustainable & Integrated Engineering International Conference (SIE) 2019. The Everly Hotel, Putrajaya, Malaysia.