NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696 Website: ijiert.org
VOLUME 7, ISSUE 8, Aug.-2020

ON-STREET PARKING IN INNER KATHMANDU: DETERMINING ON-STREET PARKING LOAD AND PARKING EFFICIENCY OF MOTORCYCLES IN THE STREETS OF NEW ROAD IN KATHMANDU METROPOLITAN CITY

SAKAR PAHARI,

SHAILENDRA KHANAL,

UTTAM KHANAL

Department of Civil Engineering, Kathmandu Engineering College,
Tribhuvan University, Kathmandu, Nepal
E-mail: sakarpahari.sp@gmail.com, sknepal2014@gmail.com, uttamkhanal.uk@gmail.com

ABSTRACT
As the demand of parking spaces has been increasing within the ever growing Kathmandu city, New Road, located at the central part of Kathmandu city, relies upon both the on-street and off-street parking system. This study is carried out to provide the basic on-street parking information and analysis on New Road, the busiest high-street of Nepal. In the present work, accumulation survey in peak hours was carried out to collect data for every day of a week. Parameters such as street length, width of the parking space, number of vehicles and parking accumulation for six street segments surrounding the New Road were collected manually since Nepal is not equipped with parking data and the use of GIS software are rarely used. Using the data obtained from the field, accumulation curve for each street segment during weekdays and weekends are made separately. Parking load during weekdays is found to be very high which has resulted in near-full to beyond-full land use of on-street parking. Longer term alternatives like multistorey parking lots are required rather than allocating parking area on the already narrow streets of New Road.

KEYWORDS: on-street parking, parking load, parking efficiency, parking accumulation curve, New Road.

INTRODUCTION AND MOTIVATION
Kathmandu, the capital city of Nepal is also the highest and most densely populated city in Nepal [1]. Rapid urbanization has transformed Kathmandu valley, Nepal, into one of the fastest-growing metropolitan regions in South Asia [2]. As of mid-March 2019, more than 3.5 million vehicles are registered in Nepal [3]. In 2014, 444,759 vehicles were registered in Kathmandu valley and this number has been increasing each year [4]. As a result, demand of parking spaces has also been increasing within the city.

New road, one of the busiest high streets of Nepal is situated east of Kathmandu Durbar Square. Located at the central part of Kathmandu City, New Road is one of the most active market places where different markets of items; from clothing, jewelry to the electronics can be found. It is the most densely populated area of Nepal where lifestyle of people of Kathmandu can be known. It was formally called Juddha Sadak (Juddha Street) as it was built by then Prime Minister Juddha Shamsher after the 1934 earthquake and was later named Naya Sadak (New Road) after the fall of Rana Regime. New Road is located to the west of Tudikhel, to the east of Basantapur, south of Pyukha and to the north of Pako, Khichhapokhari. Acting both as an urban core and a Central Business District (CBD), the proximity with New Road is of high land value and attracts the business sectors [5].

Traffic counts are the most basic of traffic studies and are the primary measure of demand: virtually all aspects of traffic engineering require volume as an input, including highway planning and design, decisions on traffic control and operations, detailed signaled timing and others [6]. All the data are collected manually because Nepal, like other underdeveloped countries, is not equipped with parking data and the use of GIS software are still hard to get access into and are rarely used.

Figure 1: The Six Street Segments Used To Collect Data To Analyze On-Street Motorcycle Parking In New Road, A. Pako Sadak, B. Khechapukhu Sadak Ii, C. Kheckapukhu Sadak I, D. Sundhara Marg, E. Pyukha Marg, F. Naya Sadak

LITERATURE REVIEW:

Very few researches have been carried out regarding the parking situations in Kathmandu. In order to examine the parking problem of the freight truck which is becoming one of the transport issues in the Kathmandu valley, Japan International Cooperation Agency (JICA) [7] carried out the parking survey for vehicle parking in the Ring Road. The survey method was to count the number of all types of vehicles parked on both sides within the Right Of Way (ROW) of the Ring Road after 11 PM. The result would be utilized for the establishment of measure to control parking of vehicles, especially freight trucks, on the Ring Road.

The effect of parking space usage on road performance on Gajah Mada St., Rambipuji, Jember, Indonesia was done by Sonya Sulistyono et al (2018) [8] along 100 m at the highest point of parking activity and traffic. The purpose of the research was to know the characteristics of parking on the road body that occurred, the comparison of road performance with and without the parking on the road body, and the influence of road parking on the road performance. The use of parking spaces on the performance of roads in condition when there was on-street parking using correlation analysis was carried out to determine the relationship between two variables and their strength.

Y. Cao et al (2017) [9] studied the effects of curb parking on road capacity and traffic safety (motor vehicle, non-motor vehicle as well as pedestrian crossing) to show that the lane effective width of road segment with curb parking significantly influences the road capacity and impacts the traffic flow volumes of the parking lane and its adjacent lane by constructing two effect models describing curb parking and road capacity based on two theories of Gap acceptance and Reduction of lane effective width. The research discussed the calculation method of capacity in road segments with curb parking according to an actual traffic investigation.

Saad Yousif and Purnawan (1999) [10] carried out research based on data collected within the Greater Manchester Area showing that on-street angle parking had more potential to create congestion than that of parallel parking. They examined three types of on-street parking which were parallel (legal), parallel (illegal) and angle parking (legal). Many factors including the types of parking, directions of travel, presence of parked vehicles, driver maneuver preferences and traffic conditions influenced different parking maneuver patterns.

The analysis of on-street parking duration and demand in Yogyakarta Metropolitan City, Indonesia was carried out by Carolina Ajeng and Tae-Hyoung Tommy Gim (2018) [11] through field survey supplemented by remote sensing and GIS. They analyzed how the parking duration and demand are differentiated by street and land use characteristics which were evaluated through a field survey, supplemented by remote sensing and GIS. They used empirical regression models to find that the parking duration was differentiated by the parking volume, street length, and existence of commercial type of land use while the parking demand was affected only by the street length.

T. Subramani (2012) [12] carried out analysis of parking study on main corridors of major Urban Centre in Salem Tamil Nadu, India to study existing parking conditions, carry out parking studies and to formulate strategies for better management for parking. The study took different data regarding availability of parking space, extent of its usage and parking surveys, and analyzed to access the parking needs.

On-street parking demand estimation for 4-wheelers in urban CBD in Kolkata, India was carried out by Saptarshi Sen et al. (2016) [13] in order to generate the parking demand model (generated by the use of SPSS) and to compute the parking demand and compare it with the present supply. The study analyzed that the controlling factors for parking demand are needed to be found out in order to control the demand.

Wesley E. Marshall et al. (2008) [14] carried out research on reassessing on-street parking in England. They did two separate studies, in the first study they developed case study for six major commercial activity centers in small New England cities and towns and in the second they investigated vehicle speeds and safety reports from more than 250 Connecticut roads and showed that on-street parking offered pedestrians a safer and more comfortable environment.

Martijn Kobus et al (2012) [15] carried out research on the on-street parking premium and car drivers' choice between street and garage parking. They introduced a methodology to estimate the effect of parking prices on car drivers' choice between street and garage parking and also assumed that the marginal benefit of parking duration does not depend on this choice.

ABOUT THE CASE STUDY

Kathmandu is the capital and largest metropolitan city of Nepal. As of 2011 census of Nepal, Kathmandu Metropolitan City has a population of 975,453 [1]. New Road, the case study, was selected mostly because of the availability of almost all types of markets in all forms. The Pako Sadak is most well-known for the markets of smartphones and personal computers and their accessories. Khechapukhu Sadak is accompanied by People's Plaza and Pashupati Plaza on its curb and its on-street parking are mostly utilized by the visitors of those plazas. Due to the ongoing reconstruction of Dharahara Tower, the individuals working on that project mostly park on-street in Sundhara Marg. Pyukha Marg is used mostly by the visitors of Mahaboudha: the market hub of wholesale garments, electronic appliances and imported goods. Bishalbazar is the first shopping mall of Nepal and the block mainly comprises of jewelry markets, thus Naya Sadak on-street parking is essential for people visiting that place.

METHODOLOGY

Accumulation survey in peak hour was done to collect data. This survey, which provides information regarding the total parking accumulation within the survey area at any given time, can be obtained by making a tour around the area and noting the number of vehicles parked in each part of the area by drawing a cordon around the area and counting the number of vehicles entering or leaving the cordon [16]. The peak hour volume is simply the highest hourly volume on the roadway for a given day. It is used because this volume places the highest demand on the roadway [17].

Figure 2: Area of Study (Source: Latitude.to)

To evaluate on-street parking index, this research collected the data manually on the following parking characteristics: street length, width of the parking space, number of vehicles and parking accumulation. Interviews were taken with the parking cashiers, who also manage the paid on-street parking, regarding the peak hour of vehicular circulation. During that time interval, number of vehicles was counted every twenty minutes for the time of two hours. Since the motorcycle parking at a certain angle is not mandatory and no separate bay for an individual motorcycle was indicated, the total available parking lots could not be counted. However the number of total available parking lots was replaced by the maximum reading at a certain parking lot throughout the one-week survey period in order to determine the closest calculation of parking efficiency/index.

The street length is defined as the distance between two marked points in a street. Parking accumulation is defined as the number of vehicles parked at a given instant of time. The accumulation of motorcycles on the street between two marked points at an instant was then divided by the area of survey and accumulation per 1000 square feet was obtained. Accumulation curve is the graph obtained by plotting the number of bays

occupied with respect to time. The area under that accumulation curve gives the parking load, which is expressed in terms of vehicle hours per 1000 square feet. Thus,

Parking load (L) = area under the accumulation curve

In this study, parking efficiency is defined as the ratio of parking load to the maximum accumulation in an hour per 1000 square feet during the study period. It gives an aggregate measure of how effectively the parking space is utilized. Thus, the parking efficiency is calculated as,

$$\eta = \frac{L}{V_{max}} \times 100\%,$$

Where, η = parking efficiency; and

V_{max} = maximum number of vehicles parked per 1000 square feet area at the parking lot during the study.

If η > 100% then the parking requirement exceeds the existing capacity and parking spaces are scarce. Conversely, if η <100% then the parking needs are still under existing capacity or there is no problem to find parking space for the time being.

ANALYSIS

Since a vast discrepancy of parking accumulation was observed during the weekend (Saturday) and the weekdays (Sunday to Friday), the graph consists of separate accumulation curves per 1000 square feet for weekend and weekdays. Street segments "Khechapukhu Sadak I" and "Khechapukhu Sadak II" represent the street segment in front of People's Plaza and Pashupati Plaza respectively.

Pako Sadak

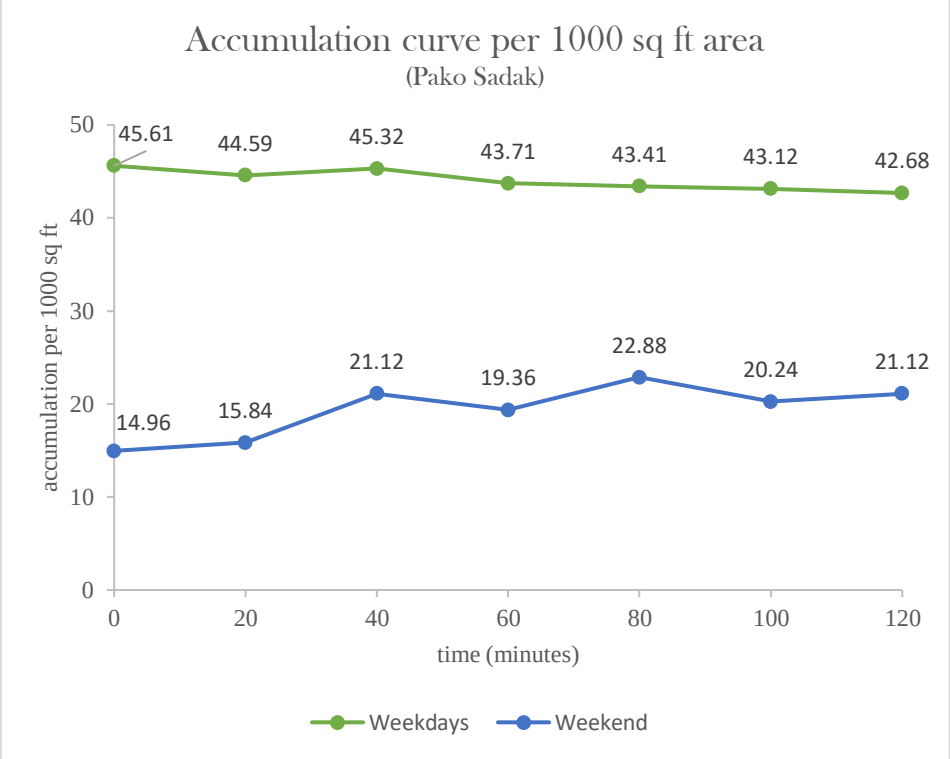

Figure 3: Parking Accumulation Graph

The parking load, obtained by calculating area under the weekdays curve was found to be 102.815 vehicle hours per 1000 square feet. Similarly the area under the weekend curve was found to be 45.17 vehicle hours per 1000 square feet.

The parking efficiency was then obtained to be 104.32% in weekdays which indicates that parking spaces are already scarce and new spaces are needed immediately. 45.83% parking efficiency during the weekend clearly shows no alarming need for new parking area in the near future for weekend parking.

Khechapukhu Sadak I

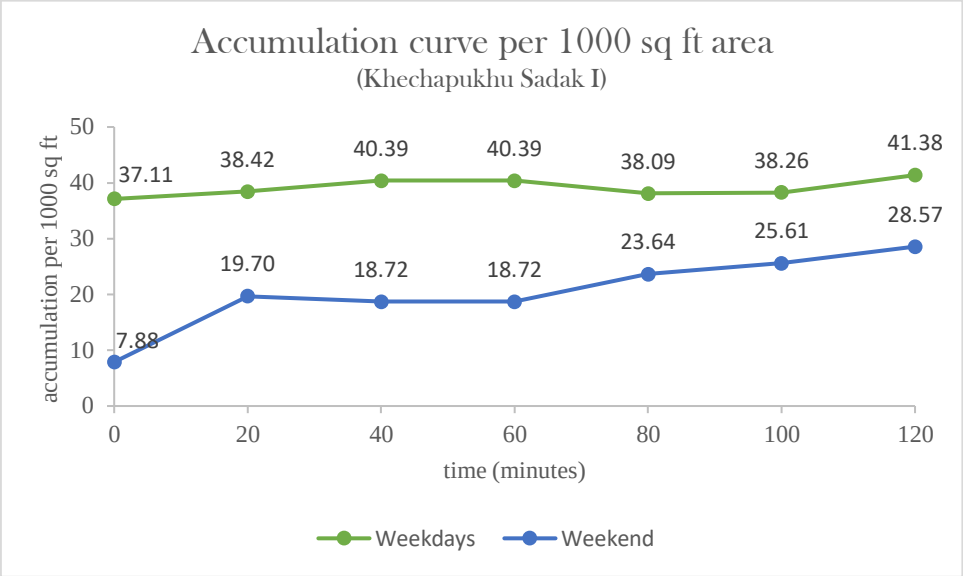

Figure 4: Parking Accumulation Graph

The parking load during weekdays was found to be 91.35 vehicle hours per 1000 square feet. Similarly the parking load during weekend was found to be 47.62 vehicle hours per 1000 square feet.
The parking efficiency was then obtained to be 90.90% in weekdays which indicates that parking congestion may arise in the near future. 47.39% parking efficiency during the weekend clearly shows no alarming need for new parking area in the near future.

Khechapukhu Sadak II

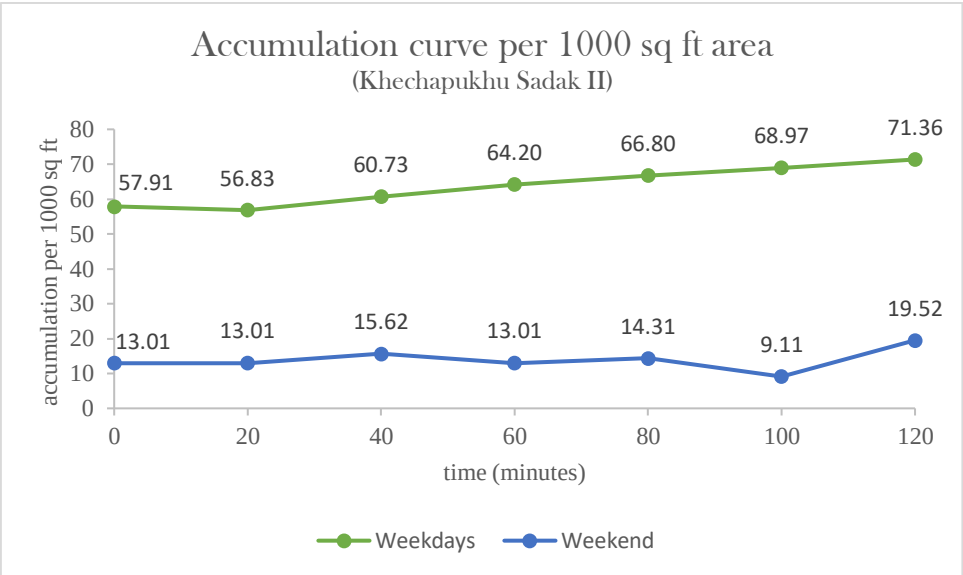

Figure 5: Parking Accumulation Graph

The parking load during weekdays was found to be 148.93 vehicle hours per 1000 square feet. Similarly the parking load during weekend was found to be 32.53 vehicle hours per 1000 square feet.
The parking efficiency was then obtained to be 88.03% in weekdays which indicates that parking congestion may arise in the near future. 19.23% weekend parking efficiency shows very low amount of parking space utilized during the weekend.

Sundhara Marg

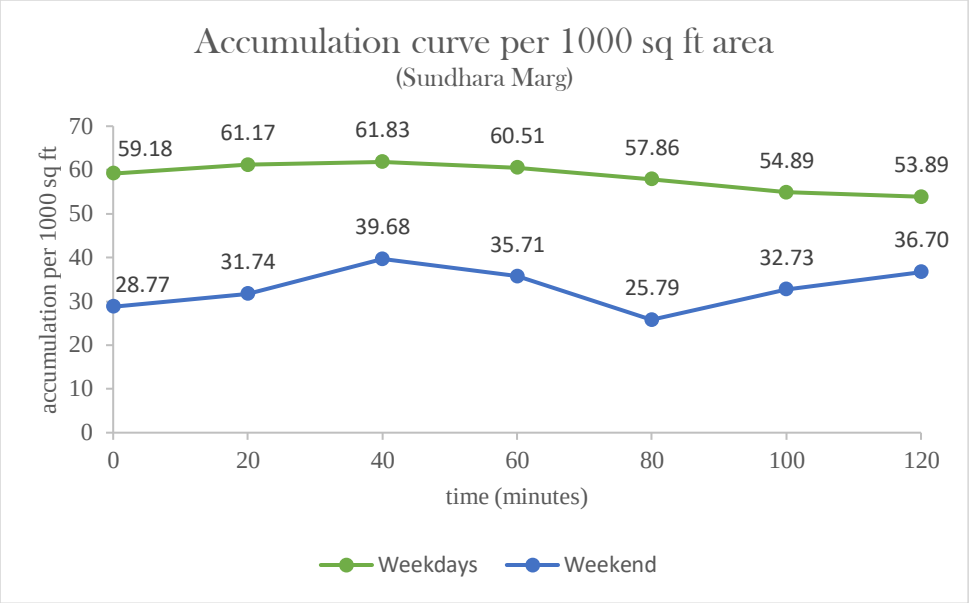

Figure 6: Parking Accumulation Graph

The parking load during the weekdays was found to be 136.444 vehicle hours per 1000 square feet. Similarly the parking load during the weekend was found to be 77.039 vehicle hours per 1000 square feet.
The parking efficiency was then obtained to be 104.21% in weekdays which indicates that parking spaces are already scarce and new spaces are needed immediately. 58.84% parking efficiency during the weekend clearly shows no alarming need for new parking area in the near future for weekend parking.

Pyukha Marg

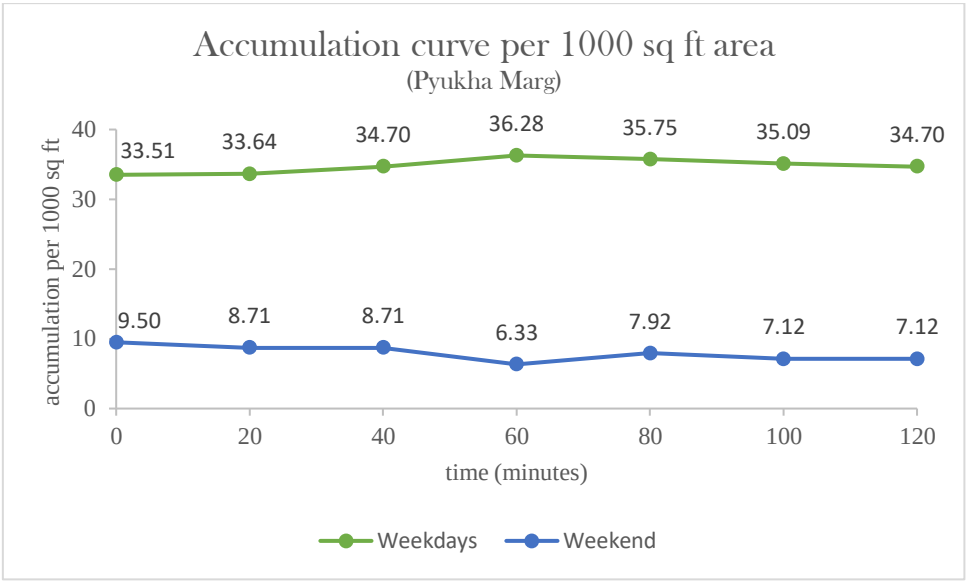

Figure 7: Parking Accumulation Graph

The parking load during weekdays was found to be 81.228 vehicle hours per 1000 square feet. Similarly the parking load during weekend was found to be 18.471 vehicle hours per 1000 square feet.
The parking efficiency was then obtained to be 91.62% in weekdays which indicates that parking congestion may arise in the near future. 20.83% weekend parking efficiency shows very low amount of parking space utilized during the weekend.

Naya Sadak

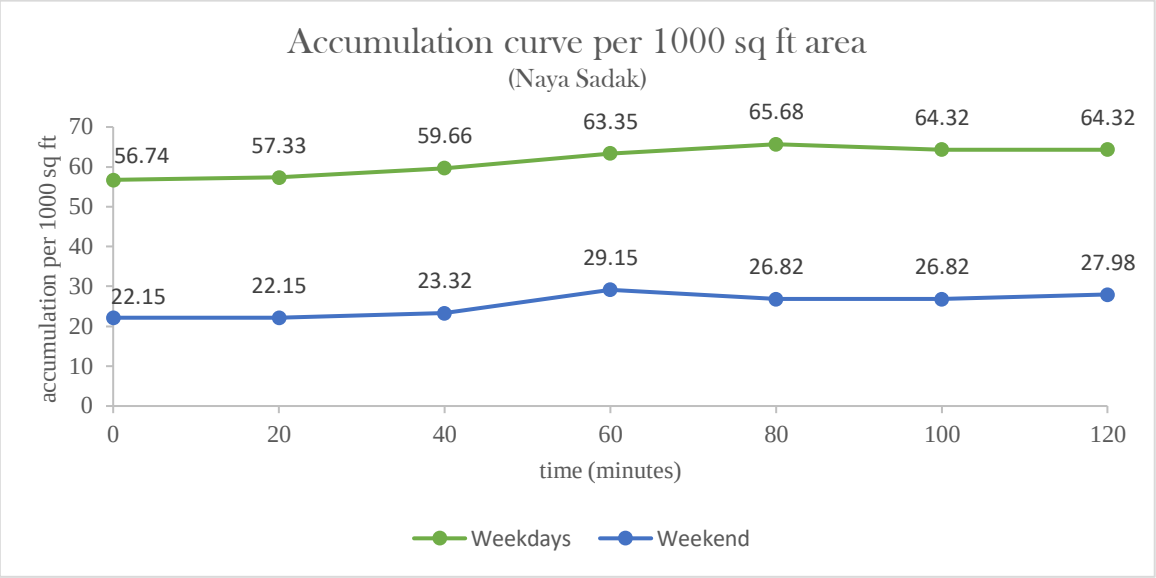

Figure 8: Parking Accumulation Graph

The parking load during the weekdays was found to be 143.801 vehicle hours per 1000 square feet. Similarly the parking load during the weekend was found to be 59.464 vehicle hours per 1000 square feet.
The parking efficiency was then obtained to be 96.35% in weekdays which indicates that parking spaces are already very hard to find. Process to increase parking spaces should be started very soon. 39.84% parking efficiency during the weekend clearly shows no alarming need for new parking area in the near future for weekend parking.

Table: Summary

Street segment	**Street Length** (feet)	**Area** (square feet)	**Maximum Reading**	**Minimum Reading**	**Parking Load** (vehicle hours per 1000 square feet)		**Parking Efficiency (η)**	
					Weekdays	**Weekend**	**Weekdays**	**Weekend**
Pako Sadak	150.6	1136.35	56	17	102.815	45.17	104.32%	45.83%
Khechapukhu Sadak I	142	1015.04	51	8	91.35	47.62	90.90%	47.39%
Khechapukhu Sadak II	93.8	768.44	65	7	148.93	32.53	88.03%	19.23%
Sundhara Marg	146.3	1008.15	66	26	136.444	77.039	104.21%	58.84%
Pyukha Marg	127.6	1263.25	56	8	81.228	18.471	91.62%	20.83%
Naya Sadak	109	857.67	64	19	143.801	59.464	96.35%	39.84%

DISCUSSION AND CONCLUSION

The busy streets of New Road combined with lack of proper off-street parking imply that New Road vastly relies in the on-street parking. However, the study shows that parking loads during weekdays are very high which has resulted in beyond-full land use on two street segments (Pako Sadak and Sundhara Marg) and near-full land use on the other street segments clearly calls for immediate need of newer on-street parking spaces. For a small area with very high vehicular density, management of parking in New Road seeks for longer term alternative like multistorey parking lots rather than allocating parking area on the already narrow streets. On-street parking in New Road has also increased the danger of accidents on the street as the streets are gradually narrowed by the parked vehicles taking up the street space during the weekdays.
This study is not free from limitations. The study didn't use modern research tools like the GIS software, remote sensor, etc. towards parking studies, which in turn may have yielded more accurate results. Moreover, the study has also taken available street segments based on the location of the marketplace of the

surrounding but not the other factors that may affect parking choices like the driver's health and attitude towards a parking spot [18], or economic reasons relating to parking prices [15]. Further research of vehicular parking with the help of questionnaire and advanced software is recommended for evaluation of on-street parking and its relationship with land use in New Road area of Kathmandu.

REFERENCES

1) Central Bureau of Statistics. National Population and Housing Census 2011 (Village Development Committee/Municipality): Kathmandu, Nepal, 2012.
2) Muzzini, Elisa and Gabriela, Aparicio. 2013. Urban Growth and Spatial Transition in Nepal: An Initial Assessment. Washington DC: World Bank Publications, 2013.
3) Department of Transport Management. Vehicle Data Registered Up to Fiscal Year 2075-76*: Nepal, 2020.
4) Adhikari, S. City Report (Draft) <Kathmandu Metropolitan City>: Kathmandu Metropolitan City, Kathmandu, Nepal, 2014.
5) KC, Shrestha, Dahal and Shrestha. Street Vendors in Kathmandu Durbar Square: Use and Management of space for Informal Activity: Urban Informal Sector, Final Seminar Presentation 2014, No. 2, 2014.
6) Roess, Elena and William. Traffic Engineering. Third ed. New Jersey: Pearson Education, 2004. Print.
7) Japan International Cooperation Agency. Data Collection Survey on Traffic Improvement in Kathmandu Valley Final Report: Department of Roads, Kathmandu, Nepal, 2012.
8) Sulitsyono, Sonya, et al. "On Street Parking and Its Impact on Road Performance." MATEC Web Conferences, 2018.
9) Cao, Y., et al. "The Effect of Curb Parking on Road Capacity and Traffic Safety." Eur. Transp. Res. Rev., 2017.
10) Yousif, Saad, and Purnawan. "A Study into On-Street Parking: Effects on Traffic Congestion." Traffic Engineering and Control, Jan, 1999.
11) Ajeng, Carolina, and Tae-Hyoung Tommy Gim. "Analyzing on-Street Parking Duration and Demand in a Metropolitan City of a Developing Country: A Case Study of Yogyakarta City, Indonesia." Sustainability, 26 Feb. 2018.
12) Subramani, T. "Parking Study on Main Corridors in Major Urban Centre." International Journal of Modern Engineering Research (IJMER), vol. 2, no. 3, 2012, pp. 742–748.
13) Sen, Saptarshi, et al. "A Case Study on On-Street Parking Demand Estimation for 4-Wheelers in Urban CBD." Journal of Basic and Applied Engineering Research, vol. 3, no. 3, 2016, pp. 254–258.
14) Marshall, Wesley E., et al. "Reassessing On-Street Parking." Transportation Research Record: Journal of the Transportation Research Board, vol. 2046, no. 1, 2008, pp. 45–52., doi:10.3141/2046-06.
15) Kobus, Martijn; Puigarnau, Eva Gutierrez; Rietveld, Piet; Ommeren, Jos Van (2012): The On-Street Parking Premium and Car Drivers' Choice between Street and Garage Parking, Tinbergen Institute Discussion Paper, No. 12-040/3, Tinbergen Institute, Amsterdam and Rotterdam, http://nbn-resolving.de/urn:NBN:nl:ui:31-1871/38488
16) Bell, M.G.H., et al. Transport Planning and Traffic Engineering. Elsevier, 1997.
17) Findley, Daniel J., et al. Highway Engineering. Elsevier, 2015.
18) Kim, Y. Impacts of the perception of physical environments and the actual physical environments on Self-rated health. Int. J. Urban Sci. 2016, 20, 73–87.