PAPER NAME

**Proceedings GEOMATE 2020 Melbourne-579-585 (361).pdf**

AUTHOR

**Aleksander Purba**

WORD COUNT

**3610 Words**

CHARACTER COUNT

**18362 Characters**

PAGE COUNT

**7 Pages**

FILE SIZE

**1.4MB**

SUBMISSION DATE

**Nov 25, 2022 11:59 AM GMT+7**

REPORT DATE

**Nov 25, 2022 11:59 AM GMT+7**

## 5% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 4% Internet database
- 3% Publications database
- Crossref database
- Crossref Posted Content database
- 2% Submitted Works database

## Excluded from Similarity Report

- Bibliographic material
- Cited material
- Manually excluded sources

*10th Int. Conf. on Geotechnique, Construction Materials and Environment, Melbourne, Australia, 11-13 November 2020, ISBN: 978-4-909106049 C3051*

# THE RELATIONSHIP BETWEEN LAND USE AND TRANSPORT PERFORMANCE: A CASE STUDY OF PADANG, INDONESIA

Aleksander Purba[1], Nikko Yulianda[2], Shahnaz Nabila Fuady[3]
[1]Faculty of Engineering, Lampung University, Indonesia; [2,3] Urban and Regional Planning Department, Insitut Teknologi Sumatera, Indonesia

**ABSTRACT**

Padang on the west coast of Indonesia is one of the oldest cities with a history of more than a century. As the west gate of Indonesia from the direction of the Indian ocean, its existence is known as a port city with the main function as warehousing and logistics center. After continuing to develop as a city of trade and services, Padang is now considered as one of the most congested cities in Indonesia. A series of secondary data has been collected including satellite imagery and both qualitative and quantitative methods were used simultaneously. The pattern of urban space has not changed significantly for decades, even though the number of trips has continued to increase. The population of close to 1 million and land use with more diverse functions results in the road network being overwhelmed to serve vehicle flow. Uncontrolled on-street parking contributes to reducing transport performance. Case study found the degree of saturation and wide road occupied for parking variables, and the speed and number of warehouse building variables are having strong correlation each other.

*Keywords: Land use, transport, relationship, Padang, Indonesia*

## INTRODUCTION

City paradigm in Indonesia according to Law No. 26/2007 governing Spatial Planning emphasizes that cities are areas with denser population concentrations compared to surrounding areas due to functional centralization related to the activities of the population for work, commerce, social, culture, recreation and education. It must be acknowledged that the model of city growth in developing countries is not by design as is common in developed countries, for example Eindhoven, the Netherland [1], and Wellington, New Zealand [2], but develops naturally, sporadically and spreads irregularly beyond administrative boundaries. Daily activities and residences are also further apart, because owning a house in the city center is not affordable for most city residents. Rapid city growth and high dependence of auto ultimately triggered new urban problems in the form of imbalance between land use from the demand side and the ability of the transportation system from the supply side to accommodate the movement of people and goods and services as experienced by Shanghai [3]. The situation in almost all cities in Indonesia is increasingly worrisome because the authority is still focused on approaching the supply side by building flyovers, underpasses, LRT and even the metro and is still very limited in steps related to reducing demand side. Lack of reference to best practices in the region as conducted by Denver in the USA [4], loose and out of date regulations and the absence of the role of civil society have triggered the city of more suffering, marked by, among others, the continuing depletion of green space. The same problem is also experienced by Lop Buri province, Thailand [5] and even Georgia (USA) due to the development of interstate highway [6], though 10% increase in a city's initial stock of highway causes about 1.5% increase in its employment over a 20-year period in the USA [7].

This paper evaluates the long experience of one of the oldest cities in Indonesia; Padang city based on the National Spatial Planning document is directed to become a National Activity Center and will be developed into the PALAPA (PAdang-Lubuk Alung-PAriaman) Metropolitan Core City. As the capital of west Sumatera province the largest city on the west coast of Sumatra is the west gate of Indonesia from Indian ocean. With a land area of almost 700 km$^2$ and a population of nearly 1 million, Padang, which was hit by a major tsunami disaster at the end of 2009, is now ranked fourth as the most congested city in Indonesia according to the INRIX 2017 Global Traffic Scorecard [8]. Integrated of land use and transport is still a big challenge in the operational agency settings and integrating it with transport systems [9], tension between bottom up and top down [10], [11], and the need to bridge the gap between the proliferation of activity-based travel demand and their integration with operational models in practice [12]; the challenges became more complex if the city sustainability issue is associated with energy scarcity and climate change [13]. The more advanced approaches using a relatively new database (LEHD) to explore land-use-transportation relationships conducted by Horner and Schleith [14], usage of

mobile phones to indicate the social function of land use in Singapore [15], and applying a spatial composite index to portray an overview of the sustainability performance [16].

## MATERIAL AND METHOD

### Study Area

Initially the city consisted of 3 districts with 15 villages. In its current development Padang covers 11 districts with elevations varying from 25 m to 1,853 m (Lubuk Kilangan) and coastal areas with elevations from 0 to 8 m (Padang Barat). Administratively, this city besides dealing directly with Indian ocean in the west is flanked by three regencies, each of Padang Pariaman in the north, Solok in the east and Pesisir Selatan in the south as shown in Fig. 1. Based on regulations, the city of Padang is classified as a large city with a population of 927,168 (2017); with an average growth of 1.53% annually the population is predicted to reach 1 million in 2022 and will position it as a metropolitan city.

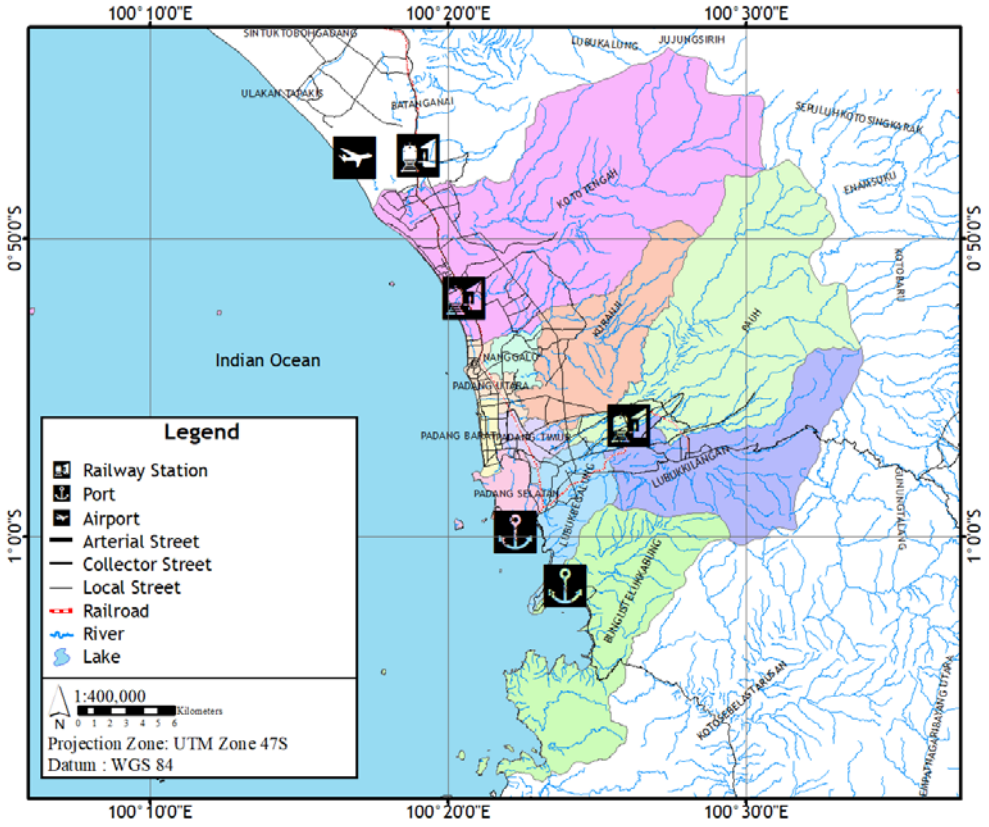


Fig. 1 Administrative map of Padang city

Interestingly, the population distribution is also diverse; Koto Tengah district has a density rate of 817 people/km$^2$ and Padang Timur is much denser at 9,751 people/km$^2$ with land use dominated by education center and middle class housing complex and closer to the central business district despite the area including in the tsunami alert zone. Based on population structure data, productive age with a range of 15-55 years dominates with a percentage of 62% indicating more than half of the population has the potential to travel and daily urban activities such as education, shopping, leisure, economic and financial activity, social, and culture. City economic structure is supported by wholesale and retail trade, car and motorcycle repair and transportation, and warehousing, respectively. While the number of registered vehicles tends to be constant and even decreases during the 2013-2017 period as shown in Fig. 2. As with other cities in Indonesia public transportation service is dominated by paratransit with capacity 12 people as many as 1.979 units covering 40 routes.

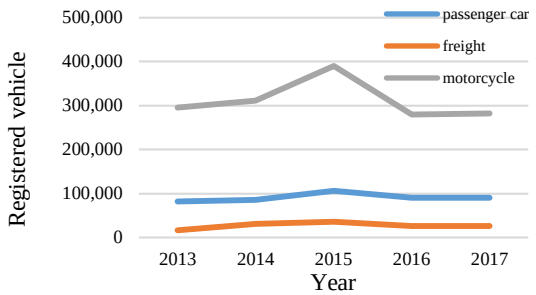


Fig. 2 Number of motorized vehicle 2013-2017

New bus service named Trans Padang with a capacity of 40 people serving two routes began to operate since the last two years. At almost the same time, downtown Padang is also connected by train to the Minangkabau international airport initiated by the central government. The first train departs from Padang station on 06:30 a.m. and the last one would depart on 06:00 p.m. with totally six trips daily and 45 minutes' travel time. Although the transport supply available varies, the facts in the field indicate the opposite condition. Based on the results of INRIX research, Padang ranks fourth as the most congested city in Indonesia as shown in Fig. 3 below. Based on Fig. 3 on average the city residents of Padang lost 45 hours annually due to congestion and delay.

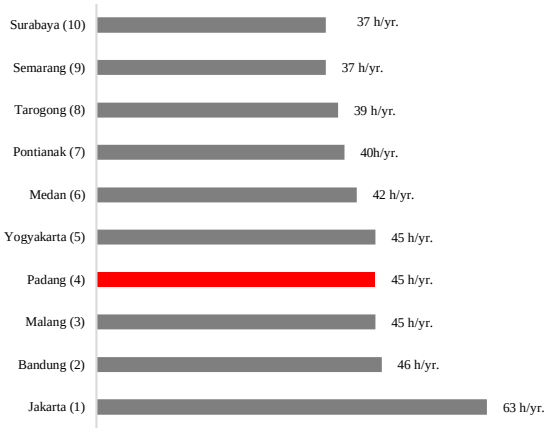


Fig. 3 Indonesia most congested cities (hours/year)

## Data Sources

Primary data related to land use was conducted by classified building function along the study corridor based on regulation (Regulation of the Minister of Agrarian Affairs and Spatial Planning / Head of National Land Agency No 16/2018 concerning Guidelines for Compiling Detailed Spatial Planning and Zoning Regulation of Regency/City). According to its regulation the building function to be classified is a building that has conformity with definition, purpose of determination and zone perform criterion of housing, trade and services, offices, industries, public service entities, tourism, and others.

In order to understand road performance, the whole information related to road section characteristics is needed. Road characteristic data was collected in a number of standard field form survey for urban road i.e. geometric form, traffic flow, and road side activity. Geometric itself covering road section type, lane number and lane width, section length, curb, shoulder, median, and pedestrian facility. Hence, the way the traffic controlled was conducted including parking management, split, and flow distribution. Moving car observer method has been used to count the traffic flow, velocity, and density for sixteen road section entire research area.

A series of secondary data has been collected including satellite imagery, population, registered vehicle, road class, and road information, spatial plans, transport master plan, and traffic and road transport master plan. Both qualitative and quantitative methods were used simultaneously in order to get convergent findings.

## RESULT AND FINDINGS

### Land use development

The area that focuses on this study is Kampung Pondok district; the historical development of this region began since 1915 and after more than a century the spatial patterns almost resemble actual current conditions. According to Topographiache Inrichting, Batavia map (1915) Kampung Pondok was clearly directed to support the commercial system of the city which at that time was functioning as a port. Its vital function was triggered by the growth of the city and was proven by permanent buildings that lined the estuary of the Batang Arau river as shown in Fig. 4.

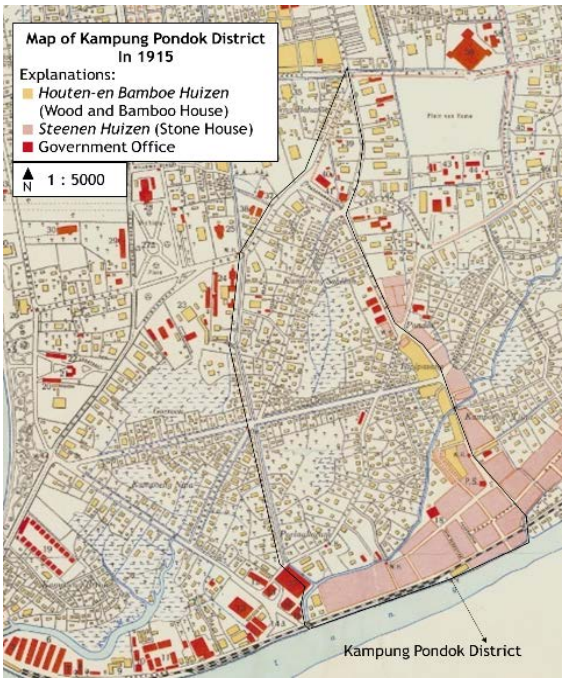


Fig. 4 Topographiache Inrichting Map (1915)

Refer to the map permanent buildings associated with function perform as government offices, rock houses and wood and bamboo houses. It is clearly seen in the map that railway line has been available direct to the port indicating an advance transport system.

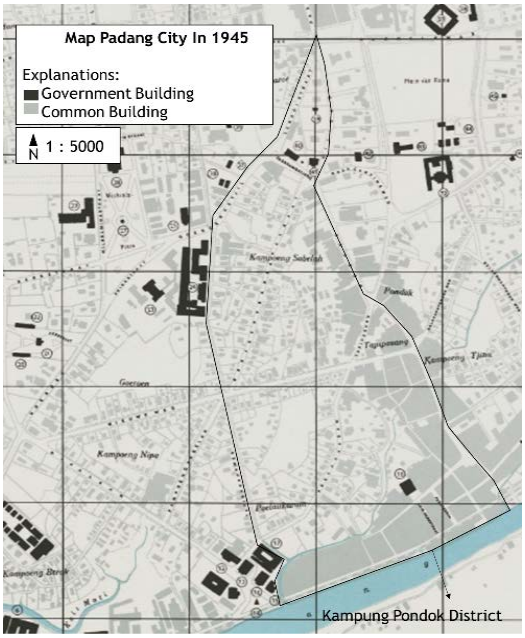


Fig. 5 Map of Kampung Pondok district (1945)

Rapid urban activity around river estuary and its surrounding coast encourage the growth of buildings supporting port activities such as warehousing and logistics centers. Hence, the existence of the port and its supporting facilities shows that the Kampung Pondok region performs a strategic function on the growth of urban areas at the time.

In 1945 the area was remapped to understand the development of urban land use after four centuries of interacting with various urban activities. As can be seen in Fig. 5 the built up area continues to grow along the river estuary and looks more concentrated in the southern part of the city. Non-government buildings are also seen beginning to fill the area that was previously green space, indicating the presence of the port has an important contribution in driving the development of land use towards the north of the city

But the delta along the Batang Arau river is still seen as a major trading area through its building function characteristics, especially warehousing, logistics centers, banks, and markets. Along with the echoes of Indonesia's independence, cities are developing more rapidly including Padang city. The city reform at that time was more focused on improving the road network to accommodate the development of land use and increasing population, which implies an increase in travel demand. Based on the comparison of maps in 1915 and 1945 with current conditions, it shows that the road sections in Kampung Pondok district have not changed significantly.

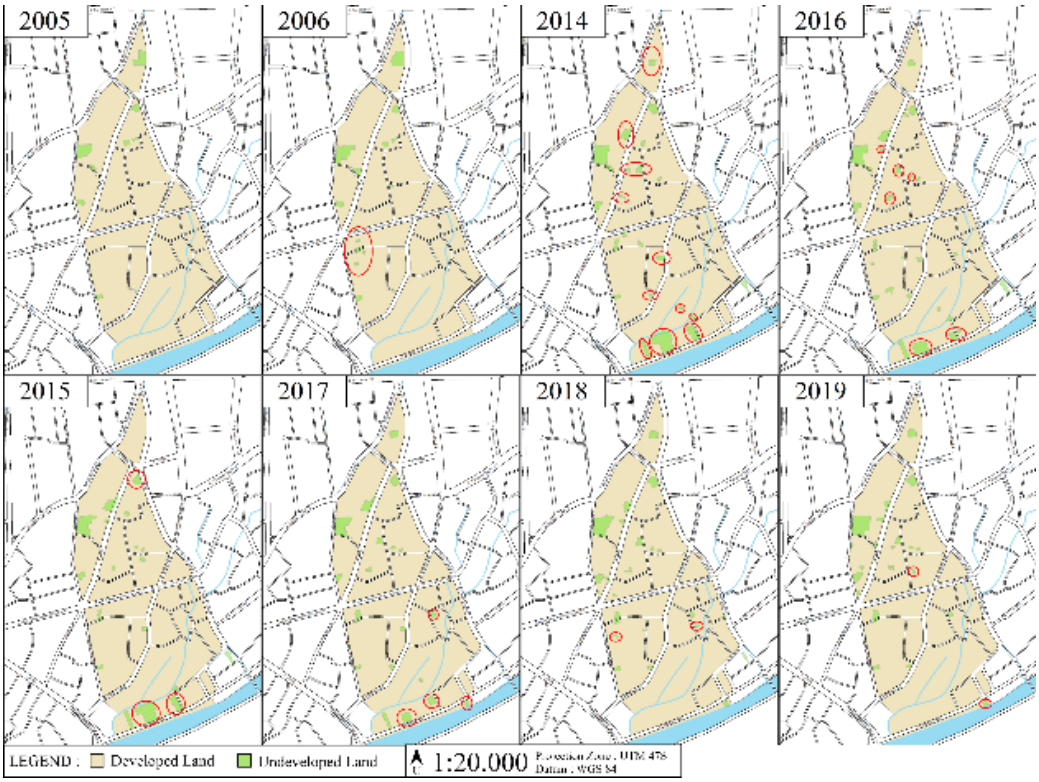


Fig. 6 Open space of Kampung Pondok (2005-2019)

This indicates that the development of the region has maintained a spatial pattern over the last century dominated by commercial support activities in the form of warehousing, logistic centers, plus trade centers and office buildings as markers of city modernization. In order to identify the latest spatial

patterns and future plans in Kampung Pondok district, the authors elaborated the city spatial planning 2010-2030 period which stated that the west Padang district will focus on a strategic area for the development of trade and services. Furthermore, more detailed identification is done based on Ministry Spatial Planning Act No 16/2018 enacted guidelines for preparation of detailed spatial planning and the regency/city zoning regulations. As can be seen at this time along the study corridor dominated by buildings that functioned as trade centers and mixed functions, in addition to part of the space functioned for reduced green space. Hence, analyses focusing on average travel speed, density, and level of service analysis according to Indonesian Highway Capacity

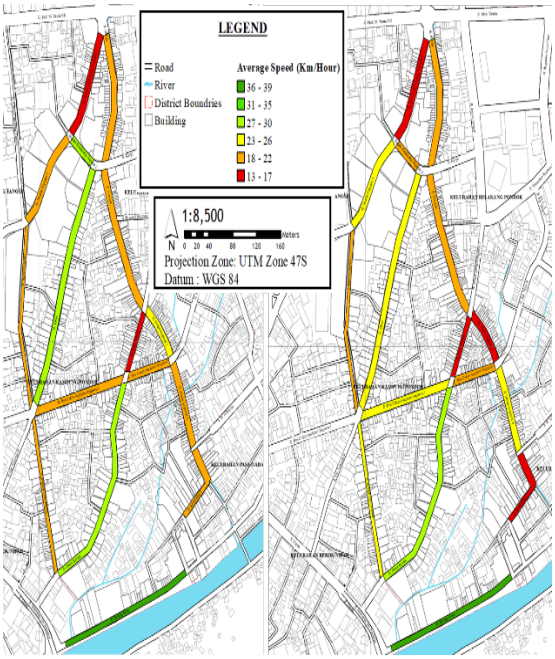


Fig. 7a (left) and Fig. 7b (right) show average speed during 12-2 and 4-6

Manual (1997) [17]. There were sixteen road sections observed in April 2019 during 12–2 and 4–6. Average travel speed in the two observation periods is shown in Fig. 7a and Fig. 7b, respectively. The next Fig. 8a and Fig. 8b express level of density (pcu/km) in the same period. Almost the same with speed motion, level of density getting worse during 4-6 period.

education, religion and military. But the growth of land use in the current condition is no longer stimulated by the existence of ports; the area develops because of the function directed as the CBD. Figure 6 shows changes in land use around Kampung Pondok district over the past few years. The existence of small roads seems to contribute to the degradation of the region with increasing population and has an impact on increasing demand for housing and roads. The next figure shows more clearly the changes in the Kampung Pondok district over the past decade. The high demand for various urban activities, resulting in

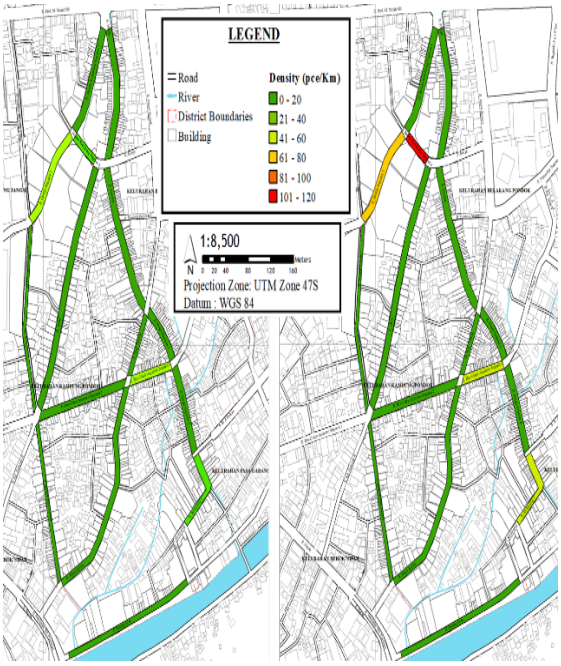


Fig. 8a (left) and Fig. 8b (right) show density level during 12-2 and 4-6

Analysis result related to the level of service as the ratio of volume to capacity can be seen in Fig. 9. As the CBD growing more excessive to northern part of entire city the level of service of road network was more suffering compare to southern part.

**Relationship between activity and road performance**

This section elaborated correlation between activity entire surrounding area and road performance in order to identify whether the land use and road network influence each other. In this case the identification of connectedness is done by the relationship between level of service of road network variables and land use variables.

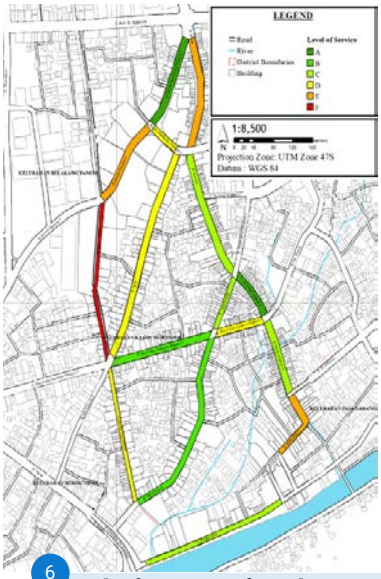


Fig. 5 Level of service of road network

Table 2 Relationship between speed and land use function

| No | Variable | Coff. of correlation | Sig. | Sig. level |
|---|---|---|---|---|
| 1 | Speed vs no. of local scale of trade and services building | -0.085 | 0.754 | N/S |
| 2 | Speed vs no. of district scale of trade and services building | 0.189 | 0.483 | N/S |
| 3 | Speed vs no. of regional scale of trade and services building | -0.143 | 0.598 | N/S |
| 4 | Speed vs no. of public facilities bldg. | -0.24 | 0.370 | N/S |
| 5 | Speed vs no. of residential building | 0.221 | 0.411 | N/S |
| 6 | Speed vs no. of warehouse building | 0.672 | 0.004 | S |
| 7 | Speed vs wide road | 0.007 | 0.980 | N/S |
| 8 | Speed vs wide road occupied for parking | -0.083 | 0.759 | N/S |
| 9 | Speed vs no. of lane | 0.132 | 0.626 | N/S |
| 10 | Speed vs no. of traffic direction | 0.423 | 0.103 | N/S |

## CONCLUSION

In this research the authors explore and find that Kampung Pondok district plays an important role in the historical development of Padang city during a decade as a center of trade and services. In the current condition the region is supported by the number of local, district and regional scale trade buildings and building services which are denser compare to other areas within the city. Growing populations and land use activities that continue to grow increase the number and intensity of travel in the region. As the icon of city, Kampung Pondok district experiencing pressure in the form of high vehicle movement while the ability of the road network to flow has not changed significantly for the last few decades. Most roads show the level of service of D and E indicating the flow rate is almost reaching capacity level or unstable flow. Average travel speed was less than 18 km/hour far below the standard average travel speed in urban areas of 40 km/hour. Interesting to note the density pattern that was shown in Fig. 8a and Fig. 8b; both figures expressed the density level varies from 20 to 60 pcu/km, which are classified as normal cases except two road sections in northern part as can be seen in Fig. 8b. According to field observation a combination of the low travel speed and a normal counted of density pattern was due to the part of wide road occupied for parking since there is no off street parking available within surrounding of the district. This fact is in-line with the findings expressed in Table 1 and Table 2, where the degree of saturation and wide road occupied for parking variables, and the speed and number of warehouse building variables are having strong correlation each other.

Table 1 shows the relationship between degree of saturation (DS) and land use function and Table 2 shows the relationship between speed and land use function.

Table 1 Relationship between DS and land use function

| No | Variable | Coeff. of correlation | Sig. | Sig. level |
|---|---|---|---|---|
| 1 | DS vs no. of local scale of trade and services building | -0.253 | 0.334 | N/S |
| 2 | DS vs no. of district scale of trade and services building | -0.337 | 0.202 | N/S |
| 3 | DS vs no. of regional scale of trade and services building | 0.177 | 0.512 | N/S |
| 4 | DS vs no. of public facilities building | 0.349 | 0.185 | N/S |
| 5 | DS vs no. of residential building | 0.252 | 0.346 | N/S |
| 6 | DS vs no. of warehouse building | -0.085 | 0.754 | N/S |
| 7 | DS vs wide road | -0.172 | 0.525 | N/S |
| 8 | DS vs wide road occupied for parking | -0.535 | 0.033 | S |
| 9 | DS vs no. of lane | 0.026 | 0.925 | N/S |
| 10 | DS vs no. of traffic direction | 0.606 | 0.013 | S |

## REFERENCES

[1] Wang, Z., Han, Q., and de Vries, B., Land Use/Land Cover and Accessibility: Implications of the Correlations for Land Use and Transport Planning, J. of Appl. Spatial Analysis, Vol. 12, 2019, pp. 923–940.

[2] Witten, K., Pearce, J., and Day, P., Neighbourhood destination accessibility index: A GIS tool for measuring infrastructure support for neighbourhood physical activity, J. of Environment and Planning A, Vol. 43, No. 1, 2011, pp. 205–223.

[3] Tian, L., Ge, B., and Li, Y., Impacts of state-led and bottom-up urbanization on land use change in the peri-urban areas of Shanghai: Planned growth or uncontrolled sprawl? J. of Cities, Vol. 60, 2017, pp. 476–486.

[4] Ratner, K. A., and Goetz, A. R., The reshaping of land use and urban form in Denver through transit-oriented development, J. of Cities, Vol. 30, 2013, pp. 31–46.

[5] Patarasuk, R., Road network connectivity and land-cover dynamics in Lop Buri province, Thailand. J. of Transport Geography, Vol. 28, 2013, pp. 111–123.

[6] Mothorpe, C., Hanson, A., and Schnier, K., The impact of interstate highways on land use

conversion, The Annals of Regional Science, Vol. 51, No. 3, 2013, pp. 833–870.

[7] Duranton, G., and Turner, M. A., Urban growth and transportation J. of Review of Economic Studies, Vol. 79, No. 4, 2012, pp. 1407–1440.

[8] INRIX Global Traffic Scorecard, 2017. Retrieved from https://english.kontan.co.id/news/jakartas-traffic-worsens-in-2017-survey

[9] Waddell, P., Integrated land use and transportation planning and modelling: Addressing challenges in research and practice, J. of Transport Reviews, Vol. 31, No. 2, 2011, pp. 209–229.

[10] Batty, M., and Marshall, S., Thinking organic, acting civic: The paradox of planning for cities in evolution, J. of Landscape and Urban Planning, Vol. 166, 2017, pp. 4–14.

[11] Chaudhuri, G., and Clarke, K. C., On the spatiotemporal dynamics of the coupling between land use and road networks: Does political history matter? J. of Environment and Planning. B, Planning & Design, Vol. 42, No. 1, 2015, pp. 133–156.

[12] Acheampong, R. A., and Silva, E. A., Land use–transport interaction modeling: A review of the literature and future research directions. J. of Transport and Land Use, Vol. 8, No. 3, 2015, pp. 11–38.

[13] Simmonds, D., Waddell, P., and Wegener, M., Equilibrium versus dynamics in urban modelling. J. of Environment and Planning. B, Planning & Design, Vol. 40, No. 6, 2013, pp. 1051–1070.

[14] Horner, M. W., and Schleith, D., Analyzing temporal changes in land-use–transportation relationships: A LEHD-based approach. J. of Applied Geography, Vol. 35, No. 1–2, 2012, pp. 491–498.

[15] Pei, T., Sobolevsky, S., Ratti, C., Shaw, S. L., Li, T., and Zhou, C., A new insight into land use classification based on aggregated mobile phone data. International J. of Geographical Information Science, Vol. 28, No. 9, 2014, pp. 1988–2007.

[16] Dur, F., and Yigitcanlar, T., Assessing land-use and transport integration via a spatial composite indexing model, J. of Environmental Science and Technology, Vol. 12, No. 3, 2015, pp. 803–816.

[17] Ministry of Public Works, Indonesian Highway Capacity Manual, Jakarta, 1997, pp. 1-564.

## 5% Overall Similarity

Top sources found in the following databases:

- 4% Internet database
- Crossref database
- 2% Submitted Works database
- 3% Publications database
- Crossref Posted Content database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

| | | |
|---|---|---|
| 1 | lppm.ub.ac.id<br>Internet | <1% |
| 2 | ejurnal.bunghatta.ac.id<br>Internet | <1% |
| 3 | geomate.org<br>Internet | <1% |
| 4 | pt.scribd.com<br>Internet | <1% |
| 5 | science.gov<br>Internet | <1% |
| 6 | Fang, Qing, and Xiaodong Pan. "Road Network Capacity Reliability Bas...<br>Crossref | <1% |
| 7 | ssbfnet.com<br>Internet | <1% |
| 8 | mdpi-res.com<br>Internet | <1% |

| | | |
|---|---|---|
| 9 | Indian Institute of Engineering Science and Technology on 2022-10-04<br>Submitted works | <1% |
| 10 | Indian Institute of Technology-Bhubaneswar on 2021-09-13<br>Submitted works | <1% |
| 11 | Gargi Chaudhuri, Keith C Clarke. "On the Spatiotemporal Dynamics of t...<br>Crossref | <1% |

## Excluded from Similarity Report

- Bibliographic material
- Cited material
- Manually excluded sources

EXCLUDED SOURCES

**repository.lppm.unila.ac.id** 86%

Internet