Land use and trip attraction modelling to pandemic anticipation policy toward sustainable development in Semarang

Rahayu Sri; Basuki Yudi ✉

Check for updates

CrossMark

View Online

Export Citation

Articles You May Be Interested In

Scaling relations in hyperfine shifts of impurity atoms in rare gas crystals

J. Chem. Phys. (June 1991)

Influence of carrier concentration and mobility tuned magneto resistance of $Bi_{1-x}Sb_x$ nanocrystals

AIP Conference Proceedings (November 2020)

The thermophysical characteristics of the ionizer in cesium sputter-type negative ion sources

Rev Sci Instrum (April 1992)

AIP Publishing

Land Use and Trip Attraction Modelling to Pandemic Anticipation Policy Toward Sustainable Development in Semarang

Rahayu Sri[a] and Basuki Yudi[b]

Urban and Regional Planning Department, Diponegoro University, Semarang, Indonesia

[a] *author : sri.yksmg@gmail.com*
[b]*Corresponding author: yudibasuki@yahoo.com*

Abstract. Semarang has land-use conversion has increased the people trip. This phenomenon will cause transportation problems that interfere with the achievement of the Semarang City Vision in realizing the concept of sustainable development. During the pandemic period, the trip of people could spread the viruses. To understand the land use that most influences the trip, a transportation model are needed. This article aims to formulate a mathematical model that can identify land uses that affect trips or movements to contribute to the policy during pandemic anticipation. In the regression model, the number of trip attractions in each district in the Semarang City is used as the dependent variable, and the square of residential, commercial, industrial and agricultural land use in 2019 is the independent variable. The regression model results obtained by the equation D (trip attraction) = 215.94 commercial + 34293 with R2 0.688. The most influential type is causing trip attraction is commercial land use. According to these findings, it requires more attention from the Semarang City Government to regulate commercial land use in anticipation of transportation problems. These findings can also serveas the basic policy to control visitors number in commercial land use for pandemic anticipation.

BACKGROUND

The urban transportation system has three central systems that influence each other. The systems are activity, network, and flow [1]. The interaction and relationship among it can be explained through a model. This model can be used to predict human mobility as demand for travel. The four-Step model is one of the famous models for predicting travel demand and indicating the transportation system performance [2]. The primary step in Four-Step Model is a trip generation that indicates trip production for mobility out of the region and trip attraction for mobility into the region [3]. The flow system will affect the load of the network system and could cause the congestion represented by the magnitude of mobility. This interaction implies the need for modelling land use and trip attraction to predict human mobility. By using this model, it can overcome the transportation problem indicated by predicting the numbers of mobility. Knowing the number of mobility can anticipate transportation problems such as congestion, pollution, and the use of energy. Besides this, the model can be used for preventive problem solving to make the urbantransportation system strong and in line with the sustainable development concept.

In the early of 2020, there was an alarming phenomenon announced by The World Health Organization (WHO) [4] as COVID-19 pandemic. This phenomenon is classified as a global world pandemic [5] and declared destructive as a natural disaster [6]. This pandemic effect has severe social problems and economic implications in various sectors, including transportation, travel, and human mobility. Safety in the conditions of an epidemic becomes a priority in problematic issues due to the social individuals' behaviour and their diverse behaviour attitudes in mobility [7]. Human mobility numbers and patterns were used to measure behavioural indicators and responses during the COVID-19 pandemic [8].

On the other hand, the number and pattern of human mobility significantly relate to social-economic interaction. Furthermore, the number of human mobility varieties is crucial to determine and predict the socio-economic status or

urban. Both diversity and socio-economic beliefs have a two-directed relationship. The more high-developed region will provide a broader range of human mobility. On the other side, higher human mobility diversification will drive higher economic opportunities. This opportunity will lead to a higher socio-economic development index [9].

According to that situation, the trip attraction model is needed to understand the interaction of type of land use asa representation of economic activity and the numbers of mobility. The land use that produced the considerable mobility must be anticipated due to the effect of COVID-19 viruses spread according to the type of land use activity.

THE STUDIES PURPOSE

This study provides a trip attraction model in four types of land use. According to the model, the recommendation could generate to anticipate the spread of COVID 19 viruses during pandemic based on the type of land use activity.

DATA AND METHOD

Data used in this study are land-use of Semarang in 2019 and trip production that was modified from 2017 to 2019 according to the population rate. Semarang City consists of 16 districts classified by four primary land use: residential, commercial, industry, and agriculture. [10] see table 1. The area of each land use was varied and represented human activity. The activity produces mobility from and to each district, known as the origin and destination matrix. The number of origin and destination for each district were extrapolated from the origin and destination matrix [11]. See figure 1 and table 2.
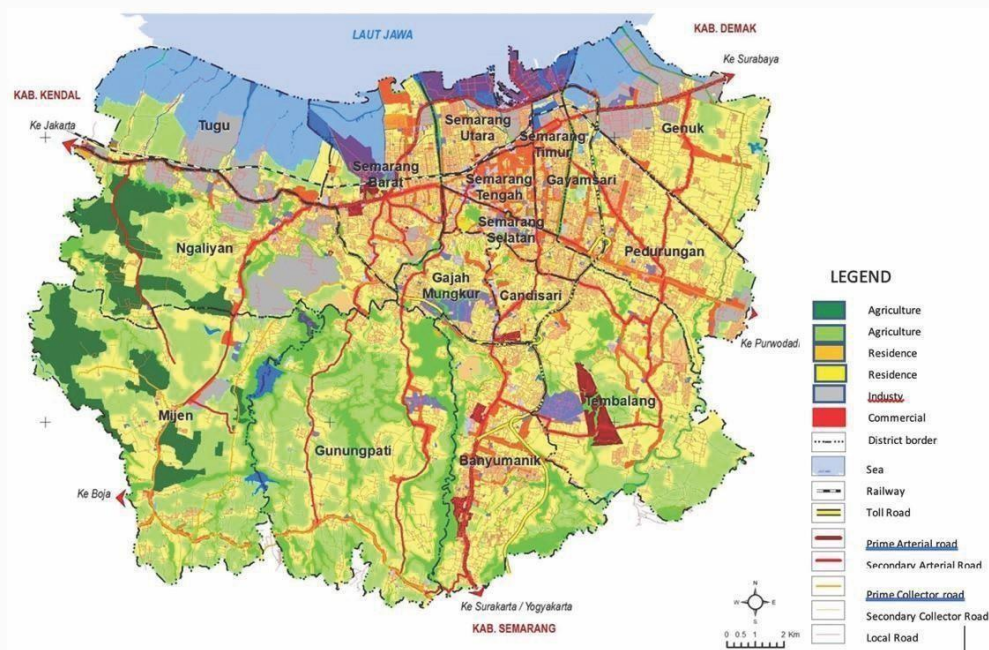

FIGURE 1. Land Use in Semarang City 2019.

TABLE 1. Land Use in Semarang City 2019 (ha).

No.	District	Residential	Commercial	Industry	Agricultur
1	GUNUNGPATI	2203	166	4	2101
2	TEMBALANG	2076	257	0	85
3	BANYUMANIK	1648	285	11	31
4	GAJAHMUNGKUR	500	68	0	0
5	SEMARANG SELATAN	306	102	0	0
6	CANDI SARI	453	82	0	0
7	SEMARANG UTARA	409	52	73	0
8	SEMARANG TIMUR	265	134	16	0
9	GAYAMSARI	322	97	24	25
10	PEDURUNGAN	1521	295	793	99
11	GENUK	1242	208	531	208
12	SEMARANG TENGAH	177	239	0	0
13	SEMARANG BARAT	1025	249	81	48
14	TUGU	280	62	437	473
15	NGALIYAN	1421	172	793	801
16	MIJEN	1516	119	82	2330

As seen in Table 1, the most extensive residential land use is located in Gunung Pati District. The most considerableCommercial land use is located in Pedurungan District and the essential industrial land use in Ngaliyan District. MijenDistrict is a location that is dominated by agricultural land use. The mobility of humans is generated by the origin anddestination matrix representing mobility to and from 16 districts, as seen in Table 2.

TABLE 2. Origin and Destination Matrix Semarang City 2019 (people).

No.	District	Origin	Destination
1	GUNUNGPATI	56998	56001
2	TEMBALANG	107862	108863
3	BANYUMANIK	87353	88714
4	GAJAHMUNGKUR	45732	43972
5	SEMARANG SELATAN	61472	61788
6	CANDI SARI	61247	60110
7	SEMARANG UTARA	84184	86634
8	SEMARANG TIMUR	57744	57369
9	GAYAMSARI	52626	54568
10	PEDURUNGAN	107582	106982
11	GENUK	70472	69254
12	SEMARANG TENGAH	55473	55166
13	SEMARANG BARAT	109783	109174
14	TUGU	20067	20900
15	NGALIYAN	90026	88456
16	MIJEN	38706	39376

According to table 2, three districts produce the most significant trip production. Semarang Barat, Tembalang and Pedurungan district contribute big three largest trip production.

To build the model, the method in this studyis multiple linear regression. [12] In this model, the destination district data mobility is the dependent variable, and land use type is the independent variable.

$$D = f(Residensial,, Commercial,, Industry,, Agriculture)$$

$$D = A0 + B1\ Residential + B2\ Commercial + B3\ Industry + B4\ Agriculture + e$$

RESULT AND DISCUSSION

According the multiple regression model and the stepwise method, with R^2 0,688 the equation derivate as

$$D = 215,94\ commercial + 34293$$

D is a destination representing the number of human mobility that go to the district, and commercial is an area of commercial land use in this district. It can be concluded that commercial is the most type of land use that attracted human mobility. Commercial activities believed to become the second common factor to trip attraction besides work activities in urban activity [13] contribution of commercial area to trip attraction can be vary depending on the characteristics of the commercial area. In some cases, the contribution of commercial activity to trip attraction is indicated by 5% within the city [14].

The commercial sector in Semarang City is a vital sector that contributes 13,78% of GRDP [15]. In terms of the COVID-19 pandemic, human mobility has a strong relationship with the spread of COVID-19 viruses [16], so according to the result of the model, the anticipation of mobility to commercial land use is urgent. However, on the other hand, the rise of the commercial sector is essential to strengthening the urban economy and citizen welfare. In some case in China, he used emergency control measures in the epidemic areas and integrated resources from multiple systems, including business, community, technology, education, and transportation, across the country [17]. Another policy in Malaysia, economic sectors have been allowed to open with enforced guidelines like strictly monitoring red zone areas [18]. The anticipation for the mobility to commercial land use with the low-risk pandemic can be like visitor restriction and serve medical tools like hand sanitizer and masker.

CONCLUSION

Commercial land use is the activity that attracted human mobility. In the term of the COVID-19 pandemic period, it must be caring for the government to anticipate the operation of commercial land use to prevent the spread of viruses. This model can be used to generate and derivate the policy in order to strengthen city toughness in a sustainable development context.

ACKNOWLEDGEMENT

REFERENCES

1. M. L. Manheim, *Fundamentals of Transportation Systems Analysis Volume 1; Basic Concept*. Massachusetts: Department of Civil Engineering, Institute of Technology Massachusetts, (1979).
2. M. G. McNally, *The Four Step Modal*. Irvin: Department of Civil and Environment Engineering and Institute ofTransportation Studies, University of California, (1986).
3. S. M. Al Razib and F. I. Rahman, *Determination of Trip Attraction Rates of Shopping Centers in Uttara Area,Dhaka,* Am. J. Manag. Sci. Eng., vol. **2,** no. 5, pp. 150–155, (2017).
4. WHO. *Coronavirus Disease (COVID-2019) Situation Reports*; World Health Organazation: Geneva,Switzerland, (2020). [GoogleScholar]
5. Cucinotta, D., Vanelli, M. WHO Declares COVID-19 a Pandemic. *Acta BioMed.*, **91**, 157–160. (2020). [GoogleScholar] [PubMed]
6. Bonaccorsi, G., Pierri, F., Cinelli, M., Flori, A., Galeazzi, A., Porcelli, F., Schmidt, A.L., Valensise, C.M., Scala,A., Quattrociocchi, W., et al. *Economic and social consequences of human mobility restrictions under COVID-19*. Proc. Natl. Acad. Sci. USA, **117**, 15530–15535. (2020). [Google Scholar] [CrossRef] [PubMed]
7. Przybylowski, A., Stelmak, S., Suchanek, M. *Mobility Behaviour in View of the Impact of the COVID-19 Pandemic—Public Transport Users in Gdansk Case Study*. Sustainability, **13**, 364. (2021). https://doi.org/10.3390/su13010364
8. Chan, H.F., Skali, A., Savage, D.A. *et al. Risk attitudes and human mobility during the COVID-19 pandemic*. SciRep **10,** 19931 (2020). https://doi.org/10.1038/s41598-020-76763-2
9. Dinas Perhubungan Kota Semarang, Masterplan Transportasi Kota Semarang, (2017).
10. N. Zenina and A. Borisov, *Regression Analysis for Transport Trip Generation Evaluation*, Inf. Technol. Manag.Sci., pp. 89–94, (2013).
11. Pappalardo, L., Vanhoof, M., Gabrielli, L., Smoreda, Z., Pedreschi, D., & Giannotti, F. An analytical framework to nowcast well-being using mobile phone data. International Journal of Data Science and Analytics, 2(1–2), 75–92. (2016). tt ps: // doi . org/ 10. 1007/ s41060 -016-0013-2
12. BPS Kota Semarang, Semarang Dalam Angka, (2019).
13. K. Sasidhar, Y. Vineeth, Vineethreddy, and S. S. V. Subbarao, *Trip Attraction Rates of Commercial Land Use: A Case Study*, Indian J. Sci. Technol., vol. **9**, no. 30, pp. 1–5, (2016).
14. P. George, G. J. Kattor, and A. M. K. V, *Prediction of Trip Attraction Based On Commercial Land UseCharacteristics,* Int. J. Innov. Res. Sci. Eng. Technol., vol. **2**, no. 1, pp. 352–359, (2013).
15. Badan Pusat Statistik Kota Semarang, *Produk Domestik Regional Bruto Kota Semarang Menurut LapanganUsaha*. Semarang: BPS Kota Semarang, (2019).
16. Chan, H.F., Skali, A., Savage, D.A. *et al. Risk attitudes and human mobility during the COVID-19 pandemic*. SciRep **10,** 19931 (2020). https://doi.org/10.1038/s41598-020-76763-2
17. Wei Liu, Xiao-Guang Yue and Paul B. Tchounwou. *Response to the COVID-19 Epidemic: The Chinese Experience and Implications for Other Countries,* Int. J. Environ. Res. Public Health (2020), **17**(7), 230. tt ps: // doi . or g/ 10. 3390/i jer ph 17072304
18. Umair S, Waqas U, Faheem M. *COVID-19 pandemic: stringent measures of Malaysia and implications for othercountries*. Postgrad Med J. **97**:130–132. (2021)