Changes of landuse in the campus area and their implications toward traffic condition

by Okto Manullang

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Abstract. This study revisits how changes in the land use affect traffic condition around a rapidly growing university campus area. Changes in landuse, associated to the increase in activity development which affects the vehicle trip rate, have increased the traffic loading in the road network in the study area. At the same time, the growing number of road users in the road network results in increasing traffic conflicts negatively impacts the traffic condition. The phenomenon has been identified in and around Tembalang Area in Semarang City, with rapid changes in land use due to the increasing demand for supporting activities to provide the needs of students, especially in the main transport corridors. This study examined changes of landuse and their implication toward traffic loading as a first step to control the use of space in the campus area. Quantitative method was applied to analyze trip attraction in comparison to the volume of traffic. The results showed that eatery land use activities were the largest traffic load increase contributor (29-33%) burdening the road network in the study area. Other types of activity identified to negatively impact the service levels of the road network are supermarket, cafe, and laundry services.

Keywords: *landuse change, trip rate, traffic volume*

1. Introduction

Land use in Tembalang Subdistrict in Semarang City ("Tembalang" hereafter) are changing rapidly especially since Diponegoro University started moving its university activities to this locale. Together with three other higher education entities namely Semarang State Polytechnic (Polines), Semarang Health Polytechnic (Poltekkes), and Pandanaran University (Unpand), the development of activities have transformed landuse in the area, either in the form of changing building function or land utilization. These changes is driven by the increasing economic interaction, i.e. the growing demand for the fulfillment of basic needs from approximately 57.000 students. New activities have developed especially in the trade and service sectors.

Changes in landuse for trade/service activities happen mostly around the main access roads in Tembalang area, this has been observed to increase the traffic loading on the road network; the higher level of utilization of a land, the higher trip rate attracted [1]. The main access to the area, specifically Ngesrep Corridor as well as Sirojudin Corridor, has an assortment of trade/service activities, such as eatery, cafe, printing, general store, stationery store, attire store, laundry, motel, etc. It is expected that if changes in land use continues to occur, the trip rate will also increase significantly, potentially leading to congestion and reducing the corridors' level of service.

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Differences in characteristics are expected to affect the level of contribution to the road loading in the two corridors in discussion. Ngesrep Corridor is the main access connecting the area to the arterial road as well as to Semarang City centers, it is understandable that this corridor develops earlier, and in the past 10 years (2008-2018), this corridor has experienced continuous changes and development of building functions. Meanwhile, changes of land use in Sirojudin Corridor are more related to activity developments along the corridor itself; this distinction of characteristic renders the two corridors very interesting as the study area.

This study compared the trip rate attracted by trade/service activities as well as calculate the additional traffic volume produced to describe the level of contribution of traffic impact on the respective corridor. The trip rate assessment of this study refers to the Institute of Transportation Engineers (ITE) methodology commonly used by researchers from various countries, both developing and developed country, as currently Indonesia have not developed its own manual. Although ITE have provided reference trip rates for various types of land use, they are not applicable as they do not reflect the lifestyle and travel pattern of people in Indonesia. To better suit the local context the trip rate is developed on a local scale [2]. The trip rate of the identified activities can be used to predict future traffic volumes, as part of traffic impact assessment (TIA) to determine the impact of a proposed land use development/change, especially in areas where higher education facilities are present. However, there is no agreement when the investigation would be fundamental and what approaches are regarded appropriate for the estimation of trip rates [3-5].

2. Trip rate of the corridors

The trip rate of the corridor was generated through a series of surveys, namely Identification of Landuse Change Survey and Trip Generation Survey. Types of trade/service activities sampled included eateries, attire stores, supermarkets, salons, cafes, cell stores, laundries, services, lens stores, shoes stores, printing places, motel, dorm and stationery stores. Each type of activity has a minimum sample size of five to strengthen the regression analysis [6]. Traffic counting was carried out during peak hours therefore the trip rate factor is used to generate trips during peak hours, not for the whole period of the way. The unit of factor was adjusted to the unit of predictor variable used.
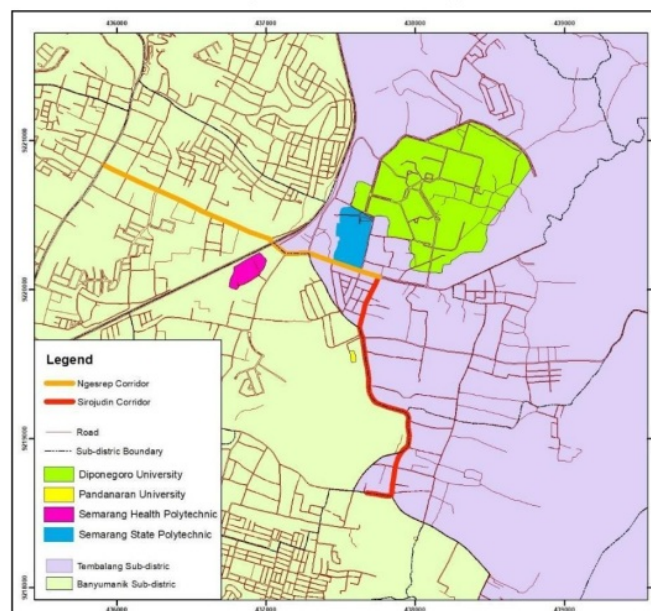

Figure 1. Study area *Ngesrep and Sirojudin Corridor*

2.1. Ngesrep corridor

In total, the Ngesrep corridor is 1.95 km long, consisting of two main road segments, namely Ngesrep Timur V Street (1.2 km long) and Prof. Soedarto SH street (0.75 Km long); it has dominantly 4/2 undivided road type with a width of ±16 meters. It has poor pedestrian path condition such as cracks, holes, and some part occupied by parked vehicles as well as street vendors. The land use along the corridor is dominated by trade and service activities, with a smaller proportion of it functioned for education, government offices, and house of worship. The trip rate modelling resulting from the analysis of the predictor factors on the Ngesrep Corridor can be observed below:

Table 1. Equation and trip rate factor of the activities on Ngesrep Corridor.

Num	Activity	Trip rate equation	Predictor Variable (x)	Trip rate Factor	Unit
1	Eatery	$y = 0{,}182\,x + 1{,}0959$	Seats	0,208	vec/unit/peak hour
2	Attire store	$y = 0{,}3368\,x + 2{,}8076$	Employees	1,417	vec/person/peak hour
3	**Supermarket**	$y = 11{,}611\,x + 10{,}944$	Cashiers	**15,031**	vec/person/peak hour
4	Salon	$y = 0{,}3904\,x + 0{,}4605$	Seats	0,500	vec/unit/peak hour
5	Café	$y = 0{,}1327\,x + 5{,}9813$	Parking spaces	0,243	vec/m^2/peak hour
6	Cell store	$y = 0{,}1563\,x + 2{,}25$	Parking spaces	0,357	vec/m^2/peak hour
7	Laundry	$y = 2{,}125\,x - 21{,}375$	Operational hours	3,821	vec/hour/peak hour
8	Services	$y = -1{,}0109\,x + 15{,}728$	Operational hours	0,357	vec/hour/peak hour
9	Lens store	$y = 0{,}1319\,x + 1{,}125$	Parking spaces	0,444	vec/m^2/peak hour
10	Shoes store	$y = 0{,}0695\,x + 1{,}233$	Floor areas	0,110	vec/m^2/peak hour
11	Printing place	$y = 0{,}9083\,x + 3{,}6667$	Parking spaces	1,825	vec/m^2/peak hour
12	**Motel**	$y = 0{,}021\,x + 1{,}9824$	Parking spaces	**0,045**	vec/m^2/peak hour

The independent variables forming the model vary for each type of activity. Variables are selected using an analogy by including variables that are considered to provide impact towards the number of trip generation and attraction. In this corridor, the presence of 75 eateries seems to have contributed to the fact that this type of activity as a whole (not per unit) attracts the largest trip during peak hours. However, individually, the largest trip rate for the one unit activity is produced by laundry activity, with supermarket activity following closely.

Table 2. Trip rate of the activities on Ngesrep Corridor.

Activity	Trip rate (y)	Sum	Trip rate of the corridor
Eatery	8,717	75	**653,8**
Attire store	3,683	22	81,0
Supermarket	48,099	7	336,7
Salon	2,100	11	23,1
Café	13,186	12	158,2
Cell store	4,000	12	48,0
Laundry	**48,150**	5	240,8
Services	4,102	10	41,0
Lens store	1,599	5	8,0
Shoes store	3,398	7	23,8
Printing place	7,299	9	65,7
Motel	3,696	9	33,3

2.2. Sirojudin corridor

The Sirojudin Corridor consists of KH Sirojudin street, Banjarsari Selatan street and Mulawarman Raya street with an overall length of approximately 1.89 km. This corridor has an average width of 8 meters and lacks pedestrian path. Ribbon pattern land use changes can be observed throughout the length of the corridor. There are many new developments and land use conversions on its first layer ribbon recently, especially on Mulawarman Raya street. The changes include land use functions such as eatery, attire store, laundry, motel, and stationery store. Several activities which were used as samples in the Ngesrep Corridor analysis were excluded from the analysis on this corridor due to the small number of occurrence. The independent variable of floor area is more suitable as a variable to predict the trip rate of each of the activity. The following is the trip rate equation, predictor variable, and its trip rate factor.

Table 3. Equation and trip rate factor of the activities on Sirojudin Corridor.

Num	Activity	Trip rate equation	Predictor variable (x)	Trip rate factor	Unit
1	**Dorm**	$y = 1,035 + 0,008\ x$	Floor areas	**0,010**	vec/m2/peak hour
2	Laundry	$y = 0.757 + 0.5\ x$	Floor areas	0,530	vec/m2/peak hour
3	Supermarket	$y = 14,954 + 0,0363\ x$	Floor areas	0,156	vec/m2/peak hour
4	Attire store	$y = 0,7532 + 0.0685\ x$	Floor areas	0,093	vec/m2/peak hour
5	Stationery store	$y = -3,7977 + 2,2136\ x$	Employees	1,791	vec/person/peak hour
6	Eatery	$y = 7,0842 + 0,1325\ x$	Parking spaces	0,340	vec/m2/peak hour
7	Café	$y = 4,8153 + 0,543\ x$	Employees	0,900	vec/person/peak hour
8	**Printing place**	$y = 1,684 + 2,467\ x$	Printers	**2,770**	vec/unit/peak hour

Printing place activity has the largest trip rate factor for each independent variable unit it has. Meanwhile, dormitory activity has the smallest trip rate factor. As a group of samples the largest trip rate in the corridor comes from the activity of the eatery, possibly due to the large number of sample. However, individually, the largest trip rate of one activity is owned by supermarket activity and the smallest by attire store activity.

Table 4. Trip rate of the activities on Sirojudin Corridor.

Activity	Trip rate (y)	Sum	Trip rate of the corridor
Dorm	5,802	12	78,1
Laundry	13,250	10	132,5
Supermarket	**19,500**	6	115,1
Attire store	**2,900**	6	17,0
Stationery store	16,119	4	60,9
Eatery	11,608	42	**475,9**
Café	12,240	6	73,4
Printing place	15,512	6	93,1

3. The comparison of trip rate toward traffic volume

Traffic volume was obtained from traffic counting on peak hour at 17:00 - 18:00. After the results of the traffic counting processed, it compared with the attracted trip from the activities on the corridor.

3.1. Ngesrep corridor

The activity of eatery was identified as the largest contributor producing the highest addition of road traffic load in the Ngesrep Corridor, with a trip rate that weighing at 29% of traffic. Characteristically, the activity of eating has a somewhat fixed time dimension, but with a flexible places dimension.

These characteristics are also observable for shopping at the supermarket activity; its trip rate contributes at 15% of traffic. Although the laundry trip rate reaches 11%, this activity is only done in a short time, so it is not significant to the road condition. Unlike cafe activity (7%), where visitors need an average of 2-3 hours to enjoy their time.
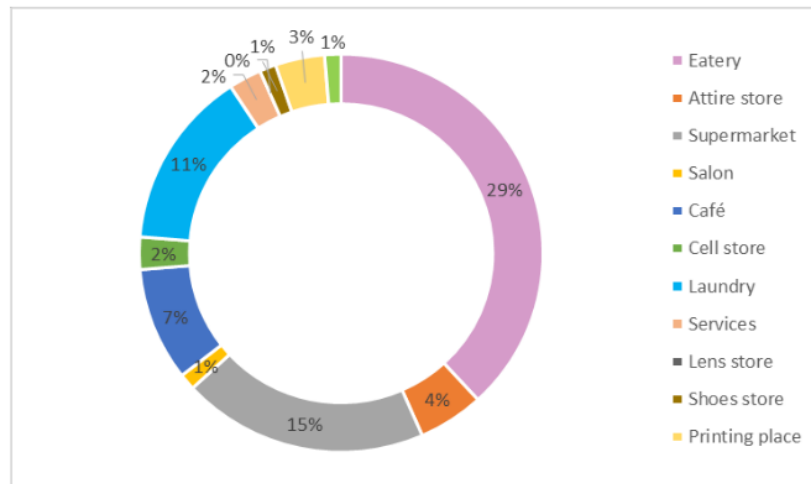

Figure 2. The contribution of trip rate of activities towards traffic on Ngesrep Corridor

The additional trips attracted by the land use activities are observable to have implications to the road network's level of service. The Ngesrep Corridor has a DS value of 0.81 with a level of road service at D level. The increasing number of conversions of buildings along the corridor into an eatery, supermarket, or cafe is expected to further affect the traffic volumes, predictably further reducing the level of service of the road network. It is also observable that lack of parking spaces also causes visitors to park on the road; despite the presence of parking attendants supposedly organizing the parking activities, it still impedes traffic flow as well as increases the potential for traffic conflicts along the corridor.

3.2. Sirojudin corridor
Eatery activities have been identified to contribute significantly to the increase of traffic load on the corridor during peak hour, reaching up to 32.7% of the total traffic. This is expected, because an eatery, or a place for eating, provides for a basic need which occurs at relatively the same period of time during the day for almost everyone. This activity has the characteristics of a fixed time and a flexible place so that accumulatively eatery will be visited two to three times a day.
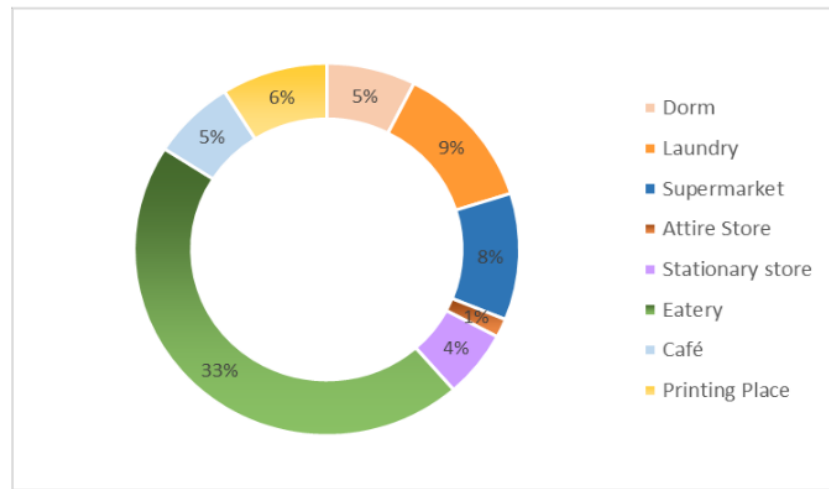
Figure 3. The contribution of trip rate of activities towards traffic on Sirojudin Corridor

On average, the trip rate of each trading/service activitiy on the corridor adds an increase of 9% in traffic volume during peak hour. At present, the Sirojudin corridor has a DS value of 0.676 with a level of road service at C level. If there is an increase in the number of eateries and supermarkets in the future, then it will increase the volume of traffic and affect the road service level.

The control of landuse utilization by the city government is also relatively low because 42% of trade/service activities have permission from the local government. Conversely, other business owners have not taken care of business licensing, but have engaged in activities or run their businesses. The landuse change from non-built to built up occurs a lot in Mulawarman Raya street. At present, the corridor still has potential to grow continually because there are still lots of non-built lands.

4. Conclusion

The college activities contribute to accelerating changes in landuse in order to provide students' needs. In the last 10 years (2008-2018), Landuse in Ngesrep Corridor encountered a shift in building functions. Meanwhile, the Sirojudin Corridor has encountered more land use changes from non-built to built up land.

Assessment of the trip rate explains that some activities can have a high trip rate value, but the population in the corridor influences the amount of contribution in road loading. For instance, the trip rate of eatery is not the highest, but due to the large population, this activity is the biggest contributor, specifically 29% in Corridor Ngesrep and 33% in Sirojudin Corridor.

The addition of activities that can affect the decline in the road service level is an activity that has a high trip rate. These types of activity are eateries, supermarkets, cafes, and laundry. Control of spatial use of these trade activities needs to be tightened, such as through the mechanism of granting business licenses. Although trading/service activity is a business interaction process, the number of supply should be monitored and restricted in order to reduce traffic impacts, such as congestion.

Trip rate equations can be used to predict the amount of permissible activity threshold. Even though the contributors who burdened the road did not only come from the first layer of the corridor, but almost 72-76% of the traffic volume during peak hours was influenced by activities located on the side of the corridor. This underlines that the importance of the threshold for knowing the capacity of the corridor in the development of new activity, especially for Higher Education Areas.

5. References

[1] Tamin O Z 2008 *Perencanaan, Permodelan, Dan Rekayasa Transportasi* (Bandung: Institute of Technology Bandung publisher)

[2] Minhans A, Zaki N H, Shahid S, and Abdelfatah A 2014 A Comparison of Deterministic and Stochastic Approaches for the Estimation of Trips Rates *Journal of Transport System Engineering 1* **1** 1-11.

[3] Minhans A, Zaki N H, and Belwal R 2013 Traffic Impact Assessment: A Case of Proposed Hypermarket in Skudai Town of Malaysia. *Jurnal Teknologi*.

[4] Schroeder B J, Cunningham C M, Findley D J, Hummer J E, and Foyle R S 2010 Manual of transportation engineering studies.

[5] Fan H S, and Lam S H 1997 Parking generation of commercial developments in Singapore. *Journal of transportation engineering*, 123(3), 238-242.

[6] Juette G W and Zeffanella L E 2007 Development of Philippine Trip Generation Rates *Presented at the Eastern Asia Society for Transportation Studies conferences*, Dalian, China, September 24-27

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