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Abstract: Sultan Agung Road is the primary collector hierarchy connecting public access between Kepanjen District and Blitar. The roadside problem on Sultan Agung Road is that there are so many street vendors, population growth, and changes in land use for trade and services there, which causes traffic jams along the corridor during rush hours. This research purpose to identify the effect of land use on road performance in the Sultan Agung Road corridor. The research method used is the analysis of the interaction model of land use and the road network, analysis of road capacity, and analysis of road service levels with updated calculations of the volume of each land use and contribution to the total volume which previously was only continuous volume. The results of the research on the performance of the Road Sultan Agung section where the highest road performance was obtained at 12.00-13.00 was 0.84 with the LOS D indicator. The total internal biggest influence is land use, trade, and services. was 1716.13 pcu/day, or 63% of the total internal volume. Sultan Agung road to reduce high road performance, including making regulations to regulate land use changes that occur in Sultan Agung and widening the road to a width of 0.5 meters from the road body's width.

Keywords: Attractive-Generation-Model; Interaction of Road Network Land use; level of service; sultan agung

1. Introduction

In many nations, transportation is crucial to the advancement of their economies and societies[1]. Transportation facilitates the delivery process in economic development. Food must be efficiently distributed from producers to distributors to suppliers along the food supply chain in order for consumers to get it[2]. Land use and transportation are related and connected to each other[3]. Planners and society as a whole are aware of the connection between urban land use and transportation. One fundamental idea of transport analysis and prediction is that the spatial dispersion of human activity generates the demand for travel and the transportation of products[4]. Appropriate transportation services are also necessary for land usage to fulfill the needs. In the context of the relationship between transportation planning and urban planning, it is important to determine the components of the city area as places for various types of activities, considering affordability and their impact on community mobility[5].

Land use activities will undoubtedly be hampered by issues with the transportation system, such as congestion. Land use and transportation development are correlated; for instance, developments in transportation, infrastructure, the economy, and social actors can impact business and the urban populace. The idea behind the land use feedback cycle for transportation is that as traffic increases, so do urban accessibility, activity, and development[6]. Cities' expansion is directly impacted by transportation, which also distributes spatial opportunities in the form of jobs, homes, and services. Planning for regional development and integrated transportation planning must happen at the same time[7]. The multiplicity of transportation options, the wide range of origins and destinations, as well as the volume and diversity of traffic, all contribute to the complexity of traffic, particularly in metropolitan regions[8]. Urban service centers that are aided by the expansion of transportation and infrastructure have raised capital flows and facilitated the movement of people and things for socioeconomic advantages[9]. However, it may also have a substantial impact on smaller communities in convenient places. In the past, the interaction between transportation and settlement developments has resulted in dynamic settlement growth on some important transport routes[10]. There are numerous issues with both land use planning and urban transportation, as well as its integration. When taking into account urban growth processes, land use, transportation, and population are subsystems that affect one another[11]. Cities are becoming larger and more complex due to the pressure of dense populations, which is increasing demand for housing and transportation[12]. Traffic congestion is caused by the expansion of metropolitan areas and the use of cars, which are encouraged by population and economic growth[13]. One common form of traffic congestion in Indonesia's major cities is heavy traffic. Congestion will arise as the flow of traffic gets close to its capacity[14].

Roads have been the subject of numerous studies. For instance, studies on traffic management scan real-time feeds from installed traffic intersection cameras and provide intensity scores that take into account the volume of traffic in each neighboring lane. The mechanism is used to manage traffic jams[15]. Research into recommendations for proactive routing protocols and reactive vehicle routing across VANETs is an essential part of ITCs that rely on communications infrastructure. This internet-connected technology helps drivers make better route decisions[16]. This is in line with a previous study by Dwivedy, et al. Road users use data via fast and robust VANET communications made possible by many routing protocols. This protocol utilizes the ideas of routing and clustering simultaneously. This helps identify the straightest and most stable route between the source and the destination. The fitness function assesses a number of factors to find the optimal course of action[17].

More research is being done on a system that may detect fatigue and distractions when driving at night. This system tracks a driver's activities as they drive and detects distractions and drowsiness using real-time video[18]. Hassan et al. carried out a similar study for the safety of road maintenance workers to avoid accidents or hazards on the emergency route directly on the highway using a danger sensor device with a Signal Warning Detector (SWAD). Road crew trucks are equipped with emergency lights and sirens that send a signal to the output when they detect things within a predetermined range, thanks to proximity sensors[19].

Indonesia as a developing country has many regional development initiatives to meet the needs of its citizens[20]. The National Development of the Indonesian State is generally aimed at realizing the prosperity of people's lives in a fair and equitable manner in all corners of the Republic of Indonesia, both those living in rural areas and urban areas[21]. With this development, there is a need for equality between Agra regions and there will be no regional disparities in terms of infrastructure. The government is currently aggressively encouraging infrastructure development in various regions in Indonesia[22]. The government is developing incentive areas in cities and regencies in Indonesia.

Following the relocation of Malang City, Kepanjen emerged as the capital of Malang Regency. This suggests that Kepanjen District serves as Malang Regency's hub. Due to changes in area functions, this transfer will have an impact on Kepanjen's transportation system and spatial patterns[23]. Kepanjen Subdistrict serves as a hub for various local activities, including trade and service centers, health centers, worship centers, regional offices, and regional-national sports and arts centers, as per the Malang Regency RTRW 2010–2030. Kepanjen District's population has grown from 93,046 in 2008 to 109,634 in 2020. Rapid changes in urban land use are a result of population growth. The situation is made more difficult by the fact that urban land is scarce and changes are leading to mixed-use developments along important urban corridors, which boost traffic and appeal.

Kepanjen District and Blitar are connected by Sultan Agung route, a key collector hierarchical route that serves as a community access point for travel outside of town and links Kepanjen District as the hub of local activities with Malang City as the hub of national activities. In Kepanjen District, Sultan Agung Road is a national highway. Shops are the main draw on Road Sultan Agung, and there are a variety of land uses along the way. There is a mosque on Road Sultan Agung that can hold up to 5000 worshippers, thus on occasion there might be a lot of activity there. The land uses that attract tourists will vary, which will have an impact on the number of cars using these routes.

The roadside of Sultan Agung Road should be used for parking because there are a lot of street vendors there. The street sellers' (PKL) activities on the roadside create traffic jams along the corridor during rush hour. According to the road performance calculation data from Malang City Transportation Service, Road Sultan Agung's road service quality in 2020 will be D[24]. If changes in land use activity result in the road section being unable to handle the growing number of vehicles, then this condition may become problematic. This results in congestion, low road service levels, and traffic bottlenecks along the Road Sultan Agung corridor.

Roads are one of the land use interaction models with transportation that have given rise to research challenges in recent years[25]. Numerous highways in Indonesia are now being identified by this investigation. To determine the ideal threshold for land use capacity and how it interacts with road services, utilize the land use interaction model in conjunction with the road's service level. Studies carried out on the Waru Surabaya – Mojokerto road[26]. When it comes to how the industry affects the performance of the Waru Surabaya-Mojokerto Road, its internal volume accounts for 41.72% of the total influence of other land uses on this specific portion of the road. Additionally, it is recommended to control residential land use for commercial and/or industrial uses along the road corridor, as the computation findings imply level F road service. Previous research has also looked at how industrial zones affect Malang City's tourism attractions[27)]. Research has been done on how the land use at the Malang City Station affects the quality of road service in addition to industrial sectors. The study's findings indicate that the peak station land use occurs between the hours of 18 and 19 and amounts to 173.31 pcu/hour, with 13.5 percent of the total volume attributed to impact[28)]. This research can be a continuation of the identification of land use on road corridor performance, based on a number of instances of previous studies on the impact of land use models. It is intended to create a more efficient regional transportation system with similar land users by looking into land use planning models in Indonesian cities and along important metropolitan corridors[7)].

Therefore, it is crucial to keep an eye on the volume of vehicles moving by looking at the way the property is now being used. The goal of this research is to ascertain how Malang Regency's land use influences the functionality of the roads along the Sultan Agung corridor. To achieve this, a strategy or method for determining approaches to land use interaction and road performance is used. The process is modeled using correlation analysis and multiple linear regression.

2. Method

This study uses quantitative research methods to examine how land use at Sultan Agung Road in Malang Regency affects the quality of the road's service. Data collection techniques utilizing primary and secondary data, which are subsequently processed through formulas and analysis, underpin this quantitative study. Using correlation analysis and multiple linear regression, data on road capacity, saturation level, internal and external volume, road service quality, and trip generation and attraction were gathered for this[29)].

The land use features of the Kepanjen District, Malang Regency, along the Sultan Agung Road corridor are the subject of this study. The broad description of traffic circumstances, land use, and road network features are produced using a descriptive technique. Preliminary studies, data gathering, data processing, data analysis, and conclusions were the first stages in the research process for the Road Sultan Agung corridor.

2.1 Data collection technique

Techniques employed for gathering data both primary and secondary surveys, The main survey was carried out using questionnaires, interviews, and field observations[30)]. The survey's needs pertain to plate matching, traffic enumeration, road geometry, and land use[28)].

For every land use in the Sultan Agung corridor, respondents were surveyed directly through interviews. The purpose of this survey was to ascertain the types and features of each type of land use that is currently in use. See Table 1 for features of land usage.

The two surveys that make up the observation survey are the traffic enumeration survey and the geometry survey. The capacity and characteristics of a road can be determined with the use of a road geometry survey. The Sultan Agung Road was observed, measured, and recorded as part of this assessment. The entire number and kind of vehicles that travel along Sultan Agung Road are being determined by the traffic enumeration study. On the Sultan Agung Road corridor, observation points were set up at both ends of the street and in front of the residential road. The observation period spanned two days, from 06.00 to 21.00, on both weekdays and weekends. Using a sample of each land use, the Sultan Agung Road land uses were the subject of the traffic enumeration survey. See Table 2 for samples of land usage. Each land use's entry and departure served as the survey locations. Traffic enumeration surveys are conducted on weekdays and weekends, with the time of the surveys varying according to the peak hours for each land use. Interview surveys were conducted to obtain data on generation and attraction for each land use such as number of family members, family income, parking area, building area, etc.

A literature review, interviews with relevant government agencies and organizations, and reviews of prior area study-related research were used to conduct the secondary survey. Data is required from the following sources: The Kepanjen District in Figures 2020, the Malang Regency Transportation Masterplan, the Malang Regency Spatial Planning Plan for 2010–2030, and the Detailed Kepanjen District Spatial Planning Plan.

2.2 Research Variable

The variables employed in this study can assist in addressing the research objectives. The following are the variables utilized in this research.

Table 1. Variable Research

Aspect	Variable	Source
The origini of land use for housing	$Y_{Housing}$ X_1 = Number of household members X_2 = Number of motor vehicle ownership X_3 = Household income X_4 = Number of bedrooms X_5 = Building area	(Tamin,2000) (Agustin & Waloeya, 2017) (Himah et al., 2023)
The attraction of land use for trade and services	$Y_{Trades\ and\ Services}$ X_6 = Number of employees X_7 = Number of visitors	(Tamin,2000) (Agustin & Waloeya, 2018) (Waloejo & Prayitno, 2020)

	X_8 = Building area X_9 = Parking area	
	$Y_{Minimarket}$ X_{10} = Number of employees X_{11} = Number of visitors X_{12} = Building area X_{13} = Parking area	
The attraction of land use for healthcare	$Y_{Healthcare}$ X_{14} = Number of employees X_{15} = Number of visitors X_{16} = Building area X_{17} = Parking area	(Waloejo, 2020) (Himah et al., 2023)
The attraction of land use for offices	$Y_{Offices}$ X_{18} = Number of employees X_{19} = Number of visitors X_{20} = Building area X_{21} = Parking area	(Waloejo et al., 2019) (Waloejo, 2020)
The attraction of land use for education	Y_{School} X_{22} = Number of students X_{23} = Number of teachers X_{24} = Number of classrooms X_{25} = Parking area X_{26} = Building area	(Waloejo et al., 2019) (Waloejo, 2020)
The Attraction of Land Use for Worship	$Y_{Worship}$ X_{39} = Number worshippers per day X_{40} = Building area X_{41} = Parking area	(Waloejo, 2020) (Himah et al., 2023)
Interaction of land use and road network	Internal volume External volume Alleyway volume	(PKJI, 2014) (Waloejo et al., 2019) (Waloeja,2020)
Level of Services	Total Volume Road's Capacity	(PKJI,2014) (Hanif & Darsono, 2022)

Table 1 lists a number of sources where studies on the relationship between land use and road performance have been conducted. There are variables Y and X in every aspect. Variable Y is land use, such as housing, trade and services, health, offices, education, and worship, which is the dependent variable[26]. In the dependent variable Y, there is an independent variable, namely X, such as X_1 = Number of household members, X_2 = Number of motor vehicle ownership, X_3 = Household income, X_4 = Number of bedrooms, and X_5 = Building area. The selection of x and y variables is based on land use, generation, and attraction on the Sultan Agung Road. In each aspect, there is a different dependent variable that adjusts the characteristics of each land use. such as housing, which is synonymous with family and income. Trade services and offices are synonymous with workers and visitors, while educational land uses are synonymous with teachers and students. Previous research also serves as a basic reference, such as the interaction of land use and road network, and level of service.

The difference between the variables in the research at Sultan Agung Road and previous research is the variable use of worship land, which is the dependent variable. The independent variable of worship is X_{39} = Number worshippers per day, X_{40} = Building area, and X_{41} = Parking area.

2.3 Population dan Sample

This study employed stratified random sampling as its sampling design, which means choosing independent samples from each level of the population after stratifying it according to the known features of each sample[31]. This study employed stratified random sampling as its sampling design, which means choosing independent samples from each level of the population after stratifying it according to the known features of each sample.

Isaac and Michael's sampling technique was applied in this investigation. The population error of Isaac and Michael's sampling technique is 5%. In order to collect samples of land usage in the Road Sultan Agung Corridor portion, sampling was done. The following formula can be used to calculate the quantity of samples of Isaac and Michael:

$$S = \frac{\lambda^2 npq}{d^2(n-1)+\lambda^2 pq} \qquad (1)$$

An arbitrary sample is taken from the population of each land use. The outcomes of the population and sample used in this investigation are listed below:

Table 2. Population and Sample

Land use	Population (Unit)	Sample (Unit)
Healthcare	5	5
Education	4	4
Trade and services	74	71
Worship	3	3
Offices	7	7
Housing	5	5

The number of land uses on Sultan Agung Road that are currently in use is used to calculate the population in Table 2. On Sultan Agung Road, there are two units: the land use sample and the population unit. Samples from the entire population were taken, and the quantity of samples was determined. The land use generation, attraction, and internal volume are all done with this land use sample.

2.4 Method of Analysis

A. Capacity on road

Capacity on road is the maximum current that can be maintained per hour passing through a point on the route under certain conditions[32]. The basic equation for determining capacity in PKJI, 2014 is[33]:

$$C = C_O x FC_W x FC_{SP} x FC_{SF} x FC_{CS} \quad (2)$$

The calculation of road capacity is seen from several factors based on PKJI 2014, starting with determining the C_O (Elementary capacity) of the road type 4/2 or 2/2, the second factor FC_W (Basic capacity adjustment factor according to lane width) of the road type and the width of the two lanes. direction, the third factor FC_{SP} (Power correction factor for direction separation) from the comparison of the sizes of the right and left lanes. The fourth factor is FC_{SF} (Side obstacle correction factor) from the type of road, whether the side obstacle class is medium, height and effective shoulder width. The final factor is FC_{CS} (City Scale Adjustment Coefficient) of the city's population and is classified into the city class.

B. Interaction Analysis of Land Use and Road Network

The following functional methods and equations are utilized in the interaction model that was used to determine how Sultan Agung Road's land use system and road network relate to one another[28]:

$$\sum Vin = e_1Y_1 + e_2Y_2 + e_2Y_3 + e_4Y_4 + \ldots\ldots EnYn \quad (3)$$

$$\sum Veks = Vex\ 1 + Vex\ 2 + \ldots\ldots + Vex\ 5 + Vex\ 6 \quad (4)$$

The first stage is to calculate the internal volume of the vehicle from the movement of each land use (V_{in}). The movement volume is obtained from the movement generation and attraction model from Correlation Analysis and Multiple linear regression. Ratio e, which is the ratio of trip volume of each arrive utilize at specific time and the whole trip volume (car unit/day)[34].

External volume (V_{eks}) calculations are obtained from traffic counting on continuous flow roads and Alleyways on one road corridor. The types of vehicles in traffic counting volume during the survey were trucks / buses (KB), cars (KR), motorcycles (SM) with units of vehicle/hour, then the results were then converted into passenger car units (PCU) according to the classification/division urban roads based on PKJI, 2014[35].

C. Road Network – Land Use Interaction Model

The results of calculating internal and external volume data in total. The following functional methods and equations are utilized in the interaction model to ascertain the link between land use systems and network infrastructure[36].

$$VCR = \left(\sum V_{internal} + \sum V_{exsternal}\right) \quad (3)$$

The interaction model of Land Use and the road network is a combination of the movement of vehicles in and out of a land use or can be called internal volume with the movement of vehicles from continuous flow and environmental roads, namely the external volume of vehicles. After the two volumes are added together, the total volume will be obtained[29].

D. The Road Level of Service

The degree of saturation is used to calculate the Road Level of Service analysis. Road traffic to capacity, or saturation (DS), is the main factor influencing how effectively intersections and specific road segments function[37]. The formula for degree of saturation in Indonesian Highway Capacity Manual, 2014 is:

$$D_j = \frac{Q}{C} \quad (6)$$

From the calculation results obtained, the degree of saturation was divided into 6 levels, these levels start from the highest level A to the lowest level F. Standards for road service levels use Indonesian Highway Capacity Manual, 1994, and Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 96 of 2015. Level A is the best traffic level, drivers have the freedom to drive at free flow speeds, and level F is the worst traffic quality level. LOS A becomes a free flow condition with a low volume of traffic movement. Service B represents a stable free flow. Service C provides steady flow conditions with controlled vehicle speed. Service D is operating at a high density, but the steady flow rate is still valid. Service E represents the unstable flow and the level at which highway capacity has been reached. Service F describes an interruption or forced flow state with a flow exceeding capacity[38].

E. Correlation Analysis

Correlation aims to discover the degree of relationship between the two variables under consideration. Correlation analysis is a statistical method for determining quantities that show how strong the relationship is between a variable and other variable, regardless of whether a variable depends on other variables. The truer the linear relationship, the stronger or higher the linear relationship between two or more variables[39]. The correlation coefficient is a measure to quantify this relationship between variables[40]. The basic equation is:

$$R_{Y.X1.X2} = \frac{r_{yx1} - r_{yx2} \cdot r_{yx1x2}}{\sqrt{1-r^2 x_1 x_2} - \sqrt{1-r^2 x_1 x_2}} \quad (7)$$

The correlation analysis method used uses the SPPS application, the steps carried out in the research are partial and bivarate correlation. in general below[41]:

1. In SPPSS click the Menu bar, select Analyze-->Correlate-->then Bivariate. After the bivariate results are done partial by repeating the same thing.
2. Next, a tab called Bivariate Correlations will appear.
3. In the left box, all your variables are displayed. Highlight the variables for which you want to test the correlation, and then transfer them to Variables.
4. Click on OK, the correlation results will appear.

E. Multiple linear regression

Multiple linear regression is an analysis method that consists of more than two variables, namely two/more[42]. independent variables and one dependent variable Multiple linear regression analysis was performed to determine the interaction pattern of land use with the road network to know the internal volume derived from land use activities. The method used in this case is the step-by-step method. The step-by-step method is a method of selecting independent variables based on the largest partial correlation with the variables included in model[26]. The formula for multiple linear regression is:

$$Y = A + b_1X_1 + b_2X_2 + \ldots + b_nX_n \quad (8)$$

The model results carried out by assumption testing must be tested to ensure that the data used meets the assumptions of the regression analysis and the feasibility of the model. To carry out the classical assumption test, there are several tests that must be carried out, namely the t-test, f-test, and significance test[43].

3. Result and Discussions

3.1 Characteristics of the Road Network

Fig. 1 : Characteristic conditions of Sultan Agung Road

Distinguish between Fig. 1 Sultan Agung Road including a Two-Lane Two-Way Undivided Road (2/2 TT) which has two lanes in two opposite directions. Characteristics of a 2/2 TT road with an effective width of 8 m with an effective shoulder width of 2 m on each side, does not have a median.

The Road Sultan Agung corridor has a primary collector street hierarchy. The road capacity on the Road Sultan Agung corridor is 2826.63 pcu/hour, explanation of the calculations in Table 3. below. The details of each capacity consist of basic capacity (pcu/hour), an adjustment factor for basic capacity due to the width of the traffic lanes, an adjustment factor for capacity separation for direction separation, an adjustment factor for side barriers, and an adjustment factor for city size.

Table 3. Road Capacity of Sultan Agung Road

Factor	Characteristics	Value
(Co) Elementary capacity	• Road type 2/2 TT	2900 (pcu/hour)
(FC_W) Basic capacity adjustment factor according to lane width	• Road type 2/2 TT • Effective traffic lane width (m)= 8,00	1.14
(FC_{SP})Power correction factor for direction separation	• Road type 2/2 TT • Separating Factor = 50-50	1.00
(FC_{SF}) Side obstacle correction factor	• Side obstacle class: S • Effective shoulder width (m)= 1,5	0.95
(FC_{CS})City scale adjustment coefficient	• The population of Malang Regency = 2.685.900	0.9

Based Table 3. The value obtained from each factor is based on PKJI 2014. The factors multiplied by each factor are C_o= 2900; FC_w = 1.14; FC_{sp}= 1; FC_{sf} = 0.95; FC_{cs} = 0.9.

3.2 Characteristics of Land Use Generation and Attraction Movements

The movement characteristics of land use generation and attraction are the number of vehicles entering and exiting each land use in the form of pcu/hour. Survey of the characteristics of movement generation and movement attraction for each land use. The result of calculating movement characteristics is that there is a ratio (e) which is used in the integration analysis of land use - road network. The ratio is obtained by dividing the total volume per hour by the total volume per day.

A. Land Use Housing

The highest total movement of the generation occurred at 07.01–08.00, as much as 3.40 pcu/hour with a ratio of 18.28%. The highest generation for residential land occurs at 07.01–08.00, as much as 3.40 pcu/hour. Meanwhile, the highest pulling movement occurred at 15.01–16.00, as much as 2.75 pcu/hour.

B. Land Use for Trade and Services

The average number of withdrawals (incoming volume) from trade and service land uses is 11.55 pcu /day. While the total market attraction is 39.90

pcu /day. The highest total movement of the generation occurred at 13.01–15.00, namely 3.15 pcu/hour with a ratio of 13.64%. while the lowest total rise and pull occurred at 20.01–21.00, as much as 0.35 pcu/hour with a ratio of 1.52%. The highest attraction for trade and service land in Road Sultan Agung Corridor occurred at 13.01–14.00, or as much as 1.75 pcu/hour. Meanwhile, the highest generation movement occurred at 14.01–15.00 at 1.75 pcu/hour.

C. LandUse Healthcare

The highest total movement of the generation occurred at 08.01-09.00 and 12.01-13.00, namely 3.75 cur/hour with a ratio of 12.30%. The highest attraction for health land use in Road Sultan Agung Corridor occurred at 08.01-09.00, or as much as 2.05 pcu/hour. Meanwhile, the highest generation movement occurred at 12.01–13.00 at 2.05 pcu/hour.

D. LandUse Office

The highest total movement of the generation occurred at 08.01-09.00, namely 9.15 pcu/hour with a ratio of 19.93%. While the lowest total rise and pull occurred at 12.01–13.00, as much as 1.05 pcu/hour with a ratio of 2.29%. The highest withdrawal for office land in Road Sultan Agung Corridor occurred at 08.01-09.00, or as much as 4.75 pcu/hour. While the highest generational movement occurred at 08.01-09.00 and as much as 4.40 pcu/hour.

E. LandUse Educational

The highest total movement of the generation occurred at 06.01–07.00, as much as 18.20 pcu/hour with a ratio of 41.27%. The highest attraction for education land in Road Sultan Agung Corridor occurred at 06.01–07.00, as much as 18.20 pcu/hour. Meanwhile, the highest generation movement occurred at 14.01–15.00, as much as 13.65 pcu/hour.

F. LandUse the Place of Worship

The average number of withdrawals (incoming volume) and generation (outgoing volume) of the use of worship land is 30.55 pcu/day. The average total movement from the use of worship land is 61.10 pcu/day. The highest attraction for worship land in Road Sultan Agung Corridor occurred at 17.01–18.00, or as much as 8.25 pcu/hour. Meanwhile, the highest generation movement occurred at 17.01–18.00, or as much as 7.90 pcu/hour. The highest total movement of the tensile generation occurred at 17.01–18.00, namely 16.15 pcu/hour with a ratio of 26.43%. While the lowest total rise and pull occurred at 19.01-20.00, as much as 0.7 pcu/hour with a ratio of 1.15%.

3.3 Application of Movement Generation and Attractive Models

The following are the results of land use modeling using correlation analysis and multiple linear regression on the Sultan Agung Road.

Table 4. Land Use Model

Land use	Trip Generation Model
Housing	The average number of family members (X_1) = 3 Average number of vehicle ownership (X_2) = 2 Amount of land use = 5 $Y_{Housing}$ = - 0.173+0.824(X_1) +0.403(X_2) $Y_{Housing}$ = - 0.173+0.824(3) +0.403(3) $Y_{Housing}$ = 3.76 $Y_{Housing}$ = 3.76 (5) = 18.785 pcu/day
Trade and services	Average number of visitors (X_7) = 43 Average building area (X_8) = 159 Average parking area (X_9) = 14 Amount of land use = 72 $Y_{Trade\ and\ services}$ = 0.739+0.482(X_7)+0.015(X_8)–0.005 (X_9) $Y_{Trade\ and\ services}$ = 0.739+0.482(43)+0.015(159)–0.005 (14) $Y_{Trade\ and\ services}$ = 23.84 $Y_{Trade\ and\ services}$ = 23.84 (72) = 1716.13 pcu/day
Minimarket	Average number of visitors (X_{11}) = 223 Average parking area (X_{13}) = 22 Amount of land use = 2 $Y_{Minimarket}$ = -0.363+0.352(X_{11})+0.063(X_{13}) $Y_{Minimarket}$ = -0.363+0.352(223)+0.063(22) $Y_{Minimarket}$ = 79.52 $Y_{Minimarket}$ = 79.52 (2) = 159.038 pcu/day
Healthcare	Average number of visitors (X_{22}) = 36 Average building area (X_{23}) = 157 Amount of land use = 5 $Y_{Healthcare}$ = 0.840 + 0.327(X_{22}) + 0.111 (X_{23}) $Y_{Healthcare}$ = 0.840 + 0.327(36) + 0.111 (157) $Y_{Healthcare}$ = 30.04 $Y_{Healthcare}$ = 30.04 (5) = 150.195 pcu/day
Offices	The average number of employees (X_{30}) = 25 Average number of visitors (X_{31}) = 52 Average building area (X_{32}) = 479 Amount of land use = 7 $Y_{Offices}$ = 5.989+0.401(X_{30})+0.333(X_{31})+ 0.025(X_{32}) $Y_{Offices}$ = 5.989+0.401(25)+0.333(52)+ 0.025(479) $Y_{Offices}$ = 45.31 $Y_{Offices}$ = 45.31(7) = 317.135 pcu/day
Education	The average number of students (X34) = 271 Average parking area (X37) = 310 Amount of land use = 4 $Y_{Education}$ = 6,417 + 0.116 (X_{34}) + 0.022 (X_{37}) $Y_{Education}$ = 6,417 + 0.116 (271) + 0.022 (310) $Y_{Education}$ = 44.68 $Y_{Education}$ = 44.68 (4) = 178.714 pcu/day

Worship	The average number of worshipers (X_{39}) = 116 Average parking area (X_{41}) = 219 Amount of land use = 3 $Y_{Worship}$ = -6.782 + 0.409 (X_{39}) + 0.097 (X_{41}) $Y_{Worship}$ = -6.782 + 0.409 (116) + 0.097 (219) $Y_{Worship}$ = 61.91 $Y_{Worship}$ = 61.91(3) = 185.715 pcu/day

Based on Tabel 4. the results of the application model are multiplied by the number of respective land uses to get the volume in one day. the highest volume of land use movement comes from trade and service land use, which is 1716.13 pcu/day. This high volume is comparable to the largest number of trade and service land uses compared to other land uses. Meanwhile, the smallest volume of movement for land use is worship at 18.79 pcu/day. From these results the attraction of land use for trade and services is greater than other land uses by providing 63% of the total volume of land use in a day.

3.4 Interaction of Land Use and Level of Services

The results of applying the generation and attraction models to each land use will obtain the total volume of each land use/internal volume. The interaction of land use and the road network is obtained by adding the internal volume to the external volume (the continuous road volume is added to the alleyway road volume) to obtain the total volume. From the total volume, the degree of saturation is calculated by dividing the total volume by the road capacity to obtain the LOS.

The total internal volume on Road Sultan Agung is 2725.72 pcu/day. The total alleyway volume roads are 204.05 pcu/hour and the continuous volume is 23621 pcu/day. The total volume burdening Road Sultan Agung is 26550.27 pcu/day. The internal volume is high in the afternoon because it is school and office home time on Sultan Agung Road. The highest road service level occurs at 12.00–13.00, which is 0.84 with a Level of Service is D. The highest LOS results were D at 11.01-15.00. This causes the flow to approach stable, speed can still be controlled, average speed ≥ 27 km/hour. This increases at this time based on the large volume of internal in and out use of land due to break times, lunch and after school. Likewise, the comparable external volume increases during peak hours. The high volume of continuous flow passing through Sultan Agung Road every hour indicates that Sultan Agung Road is the main road connecting districts in the South Malang region of Malang and Blitar districts. Details of the interaction of land use and Sultan Agung roads per hour are presented in Table 4.

Table 4. Interaction of Land Use and Sultan Agung Road

Time	Internal Volume (pcu/hour)	Alleyway volume (pcu/hour)	Continuous volume (pcu/hour)	Total Volume (pcu/hour)	Roads Capacity	Ratio (V/C)	LOS
06.00-07.00	95.62	4.55	1110	1210.32	2826.63	0.43	B
07.01-08.00	119.73	13.65	1306	1439.73	2826.63	0.51	C
08.01-09.00	223.97	10.85	1681	1916.27	2826.63	0.68	C
09.01-10.00	165.37	18.20	1831	2014.42	2826.63	0.71	C
10.01-11.00	233.98	-6.70	1866	2093.58	2826.63	0.74	C
11.01-12.00	196.06	26.35	2118	2339.96	2826.63	0.83	D
12.01-13.00	221.77	37.55	2124	2383.52	2826.63	0.84	D
13.01-14.00	325.71	28.40	1940	2293.91	2826.63	0.81	D
14.01-15.00	352.78	15.15	1789	2157.28	2826.63	0.76	D
15.01-16.00	204.88	4.70	1806	2016.03	2826.63	0.71	C
16.01-17.00	99.08	11.60	1629	1739.53	2826.63	0.62	C
17.01-18.00	189.37	-6.00	1441	1624.22	2826.63	0.57	C
18.01-19.00	177.37	27.80	1132	1337.32	2826.63	0.47	C
19.01-20.00	85.67	14.35	996	1095.52	2826.63	0.39	B
20.01-21.00	34.33	3.60	851	888.63	2826.63	0.31	B
Total	2725.72	204.05	23621	26550.27			

3.5 Effect of Land Use on Road Performance

The influence of land use attraction generation on road performance can be determined from the contribution of internal volume, alleyway road volume and continuous volume to the total volume by dividing each hourly volume by the total volume. Next, the contribution of the internal volume is calculated by calculating the contribution of each land use to the total volume, then we will get the contribution of the influence of land use to road performance.

The results Table 5. below shows that the continuous volume has the greatest influence on the total volume on the Sultan Agung Road. The highest total volume occurs at 12.00–13.00. Based on Table 5. the internal volume contribution to the total volume at 12.00–13.00 is 9.3%. Contributions from alleyway volume and continuous volume are, respectively, 1.6% and 89.1%.

Table 5. Internal and External Volume Contribution to Total Sultan Agung Road

Time	Internal Volume (pcu/hour)	Alleyway volume (pcu/hour)	Continuous volume (pcu/hour)	Total Volume (pcu/hour)	Contribution to Total Volume (%)		
					Internal Volume	Alleyway volume	Continuous volume
06.00-07.00	95.62	4.55	1110	1210.32	7.9%	0.4%	91.7%
07.01-08.00	119.73	13.65	1306	1439.73	8.3%	0.9%	90.7%
08.01-09.00	223.97	10.85	1681	1916.27	11.7%	0.6%	87.7%
09.01-10.00	165.37	18.20	1831	2014.42	8.2%	0.9%	90.9%
10.01-11.00	233.98	-6.70	1866	2093.58	11.2%	-0.3%	89.1%
11.01-12.00	196.06	26.35	2118	2339.96	8.4%	1.1%	90.5%
12.01-13.00	221.77	37.55	2124	2383.52	9.3%	1.6%	89.1%
13.01-14.00	325.71	28.40	1940	2293.91	14.2%	1.2%	84.6%
14.01-15.00	352.78	15.15	1789	2157.28	16.4%	0.7%	82.9%
15.01-16.00	204.88	4.70	1806	2016.03	10.2%	0.2%	89.6%
16.01-17.00	99.08	11.60	1629	1739.53	5.7%	0.7%	93.6%
17.01-18.00	189.37	-6.00	1441	1624.22	11.7%	-0.4%	88.7%
18.01-19.00	177.37	27.80	1132	1337.32	13.3%	2.1%	84.7%
19.01-20.00	85.67	14.35	996	1095.52	7.8%	1.3%	90.9%
20.01-21.00	34.33	3.60	851	888.63	3.9%	0.4%	95.7%
Total	2725.72	204.05	23621	26550.27	10.3%	0.8%	89.0%

The percentage results are obtained by dividing the total volume of each land use movement by the total volume. At 12.00–13.00, the volume of trade and service land use has the greatest influence, namely 6.55%, and the second largest influence of land use, namely health, is 0.77%. The land use with the least contribution is residential land, which is 0.04%.

From the results of the total internal volume in a day, the biggest influence is land use, trade, and services. The total internal volume of trade and services was 1716.13 pcu/day, or 63% of the total internal volume. Details of the influence on each land use: housing accounts for 0.7%, minimarkets 5.8%, healthcare 5.5%, offices 11.6%, and education respectively 6.6% and 6.8% of the total volume total internal. This indicates that the attraction of the service trade is the main attraction in the Sultan Agung Road corridor.

In research on the Singosari-Lawang corridor, similar results were also obtained that the largest influence was land use for trade and services, up to 70%, especially the LOS obtained up to E traffic jams[30,45]. This road corridor is the main road in Malang district, and of course, the traffic flow is also busy as a link between districts and sub-districts. So it is necessary to take action or steps to regulate changes in land use in the future that limit trade and service buildings, as well as move trade and service areas to other roads along the corridor. As in previous research conducted in Surabaya-Sidoarjo, industrial land use had the greatest influence on internal volume[29]. So it is necessary for the government to organize industrial areas [46,47]. Likewise, in research in Tanzania, the impact of changes in land use has shown an impact on the rapid increase in population, building patterns which have resulted in an increase in the number of trips resulting in several existing roads losing their capacity to accommodate traffic, resulting in traffic jams[44].

4. Conclusion

From the results above, the road capacity in the Road Sultan Agung corridor is 2826.63 pcu/hour. The results of each factor consist of C_0 = 2900; FC_w= 1.14; FC_{sp}; FC_{sf} = 0.95; and FC_{cs} = 0.9. The results of the performance of the Road Sultan Agung selection that have been carried out obtained the highest road performance occurring at 12.00–13.00, namely 0.84 with the LOS D indicator. The degree of saturation is obtained by LOS D from the road service level standards, where the v/c value of LOS D is 0.75-0.84. The results of the calculation of LOS D mean that Sultan Agung Road has high road density, vehicle speed can still be controlled, and the flow rate still applies. The internal volume contribution to the total volume at 12.00–13.00 is 9.3%. Contributions from alleyway volume and continuous volume are, respectively, 1.6% and 89.1%. total internal volume in a day, the biggest influence is land use, trade, and services. The total internal volume of trade and services was 1716.13 pcu/day, or 63% of the total internal volume. Details of the influence on each land use: housing accounts for 0.7%, minimarkets 5.8%, health 5.5%, offices 11.6%, and education respectively 6.6% and 6.8% of the total volume total internal. This indicates that the attraction of the service trade is the main attraction in the Sultan Agung Road corridor.

These findings indicate that in order to make the LOS on Sultan Agung Road even better, planning is required. The author offers some remedies and suggestions that could be implemented on Sultan Agung Road to lower the road's high performance, including regulating on-street parking and widening the road. Additionally, the roadside is taken up by the 0.5 meter wide extension to the road body's width. Expanding the width of the road can lead to a 2936.25 pcu/hr increase in capacity.

The results of this study explain the impact of the pull and generation effects of land use on transportation, namely the road network. The use of the largest trade and service areas attracts people to come, bringing their own vehicles during peak hours. Land use has resulted in an increase in the number of vehicle trips exceeding estimated transportation needs. The excessive number of vehicles causes existing roads to lose their capacity and become overloaded to accommodate traffic, resulting in traffic jams and hampered travel.

The author certainly has obstacles and limitations in the research studied. Time limitations and surveyors need to be considered so that traffic counting calculations in one day can be maximized. Moreover, the number of land uses must also be balanced with the number of surveyors. Suggestions or directions for further research in this area can be developed in the future at the same location, taking into account the influence of traffic and delays from the railway line.

If it is carried out in different places, of course the problems will be different, as will adjustments to variables or methods according to the study location. Locations where there are intersections also need to be analyzed, dividing certain segments and calculating the volume at the intersection. The results of this study require further study of the influence of land use by studying the distance and accessibility of the Sultan Agung Road.

The government needs to make regulations to regulate land use changes that occur in Kepanjen so that land use and road volume do not accumulate in Kepanjen urban areas, especially Sultan Agung Road. In the future, there will be the addition of a new road in Kepanjen as a connection between the district and the city center in anticipation of reducing vehicle loads.

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Nomenclature

S	Number of Samples
n	Number of Population
P	Proportion in population (p=q=0.50)
Q	probability of being wrong (0.5)
D	Accuracy / degree of certainty (0.05)
λ^2	Chi Square Value (5% error rate =3.841)
C	Capacity (pcu/hour)
C_O	Elementary capacity (pcu/hour)
FC_W	Basic capacity adjustment factor according to lane width
FC_{SP}	Power correction factor for direction separation
FC_{SF}	Side obstacle correction factor
FC_{CS}	City scale adjustment coefficient
VCR	Ratio Volume Capacity (level of servive)
V	Traffic Volume (pcu/hour)
$V_{Internal}$	Amount of Vehicle Volume from Generation/Attraction of Land Use
$V_{external}$	Amount of on-going Vehicle Volume on the Main Street
C	Road Capacity (pcu/hour)
$e1= V_1/Y_1$	The ratio of the total volume of vehicle movements per hour to the total volume of vehicle movements in one day
Y_1	Volume of vehicle movement/day of influence of the trip generation/attraction of land use for Healthcare
Y_2	Volume of vehicle movement/day of influence of the trip generation/attraction of land use for Education
Y_3	Volume of vehicle movement/day of influence of the trip generation/attraction of land use for Trade and services
Y_4	Volume of vehicle movement/day of influence of the trip generation/attraction of land use for Worship
Y_5	Volume of vehicle movement/day of influence of the trip generation/attraction of land use for Offices
Y_6	Volume of vehicle movement/day of influence of the trip generation/attraction of land use for Housing
Y_n	Volume of vehicle movement per day of influence of the trip generation or attraction for Land use
V_{Ex-1}	Volume of vehicle movements/hour leaving neighborhood streets/alley 1
V_{Ex-2}	Volume of vehicle movements/hour leaving neighborhood streets/alley 2
V_{Ex-3}	Volume of vehicle movements/hour leaving neighborhood streets/alley 3
V_{Ex-5}	Volume of movement of vehicles/hour continuously on the main road
V_{Ex-6}	volume of movement of vehicles/hour continuously on the main road
D_J	Degree of saturation
Q	Traffic Flow (pcu/hour)
r	pearson's correlation correlation
X	Independent variable
Y	Dependent variable
A	Contanta
$X_1 ... X_n$	Independent variable
$b_1 .... b_n$	Regression coefficient

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