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Analysis Intersection Performance Based on Regional Characteristics, Traffic Characteristics and Accessibilities
(Case study of central business district area of Ternate city)

*** Nurmaiyasa Marsaoli, ** Lawalenna Samang, *** Shirly Wunas, **** Sumarni Hamid Aly**

[*] *Doctoral Course Student of Civil Engineering Department, Hasanuddin University, Makassar, 90245, Indonesia.*

[**] *Professor, Civil Engineering Department, Hasanuddin University, Makassar, 90245, Indonesia.*

[***] *Professor, Architect Engineering Department, Hasanuddin University, Makassar, 90245, Indonesia.*

[****] *Associate Professor, Civil Engineering Department, Hasanuddin University, Makassar, 90245, Indonesia.*

**Orcid ID: 0000-0002-3084-0700*

Abstract

This research aims to analyze the interaction relationship between the characteristics of area, traffic and accessibility to the intersection performance and to model the simultaneous interaction of the characteristics of area, traffic, accessibility and its implications on the intersection performance. The research area is Ternate Central Businis District. The intersection serves as a connectivity road that connects the movement of people and goods traffic, in and out of the area. The research design is based on survey of the characteristics of area and accessibility as well as survey of the traffic flows. Analysis of the characteristics and accessibility of the area used quantitative descriptive method and questionnaire-based analysis, while the characteristics of traffic and intersection performance adopted MKJI 1997 method, factor interaction was modeled simultaneously. The relationship of interaction between indicators used SEM PLS 2M3 analysis method. The exogenous variable (cause) is an indicator of the characteristics of CBD area and the endogenous variable is the indicators of traffic, accessibility and intersection performance. The results of intersection performance based on the degree of saturation (DS) values of 0.94> 0.85 (MKJI standard) show that the road segment at the intersection is in condition of unstable traffic flow capacity, sometimes stopped speed, and E service level. Based on the interaction analysis results using SEM PLS model, indicator which directly influences to intersection performance is accessibility.

Keywords: Area, traffic, accessibility, intersection performance

INTRODUCTION

The Central Business District of Ternate is the most visited places in Ternate City. Located in the downtown, it has an easy accessibility to reach. The developments of this CBD area have an impact to the performance of streets around it (Pahlawan Revolusi roads and Halmahera roads), particularly the junction that connecting the roads to another's. Soehady (2013) present that "a large-scale public activity, such as the CBD, it has contributed substantially to the traffic load. Eventually, these conditions will give an impact on the performance of the road service". The performance of the roads and the junctions are strongly influenced by the volume of the vehicle throughout the lane or traffic loads. Several studies have been conducted to identify the factors causing the decline of road performances, either the junction. Ayu (2013) found that the increasing of the central business district have an impact to road and junction services around it, and this condition presented by the increasing in road density, reduction in vehicle speed and traffic jam in hours on the junctions. Aly (2011) stated that the factors that may affect the performance of the road and the junction are: increasing in income, growth of population and vehicle, where these parameters will induce the augmentation of need in transportation. Another studies conducted by Li et. al. (2004) trying to analyzed the performance of a junction and their correlation due on traffic heterogeneity and traffic accident based on Gray System Theory. While Agustinus (2013), trying to minimize the traffic problems in Residential Area and his relation on junction's performance. In general, research focuses on aspects of traffic. By looking at the correlation or influence on partial performance of the intersection. Parameters of measures of intersection performance in this study are not only measured by traffic but also measured also based on the characteristics of the region, and accessibility, from several correlated factors, it is not known which factors affect the performance of intersections directly or indirectly.

Figure 1: Research Location

METHODOLOGY

Research Object

The research was done in the CBD area of Ternate, the research object was the intersection of *Jalan Pahlawan Revolusi* and *Jalan Halmahera* located in the CBD area serving as a connectivity road.

In this study were used three methods of analysis in accordance with research objectives, as follows :

1. Qualitative descriptive analysis method and questioner result data, method and result of quieter were used to analyze characteristic of CBD area and its accessibility analysis
2. Methods of performance analysis and analysis of intersection characteristics based on Manual of Indonesia Road Capacity (*MKJI*) were to analyze the value of DS and level of service intersection (intersection performance).
3. Method of SEM PLS model was to know the relationship of characteristic factor model of CBD area, traffic characteristic and its accessibility toward intersection performance, which based on the research concept on the indicator variable and the model image of the correlation between the variables. As follows : Table 1. Research Variable and Indicator.

Analysis Approach

The analysis approach used qualitative descriptive method that explains the study of the characteristic of activities in the area, both from physical aspect in the form of area structure and non-physical aspect in the form of activity system in the area. The analysis approach of the traffic characteristic adopted MKJI 1997 method and PLS micro-structural modeling. Descriptive method was used to analyze and describe the characteristics of the indicators that made up the model, whereas the PLS structural equation aimed to predict the interaction between the factors in the model. The use of PLS in the research was compared with covariant-based SEM due to consideration of sample size, multivariate non-normally distributed data, unequal data units, and the main substance of the research aimed to test the predicted relationship or effect among construction.

Partial Least Square (PLS)

The concept of structural model in this research was divided into the latent exogenous and endogenous variables. The variable causing the intersection performance decreased the service level was assumed on the factor of area characteristic (KKCBD), accessibility (AK), and traffic (KLL). From the indicator, however, these variables were indicated to interact with each other. Exogenous variables are area characteristics (KK), while traffic characteristics (KLL), accessibility (AK), and intersection performance (KS) are endogenous variables. Visually, the interaction relationship between indicator variable can be described in structural model diagram path of Figure 2.

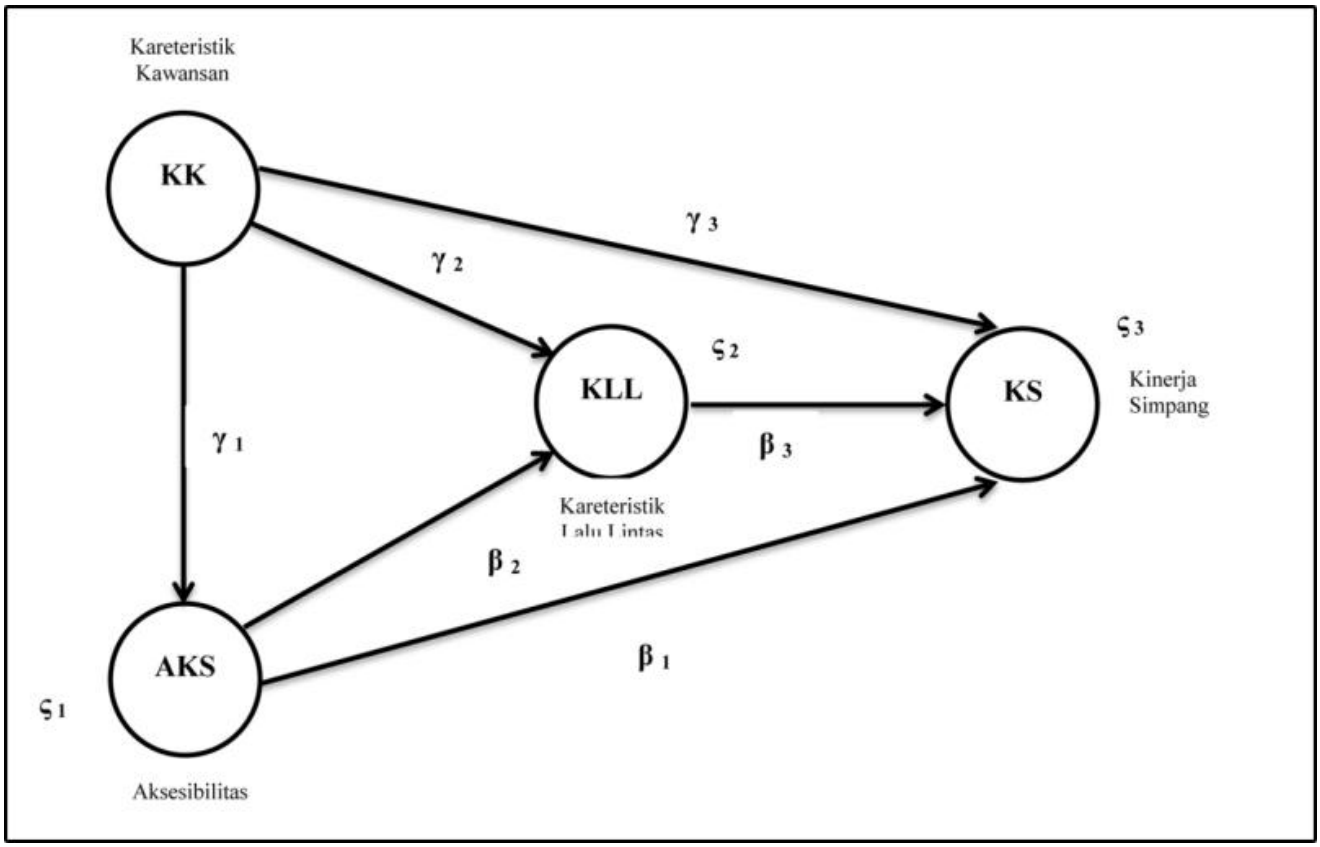

Figure 2: Conceptual framework of inner model

Based on the conceptual framework of inner model, mathematically the regression model of structural model is as follows :

$AK = \gamma 1\ KK + \varsigma 1$

$KLL = \beta 2\ AK + \gamma 2\ KK + \varsigma 2$

$KS = \beta 1\ AK + \beta 3\ KLL + \gamma 3\ KK + \varsigma 3$

From the above equation can be explained that the accessibility factor (AK) is the function of regional characteristics (KK). Traffic characteristics are the function of regional characteristics (KK) and accessibility (AK). Intersection performance (KS) is the function of accessibility (AK), traffic characteristics (KLL), and regional characteristics (KK). Path coefficient of exogenous variable toward endogen is regional characteristics (KK) toward accessibility (AK) that is symbolized by γ1, regional characteristics toward traffic characteristics is symbolized by γ2, regional characteristics toward intersection performance is symbolized by γ3. Endogenous path coefficients toward endogen are accessibility variables toward intersection performance is symbolized by β1, accessibility toward traffic characteristics is symbolized by β2, and traffic characteristics toward intersection performance is symbolized by β3, while ς^{123} (zeta) is its model error.

RESULTS AND DISCUSSION

Intersection Performance

The indicator of intersection performance was determined based on the quantitative value of V/C ratio of the speed or freedom of the driver in moving to choose the speed of the degree of traffic barriers and comfort. The standard value in this research was set VCR = 0.85,meaning that at VCR value <0.85, the road segment was in normal qualitative condition, otherwise if VCR> 0.85, the road segment was in abnormal qualitative condition. Results of DS analysis can be seen in Figure 3.

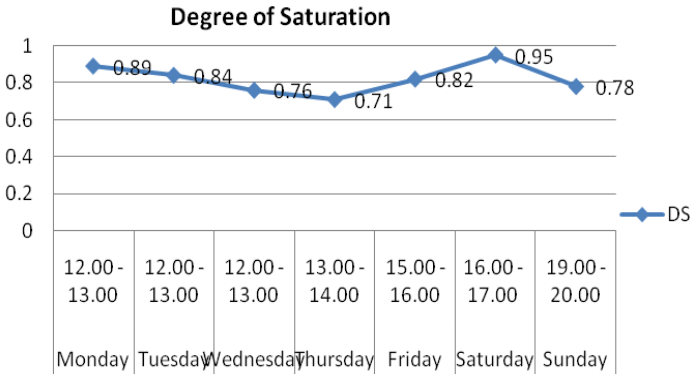

Figure 3: Degree of saturation of the maximum traffic

Based on Figure 3, the degree of saturation (DS) value is equal to 0,95 where maximum traffic flow happened on Saturday at 16.00-17.00, which is bigger than standard MKJI. This indicates that the intersection accepts high maximum traffic load. The condition of maximum traffic degree of saturation can be seen in Figure 3.

Area Characteristics and Accessibility

Based on descriptive qualitative analysis of space function as well as analysis of public perception results through the distribution of questionnaires as visitors or users of the CBD area, characteristic analysis of public service space function in CBD area is in accordance with the public service space function that can provide some facilities and can accommodate some activities in the CBD area intended for the community in general,where people blend in with each other who do not know each other. Based on the assessment of 140 respondents from the percentage of facility availability diagram, 24% of respondents stated very complete, 34% of respondents stated complete, 28% of respondents stated quite complete and 14% of respondents stated less complete.

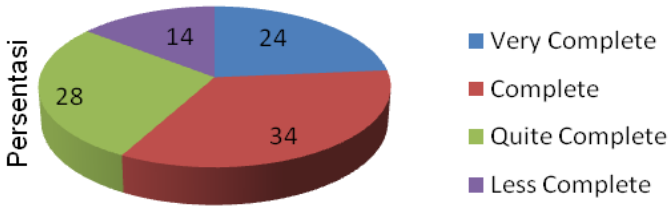

Figure 4: Facility availability diagram

CBD area is an area where spatial planning is prioritized because this area has a very important influence on the development of the macro area of the city. Based on the Spatial Plan (RTRW) of Ternate, CBD area is included in the area of economic growth strategy which directed towards its development covering Minapolitan area, as hiterland area for other sub-districts, as Water Front City area (Ternate Reclamation Area) of Ternate.

The determination of accessibility is done based on the distance/location of the area, the road network, and the existence of transportation facilities and infrastructure. Based on qualitative descriptive analysis of accessibility and analysis of community perception results through distribution questionnaires as visitors or users of the CBD area. The classification of accessibility levels to and from CBD area based on and community description and perceptions indicates a high degree of accessibility seen from close distance and good road infrastructure conditions. The quality of the road network is a factor that affects the determination of the accessibility level of an area based on the public perception which can be seen in Figure 5.

The road surface condition will determine the traffic activity passing through the intersection, based on the respondents' perceptions of the road surface quality, 140 respondents provided varied inputs as perceived, 58% of respondents said the road surface layer was very good, accelerating yhe movement without experiencing travel delays due to road damage, 39% of respondents said the road surface layer was in good condition and 3% of respondents said the road surface layer was quite good. Figure 5. Quality of Road.

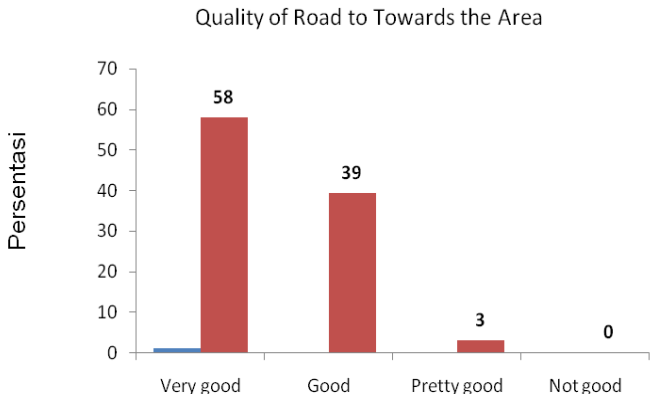

Figure 5: Quality of road surface at CBD area

Traffic Characteristics

The traffic volume and speed are the characteristics used to analyze traffic characteristics. The data were obtained from the field survey results in unit of vehicles per hour maximum traffic volume occurred on Saturdat at 16:00 to 17:00, ie 5,185 vehicles/hour, which is dominated by two-wheeled vehicles. Visually the results of traffic volume analysis can be seen in Figure 6.

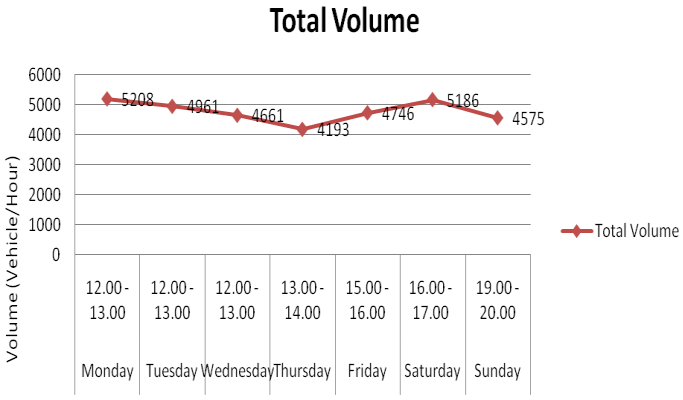

Figure 6: Maximum traffic volume

The maximum traffic volume passing through the intersection will affect the speed of the traffic movement. The speed that occurs at the maximum traffic volume intersection is 15 km/h for motor vehicles, 10 km/h for light vehicles and 10 km/h for

heavy vehicles. Based on Figure 6, it can be seen that the speed of the vehicles passing through the intersection is below 40 km/h. The low speed that occurs at the intersection is due to the high traffic volume passing through the intersection. The average speed of vehicles passing through the intersection of 12 km / h occurred on Saturday at 12.00-14.00 later in the afternoon at 16.00-17.00. Visually, the results of vehicle speed analysis can be seen in Figure 7.

Structural Model Analysis

Inner Model or Structural Model describes the relationship between latent variables based on substantive theory. Design of Structural Model relationship between latent variables based on the formulation of the problem or research hypothesis. Research variables and indicators can be seen in Table 1.

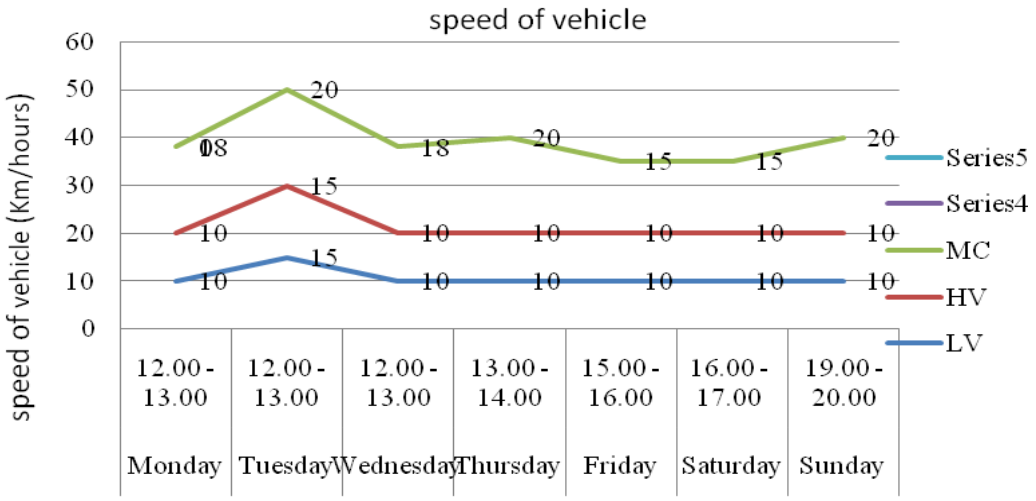

Figure 7: Vehicle speed for maximum flow

Table 1: Research variables and indicators

No.	Latent Variables	Indicators	Unit	Remark
1.	Area characteristics	• Facility abilities • Spatial system of the area • Feasibility of facility condition	Likert scale	Questionnaire/ respondents' perception
2.	Traffic characteristics	• Traffic volume • Traffic composition • Vehicle speed • Vehicle density	Vehicle/h% Km/h Vehicle/km	Traffic analysis
3.	Accessibility	• Road condition to the area • Accessibility to the area • Area safety • Area comfortness	Scale Scale Scale Scale	Questionnaire/ respondents' perception
4.	Intersection performance	• Capacity • Degree of saturation (DS) • Intersection delay • Opportunity of queue	PCU/h Sec/PCU %	Traffic analysis

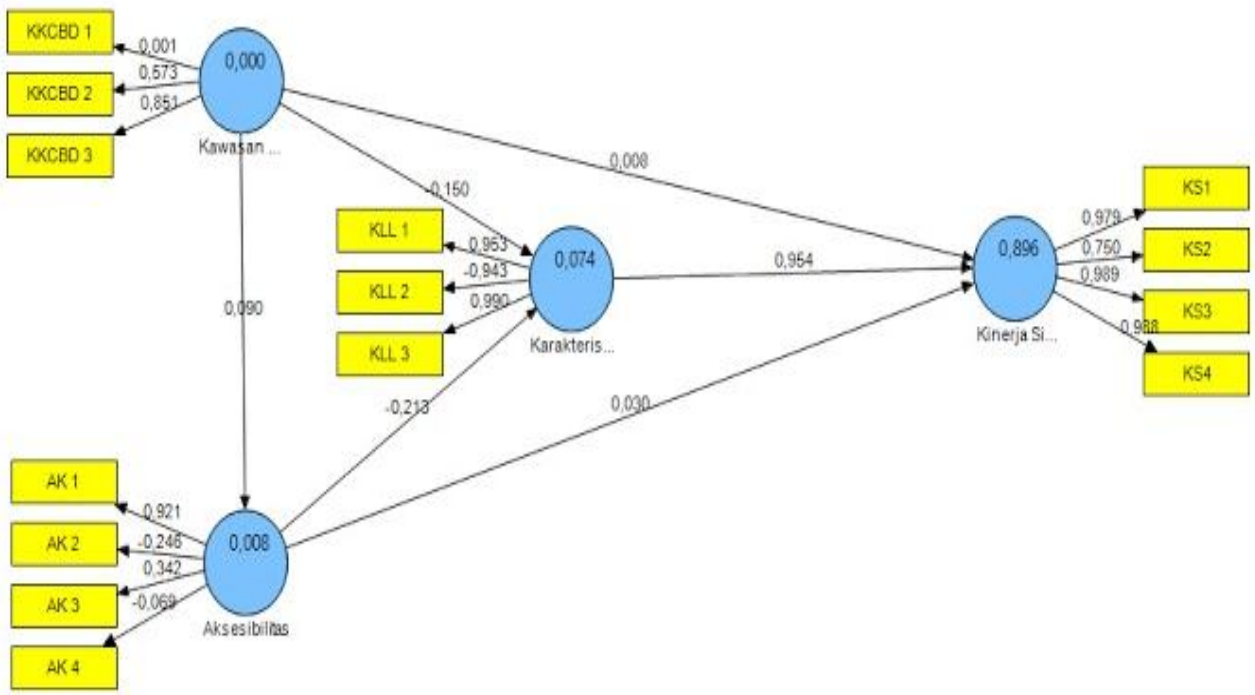

Figure 8: Results of loading factor

Figure 8 shows that the value of the loading factor of all indicators belongs to the criteria of convergence validity 0.50. Indicator included in the criteria of convergence validity is accessibility, ie AKS1 road condition indicator (0.921), indicator of valid indicator traffic characteristic of KKL1 (0.953), KKL2 (0.943) and KKL3 (0.990). The CBD area is a valid indicator of KKCBD2 (0.573) and KKCBD3 (0.850). The intersection performance variable of all indicators is valid.

Based on the convergence validity test results, the value of discriminant validity loading obtained can be seen in Table 2.

Table 2. Value of discriminant validity loading ran II

	Accessibility	Traffic characteristics	CBD area	Intersection performance
AKS 1	0.920			
KKCBD 2			0.573	
KKCBD 3			0.850	
KLL 1		0.953		
KLL 2		-0.943		
KLL 3		0.989		
KS 1				0.979
KS 2				0.704
KS 3				0.989
KS4				0.988

Table 2 shows the existence of good discriminant validation because the correlation value of the indicator to its construction is higher than the correlation value of the indicator with other construction. As illustration, AKS1 (road condition) is equal to 0.920, which is higher than loading factor of other construction factor, the indicator values of traffic characteristic of 0.953 for KKL1, 0.943 forKKL2and 0.989 for KKL3 also have loading factor value higher than loading factor with other construction. This is also evident in CBD area indicators and intersection performance indicators.

In addition to the construct validity test, construct reliability test was also done measured by composite reliability and Cronbach's alpha from the indicator block measuring the construct. The result of composite reliability test and Cronbach's alpha from Smart PLS can be seen in the table below.

Table 3: Reliability rest results

Construct	Composite Reliability	Cronbach's Alpha
Accessibility	0.232	-0.015
Traffic characteristics	0.818	-1.769
CBD area	0.510	0.072
Intersection performance	0.963	0.946

The construct is declared reliable if it has composite reliability value of above 0.7 and its Cronbach'salpha of above 0.6. From the output of Smart PLS 2.0M3 above, not all constructs have composite reliability value of 0.7 and Cronbach's alpha of 0.6. Thus, it can be concluded that only certain constructs have good reliability, namely for composite reliability of performance intersection and traffic characteristics and Cronbach's alpha of traffic characteristics and intersection performance. After validity and reliability test formed a measurement model, the next is to analyze the influence between latent variables called structural model (inner model).

The structural model in the PLS was evaluated using R^2 for the dependent variable. The coefficient value for the independent variable was then assessed by the t-statistic value of each path. The structural model of there search can be seen in the following figure.

Table 4. Coefficient value for determination of simultaneous model

Variable	R-Square
Accessibility	0.008
Traffic characteristics	0.073
CBD area	
Intersection performance	0.896

R-square functions to describe the ability of independent variables in explaining dependent variables. The higher the R-square value, the greater the ability of the independent variable can explain the dependent variable. Based on the R-square value table above, the variable of performance of intersection is 0.896, which means that simultaneously variable of performance of intersection can be explained by three factors in model, namely accessibility, traffic characteristic and CBD area, presentation ability of explanation of all three factors is 89,7% while 10.3% is explained from other factors.

Hypotesis Testing

Hypothesis Testing (β, γ, and λ) was done by Bootstrap resampling method developed by Geisser & Stone. The test statistic used was t-statistic or t-test. The application of the resampling method which allows the enactment of distributed free data does not require the assumption of normal distribution, nor does it require large samples (recommended minimum sample of 30). Testing was done by t-test.

Table 4. Inner model hypothesis test results

Hypotheis	T-table	T-statistics	Deskripsi
Accessibility -> Traffic characteristics	1.96	3.591	Reject Ho-Accept H1
Accessibility -> Intersection Performance	1.96	2.719	Reject Ho-Accept H1
Traffic characteristics -> Intersection Performance	1.96	125.641	Reject Ho-Accept H1
CBD area-> Accessibility	1.96	1.042	Reject H1-Accept H0
CBD area -> Traffic characteristics	1.96	2.946	Reject Ho-Accept H1
CBD area -> Intersection Performance	1.96	2.690	Reject Ho-Accept H1

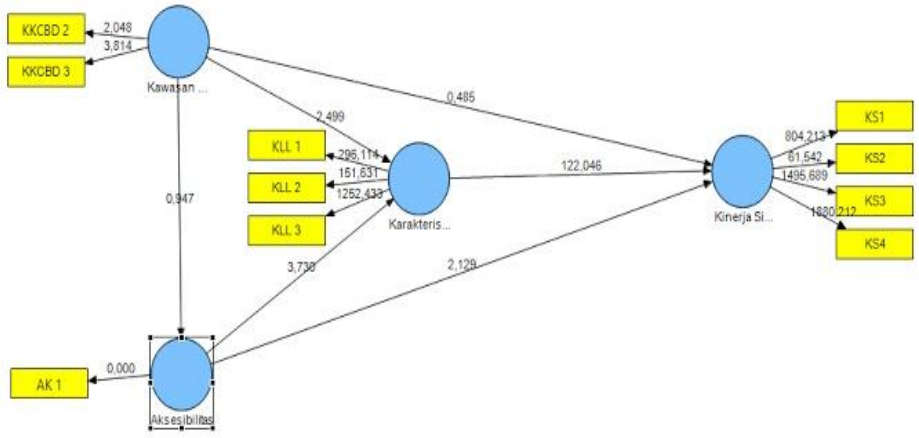

Figure 9. Hypothesis testing research design model

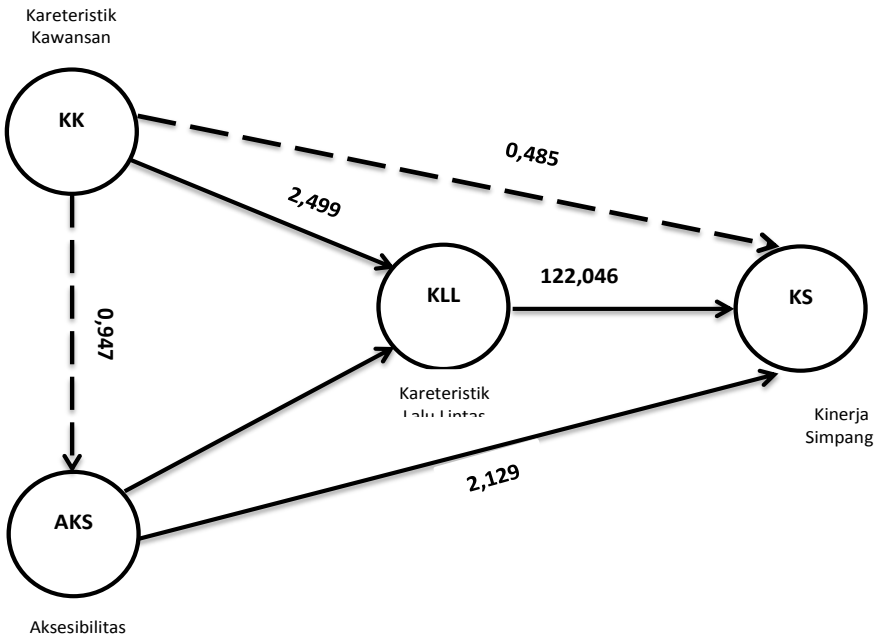

Figure 10. Correlation between Indicators

From the above results can be made correlation model as a result of research findings such as in figure 10 below.

CONCLUSIONS AND SUGGESTION

Simultaneously, indicators of accessibility and traffic characteristics have strong interaction with intersection performance, indicators of CBD area and accessibility have strong interactions with traffic, while the area simultaneously has a weak indication of intersection performance and accessibility.

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