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DETERMINATION OF THE LOCATION INTERCITY BUS TRANSIT IN MAKASSAR CITY USING EXPERT SYSTEM MODEL AND GIS

ASHARI ABDULLAH[1], ANANTO YUDONO[2], SAKTI ADJI ADISASMITA[3], ARIFUDDIN AKIL[4]

[1]Student, Departemen of Architecture, Hasanuddin University, Indonesia

[2] Professor, Departemen of Architecture, Hasanuddin University, Indonesia

[3] Professor, Departemen of Civil Engineering, Hasanuddin University, Indonesia

[4] Associate Professor, Departemen of Architecture, Hasanuddin University, Indonesia

E-mail: [1]ashari.arsitek@gmail.com, [2]yudono@unhas.ac.id, [3]adisasmitadji@unhas.ac.id, [4]arifuddinak@unhas.ac.id

ABSTRACT

This research adapts Intercity Bus transit (ICBT) Index according to the variables developed by Abdullah et al., [7]. The ICBT index is used to measure potential location to be used as transit location of intercity bus passengers. The ICBT variables used consist of Commercial facility area (CO), Traffic Seamless (TR), Housing coverage area (L), distance to main road (DR) and capacity of road (RC) which then called as ICBT supported area. This research adds ICBT category of unacceptable area consisting of natural disaster area , transportation infrastructure area, and ICBT category of limited area consisting of military and policy private area, city engineering service area, slope steepness, and flood risk area. This research uses expert system analysis with IF-THEN rules as well as GIS analysis. Research population is grid-based location with size of 100x100. Case study is conducted in Makassar city. First research results show that most of ICBT with high value is close to center of city in arterial roads. Both methods can be used to determine potential transit location to serve intercity bus passengers.

Keywords: *Intercity Bus Transit, Location Index, Expert System, GIS*

1. INTRODUCTION

There is annual growth of intercity bus transportation in Indonesia in 2016 with 22.971 units of operating buses and 1.574 bus companies [1]. To support the operation of intercity bus transportation system then Indonesian government builds terminal facility as the intercity bus passenger transit facility. This construction id conducted in any city without terminal as well any city with already terminal but also with willingness to relocate the terminal into suburb area. The terminal relocation is conducted because of rapid urban growth so that the terminal in the center of city leads to congestion and have low capacity. Until 2017, Indonesia has 823 units of terminal [1] with three types of terminal, namely terminal A functions to serve inter-province, terminal B functions to serve intercity or regency, and terminal C to serve inter-village. However, ready-established terminal tends to be lack of transit activity; the passengers prefer to conduct the transit activity outside the terminal. The transit activity is conducted in curbside or bus pool in the center of the city. Although the passengers prefer to transit in bus pool or curbside but both issues are not the factors causing the passengers not to use the terminal but it is more caused by quality of terminal service factor to the passengers [2]. Further, according to Abdullah et al., [2] connectivity is the most influential factor on transit service. To improve connectivity of transit facility, then transit model cannot be done in a conventional manner but by making transit facility closer to prospective passengers.

Makassar is one of the growing and developing cities in Indonesia with an area about 175.77 Km2 and there are 1.469.601 population [3]. Spatially, Makassar has relatively round shape and develops from south to north, this is a result of land availability in suburb areas [4]. Currently, Makassar City has 2 terminals, namely metro terminal and Maliengkeri terminal. In 2003, it relocated terminal fromPanaikang terminal located in Km 5 intoDaya terminal (currentlyMakassar Metro Terminal) in Km 15, Makassar Metro Terminal is the type A terminal. There are 4 purposes of the relocation conducted by the government, namely reducing congestion in former terminal, increasing terminal capacity, being the motor of area growth and being the source of Regional Origin Revenue [5]. But, out of the four purposes, it can only solve two issues, namely congestion and capacity, two other purposes recently yet show effective results. Quite far transit location leads to less efficient passenger movement since the terminal is located in suburb area and most of passengers use private vehicles [2].

There are very limited studies on intercity bus transit. Abdullah et al., [2]studies on behavioural intention of intercity bus passengers in using transit facility using SEM analysis, results of the research show four factors determining the quality of terminal facility service as the transit facility, namely connectivity, terminal performance, operator performance and service reliability. Abdullah et al., [6] studied on LOS distance transit of intercity bus passengers using law successive interval scalling analysis. Abdullah et al [7] studied on the framework to measure intercity bus transit (ICBT) index. There are differences among the researches above, in this research, ICBT is measured and determined using GIS-based expert system adopting the research by Abdullah et al [7]. There are also other researches related to transit facility, such as Dell'asin [8],studying on the main factors affecting on travellers profile in interurban interchange using Multiple correspondence analysis (MCA and cluster analysis (CA), the research used connectivity indicator between transit/interchange with origin and destination, as well as integrity between different transportation as well as shopping facility. Hernandez and Mozon[9] studied on the main factors determining the efficiency of interchange using PCA analysis, the research indicators arecoordination transport operator, coffee shops and restaurant, shop. Iseki and Taylor [10]studied on perception toward transit stops and station using Important -satisfaction analysis and ordered logistic regression analysis, the research indicators are easiness to find transit location and station facility as a place to buy food and drinks, silva and Bazrafshan [11]studied on user satisfaction at intermodal transfer facility using SEM analysis, the research used indicators byIseki and Taylor [10]butSilva and Bazrafshan [11]also used indicator of easiness of station access from private vehicles. Yatskiv et al., [12]studied on indicator of bus terminal service quality using Least Squares Method analysis for linear regression model, it used related indicators namely accessibility from extern users, and accessibility for terminal passengers, implicitly it also mentioned terminal completeness facility.Hine and scott [13] studied on smoothness and accessibility of passenger journey and interchange using in-depth interview analysis, the related indicators are bus service with high frequency and reliability, availability of adequate shopping, restaurant and cafeteria facility.

From literature study above, it can be seen that transit facility has very close correlation with accessibility, connectivity and supporting facilities both terminal function as transit facility or as a place for waiting [9]. But, the researches above can yet be seen any research on how to determine transit location for intercity bus passenger. There is a tendency that the transit activity for intercity bus passengers can be decentralized as other intercity transportation modes such as train, ship and plane since in transit activity, the passengers should minimize traveling time and ease in accessing other transportations[14]. In some countries who have make deregulation of intercity bus transportation, they give no obligations for buses to come into the terminal but buses can conduct the transit activity in curbside, this service is called as bus curbside [15, 16, 17, 18).

There are some researches using expert system analysis and GIS related to location determination, namely Taridalla et al. [19] studying on determination of fire station location, Arief et al. [20] studied determination of TOD locations for commuters from the island. The research similarity is that in this study, it also uses 3 variable categories namely unacceptable area, limited area and supported area while the difference with the research is that in determining the research certainty factor value, it has not considered the spatial area of each variable. This study aims to develop measures and determine transit locations for intercity bus passengers using GIS-based expert system models. From the literature review, there is no any research studying on this matter.

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2. DEVELOPMENT EXPERT SYSTEM MODEL

2.1 General Description Model

This study uses a GIS-based system expert approach in measuring suitable locations to be used as ICBT facilities. Expert system is a problem solving model based on expert knowledge and tranfer the knowldge to computer. Findikaki [21] proposed the SISES (Site Selection Expert System) Structure. SISES consists of 4 parts, namely knowledge acquisition, induction, design and decision analysis unit (fig. 1).

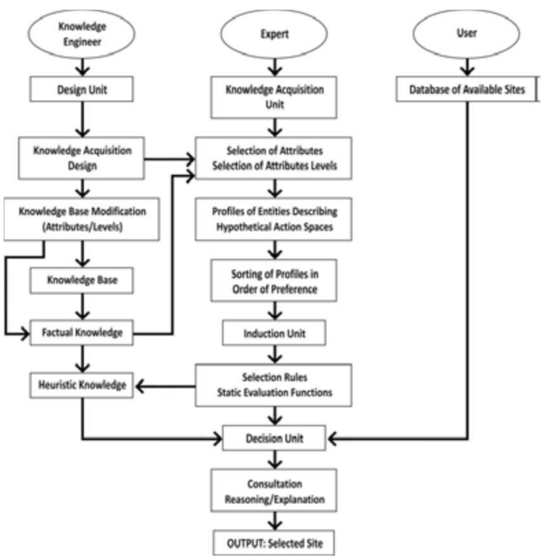

Figure 1: SISES Structure

The expert system model used is to compile three variable categories, namely the first is unacceptable ICBT area, the second is ICBT limited area and the third is ICBT supported area.

The GIS-based Grid Analysis is used to analyze variables at each location. The grid used is 100x100, this is because based on the research by Abdullah et al, [6] that the most convenient distance from the road for passengers is <100m.

This research is a development of Abdullah et al., [7], from the research, it is used as supporting variables for the development of transit facilities.

2.2 Input variable

2.2.1 Natural disaster area

Disaster area refers to areas facing natural disaster with destructive potential. This is an important variable because areas with high frequency by natural disaster effects will be difficult to be developed into transit facilities because they require very high costs. There are various types of natural disaster but for this research, the natural disaster used is floods with damage potential or floods with water level> 200cm, because natural disaster that often occurs in Makassar city is a flood. The areas affected by flooding in this category are considered as unacceptable area.

Table 1. Set up of category for ICBT indicator

Criteria / Variable	kategory	Category
High risk area on tsunami		Y/N
Destroyer flood		Y/N
Destroyer landslide		Y/N
Tollway, flyover, underpass,elevatelevated Way		Y/N
Military and police private area		
City Enggingering service infrastruture area	Sanitary landfill Water treatman plan Cemetary	
Slope steepness	≤10% (flat) 11-20% (Slope) 21-30% (rather steep) ≥30% (Steep)	1 0,75 0,5 0,25
Flood disatser risk	<50 (Safe) 50-100 (rather vulnerable) 101-150 (Vulreable) 151-200 (Very vulnerable)	1 0,75 0,5 0,25
Traffic Seamles	Very Fast (Green) Fast (orange) Slow (red) Very slow (Maroon)	1 0,75 0,5 0,25
Distance of transit to main road	<100 m (Walking) 101m-1000m (mini feeder) >1000 (Mini bus)	1 0,67 0,33
Road lane	6 lane 4 lane	1 0,67
Comercial Facility Area	Shoop house ,Restaurant ,Cafe Mall Market	1 0,7 0,3
Housing Coverage Area	Flats housing = 5 Low housing = 2	1 0,4
Security Facilites (police Post)	<500 m (Safe) 501-1000 m (Rather safe) 1001-1500m (rather unsafe) >1500m (unsafe)	1 0,75 0,5 0,25

2.2.2 Transportation infrastructure area.

Transportation infrastructure area refers to locations with toll road infrastructures, underpass and fly over. Areas with this variable are not recommended as transit facilities. This is because the social and economic activities in this area tend to decrease so that it is difficult to develop transit facilities. The variables are applied by buffering for 100 meters from the infrastructure area. As the

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natural disaster area, the transportation infrastructure area is considered as an unacceptable area.

2.2.3 Military and police private area

Military and police private areas refer to private military and police areas. This variable is one of the variables giving obstacles to the development of transit locations. This variable is used because activities in the locations are dangerous for visitors so that they are not allowed to have public activities around it, such areas are head quarter, storage area ammunition, fire exercise.

2.2.4 City engineering service area

City engineering service area refers to city service areas such as sanitary landfill, WTP waste, city cemeterycenters. This variable is one of the variables giving obstacles to the development of transit locations. This variable is used because this variable is considered to give adequate disruption to the visitor comfort if the transit location is developed in any location in this variable.

2.2.5 Sloope stepness

Slope steepness refers to the level of land slope. This variable is one of the factors giving obstacles to the development of transit locations. . This variable is used because this variable is related to the operation of bus vehicles, higher land steepness will lead to more difficulty for bus operation. Thus, there are four categories of steepness used, namely flat category if the steepness is <10%, slope category if the steepness ranges from 11-20% (Slope), rather steep if the steepness ranges between 21-30%, the steep category if the steepness ranges between> 30%.

2.2.6 Flood disaster area

Flood Disaster area refers to the level of water level due to flooding. This variable is the level of flood vulnerability in safe, rather vulnerable, vulnerable and very vulnerable categories. Importance of using this variable because flooded areas have difficulties in developing the location and maintenance in the future so that this variable is included as an inhibiting factor for the development of transit facilities. There are four categories of flood disaster area variable, namely floods with safe category if the water level is <50 cm, the rather vulnerable category if the water level is 51-100 cm, the vulnerable category if the water level is 101-150 cm, very vulnerable category if the water level is 151-200 cm.

2.2.7 Traffic Seamless

Traffic Seamless refers to traffic smoothness in roads. This variable is used because transit location is directed to any areas with a high level of smoothness so that the presence of transit facilities does not have significant effects on traffic smoothness. This variable is one of the variables supporting the development of transit facilities, more traffic smoothness in a location will lead to higher location value. Seamless data traffic is taken from Google Maps traffic data composing 4 traffic categories, which are green as very smooth, orange as rather smooth, red as slow, dark red as very slow. This variable is analyzed using GIS by buffering about 100m from the road. A value of 100 meters is taken based on the most comfortable distance for passengers to transit from the road [7].

2.2.8 Distance transit to Main road

Distance ro main transit refers to transit location distance from the main road. Abdullah et al., ([7] arranged the LOS distance of the transit location from the main road, the variable is also arranged using law successive scaling interval analysis. Then it forms the LOS of A-B ≤ 100m (very close), LOS C = 101m-1000m (rather close), LOS D = 1001m-2000m (quite far), LOS E = 2001m-2400m (far), LOS F> 2400m (very far). To perform valuestandardization, the LOS service is converted with a scale ranging from 1-6 from very far to very close. From the formedLOS, there are only 5 so that the criteria are very closely represented by two values, namely 5 and 6, and the values used to represent the criteria are very close, 4 for rather close and so on. The variable isanalysed using GIS by buffering the main road network with a distance according to the LOS category if there are many transit locations to be evaluated. The main road in question is arterial road.

2.2.9 Road Lane

The road lane refers to the number of lanes on the road. This variable is the number of road lanes. This variable is one of the supporting variables for the development of transit facilities. More lanes in the transit facility will lead to more potential to be developed. There are 4 road lanes or more included in the calculation, while the following is not included in the indicator because it is less supportive for the bus to pass. Lane standardization is for 6 lanes if there are more than 6 lanes then the value is considered equal to 6. The lane map is conducted the buffering at 100 m, this value refers to the nearest value at the distance of the transit location from the main road [6].

2.2.10 Housing coverage area

Housing coverage area refers to the area of housing covered by the transit facility. This variable is one of the variables supporting the development of transit facilities. There are two types of housing used, namely housing and flats.

2.2.11 Shopping facilites area

Shopping facilities area refers to commercial facilities such as shopping, restaurants and cafes. This variable is divided into three categories, namely shop house, mall, market. Out of the three categories,shopehouse has the highest order, then mall and the last one is market. This is related to the factor of ease of interaction and comfort when interacting. Shophouse has easier to interact than others and market is sometimes less comfortable because the condition is not clean. This variable is one of the supporting variables in the development of transit facilities

2.2.12 Security facilities

Security facilities refer to security facilities in the form of police stations, sector police and resort police. This variable is applied based on the radius in each category. There are 4 categories, namely safe distance of the police post by <500 m, rather safe category if the distance of police post is 501-1000 m, the rather vulnerable category if the distance of police post is 1001-1500m, the vulnerable category if the distance of police post is> 1500 m.

2.3 Inference rule

In this section, the expert system is applied with IF-THEN logic. The rules used can be seen in figure 4, Calculation of the variable values is conducted to each variable on each grid. It used the following formulation :

$$CA_{\,i} = A_i \;/ TA_{grid}$$

Where, CA_i^n= ivariableA_i = area of ivariable area, TA_{grid}= area of grid,

After obtaining CA value for each variable in each grid, the initial value of certainty factor (CF) is calculated. Determining CF, it is formulation model, this is based on the category of unacceptable area, limited are andsupported area variables. For the unacceptable area CF, its CF formulation is

$$\text{If } CA_{1,2} = 0 \text{ , then } CF_{1,2} = 1,$$

$$\text{If } CA_{1,2} > 0 \text{ , then } CF_{1,2} = 0$$

Meanwhile in limited area variable, the CF formulation model is:

$$CF_{\,i} = (1 - CA_i\,) * y_i$$

Meanwhile in supported area variable, the CF formulation model is:

$$CF_{\,i} = CA_i \;\; * y_i$$

Where, CF_i = certainty factor value for variable i, and y_i =category weight value from the variable. To combine the variables, SISES [21] used weight linear combination (WLC). WLC formulation developed by Fishbein [22] and Rosenberg [23] is

$$\text{Site value} = \textstyle\sum_{i=1}^{n} W_i \; * X_{ji}$$

Where, X_{jp} is the value of variable i in j site, W_p is the level of interest of variable i. In this research, WLC is developed since there is unacceptable area variable with value of 0 or 1 so that it can obtain CF value, then it is calculated the ICBT value or site value by the following formulation:

$$ICBT = CF_{1,2} * (\textstyle\sum_{i=3}^{12} CF_i * \; W_i \;)$$

Where, ICBT = Intercity Bus Transit

2.4 Output

The analysis results will obtain the ICBT value, it used the range of location measurement value by 0-1 (unacceptable), 1-1.2 (Not Potential), 1.2-1.35 (Less Potential), 1.35-1.4 (Quite potential), 1.4- 2 (Potential). Whereas the selected location as the potential transit location is <1% of the total grid formed. Of the 1 percent is divided into 3 categories consecutively namely 30% of the highest first grid of Suitable I category, 30% of the second highest of Suitable II category, and 40% of the third highest of Suitable III category.

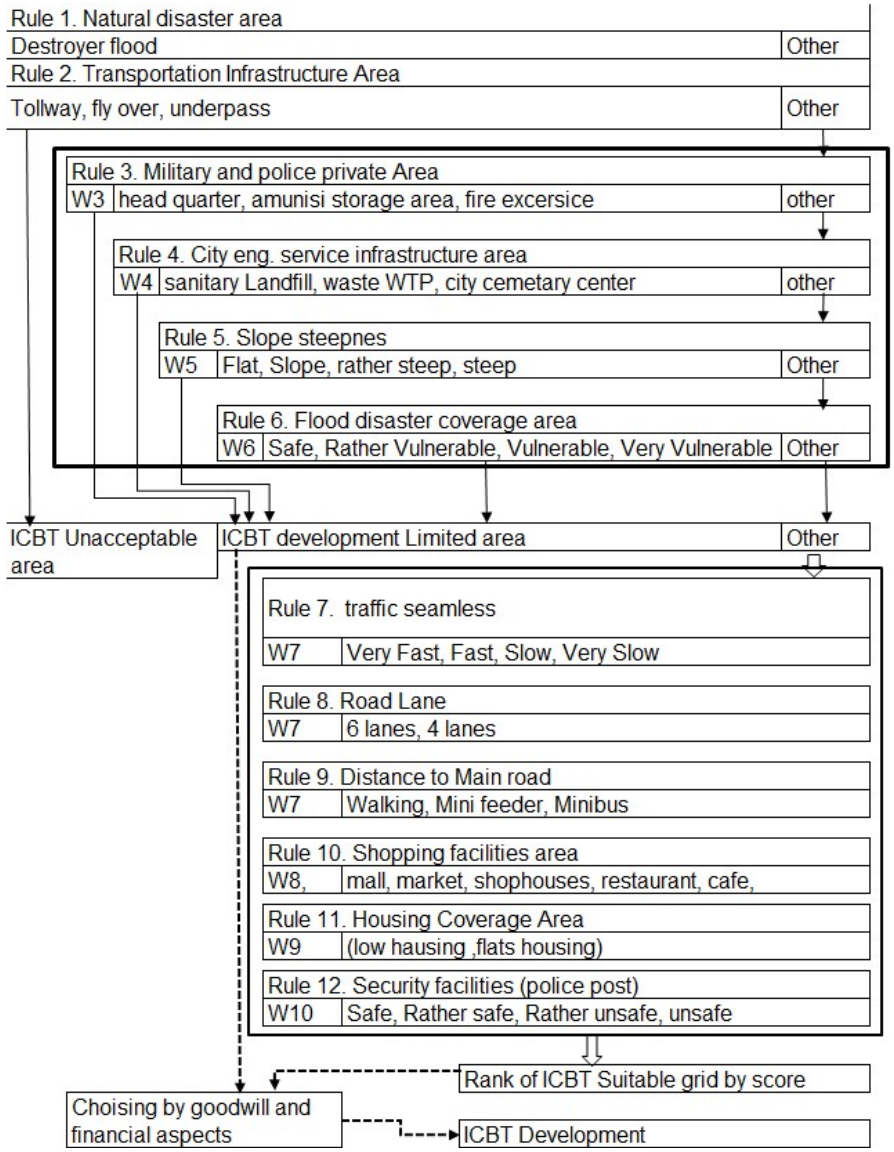

Figure 2: Expert system rules Model For ICBT Location index

2.5 Sensitivity Analysis

To calculate the potential transit location index, it is necessary to test the stability of method in determining the location value. Small changes in the weight can influence significantly and influence on the changes of index values. Therefore, sensitivity analysis is used to determine the probability of order changes from the index. The method used in weight changes is changing the ranking sequence from one variable to one ranking while other variables remain in the order of initial weight order, ranking changes influence on weight value changeof each variable.

3. EXAMPLE PROBLEM

A sample rule for the above formulation is shown below :

Sample 1 :

Rule 1 : IF grid 1 includes in destructive flood area THEN the grid includes in unacceptable area category (CF=0), or

Rule 2 : IF grid 1 includes in fly over, underpass, tollroad areas, THEN the grid includes in unacceptable area category (CF=0)

To calculate the ICBT index then the rules are:

IF	Certainty factor for Natural disaster area or transportation infrastrucutre area of grid 2 is 0
THEN	Grid 2 include unacceptable area for ICBT

Sample 2 :

Rule 1 : IF grid 2 is not included in destructive flood area, THEN the grid 2includes in the acceptable area category with CF=1

Rule 2 : IF grid 2 is not included in flyover, underpass, toll road areas, THEN the grid 2 includes in the acceptable area category with CF=1
Rule 3 : IF grid 2 has military and policy private area THEN the grid 2 is not included in limited area with CF= 1- (0/10.000) => CF= 1
Rule 4 : IF grid 2 has city engineering service area THEN grid 2 is included in limited area with CF= 1-(146/10.000) => CF= 0,99)
Rule 5 : IF Slope steepness of grid 2 <10% THEN grid 2 is included in limited area with CF= 1-(6.500/10.000) *1 => CF= 0,35
Rule 6 : IF grid 2 has flood height of 75 cm THEN grid 2 is included in limited area with CF= 1-(45.00/10.000) *0,75 => CF= 0,41
Rule 7 : IF grid 2 has rather fast traffic seamless THEN grid 2 is included in Supported area with CF= (3.500/10.000) *0,75) => CF= 0,26
Rule 8 : IF grid 2 is easy to be reached by vehicle feeder THEN grid 2 is included in Supported area with CF= (7.500/10.000) *0,67 => CF= 0,50
Rule 9 : IF there are 6 lanes in grid 2 THEN grid 2 is included in Supported area CF= (5.000/10.000) *1 => CF= 0,50
Rule 10 : IF grid 2 has no commercial facilities THEN grid 2 is included in unsupported area with CF= (0/10.000) *0 => CF= 0
Rule 11 : IF grid 2 has housing area THEN grid 2 is included in supported area with CF= (675/10.000) *0,4 => CF= 0,03
Rule 12 : IF grid 2 includes in rather safe category THEN grid 2 is included in supported area CF= (1.250/10.000) *0,75 => CF= 0,09

To calculate the ICBT index then the rules are:

IF certainty factor for all variable of grid 2 is known

THEN Total certainty factor for Grid 2

- x Certainty factor for natural disaster area of grid 2
- x Certainty factor for transportation infrastructure area of grid 2
- \+ Certainty factor for military and policy private area of grid 2 x weight for military and policy private area
- \+ Certainty factor for city engginering service of grid 2 x weight for city engginering service
- \+ Certainty factor for Slope steepness area of grid 2 x weight for slope steepness
- \+ Certainty factor for flood disaster risk area of grid 2 x weight for flood disaster risk
- \+ Certainty factor for traffic seamless area of grid 2 x weight for flood disaster risk area
- \+ Certainty factor for traffic seamless area of grid 2 x weight for traffic seamless
- \+ Certainty factor for distance to main transit area of grid 2 x weight for distance to main transit
- \+ Certainty factor for road lane area of grid 2 x weight for road lane
- \+ Certainty factor for comercial faciltiy area of grid 2 x weight for comercial faciltiy
- \+ Certainty factor for security facility area of grid 2 x weight for security facility

ICBT = 1 * 1 * ((1*0,5) +(0,99*0,2) +(0,35*0,05) +(0,41*0,25) +(0,26*0,25)+ (0,5*0,1) +(0,5*0,1) +(0*0,1) +(0,03*0,25) +(0,09*0,1)
ICBT = 1,05

4. RESULT AND DISCUSSIONS

4.1 ICBT Unacceptable area

Areas with destructive floods in Manggala sub-district is close to the Tello river lane while the underpass is located in Biringkanaya sub-district bordering Maros, the toll road connects between the border of Makassar city and Maros city to the port in Wajo and Makassar districts, and connects to Panakkukang sub-district. Fly over is at the end of the highway leading to the Pannakukang sub-district. Based on Figure 3, out of 18,547 grids, there are around 685 grids in the unacceptable area, from the picture, it can be seen the red part as unacceptable area, at the top part, it is a toll road that is connected with flyovers and underpasses while the lower part is an area with destructive flood category.

4.2 ICBT Limited area

ICBT Limited area is an area with military and policy private areas, city engineering service infrastructure area, slope steepness and flood disaster coverage area. Military and policy private areas in Makassar city are located at 8 locations. There are about 175 grids obtaining the effects of this variable. City engineering service areas can be found in 25 location points, there are about 249 grids obtaining the effects of this variable. Each

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grid has barriersto develop into a transit location with varying levels. Most of the grid on the ICBT limited area has a moderate obstacle category, only some locations have high barriers.

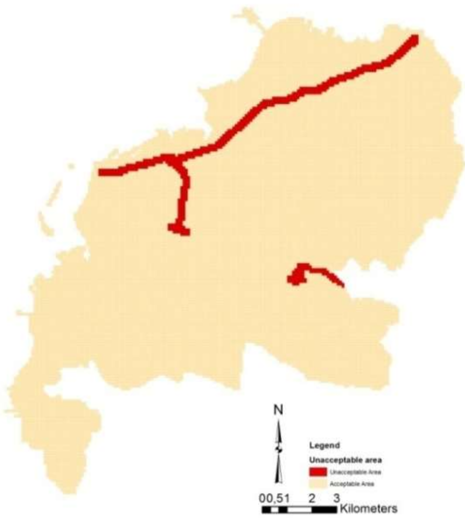

Figure 3. Map Of ICBT unacceptable area based on expert system model in Makassar city

4.3 ICBT support area

Based on the figure 4, it can be seen that the supporting area for development of public transit locations are around the arterial roads such as urip Sumoharjo street, Pettarani street, Veteran street, Ratulangi street and Nusantara street. Approximately 350 grids or 1.88% of the total grid are categorized as supported and very supported areas.

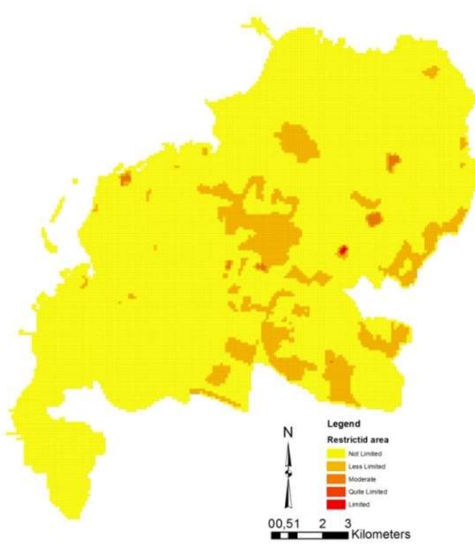

Figure 4. Map of ICBT Limited area based on expert system model in Makassar city

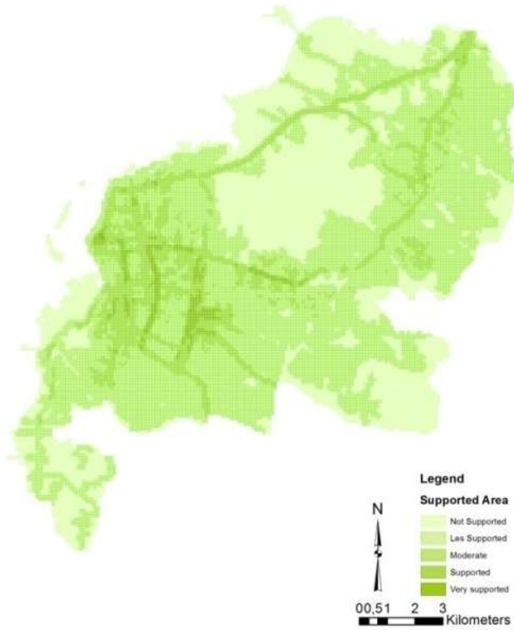

Figure 5. Map of ICBT supported area based on expert system model in Makassar city

4.4 ICBT Potential area

The calculation of transit location index is in the range of 0-2. supporting Areas the development after calculation with the inhibiting indicators show that most of the grid values decrease so that it becomes not potential. Based on the analysis results, most of the areas are less potential and not potential areas, while there is only about 16.5% of the grid that is categorized as quite potential and potential. Far areas from the arterial road are less potential to be developed into this transit facility as expected.

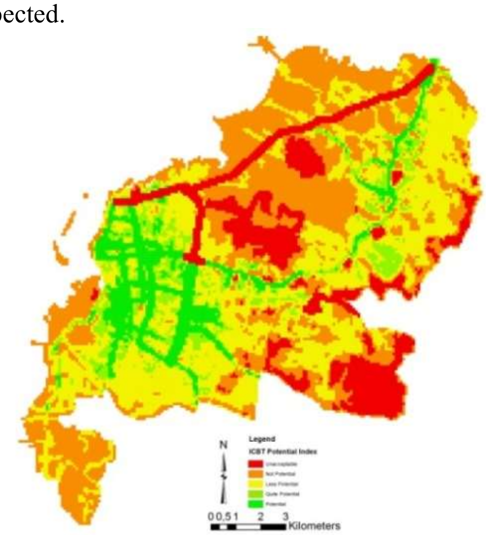

Figure 6. Map of ICBT Potential area based on expert system model in Makassar city

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4.5 ICBT suitable area

Based on figure 7, there are 77 grids included in suitable I category, most of which are on Veteran, Pettarani streets, only a small portion are in UripSumoharjo, Nusantara street and Bandang street. There are 55 grids included in suitable 2 category, there are 55 grids, most of which are still on Pettarani And Veteran street, but it has extended to Ratulangi Street in west part of the city, there is also addition of grid distribution in Urip Street so that distribution of Suitable 2 is more evenly than the Suitable 1, meanwhile suitable 2 and suitable 3 have quite similar distribution.

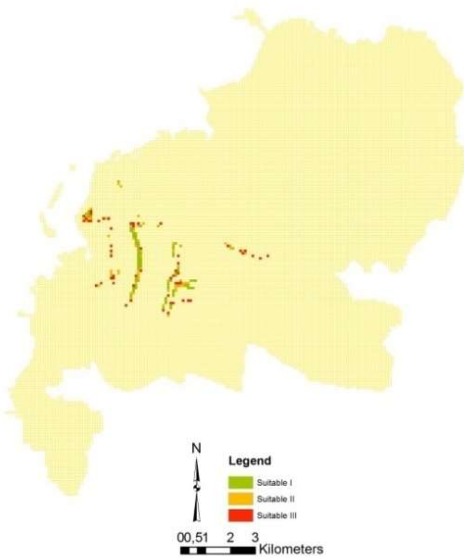


Figure 7. Map of ICBT Suitable area based on expert system model in Makassar city

4.6 Sensitivity analysis

Sensitivity analysis is conducted to determine the result changes if there are changes in weight and ranking for each variable. There are 4 weight settings, namely base scenario and 3 scenarios to calculate ICBT index. In the base scenario, seamless and housing coverage have the highest weight as well as quite potential and potential locations, in scenario 1, if the seamless traffic is considered the most influential, then, there is 8,8% of quite potential and potential locations. In scenario 2, commercial facility is the most influential variable, there is 2,3% of quite potential and potential locations, while in scenario 3 if each variable is considered to have the same effect, there is 0,9% of quite potential and potential.

Table 2. Selected Grid for ICBT in Makassar City

Grid number	value
6393, 8190, 8339, 8340, 8491, 8492, 8791, 9099, 9106, 9238, 9239, 9382, 9525, 9526, 9666, 9667, 9803, 9937, 10070, 10071, 10086, 10203, 10217, 10220, 10337, 10351, 10375, 10476, 10619, 10620, 10633, 10763, 10777, 10906, 10907, 11049, 11050, 11188, 11189, 11321, 11322, 11451, 11467, 11593, 11715, 11828, 11929, 12051, 12052, 12065, 12069, 12073, 12074, 12075, 12187, 12298, 12311, 12315, 12318, 12319, 12423, 12424, 12437, 12445, 12446, 12447, 12549, 12565, 12692, 12801, 12818, 12942, 13069, 13204, 13347, 13488, 13491	Suitable I 1,56 -1,65
6543, 6695, 8042, 8490, 8511, 8640, 8642, 8643, 8649, 8957, 9095, 9098, 9383, 9656, 9802, 9938, 10085, 10106, 10202, 10240, 10374, 10477, 10490, 10517, 10518, 10608, 10662, 10764, 11337, 11452, 11566, 11569, 11577, 11689, 11692, 11700, 11802, 11813, 11930, 12064, 12174, 12193, 12194, 12195, 12283, 12314, 12316, 12317, 12440, 12563, 12566, 12675, 12676, 12928, 13344, 13939	Suitable II 1,54-1,56
8191, 8341, 8489, 8641, 8648, 8650, 8790, 8792, 8793, 8796, 8952, 8953, 8955, 8964, 9096, 9230, 10192, 10239, 10338, 10465, 10517, 10519, 10661, 10752, 10779, 10809, 10815, 10955, 11204, 11578,11592, 11716, 11803, 11812, 11827, 11919, 11920, 11943, 12160, 12165, 12190, 12191, 12192, 12282, 12297, 12816, 13055, 13076, 13078, 13079, 13206, 13207, 13329, 13634, 13785	Suitable III 1,53- 1,54

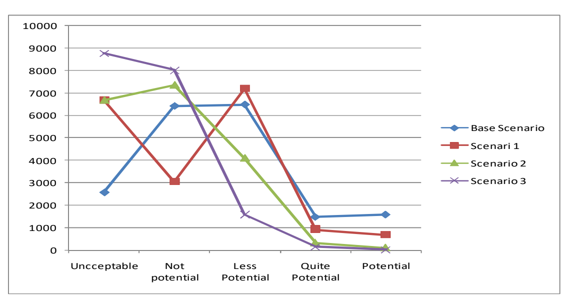
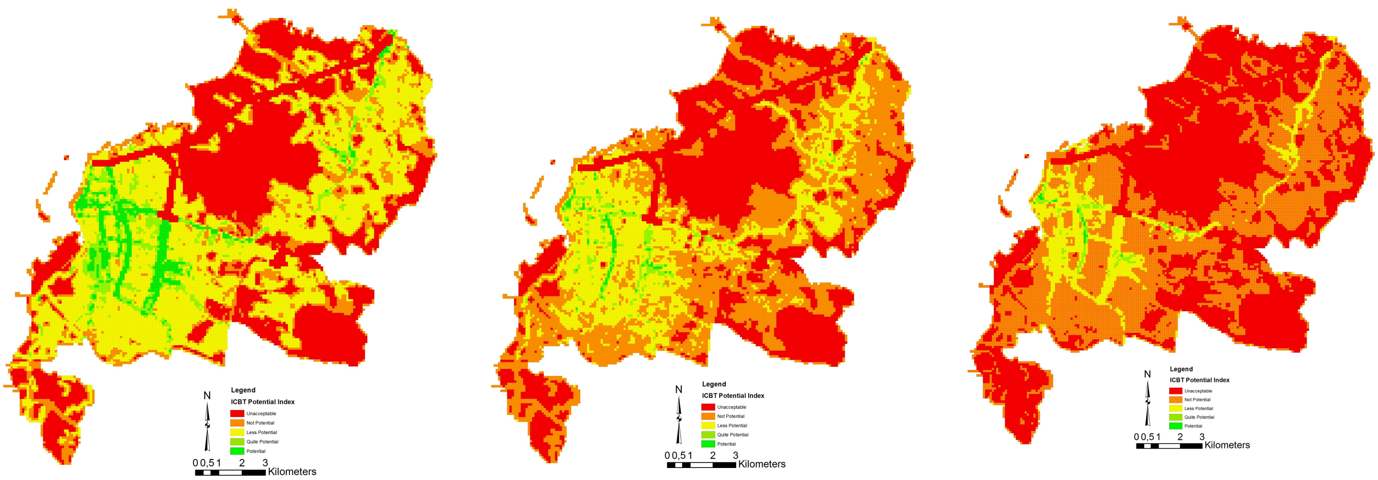


Figure 8. Number of grid a with Sensitivitas Analysis

Table 3. Base And Alternate Scenarios – Sensitivity Analysis.

Variable	Scenario Base		Scenario 1		Scenario 2		Scenario 3	
	CF	Rank	CF	Rank	CF	Rank	CF	Rank
Military and police private area	0.5	1	0.3	2	0.3	2	0.25	1
City Engginering area	0.2	3	0.2	3	0.4	1	0.25	1
Slope steepness	0.05	4	0.1	4	0.1	4	0.25	1
Flood disatser risk	0.25	2	0.4	1	0.2	3	0.25	1
Traffic Seamles	0.25	1	0.3	1	0.15	4	0.167	1
Distance of transit to main road	0.1	3	0.1	5	0.1	5	0.167	1
Capacity Of roads	0.2	2	0.15	4	0.15	4	0.167	1
Comercial Facility Area	0.1	3	0.2	3	0.3	1	0.167	1
Housing Coverage Area	0.25	1	0.25	2	0.25	2	0.167	1
Safety Facilites (police Post)	0.1	3	0.05	6	0.05	6	0.167	1



Scenario 1 Scenario 2 Scenario 3

Figure 9 Maps Of ICBT Index Based On Scenario 1,2 And 3

5. CONCLUSION

This study aims to develop, measure and determine the transit location for intercity bus passengers using an GIS-based expert system model. There are 3 categories of variables used namely ICBT unacceptable area consisting of natural disaster area and transportation infrastructure areavariables; ICBT limited area consisting of military and policy private area, city engineering service area, slope steepness, flood disaster area; ICBT supported area consisting of traffic seamless, road lane, distance to main road, shopping facilities area, housing coverage area, safety facilities.

The main contributions of this research are (1) developing a research on inter-city bus passenger transit facilities (2) developing an GIS-based expert system model in determining transit locations for inter-city bus passengers (3) this study considers the area of each variable in terms of certainty value factor (4) the suitable transit location for the city bus is close to the city center and close to the arterial road.

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