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Land Use Management Based on Community Movement Patterns in Pajukukang District, Bantaeng Regency

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ABSTRACT

Traffic and transportation are two interrelated aspects. The movement of people toward activity centers impacts the transportation system, where the concentration of activities leads to a need for transportation infrastructure and facilities to support this movement. This study aims to analyze the generation and distribution from eight functional areas studied through interviews, documentation, and literature review with 300 respondents. The data collection was conducted over two days, including a holiday and a workday. The results of this study are findings showed that the travel movement generation and distribution from the 300 respondents amounted to 385 movements across different origin and destination zones. Based on the Origin-Destination Matrix, land use management in Pajukukang District designated Baruga Village as a trade and service zone as well as a public space zone, Papanloe Village as an industrial zone, Borongloe Village as a worship zone, and Pajukukang Village as a health, port, and educational zone.

Keywords: Origin-Destination Matrix, Transportation, Land Use

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INTRODUCTION

Trip generation is a modeling step that estimates the number of trips originating from a zone or land use or the number of trips attracted to a certain land use or zone [1]. Trip generation refers to the total number of trips that occur within a unit of time in a land use zone [2]. Traffic trip distribution is part of the traffic planning process related to the movement between zones, resulting in an origin-destination matrix (ODM).

The primary objective of trip generation is to create a model that links land use parameters with the amount of movement per unit of zone or the number of movements leaving the zone. Every trip has an origin and a destination, where the origin is the zone that triggers the behavior, while the destination is the zone that attracts the action [3]. Therefore, there are two types of trip generation: Trip Production, which is the number of trips produced by a zone, and Trip Attraction, which is the number of trips attracted by a zone. Movement and attraction are modeling steps that estimate the number of movements exiting a zone or land use and the number of movements attracted to a land use or zone [4].

Bantaeng Regency is located in South Sulawesi Province, situated along the northern coast of Flores Sea and traversed by the Trans Sulawesi route, making Bantaeng Regency a vital connecting corridor in the southern region. The transportation development policy in Bantaeng Regency aims to serve as the economic lifeline of the area, supporting the movement of people, goods, and services, as well as fostering regional development and inter-regional relations. The

high volume of transportation movements in Bantaeng Regency is influenced not only by internal movements but also by movements from other regions, as Bantaeng Regency is part of the Trans Sulawesi route.

In the Regional Spatial Planning (RTRW) of Bantaeng Regency for 2012-2032 [5], Pajukukang District has been designated as a Strategic Area for the Regency. Research conducted in Bantaeng Regency identifies Pajukukang District as the center for transportation movement distribution, which encompasses five villages serving as daily activity hubs due to the ease of transportation access, ultimately leading to increasing residential density in Pajukukang District. The research problem formulated in this study is to explore the relationship of movement between zones in relation to land use. This study will illustrate the desired movement lines in several functional areas of Pajukukang District, Bantaeng Regency. The aim of this research is to establish the relationship of movement between zones associated with land use, quantified by the amount of movement connecting these zones.

METHODS

The methods in this research begin with data collection, analysis of population movement (Origin-Destination Matrix), Sturges' method, and mapping analysis using a quantitative research approach.

Data Collection

This research was conducted in Bantaeng Regency, specifically in Pajukukang District, over a period of 2 days, covering both a weekday and a weekend, in 8 functional areas (residential, healthcare, open spaces, industrial, port, trade and services, religious, and educational) located in Pajukukang District. The data collection method used two data sources: primary data (interviews) and secondary data (literature review).

Population Movement Analysis

The Origin-Destination (OD) Matrix, or movement matrix, is a matrix that shows the volume of movement from the origin zone to the destination zone [6]. This analysis is used to determine the generation and attraction of traffic movements between residential zones[7]. Population movement analysis begins by examining the distribution of movement using the Origin-Destination Matrix method, which is a two-dimensional matrix containing information on movements between places (zones) within a specific region[8]. This analysis is based on the identification of public movement, referring to respondents' (public) access to various alternative conditions. The population displacement analysis starts with examining the distribution of movement using the Origin-Destination (OD) matrix method, a two-dimensional matrix that contains information about movements between specific areas. The OD survey, conducted under existing conditions, aims to forecast movement generation and attraction[9]. The structure of the origin-destination matrix can be shown in Table 1.

Table 1 Origin-Destination Matrix

Origin/Destination	1	2	3	….	N	Oi
1	T_{11}	T_{12}	T_{13}	.	T_{1N}	O_1
2	T_{21}	T_{22}	T_{23}	.	T_{2N}	O_2
3	T_{31}	T_{32}	T_{33}	.	T_{3N}	O_3
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
N				.	TN_n	O_n
Dd	D_1	D_2	D_3	.	D_n	T

Source : Tamin (2002)

Where :

Tid = Movement from origin zone i to destination zone d

Oi = The total movement originating from origin zone i

Dd = The total movement heading to destination zone d.
{Tid} atau T = Total Matrix

Sturges' Method

Sturges' Method is a rule for determining the range of data selected from bar charts in histograms. This rule was published in the American Statistical Association (ASA) journal in 1926. Sturges assumes that the number of data points is proportional to the binomial coefficient, and he posits that well-distributed data sets can be approximated by a binomial distribution with a probability of 0.5, resulting in a symmetric distribution[10]. The derivation of this rule uses the identity of binomial expansion and logarithmic properties, known as Sturges' Rule.

$$K \approx 1 + 3{,}322 \log n$$

Spatial Analysis

Spatial analysis in this study was conducted after determining the traffic generation volumes and the amount of traffic directed toward each zone. This analysis involved visualizing the traffic generation obtained from the Origin-Destination Matrix (OD Matrix) onto maps using ArcGIS version 10.3 and Google Earth Pro, followed by creating desire lines representing daily traffic movements according to the origin-destination patterns. Through this process, patterns of traffic generation were produced, where the lines indicate trips (movements) of traffic between zones among residents in the Pajukukang District.

RESULTS AND DISCUSSION

Pajukukang District is located between 120°02'19" East Longitude and 05°30'01" South Latitude. The area of Pajukukang District is 48.9 km², occupying 12.35% of the total area of Bantaeng Regency. Pajukukang District is one of the coastal districts of Bantaeng Regency [12]. The district is divided into 10 villages/sub-districts, namely Baruga Village, Papan Loe Village, Borong Loe Village, Pajukukang Village, Lumpangan Village, Biang Loe Village, Rappoa Village, Batu Karaeng Village, and Biangkeke Village, with the capital located in Nipa-Nipa Village[13]. The research area encompasses 5 villages in Pajukukang District, which are Nipa-Nipa Village, Pajukukang Village, Borong Loe Village, Papan Loe Village, and Baruga Village. For further clarification, refer to the land use map (Fig. 1) and the zoning map (Fig. 2) of the Functional Areas of Pajukukang District below.

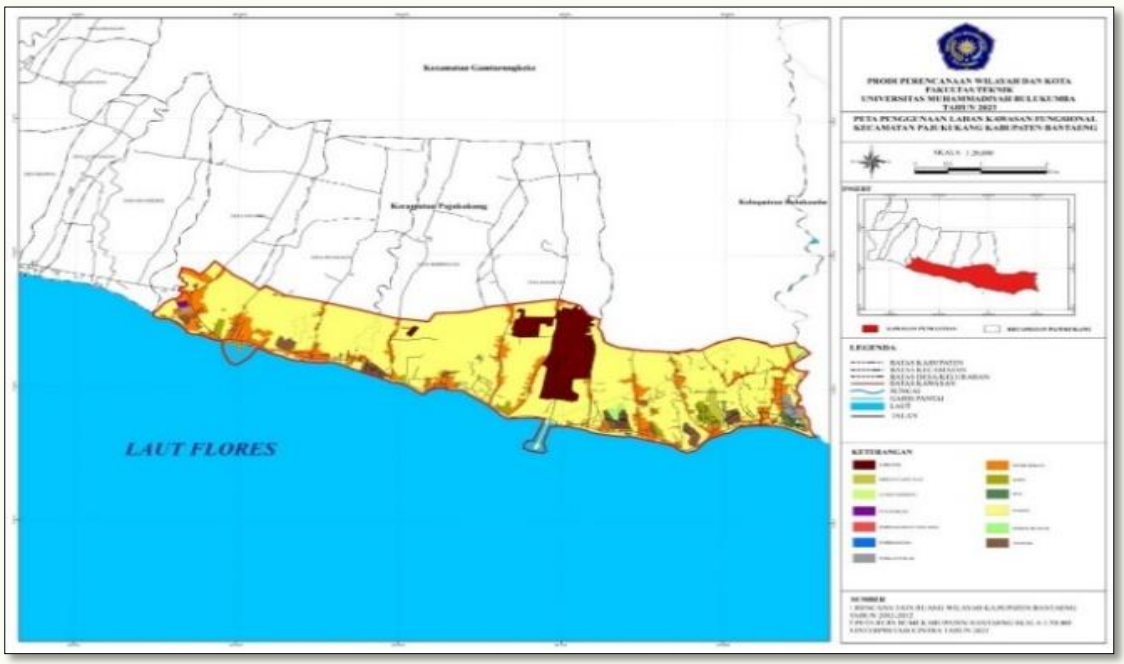


Fig. 1. Map of land use of the functional area in Pajukukang District

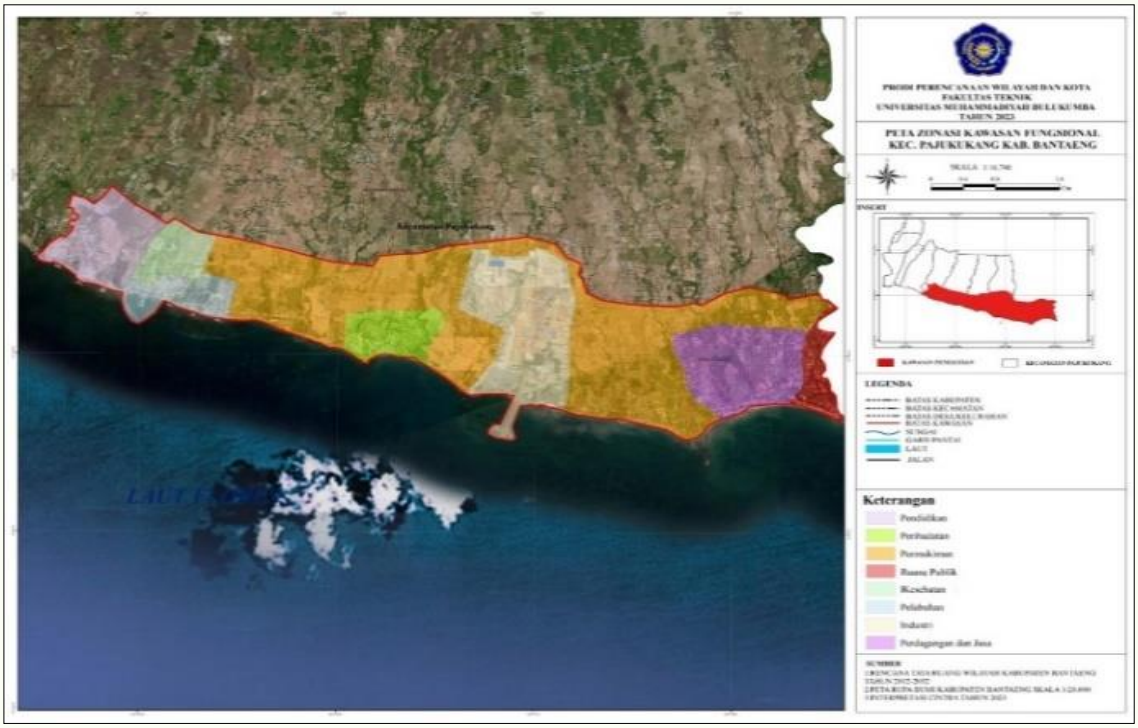


Fig. 2. Zoning map of the functional area in Pajukukang District

The results of the recapitalization of calculations regarding age, gender, occupation, and origin-destination using questionnaires in 8 distribution areas of community movement in Pajukukang District, Bantaeng Regency, can be seen in the table below.

Table 2 Recapitulation Of Age and Gender

No	Age (Year)	Amount (Soul)	Gender	
			Woman	Man
1	11-15	23	6	17
2	16-20	40	19	21
3	21-25	44	15	29
4	26-30	46	22	24
5	31-35	45	28	17
6	36-40	53	18	35
7	>40	49	15	34
Amount		300	123	177

Source : Field Survey, 2023

The table above shows the recapitalization results of age and gender, indicating that in the age group of 36-40 years, there is a higher number of respondents, with 35 males and 18 females. In contrast, the age group of 11-15 years has the lowest number of respondents, consisting of 6 females and 17 males.

Table 3 Job Recap

No	Job	Amount (Soul)
1	Student/University Student	78
2	Civil Servant	34
3	Housewife	46
4	Trader/Entrepreneur	53
5	Fisherman	20
6	Laborer	19
7	Farmer	21
8	Employee	13
9	Security Personnel	3
10	Nurse	13
Amount		300

Source : Field Survey, 2023

The table above reveals the recapitalization of occupations, indicating that the student/university student category has the highest number of respondents, totaling 78 individuals. In contrast, the security category has the lowest number of respondents, with only 3 individuals.

Table 4 Recapitulation of Origin and Destination

No	Region	Amount (Soul)	
		Origin	Destination
1	Residential Areas	246	14
2	Health Facilities	6	50
3	Industrial Areas	12	17
4	Trade and Services	7	143
5	Public Spaces	4	36
6	Places of Worship	2	44
7	Educational Institutions	10	52
8	Ports	13	29
	Amount	300	385

Source : Field Survey, 2023

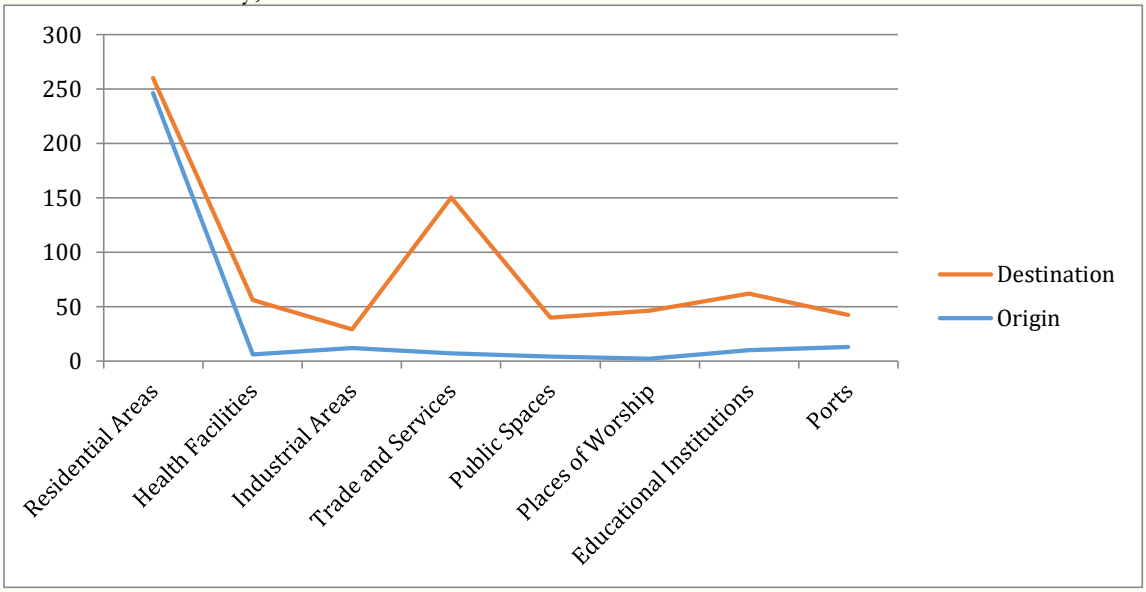


Fig. 3 Graph of Origin and Destination

The table and Fig. 3 indicates that the recapitalization of origin and destination shows a total of 300 respondents, with passenger origins and destinations distributed across various functional areas, including residential, health, open spaces, industrial zones, ports, trade and services, places of worship, and educational institutions, resulting in a total of 385 destinations.

The trip generation process consists of trip origins and trip attractions[14]. Based on the recapitalization at the 8 functional areas with a total of 300 respondents, the following table provides insight into the traffic flow from origin zones to their respective destinations.

Table 5 Origin Destination Matrix

No	Destination / Origin	A	B	C	D	E	F	G	H	Origin
1	A		46	17	115	35	37	51	29	330
2	B	5		-	3	-	1	-	-	9
3	C	2	1		8	-	-	-	-	11
4	D	-	-	-		-	2	-	-	2
5	E	-	-	-	3		3	-	-	6
6	F	1	-	-	1	-		-	-	2
7	G	4	1	-	4	1	1		-	11
8	H	2	2	-	9	-	-	1		14

No	Destination / Origin	A	B	C	D	E	F	G	H	Origin
Total Goal		14	50	17	143	36	44	52	29	385

Source : Analysis Results, 2023

Pajukukang Village is designated as a health zone, port zone and education zone. Information :

A = Residential
B = Health
C = Industrial
D = Trade and Services
E = Public Space
F = Place of Worship
G = Education
H = Port

Analysis of the origin-destination matrix in Pajukukang District shows the total number of trips, namely 385 trips, as shown in the calculated T value. Traffic generation is then determined based on data analysis from questionnaires distributed to residents. The Desire Line is a straight line that depicts the relationship between the origin and goal of a movement. The flow of movement has a direction and quantity that describes the size of passengers and goods. The Sturges method is a rule for determining how widely selected data is in a bar graph on a histogram [15]. In using Sturges' rules, the initial steps taken are determining the maximum and minimum values as well as determining the amount of data, class range, class interval and class length. The following is the use of Sturges' rule for determining intervals in making desire line maps.

Determination of Max and Min values.
Max Value = 115
Min Value = 1

Determining the amount of data
Number of Data (N) = 27

Determining Class Intervals Class Range = Max Value – Min Value
= 115 -1
= 114

Ranges Determining Class
Class Interval = 1 + 3(LogN)
= 1 + 3 (Log 27)
= 5.72

Determining Class Length
Class Length = Class Range : Class Interval
= 114 : 5.72
= 20

So that it produces a line classification value, namely:

Table 6 Intervals for Determining Management Direction Desires

No	Movement	Frequency	Classification of Desire Lines
1	1-21	21	Low
2	22-42	1	Low
3	43-63	4	Currently
4	64-84	0	Currently
5	85-105	0	Tall
6	106-126	1	Tall
Total Movement		27	

Source: Analysis Results, 2023

The trips of 300 respondents based on the results of the questionnaire, observed from the origin and destination of the journeys, can be seen in the following desire line map.

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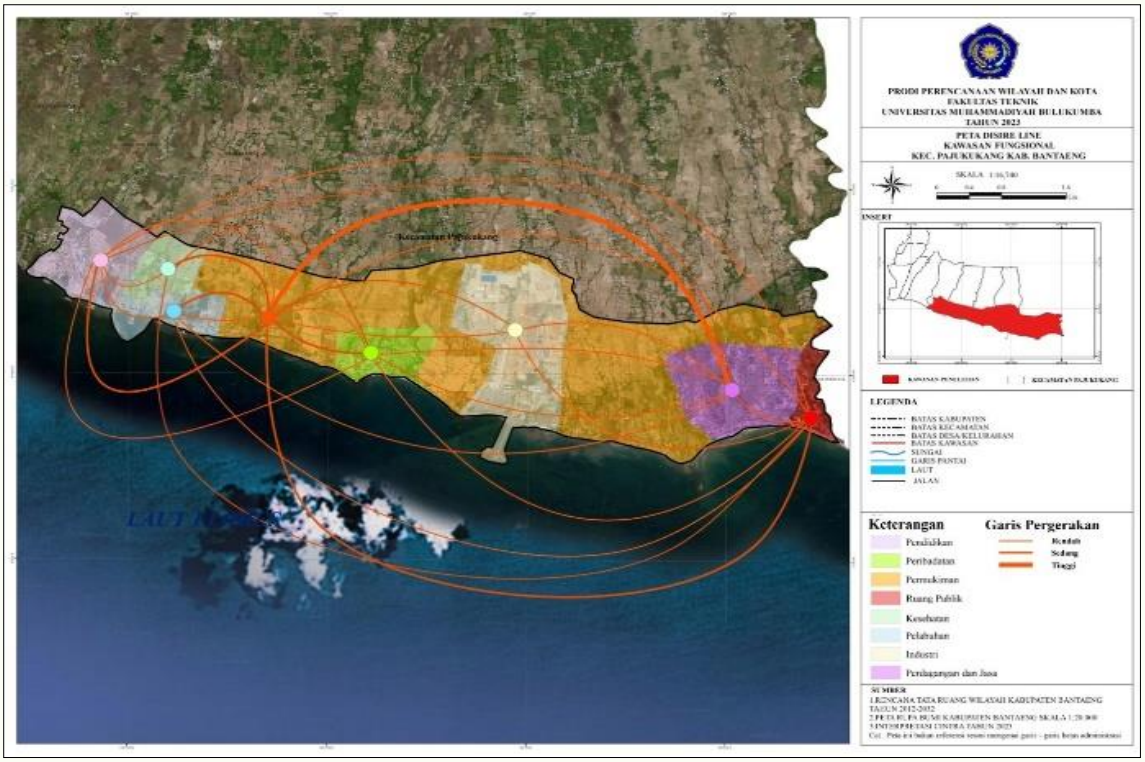


Fig. 4 Desire Line Map of Functional Areas in Pajukukang District

Based on the map above, it can be observed that there are 8 existing activity centers in Pajukukang District, which are interconnected with one another. Land use can be grouped into two broad categories: agricultural land use and non-agricultural land use. Land use can be depicted as an organized space. Organized means making an effort to plan land use in a given area, dividing it into special zones or functions. The Origin-Destination Matrix (MAT) can provide detailed indications of movement needs, playing a crucial role in various traffic planning and management studies, while desire lines help illustrate the direction of movement [16].

Actions known as trip generation determine what mode of transportation is needed to facilitate movement [17]. The direction of land use management aims to organize land use according to its capabilities to achieve a balance between land capability and the types of technological utilization [18]. Movements resulting from activities in specific zones or lands generate trip generation that includes movements leaving one zone and heading to another [19].

The direction for land use management first establishes the travel intervals based on the responses of 300 respondents from the questionnaire, considering the origin and destination of their journeys. For more clarity, please refer to the following land use management direction map.

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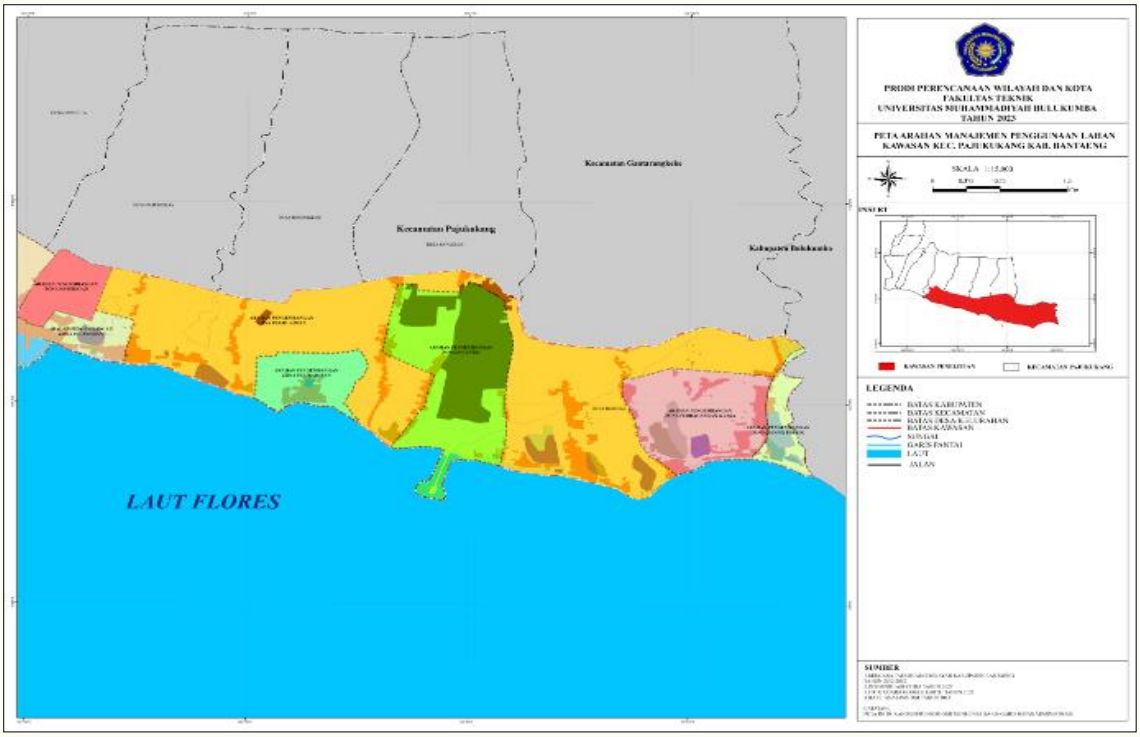


Fig. 5 Land Use Management Direction Map of Functional Areas in Pajukukang District

Pajukukang District land use management directions in Baruga Village have been designated as a trade and services zone as well as a public space zone, Papanloe Village has been designated as an industrial zone, Borongloe Village has been designated as a worship zone, and Pajukukang Village has been designated as a health zone, port zone and education zone. The results of the land use zoning analysis can serve as a follow-up reference in determining an appropriate multimodal public transportation system to enhance the efficiency of movement and mobility [20].

CONCLUSION

This research involves analysis of travel patterns, the relationship between transportation and land use, as well as a survey method of 2023 household interviews to collect data. Based on the results of primary data processing, the origin destination matrix for Pajukukang District concluded that the total number of movements was 385 carried out in different origin and destination zones. The highest movement generation in the residential zone was 330 movements, while the highest movement destination was in the trade and services zone, namely 143 movements. This is related to the factors that trigger dense interaction so that the greater the function of an area, the greater the interaction generated. Pajukukang District land use management directions based on MAT can be determined that Baruga Village is a trade and services zone as well as a public space zone, Papanloe Village is designated as an industrial zone, Borongloe Village is designated as a worship zone, and Pajukukang Village is designated as a health zone, port zone and education zone.

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AUTHORS' DECLARATION

Author contribution : Conceptualization the framework of the research, D.N.A.A., AFH; Methodology, D.N.A.A., U.N., N.H; Spatial Analysis, S.S.P; Field Survey, U.N., N.H., S.S.P; Draft Preparation, U.N.

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