

Application Of The Detroit Method in The Distribution of Ferry Passenger Movements in North Maluku

Ryan Rinaldy R Bachmid¹, Abdul Gaus², Sabaruddin³

^{1,2,3} Program Studi Teknik Sipil, Fakultas Teknik, Universitas Khairun

Jl. Pertamina Gambesi Ternate 55281, Indonesia

Email: ryanrinaldy428@gmail.com, gaussmuhammad@gmail.com, sabaruddin.abuahmad@gmail.com

ABSTRACT

Movement generation modeling estimates the amount of movement generated from the origin zone and attracted to the destination zone. The research aims to distribute the movement of passengers and vehicles for Ferries in North Maluku Province using the Detroit method in 7 movement distribution zones (Bastiong, Sidangoli, Rum, Sofifi, Batang Dua, Makian, and Moti). To find the distribution of ferries, the Geometric Method is used, where the value of r (growth ratio) is used as the growth factor (E), and the calculation of the distribution of movements uses the Detroit Method. The largest distribution of passengers is in the origin zone, namely Bastiong (movement 204577), and in the destination zone, namely Sidangoli (movement 190621). The smallest distribution of passengers is in the origin zone, namely Batang Dua (movement 297), and in the destination zone, namely Batang Dua (movement 415). The largest distribution of vehicles is in the origin zone, namely Bastiong (movement 74828). In the destination zone, namely Sofifi (movement 72057), the distribution of the smallest vehicle in the origin zone is Batang Dua (movement 97), and in the destination zone is Batang Dua (movement 101).

Keywords: Ferry Ships, Distribution of Movements & Growth Factors

Introduction

In Indonesia, there are known modes of transportation, including river and lake transportation and crossings [1]. In North Maluku Province, a ferry transportation service company and ferry port management for passengers, vehicles, and goods is PT ASDP Indonesia Ferry Ternate branch. This is one of the main ferry port branches with 16 trajectories, eight vessels, and three ports (ports) [1].

Talking about crossing modes is the same as talking about transportation, which functions as a bridge that connects the road network and/or railway network separated by water (river, lake, sea) to transport passengers and vehicles and their cargo. [2], [3]. The existence of this function triggers movement, where this movement needs to be modeled[4].

Movement generation modeling estimates the movement generated from the origin zone and attracted to the destination zone [5]. The magnitude of movement generation and attraction is very valuable information that can be used to estimate the magnitude of movement between zones and is certainly greatly influenced by the level of exclusivity of the system between zones and the level of generation and attraction of each zone. Of the several methods that have been developed, the Detroit method is a fairly simple method that is only suitable for the short term to a method that can accommodate the influence of changes in exclusivity on the distribution of movements that may occur in long-term planning[6], [7], [8], [9].

Movement is an activity that we carry out every day, where movement patterns in the transportation system are often described in the form of a flow of movements (vehicles, passengers, and goods) that move from the origin zone to the destination zone within a certain area and during a certain time period. Origin Destination Matrix (MAT) is a two-dimensional matrix containing information about the movement's magnitude between locations (zones) within a certain area[10], [11], [12], [13], [14]. Rows represent the origin zone, and columns represent the destination zone, so the matrix cells express the magnitude of the flow from the origin zone to the destination zone. In this case, the notation T_{id} states the movement flow (vehicles, passengers, and goods) from origin zone i to destination zone d during a certain time interval. The analogy method is a method that only considers growth factors without taking into account changes in the accessibility of the transportation network system [15], [16], [17], [18], [19], [20].

This research is intended to find the magnitude of movement between the origin zone and the destination zone using an analogous method, namely the Detroit method. It will do so by paying attention

to the growth ratio (r) of passengers and vehicles on the ferry, which is then used as the value of the growth factor (E) in the Origin-Destination Matrix (MAT).

Research Methods

This research was conducted at the Lake River Transport Port and Indonesia Ferry Crossing, Bastiong Branch, South Ternate City. When the research was carried out in 2022

Data collection

The data used in this research are secondary data from related institutions (data from the combined recapitulation of passenger and vehicle trajectories on ferries) and various sources of literary explanations related to travel movements. Taking into account the division of movement zones (see table 1 and figure 1) below this:

This research uses one of the growth factor models, namely the Detroit method, where it is known that there are several methods in the growth factor model, including the uniform, average, frater, Detroit, and Furness methods[21], [22], [23], [24]. The trip distribution method (Detroit) calculates future trip distribution by looking at growth and using repetition or literacy to show normative [17], [18], [25]. Meanwhile, basic origin-destination data between 7 zones was carried out through an origin-destination survey located at the Lake River Transport Port and Indonesia Ferry Crossing, Bastiong Branch, South Ternate City (see Table 6 and Table 7).

Table 1. Distribution of Movement Distribution Zones

Zona	Harbor
Zona A	Bastiong
Zona B	Sidangoli
Zona C	Rum
Zona D	Sofifi
Zona E	Batang Dua
Zona F	Makian
Zona G	Moti

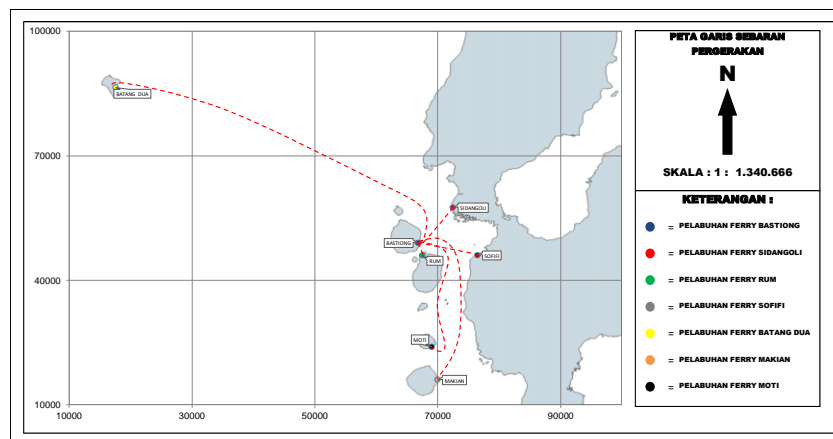


Figure 1. Map of Movement Distribution Lines

Data analysis

This research aims to examine hypotheses by analyzing objective matters based on research results or numerical data.

Results and Discussion

Passenger and Vehicle Growth Ratio

1. Calculating the percentage value (r) of passenger growth for ferries:

- Ratio value (r) for Origin zone passengers:

$$r = \frac{(168400)^{1/4}}{308828} + 1$$

$$r = \frac{0,859322839}{4} + 1$$

$$r = 1,2148307098$$

- Ratio value (r) for destination zone passengers:

$$r = \frac{\left(\frac{148453}{325610}\right)^{1/4}}{4} + 1$$

$$r = \frac{0,82171802}{4} + 1$$

$$r = 1,205429505$$

Table 2. Calculation of Passenger Ratio (r) Values

Lintasan	Zone	Number of Adult and Child Passengers					r
		Year					
		2017	2018	2019	2020	2021	
Bastiong	Origin	308828	214791	230336	141927	168400	1,215
	Destination	325610	226861	232774	124759	148453	1,205
Sidangli	Origin	325623	226874	232787	124772	148466	1,205
	Destination	326971	221726	228860	128320	157752	1,208
Rum	Origin	350165	230465	245679	116757	119094	1,191
	Destination	345302	227926	250609	116143	115801	1,190
Sofifi	Origin	638560	399954	428386	163356	133231	1,169
	Destination	616890	391420	420994	176176	145520	1,174
Batang Dua	Origin	6433	10490	17340	5548	267	1,113
	Destination	6908	11070	19186	5667	370	1,120
Makian	Origin	19012	11190	17375	15215	18408	1,248
	Destination	23290	12052	17945	16294	18930	1,237
Moti	Origin	10950	10021	44880	14862	15051	1,271
	Destination	14600	12729	46415	15078	16091	1,256

Table 3. Growth Factor (E) of Passengers

No	Zona	Origin	Destination
		E _i	E _j
1	Bastiong	1,215	1,205
2	Sidangoli	1,205	1,208
3	Rum	1,191	1,190
4	Sofifi	1,169	1,174
5	Batang Dua	1,113	1,120
6	Makian	1,248	1,237
7	Moti	1,271	1,256

2. Calculate the percentage value (r) of vehicle growth for groups I – III for ferries:

- Ratio value (r) for class I - III vehicles in the Origin zone:

$$r = \frac{\left(\frac{60432}{73311}\right)^{1/4}}{4} + 1$$

$$r = \frac{0,9528498194}{4} + 1$$

$$r = 1,2382124548$$

- Ratio value (r) for destination zone vehicles:

$$r = \frac{\left(\frac{48146}{84644}\right)^{1/4}}{4} + 1$$

$$r = \frac{0,8684423787}{4} + 1$$

$$r = 1,2171105947$$

Table 4. Calculation of Ratio Value (r) for Class I - III Vehicles

Lintasan	Zona	Number of Goal Vehicles. I - III					r
		Year					
		2017	2018	2019	2020	2021	
Bastiong	Origin	73311	53989	54929	41590	60432	1,238
	Destination	84644	55766	56304	35256	48146	1,217
Sidangli	Origin	84663	55785	56323	35275	48165	1,217
	Destination	86103	55889	56788	38498	55421	1,224
Rum	Origin	95369	61403	62421	31399	33357	1,192
	Destination	89655	58358	61730	30424	33117	1,195
Sofifi	Origin	152861	86667	95989	46703	43077	1,182
	Destination	144468	86922	93865	50223	47984	1,190
Batang Dua	Origin	1299	2688	3779	1186	86	1,127
	Destination	1372	2771	4261	1219	90	1,126
Makian	Origin	4458	1875	2809	3460	3647	1,238
	Destination	5175	2137	3099	3918	3895	1,233
Moti	Origin	789	2322	8818	3198	2964	1,348
	Destination	1333	2886	9021	3273	3075	1,308

Table 5. Growth Factor (E) of Class I - III Vehicles

No	Lintasan	Origin	Destination
		E _i	E _j
1	Bastiong	1,238	1,217
2	Sidangoli	1,217	1,224
3	Rum	1,192	1,195
4	Sofifi	1,182	1,190
5	Batang Dua	1,127	1,126
6	Makian	1,238	1,233
7	Moti	1,348	1,308

The results of the origin-destination survey between zones in the observation area as in Figure 1 above are presented in the table below;

Table 6. Passenger Origin-Destination Matrix for seven zones

i/j	A	B	C	D	E	F	G	Total
A	0	73.712	31.751	54.397	142	4.361	4.037	168.400
B	64.426	0	35.046	42.111	42	3.841	2.999	148.466
C	35.044	35.046	0	42.114	45	3.843	3.002	119.094
D	42.108	42.111	42.114	0	49	3.845	3.004	133.231
E	39	42	45	49	0	41	51	267
F	3.839	3.841	3.843	3.845	41	0	2.999	18.408
G	2.997	2.999	3.002	3.004	51	2.999	0	15.051
Total	148.453	157.752	115.801	145.520	370	18.930	16.091	602.918

Table 6 shows that the total number of trips currently occurring is 602918. So, from the origin-destination matrix (MAT) table, growth results are obtained using growth factors in the form of community activity intensity in the 7 zones by applying the Detroit model.

Tabel 7. Matriks Origin Destination Kendaraan Golongan I – III tujuh zona

Table 7. Matriks Origin Destination Kendaraan Golongan I – III tujuh zona

i/j	A	B	C	D	E	F	G	Total
A	0	73.712	31.751	54.397	142	4.361	4.037	168.400
B	64.426	0	35.046	42.111	42	3.841	2.999	148.466
C	35.044	35.046	0	42.114	45	3.843	3.002	119.094
D	42.108	42.111	42.114	0	49	3.845	3.004	133.231
E	39	42	45	49	0	41	51	267

F	3.839	3.841	3.843	3.845	41	0	2.999	18.408
G	2.997	2.999	3.002	3.004	51	2.999	0	15.051
Total	148.453	157.752	115.801	145.520	370	18.930	16.091	602.918

Table 7 shows that the total number of trips currently occurring is 261580. So, from the origin-destination matrix (MAT) table, growth results are obtained using growth factors in the form of community activity intensity in the 7 zones by applying the Detroit model.

Passenger and Vehicle Origin Destination Matrix (MAT)

1. Passenger Origin Destination Matrix

Table 8. Passenger Origin Destination Matrix

Zona	Bastiong	Sidangoli	Rum	Sofifi	Batang Dua	Makian	Moti	oi	Oi	Ei
Bastiong	0	73712	31751	54397	142	4361	4037	168400	204577	1,215
Sidangoli	64426	0	35046	42111	42	3841	2999	148466	178966	1,205
Rum	35044	35046	0	42114	45	3843	3002	119094	141832	1,191
Sofifi	42108	42111	42114	0	49	3845	3004	133231	155742	1,169
Batang Dua	39	42	45	49	0	41	51	267	297	1,113
Makian	3839	3841	3843	3845	41	0	2999	18408	22973	1,248
Moti	2997	2999	3002	3004	51	2999	0	15051	19126	1,271
di	148453	157752	115801	145520	370	18930	16091	602918		
Dj	178950	190621	138425	171466	415	23424	20213		723512	
Ei	1.205	1,208	1,195	1,178	1,120	1.237	1.256			1.2

From the travel data for the Origin and Destination Zones (table 8), the total number in the future can be obtained if it is assumed that the total zone growth rate is the same, namely (E = 1,200), because the seven zones observed, the growth is not that big and significant, then we get the number of trips from the origin and future destination zones in table 12 and table 13, where previously 9 iterations were carried out. The following shows iteration 2 (see table 9)

Table 9. Detroit Iteration 2 Passenger Method

Zona	Bastiong	Sidangoli	Rum	Sofifi	Batang Dua	Makian	Moti	oi	Oi	Ei
Bastiong	0	90.386	38.557	64.608	159	5.438	5.117	204.266	204.577	1,002
Sidangoli	78.585	0	42.259	49.664	47	4.756	3.775	179.085	178.966	0,999
Rum	42.168	42.095	0	48.996	50	4.695	3.727	141.730	141.832	1,001
Sofifi	49.477	49.391	48.917	0	52	4.587	3.642	156.065	155.742	0,998
Batang Dua	43	47	50	52	0	46	58	297	297	1,002
Makian	4.811	4.805	4.761	4.659	47	0	3.878	22.962	22.973	1,001
Moti	3.830	3.826	3.792	3.711	59	3.890	0	19.107	19.126	1,001
dj	178.914	190.550	138.334	171.690	414	23.412	20.196	723.511		
Dj	178.950	190.621	138.425	171.466	415	23.424	20.213		723.512	
Ej	1,000	1,000	1,001	0,999	1,001	1,000	1,000			1,000

2. Origin-Destination Matrix for Class I – III Vehicles

Class I – III vehicles include I (sedans, jeeps, pick-ups, or small trucks, and buses); II (large truck with two axles); III (large truck with three axles)

Table 10. Origin Destination Matrix for Class I - III Vehicles

Zona	Bastion ng	Sidang oli	Ru m	Soffi i	Batang Dua	Maki an	Mot i	oi	Oi	Ei
Bastiong	0	38472	1452 7	1934 9	11	1431	110 5	7489 6	9273 7	1,23 8
Sidangoli	28812	0	1467 9	1403 5	12	1106	946	5959 0	7252 8	1,21 7
Rum	10623	10686	0	1375 3	17	1087	931	3709 8	4423 1	1,19 2
Soffifi	16247	16343	2199 7	0	22	1082	928	5661 9	6693 2	1,18 2
Batang Dua	7	12	24	19	0	10	29	101	114	1,12 7
Makian	1107	1117	1508	1278 6	10	0	36	1656 4	2050 3	1,23 8
Moti	971	981	1326	1336 8	30	37	0	1671 1	2252 7	1,34 8
dj	57765	67612	5406 0	7331 0	103	4754	397 5	2615 80		
Dj	70307	82752	8902 6	7484 2	116	5862	520 0		3195 72	
Ej	1,217	1,224	1,64 7	1,02 1	1,126	1,233	1,30 8			1,22 2

From the travel data for the Origin and Destination Zones (table 10), the total number in the future can be obtained if it is assumed that the total zone growth rate is the same, namely (E = 1.222), because the seven zones observed, the growth is not that big and it is not yet significant, then another iteration is carried out to get the number of trips from the origin and future destination zones in the next table: where previously 9 iterations were carried out. The following shows iteration 2 (see table 11)

Table 11. Detroit Method Iteration 2 for Group I - III Vehicles

Zona	Bastion ng	Sidang oli	Rum	Soffif i	Batang Dua	Maki an	Mot i	oi	Oi	Ei
Bastiong	0	38.508	14.6 21	18.9 74	11	1.442	1.11 6	74.67 2	74.82 8	1,00 2
Sidangoli	28.712	0	14.5 47	13.5 52	12	1.098	940	58.86 2	58.62 3	0,99 6
Rum	11.536	11.477	0	14.4 71	18	1.176	1.00 9	39.68 7	39.77 0	1,00 2
Soffifi	14.803	14.726	19.9 31	0	20	981	843	51.30 4	50.92 4	0,99 3
Batang Dua	7	12	23	18	0	10	28	97	97	0,99 7
Makian	1.266	1.263	1.71 5	14.1 67	11	0	41	18.46 3	18.69 8	1,01 3
Moti	1.118	1.118	1.51 9	14.9 26	33	43	0	18.75 7	19.01 0	1,01 4
dj	57.441	67.104	52.3 57	76.1 08	105	4.750	3.97 7	261.8 41		
Dj	58.599	67.832	54.5 38	72.0 57	101	4.802	4.02 2		261.9 51	
Ej	1,020	1,011	1,04 2	0,94 7	0,962	1,011	1,01 1			1,00 0

Analogy Method of Movement Distribution (Detroit).

1. Analogy Method of Passenger Movement Distribution (Detroit)

$$Tid = 73712 \cdot \frac{1,215 \cdot 1,205}{1,200}$$

$$Tid = 90170$$

Table 12. Detroit Method Iteration 1 Passenger

Zona	Bastiong	Sidangoli	Rum	Sofifi	Batang Dua	Makian	Moti	oi	Oi	Ei
Bastiong	0	90170	38422	64887	161	5463	5134	204237	204577	1,002
Sidangoli	78011	0	42082	49843	47	4774	3785	178543	178966	1,002
Rum	41923	42027	0	49247	50	4719	3742	141708	141832	1,001
Sofifi	49445	49568	49039	0	53	4635	3676	156415	155742	0,996
Batang Dua	44	47	50	53	0	47	59	301	297	0,989
Makian	4813	4827	4778	4712	48	0	3917	23094	22973	0,995
Moti	3825	3838	3799	3748	60	3929	0	19200	19126	0,996
dj	178060	190477	138171	172490	420	23567	20312	723498		
Dj	178950	190621	138425	171466	415	23424	20213		723512	
Ej	1,005	1,001	1,002	0,994	0,987	0,994	0,995			1,000

In Table 10, we get a total of 723512 trips from the origin and destination zones, but not yet at number 1

Table 13. Detrit Method Iteration 10 Passengers

Zona	Bastiong	Sidangoli	Rum	Sofifi	Batang Dua	Makian	Moti	oi	Oi	Ei
Bastiong	0	90555	38684	64597	159	5451	5131	204577	204577	1,000
Sidangoli	78600	0	42278	49513	47	4754	3774	178966	178966	1,000
Rum	42261	42138	0	48947	50	4702	3734	141832	141832	1,000
Sofifi	49390	49246	48844	0	52	4576	3634	155742	155742	1,000
Batang Dua	43	47	50	52	0	46	58	297	297	1,000
Makian	4818	4806	4769	4651	47	0	3882	22973	22973	1,000
Moti	3837	3828	3800	3706	59	3895	0	19126	19126	1,000
dj	178950	190621	138425	171466	415	23424	20213	723512		
Dj	178950	190621	138425	171466	415	23424	20213		723512	
Ej	1,000	1,000	1,000	1,000	1,000	1,000	1,000			1,000

Table 13 shows that the number of future trips is 723512, with growth at number 1. So, literacy can be stopped (6).

2. Analogy Method for Movement Distribution (Detroit) of Group I – III Vehicles

$$Tid = 38472 \cdot \frac{1,238 \cdot 1,2217}{1,222}$$

$$Tid = 38472$$

Table 14. Detroit Method Iteration 1 Vehicles Group I – III

Zona	Bastiong	Sidangoli	Rum	Sofifi	Batang Dua	Makian	Moti	oi	Oi	Ei
Bastiong	0	38472	14527	19349	11	1431	1105	74896	74828	0,999
Sidangoli	28812	0	14679	14035	12	1106	946	59590	58623	0,984
Rum	10623	10686	0	13753	17	1087	931	37098	39770	1,072
Sofifi	16247	16343	21997	0	22	1082	928	56619	50924	0,899
Batang Dua	7	12	24	19	0	10	29	101	97	0,958
Makian	1107	1117	1508	12786	10	0	36	16564	18698	1,129
Moti	971	981	1326	13368	30	37	0	16711	19010	1,138
dj	57765	67612	54060	73310	103	4754	3975	261580		
Dj	58599	67832	54538	72057	101	4802	4022		261951	
Ei	1,014	1,003	1,009	0,983	0,982	1,010	1,012			1,001

In Table 14, we get 261951 trips from the origin and destination zones, but they are not yet at number 1.

Table 15. Detroit Iteration Method for 10 Class I - III Vehicles

Zona	Bastiong	Sidangoli	Rum	Sofifi	Batang Dua	Makian	Moti	oi	Oi	Ei	
Bastiong	0	39140	15527	17536		11	1474	1141	74828	74828	1,000
Sidangoli	29176	0	15130	12267		11	1098	942	58623	58623	1,000
Rum	12125	11818	0	13549		17	1217	1045	39770	39770	1,000
Sofifi	14653	14281	20194	0		18	957	822	50924	50924	1,000
Batang Dua	7	12	24	16		0	10	28	97	97	1,000
Makian	1398	1367	1939	13939		12	0	45	18698	18698	1,000
Moti	1241	1215	1725	14750		33	46	0	19010	19010	1,000
dj	58599	67832	54538	72057		101	4802	4022	261951		
Dj	58599	67832	54538	72057		101	4802	4022		261951	
Ej	1,000	1,000	1,000	1,000		1,000	1,000	1,000			1,000

Table 15 shows that the number of future trips is 261951, with growth at 1. So, literacy can be stopped (6)

Conclusion

To forecast the distribution of passengers and vehicles for the coming year, the largest distribution was obtained for passengers in the origin zone, namely Bastiong, with a total movement of 204,577 passengers, and the largest distribution for passengers in the destination zone, namely Sidangoli, with a total movement of 190,621 passengers. The smallest distribution for origin zone passengers is Batang Dua, with a total movement of 297 passengers, and the smallest distribution for destination zone passengers is Batang Dua, with a total movement of 415 passengers. The largest distribution for origin zone vehicles is Bastiong, with a total movement of 74,828 vehicles, and the largest distribution for destination zone vehicles is Sofifi, with a total movement of 72,057. The smallest distribution for origin zone vehicles is Batang Dua, which has a total movement of 97 vehicles, and the smallest distribution for destination zone vehicles is Batang Dua, which has a total movement of 101 vehicles.

References

- [1] “[3] Profil ASDP Indonesia Ferry Cabang Ternate.”
- [2] “, Penyelenggaraan Kewajiban Publik Untuk Angkutan Barang Dari Dan Ke Daerah Tertinggal, Terpencil, Terluar Dan Perbatasan”
- [3] F. Hidayati and A. D. Rarasati, “Factors Affecting The Development Of An Integrated Toll Transaction System To Improve Traffic Volume Distribution,” *Jurnal Pensil: Pendidikan Teknik Sipil*, 2023, [Online]. Available: <https://journal.unj.ac.id/unj/index.php/jpensil/article/view/36337>
- [4] F. Miro and V. P. Mukhtim, “Analisis Sebaran Perjalanan pada Empat Zona dalam Wilayah Administrasi Kota Solok,” *Jurnal Ilmiah Rekayasa Sipil*, 2022, [Online]. Available: <http://ejournal2.pnp.ac.id/index.php/jjrs/article/view/673>
- [5] A. Gaus, “Estimasi distribusi pergerakan arus lalu lintas di kota Ternate dengan menggunakan metode detroit”.
- [6] A. Injavira and K. Hasanah, “Analisis Beban Kerja Melalui Metode Full Time Equivalent Untuk Mengoptimalkan Kinerja Pegawai Dinas Kependudukan Dan Pencatatan Sipil Kota Madiun,” *Jurnal Ekonomi dan Bisnis (EK&BI)*, vol. 5, no. 1, pp. 29–35, 2022, doi: 10.37600/ekbi.v5i1.439.
- [7] G. A. Hormati and D. A. A. Pesudo, “Pengaruh Tekanan, Kesempatan, Rasionalisasi Dan Kemampuan Terhadap Kecenderungan Aparatur Sipil Negara Dalam Melakukan Kecurangan Akuntansi Studi Empiris Satuan Kerja Perangkat Daerah Kabupaten Bolaang Mongondow Timur,” *Jurnal Ilmiah Akuntansi dan Humanika*, vol. 9, no. 2, pp. 172–190, 2019.
- [8] P. Negara, H. Setiawan, and N. Umami, “Penilaian Perilaku Kerja Pegawai Negeri Sipil (PNS) Menggunakan Metode Analytical Network Process (ANP) dan Rating Scale Untuk Menentukan Pegawai Berprestasi di Dinas Pekerjaan Umum Kabupaten Serang,” *Jurnal Teknik Industri Untirta*, no. 1, 2018.
- [9] A. A. Tuati, D. Daud, and A. R. Zulfiani, “Analisis Dampak Covid 19 Terhadap Kinerja Lalu Lintas Di Ruas Jalan Siliwangi Kota Kupang,” *JUTEKS (Jurnal Teknik Sipil)*, 2023, [Online]. Available: <http://jurnal.pnk.ac.id/index.php/jutek/article/view/1009>
- [10] H. Li, “Film mulching, residue retention and N fertilization affect ammonia volatilization through soil labile N and C pools,” *Agric Ecosyst Environ*, vol. 308, 2021, doi: 10.1016/j.agee.2020.107272.

- [11] L. Kwok, "Labor shortage: a critical reflection and a call for industry-academia collaboration," *International Journal of Contemporary Hospitality Management*, vol. 34, no. 11, pp. 3929–3943, 2022, doi: 10.1108/IJCHM-01-2022-0103.
- [12] M. Zhang, "Selective retention of extracellular polymeric substances induced by adsorption to and coprecipitation with ferrihydrite," *Geochim Cosmochim Acta*, vol. 299, pp. 15–34, 2021, doi: 10.1016/j.gca.2021.02.015.
- [13] Q. Lv, "Volume Retention After Facial Fat Grafting and Relevant Factors: A Systematic Review and Meta-analysis," *Aesthetic Plastic Surgery*, vol. 45, no. 2, pp. 506–520, 2021. doi: 10.1007/s00266-020-01612-6.
- [14] X. Hao, "Dynamics and composition of soil organic carbon in response to 15 years of straw return in a Mollisol," *Soil Tillage Res*, vol. 215, 2022, doi: 10.1016/j.still.2021.105221.
- [15] [1] Tamin Z. Ofyar, "Perencanaan & Pemodelan TransportasiNo Title."
- [16] A. R. FIRMADI, "Analisis Perbandingan Pci Girder Existing Dengan Pcu Girder Pada Proyek Jembatan Utama Kali Pesanggrahan," *Jurnal Online Mahasiswa (JOM) Bidang Teknik Sipil*, 2023, [Online]. Available: <https://jom.unpak.ac.id/index.php/tekniksipil/article/view/2761>
- [17] T. S. Gulo and S. D. Tarigan, "Perencanaan Pondasi Mesin Pabrik Kelapa Sawit (Studi Kasus: PT. Brau Agro Asia)," *Jurnal Rekayasa Konstruksi Mekanika Sipil ...*, 2023, [Online]. Available: <https://ejournal.ust.ac.id/index.php/JRKMS/article/view/2560>
- [18] P. Harprastanti, A. Antonius, P. Purwanto, and ..., "Modifikasi Koefisien Diagram Tegangan Beton Serat Pada Berbagai Suhu," *Wahana Teknik Sipil ...*, 2021, [Online]. Available: <https://jurnal.polines.ac.id/index.php/wahana/article/view/3127>
- [19] N. Ngudiyono, "Perilaku Joint Balok-Kolom Beton Fiber Bendrat: The Beam-Column Joint Behavior of Bendrat Fiber Concrete," *Spektrum Sipil*, 2022, [Online]. Available: <http://spektrum.unram.ac.id/index.php/Spektrum/article/view/273>
- [20] R. R. Syarifuddin, H. Manalip, and ..., "Pengaruh Penggunaan Serbuk Cangkang Keong Sawah Sebagai Substitusi Parsial Semen Terhadap Nilai Modulus Elastisitas," *Jurnal Sipil ...*, 2021, [Online]. Available: <https://ejournal.unsrat.ac.id/index.php/jss/article/view/31839>
- [21] I. R. Rosida and T. M. C. Agusdini, "Tinjauan Tarif AKDP Rute Surabaya-Malang Kelas Ekonomi Akibat Perubahan Harga Solar," *Jurnal Teknik Sipil*, 2023, [Online]. Available: <https://ejournal.itats.ac.id/jts/article/view/4647>
- [22] R. E. Wibisono and R. F. Putri, "Evaluasi Kualitas Pelayanan Halte Terminal Purabaya Pada Transportasi Umum Suroboyo Bus," ... *Perencanaan Dan Rekayasa Sipil*, 2022, [Online]. Available: <https://ejournal.unitomo.ac.id/index.php/gestram/article/view/4636>
- [23] S. Sahrial, I. Irwan, and S. Suranto, "Analisis Faktor-Faktor yang Mempengaruhi Keterlambatan Proyek Peningkatan Jalan Rel Kereta Api Medan-Binjai," ... *Ilmiah Teknik Sipil ...*, 2022, [Online]. Available: <http://jurnalmahasiswa.uma.ac.id/index.php/jitas/article/view/1209>
- [24] W. Widjonarko and A. U. Fikri, "The Economic Impact of the Road Infrastructure Utilization and the Consumption of Electrical Energy in the Kedungsepur Urban Area," *Jurnal Teknik Sipil dan Perencanaan*, 2023, [Online]. Available: <https://journal.unnes.ac.id/nju/jtsp/article/view/42617>
- [25] M. Mooy, "Kapasitas Geser Balok Tinggi dengan Campuran Fly Ash tanpa Tulangan Geser," *Jurnal Teknik Sipil*, 2022, [Online]. Available: <http://sipil.ejournal.web.id/index.php/jts/article/view/528>
- [26] F. M. Dkk, "Analisis Sebaran Perjalanan pada Empat Zona dalam Wilayah Administrasi Kota Solok".