



Study of Public Perceptions on the Urban Railway Planning of the City of Banda Aceh and the Surrounding Areas

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Abstract – The urban railway in the City of Banda Aceh and the surrounding areas is currently being proposed by the Aceh Provincial Government through the Department of Transportation of Indonesia. The presence of this rail transport mode is expected to change the travel behavior of the commuter. As such, people who use private vehicles may shift to public transport mode, thereby reducing congestion, noise, and pollution. The objective of this study is to determine factors and indicators—related to rail transport—that are important to the community. This study was conducted to provide information on the urban railway planning of the City of Banda Aceh. The principal component analysis (PCA) was utilized in this study. The results analysis of the study shows that the most significant variable influencing the public on the urban railway for Banda Aceh City is land use (19.09%). The indicator that is important to the community under the land use factor includes the property used as railway (0.911), land use used as railway (0.907), adjacent land used as railway infrastructure (0.876), and adjacent property used as railway infrastructure (0.861). Overall, the respondents positively perceived the urban railway planning of Banda Aceh City and accepted the city's rail transport plan.

Keywords: railway, traffic reduction, emission reduction, land use, environmental impact, PCA

Introduction

One aspect of the implementation of infrastructure development that may not be avoided is the issue of land needs. Undeveloped land in a restricted area used for a certain activity is known as land use (Miro, 2005). According to Nasrudin (2019), land is the most important need for infrastructure development. Thus before the implementation of any development, land should be available. Land acquisition for any development indirectly changes land use purpose from the past, affecting the surrounding areas (Pavlovic *et al.*, 2022; Maes *et al.*, 2015). The infrastructure project that requires extensive land acquisition is the transportation facility development.

According to Miro (2005), transportation is an effort to move, carry, or divert an object from one place to another; As a result, the object becomes more useful than before. The transport system is one of the community activities that support transportation objectives. Nevertheless, the transportation system faces obstacles, for example, the high percentage of people using private vehicles. This causes congestion, noise, increased accident risk, and air pollutants, all negatively impacting society (Baldwin, 2015; Chen *et al.*, 2019). As a result, people need alternative modes of transport to overcome the problems mentioned above (Salon, 2009; Heinold *et al.*, 2018; Oggero *et al.*, 2006; Bohatkiewicz, 2021).

The Aceh Provincial Government, through the Indonesian Department of Transportation, has conducted a preliminary study to provide the rail transport mode. The train planned to be built in Banda Aceh City and surrounding areas are designed to serve the community to travel within and around the city; As a result, people could get around faster and safer. The planning to develop the urban railway for the City of Banda Aceh and surrounding areas will hopefully optimize public transport use and increase public

interest in choosing public transport rather than private vehicles. Currently, the main public transport with a fixed route in Banda Aceh city is the urban public transport called Trans Koetaradja. This public transport is a government-owned bus that has operated since early 2018 at free fares (Mutiawati *et al.*, 2022; Sugianto *et al.*, 2018). In general, infrastructure developments will increase the economic growth of a region, both the community and the government. The increasing infrastructure is believed to lead the region to overgrow. One infrastructure project that may increase Banda Aceh City's regional economy is the Banda Aceh urban railway.

There are three planned routes for the Banda Aceh City urban railway, namely Route 1, which will serve Sultan Iskandar Muda (SIM) Airport to Ulee Lheue Port, Route 2, which will serve Lam Ujong village to the Banda Aceh City downtown (Masjid Raya building), and Route 3 from Banda Aceh City downtown (Masjid Raya building) to Rukoh village (Figure 1). These three routes accommodate areas with high traffic movements and pedestrian and dense traffic networks due to access to public service areas, offices, and Banda Aceh City downtown. In addition, the planned routes could also increase regional development, tourism, and industry because they connect the airport to the Port of Ulee Lheue, which links Banda Aceh city to Weh Island, a tourist destination.

This urban railway planning is novel for the government in the Province of Aceh; thus, the government encourages many parties, including the owners, to conduct research related to the proposed rail mode. This study was carried out by distributing questionnaires to communities around the planned route. This was to determine the important variables and indicators to the community towards the urban rail planning of the City of Banda Aceh and surrounding areas. The Principal Component Analysis (PCA) method is utilized in this research.

Materials and Methods

The questionnaire survey in this research covers nine sub-districts of the City of Banda Aceh and the surrounding areas, as illustrated in Figure 1. The population of the surveyed areas will be approximately 746.492 by 2022.

Table 1. Summary of the questionnaire survey

Description	Information
Time of data collecting	March 2022
Place of data collecting	Banda Aceh City and Aceh Besar Dsitric, Indonesia
Data collecting method	Questionnaire
Total sample	400
Characteristics of passenger	Gender, age, education, occupation, number of family members, monthly earnings, vehicle ownership, driving license ownership, and transportation cost per month.

The research was conducted by distributing questionnaires to respondents. The answer choices are determined using the Likert scale. According to Likert (1932), quoted by Affandi *et al.* (2017), the Likert is a psychometric scale commonly used in questionnaires or questionnaires in surveys. The categories that are often used on the Likert are: totally agree (SS), agree (S), neutral (N), disagree (TS), and wildly disagree (STS); all of those are for both positive statements and negative questions.

The questionnaire survey technique for the urban railway planning for the City of Banda Aceh is the stated preference technique. The sample collection technique is probability sampling with a disproportionate stratified random sampling system. The sampling is the community around the railway stations. The existing strata are not proportional. The number of research samples is calculated from the number of residents around the stations and the passengers of Sultan Iskandar Muda Airport and Ulee Lheue Port. These secondary data are obtained from the Central Bureau of Statistics (BPS) official website. The determination of the number of samples (*n*) is from the Slovin formula, which is as follows:

$$n = \frac{746.492}{1 + 746.492 \times (0,05)^2} = 399,786 \approx 400 \quad (1)$$

From the above calculation, 400 samples were needed from the community around the planned urban railway stations and the passengers at Sultan Iskandar Muda Airport and Ulee Lheue Port, respectively (Figure 1). The confidence level used in this study is 95%; thus, this is a 5% of the error margin.



Factor analysis is a technique used to identify factors that may explain the connections or correlations between various independently observed indicators (Aprianto et al., 2015). The principal component analysis is a multivariable data selection technique that transforms an original data matrix into a collection of fewer uniform combinations but absorbs many initial data variants (Nasution, 2019). Therefore, PCA is an analysis that tries to simplify the variables without losing much information.

1. They are performing matrix correlation testing to see the effect of indicators on factors or components. There are three matrix correlation tests, namely, Kaiser Meyer Oikin (KMO), which is used to measure the appropriateness of the sampling with the resulting figures; Bartlett's test, which is used to determine that the variables are correlated in the population; and Measure of Sampling Adequacy (MSA), which is used to measure homogeneity between variables and to filter between variables so that only variables that meet the requirements can be processed.
2. The correlation matrix is tested repeatedly until all indicators have KMO values > 0.5 and become significant, such as having a 5% error margin and MSA values > 0.5 .
3. They are performing factor extraction with an eigenvalue limit > 1 .
4. Rotating factors to provide interpretation.
5. Determining factors based on indicators developed.

Matrix Correlation Test

Table 2 shows that the KMO value is 0.773, which indicates that the obtained value fulfills the requirements, i.e., $KMO > 0.5$. This concludes that the data used is adequate to be factored. The Bartlett test shows that the result is 0.00, meaning that the value fulfills the significant requirements of < 0.05 . These results indicate that there is a correlation between the variables. Table 3 shows that the MSA test has a value > 0.5 . This value means that the results are used to measure the homogeneity between variables. Moreover,

the results perform filtering between variables so that it can be processed further, i.e., the PCA can be carried out.

Table 2. Kaiser Meyer Olkin (KMO) and Bartlett Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.773
Bartlett's Test of Sphericity	Approx. Chi-Square	6389.289
	df	595
	Sig.	.000

Table 3. The measure of Sampling Adequacy (MSA) Test Results

Component variable	MSA Value	Component variable	MSA Value
X ₁	0.892	X ₁₉	0.881
X ₂	0.728	X ₂₀	0.764
X ₃	0.806	X ₂₁	0.895
X ₄	0.741	X ₂₂	0.823
X ₅	0.752	X ₂₃	0.805
X ₆	0.622	X ₂₄	0.767
X ₇	0.530	X ₂₅	0.750
X ₈	0.535	X ₂₆	0.854
X ₉	0.700	X ₂₇	0.817
X ₁₀	0.662	X ₂₈	0.828
X ₁₁	0.793	X ₂₉	0.822
X ₁₂	0.862	X ₃₀	0.762
X ₁₃	0.803	X ₃₁	0.866
X ₁₄	0.775	X ₃₂	0.667
X ₁₅	0.824	X ₃₃	0.641
X ₁₆	0.876	X ₃₄	0.628
X ₁₇	0.774	X ₃₅	0.610

Table 4. Factors Extraction and Determination of Total Variation of Components Represented

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	6.682	19.092	19.092	6.682	19.092	19.092
2	3.355	9.586	28.678	3.355	9.586	28.678
3	2.500	7.144	35.822	2.500	7.144	35.822
4	2.348	6.707	42.529	2.348	6.707	42.529
5	1.725	4.928	47.458	1.725	4.928	47.458
6	1.651	4.718	52.175	1.651	4.718	52.175
7	1.486	4.246	56.422	1.486	4.246	56.422
8	1.402	4.007	60.428	1.402	4.007	60.428
9	1.202	3.433	63.861	1.202	3.433	63.861
10	1.017	2.907	66.768	1.017	2.907	66.768
11	.903	2.581	69.349			
12	.867	2.478	71.826			
13	.832	2.377	74.203			
14	.767	2.191	76.394			
...	...	...	...	...	...	...
34	.133	.379	99.810			
35	.067	.190	100.000			

Factor Analysis with PCA

Table 4 presents the analysis of the components with their eigenvalue > 1 , namely components 1 to 10. The table shows a total variation of 66.678. Components having a proper value of > 1 are then selected and extracted to get the indicators that mostly affect each selected factor. The factor rotation is then carried out to simplify the distribution of indicators that fit into a group of factors. The rotation of factors uses the varimax method with a load factor value of ≥ 0.5 . The results of factor rotation using the varimax method are presented in Table 5, which shows the categories of indicators concerning the factors formed.

Table 5. Component Matrix

	Component									
	1	2	3	4	5	6	7	8	9	10
X ₁	.569	.050	.101	-.153	.061	-.071	.120	.030	-.018	.050
X ₂	.514	-.649	.277	-.034	.211	-.059	-.108	-.071	.144	-.072
X ₃	.596	-.622	.186	-.067	.179	-.114	.016	-.061	.101	-.041
X ₄	.538	-.664	.238	-.116	.156	-.040	-.101	-.040	.169	-.040
X ₅	.562	-.640	.164	-.129	.079	-.077	.040	-.135	.153	.027
X ₆	.190	-.044	-.167	-.252	.104	-.106	.567	.249	.059	.216
X ₇	.097	.339	-.012	.015	-.087	.036	-.144	-.044	.626	.377
X ₈	.177	-.102	-.161	-.360	.268	-.009	.450	.350	-.167	-.234
X ₉	.372	-.392	.089	.232	-.365	.309	-.007	.254	-.231	-.057
X ₁₀	.324	-.293	.126	.309	-.446	.386	.054	.218	-.213	.091
X ₁₁	.333	-.086	.132	.060	-.302	.477	.123	.231	.279	-.177
X ₁₂	.500	-.138	.033	.071	-.339	.011	.038	-.094	-.027	.273
X ₁₃	.320	.239	.314	.138	-.108	.250	-.064	-.247	-.083	.082
X ₁₄	.223	.385	.155	-.127	.051	.289	.161	.092	.151	-.366
...	...	...	...	...	...	...	...	...	...	...
X ₃₄	.222	.275	.182	-.122	.520	.474	.156	-.141	.010	.210
X ₃₅	.158	.188	.256	-.085	.292	.543	.141	-.162	-.265	.348

Table 6 presents the results of factors rotation where the categories of indicators against the factors formed. It is seen more clearly for values between factors that have higher differences. The weight value in the table is the loading factor value which shows the magnitude of the correlation factor between variable 1 and variable 6. The value of the loading factor is absolute. Rotation of the component matrix is carried out if in doubt, i.e., the difference is not too far from the correlation value. The more detailed distribution of factors indicators can be seen in Table 7.

Table 6. Rotated Component Matrix

	Component									
	1	2	3	4	5	6	7	8	9	10
X ₁	.268	.348	.270	.095	.053	.089	.265	.138	.111	.009
X ₂	.907	.061	.073	.087	.100	-.017	-.037	.014	.013	-.052
X ₃	.876	.106	.112	.123	.114	.069	.117	-.003	-.021	-.075
X ₄	.911	.124	.009	.067	.136	-.001	.020	-.001	.010	-.012
X ₅	.861	.109	.049	.040	.150	.151	.131	.001	-.070	.020
X ₆	.064	.015	-.027	.047	-.017	.027	.756	.062	-.029	.020
X ₇	-.088	.098	.053	.080	-.108	-.024	-.002	.058	.094	.800
X ₈	.117	.092	-.166	.067	-.078	-.021	.612	.032	.235	-.430
X ₉	.239	.053	.024	.136	.767	-.009	-.032	-.046	.045	-.180
X ₁₀	.113	-.010	.079	.098	.848	.002	-.023	.049	-.005	-.052
X ₁₁	.163	-.001	-.064	.024	.548	.064	.074	.036	.507	.190

X ₁₂	.219	.238	.235	.071	.422	.220	.096	.025	-.182	.201
X ₁₃	.001	.150	.351	-.055	.225	.145	-.227	.363	.113	.118
X ₁₄	-.096	.119	.095	-.049	-.004	.081	.086	.184	.657	-.011
X ₁₅	.077	.197	.104	-.048	.069	.093	.506	-.017	.167	.348
X ₁₆	.135	.782	.034	.134	.013	-.018	-.030	.068	.213	.027
X ₁₇	.104	.844	-.026	.053	.034	.107	.007	.045	.114	.128
X ₁₈	.046	.854	-.018	.061	.032	.148	.065	-.006	.061	.118
X ₁₉	.125	.538	.342	.124	-.009	.046	.323	.076	-.163	-.099
X ₂₀	.138	.425	.239	.021	-.155	-.105	-.258	.279	.335	-.194
X ₂₁	.051	.480	.178	.121	.182	.215	.310	-.041	-.136	-.192
X ₂₂	-.042	.218	.524	.208	.013	-.010	.089	.063	.461	.089
X ₂₃	-.005	.222	.495	.128	.085	-.039	.013	-.010	.486	.160
X ₂₄	.041	.019	.799	.067	-.036	.025	-.042	.142	.012	-.119
X ₂₅	.155	-.028	.742	.092	-.061	-.005	-.028	.067	.106	.018
X ₂₆	-.186	.291	.491	.156	.017	.212	.244	-.112	.233	.129
X ₂₇	.098	-.005	.674	.000	.257	-.041	-.030	-.093	-.097	.112
X ₂₈	.066	.124	.096	.765	.076	.166	.112	.024	-.068	.082
X ₂₉	.011	.129	.040	.846	.131	.062	.020	-.094	.028	-.016
X ₃₀	.143	.039	.094	.821	-.001	.028	.012	.017	-.025	.005
X ₃₁	.079	.054	.083	.782	.064	.148	-.023	.097	.127	.000
X ₃₂	.100	.138	.023	.193	.068	.896	.028	.069	.037	-.011
X ₃₃	-.073	-.138	.000	-.191	.004	-.908	-.064	.041	-.054	-.005
X ₃₄	.051	.035	.031	.099	-.151	.000	.103	.809	.219	.075
X ₃₅	-.037	.060	.043	-.035	.122	-.005	.034	.852	-.009	-.029

Table 7 shows 10 factors affecting public perceptions regarding Banda Aceh City's urban rail planning. The factors are land use, regional development, traffic, adverse impact, infrastructure location, improvement, compensation, line location, underpass, and compensation factor. The variance by land use related factor is 19.09%, by regional development factor is 9.59%, by traffic is 7.14%, by negative impact factor is 6.71%, by infrastructure location factor is 4.93%, by improvement factor is 4.72%, by compensation factor is 4.25%, by line location factor is 4.01%, by underpass factor is 3.43%. By compensation, the factor is 2.91%. The total variance explained by the 10 factors is 66.77%, whereas the remaining 33.23% are in other factors.

Table 7. Factors Tested to Attain Public Perception Related to the Urban Railway Planning

No.	Factor / Variable	Indicator	Variance
1.	Land Use	Land used as railway (X ₂)	19.09%
		Adjacent land is used as railway infrastructure (X ₃)	
		Property used as railway (X ₄)	
		Adjacent property is used as railway infrastructure (X ₅)	
		Agree with the urban railway planning (X ₁)	
2.	Regional Development	Train improves residents' economic (X ₁₆)	9.59%
		Train construction will create jobs (X ₁₇)	
		Train operation will increase employment (X ₁₈)	
		Train presence will increase tourism (X ₁₉)	
		Train presence will increase industry (X ₂₀)	
		Train presence will increase the land price (X ₂₁)	
3.	Traffic	Solve traffic problems (X ₂₂)	7.14%
		Reduce traffic accidents (X ₂₃)	
		Reduce the use of private vehicles (X ₂₄)	
		Reduce transportation costs (X ₂₅)	
		Travel distance is shorter by train (X ₂₆)	
		Train is more comfortable than private modes (X ₂₇)	

		Train construction causes noise (X ₂₈)	
		Train construction causes pollution (X ₂₉)	
4.	Negative Impact	The presence of trains causes electrical faults (X ₃₀)	6.71%
		The presence of trains causes the ground level to rise/fall (X ₃₁)	
		Agricultural land/plantation is used as rail infrastructure (X ₉)	
5.	Infrastructure Location	Open space is used as rail infrastructure (X ₁₀)	4.93%
		The width of the railway track is 30 m (X ₁₁)	
		The train stations are in a residential area (X ₁₂)	
		Provide a retaining wall when construction is damaged (X ₃₂)	
6.	Improvement	Relocate residents when experiencing construction damage (X ₃₃)	4.72%
		Compensation is required (X ₆)	
7.	Compensation	Compensation according to market price (X ₈)	4.25%
		The railway line uses a flyover system (X ₁₅)	
		The railway track is on the median road (X ₁₃)	
		The railway track connects the Sultan Iskandar Muda Airport area - Ulee Lheue Harbor - Khaju Toll Road Gate – Masjid Raya Baiturrahman building – Lambaro village - Keutapang village – Darussalam village (X ₃₄)	4.01%
		The railway track crosses the Baiturrahman mosque building area (X ₃₅)	
9.	Underpass System	Railway track uses the underpass system (X ₁₄)	3.43%
10.	NJOP (tax object sales value) compensation	Compensation according to NJOP (tax object sales value) (X ₇)	2.91%

Discussion

There are positive responses from the community, and they believe that the urban railway development plan of Banda Aceh City is important, as seen from the value of the indicators' coefficient. Sugiarto (2019) and Mutiawati et al. (2022) also suggested this positive response for other public transport in Banda Aceh. Moreover, the commuter of the city of Banda Aceh has an interest in using this proposed urban railway. The responses may also show the possibility of reducing traffic volume through good socialization by the government.

The above-mentioned potential traffic reduction leads to increased road level of service. Moreover, this is one of the efforts to prevent daily traffic jams in the future. Road traffic reduction could happen because car users might shift to rail transportation due to the benefit they can get (Salon, 2009). The existence of rail mode, in addition to road mode, might lead to a reduction in CO₂ emissions; this is in line with Heinold & Meisel (2018).

Conclusions

The results analysis of the rotated factors with the varimax method obtained 10 determinants that have a significant impact on urban railway planning, namely, (1) land use, (2) regional development, (3) traffic, (4) negative impact, (5) infrastructure location, (6) improvement, (7) compensation, (8) track location, (9) underpass, and (10) compensation factor. The total variance these 10 factors can explain is 66.77%, whereas other factors explain the remaining 33.23%. The most dominant factor affecting the urban rail planning for Banda Aceh City is the land use factor, which is 19.09%. The most dominant indicator is the property used as railway infrastructure (0.911), land used as infrastructure railway (0.907), adjacent land used as railway infrastructure (0.876), and adjacent property used as railway infrastructure (0.861). In addition, there is a positive perception from the respondents regarding the urban railway planning in Banda Aceh City.

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