Investigating public perceptions and its implication toward Trans Koetaradja policy considering latent motivation

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Abstract. Urban bus system so-called Trans Koetaradja (TK) has been considered and piloted as a way to mitigate motorcycles and cars dependency in Banda Aceh, capital of Aceh Province. It is assumed that the effectiveness of the such proposed policy would be useful if the public acceptance of this policy has a positive response. Therefore, this study intends to investigate the attitudes of the public in responding to such proposed policy. The data were collected within line 3 and line 4 of TK that is City Center - Mata Ie and City Center - Ajun - Lhoknga. The data collection method used was Stated Preference (SP) with a total of 220 samples collected using a stratified random sampling method. The SP questionnaire contains information about socio-economic, travel behavior, and respondents' perceptions representing their attitudes towards TK policy. People are dependent on their vehicles due to public transport challenging to use. The psychological indicators such as like driving a car & motorcycle and TK has limited accessibility have significant manifested to the latent variable of Inhibition of freedom of movement/activity. These sign representing the attitudes of the people in Banda Aceh would be dependence to their own vehicles and directly affected to the rejection to use proposed bus system of the proposed policy. Furthermore, male commuters who have low education level and income households more likely to autos dependent and more feeling inhibition of freedom of movement/activity if they use public transport.

1. Introduction
Public transportation as an element of the urban transportation system plays a critical role. Public transportation must be able to provide convenience for all communities in all their activities and be able to reach every urban area. Adequate public transportation will be able to increase road capacity and reduce traffic density, especially in urban areas so that it is excellent if supported by careful planning. As a result of the increase in public income and the high number of private vehicle ownership in Banda Aceh resulted in severe transportation problems, including congestion. Public dependence on private transportation modes is a significant factor in congestion in Banda Aceh. For this reason, the Aceh Government applies the policy of urban transport system with a mass transit system, namely the operation of the Bus Trans Koetaradja as a policy to reduce congestion impacts. TK is planned to operate at several lines within Banda Aceh City (See Fig. 1) and the TK Line can be seen in Figure 2.

Several studies have proven that bus reform policy such as bus rapid transit (BRT) in Jakarta has emerged as an economical transit alternative with significant potential for Jakarta [1,2]. Furthermore, providing proper public transportation would mitigate traffic congestion, reduce CO₂ emissions, and

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improve the effectiveness of energy consumption [3,4]. A tactic to advance a well-performing public transportation service could have a special place in the overall strategy of transportation planning [5].

Figure 1. Banda Aceh city (map data © 2018 Google)

Figure 2. Study area & Trans Koetaradja Lines (overlay on map data © 2018 Google)

Understanding the social aspect related to the travel behavior that influencing the public acceptance in particular transport policies is a very crucial issue in order to ensure the effectiveness of the specific transport policy proposed by the government. For example [6] pointed out that determinants such as problem awareness, policy fairness, and perceived effectiveness are important factors affecting the acceptability of transport pricing proposal in Jakarta, capital of Indonesia. Research in the emerging world conducted by [7, 8, 9, 10] examined respondents’ psychological motivations to assess the effects or observable and unobservable attributes of respondents’ choice behavior. They found that determinant factors such as recognition, fairness, and consciousness of congestion problems and inhibition of freedom of movement have the most substantial encouragement on causal acceptability to transport measures in Jakarta. Existing literature mentioned above pointed out that travel behavior is significantly linked with the personal judgment that substantially associated with perceived benefit or effectiveness of the particular policy. Most profound understanding to the public need is crucial to any investigations for ensuring the efficiency of bus reform policy. Therefore, this study intends to investigate the attitudes of the public in responding such proposed policy by examining public perceptions of the TK policy.
especially within line 3 and 4 of TK, namely the corridor of the City Center - Mata Ie and the City Center - Ajun - Lhoknga TK’s lines. Through this research, it is also expected that the information on the extent of public perception of TK policy will be obtained as input for relevant agencies in making decisions.

2. Literature Review

2.1 Trans Koetardja Policy
As a step to improve transportation services in Banda Aceh, the Aceh Government through the Department of Transportation, Communications, Information, and Telematics plans for urban bus system transportation, the Bus Trans Koetaradja. The Department of Transportation, Communication, Information and Telematics (2016) stated that the objectives of Trans Koetaradja policy were:
1) Resolve urban transportation problems such as congestion, parking chaos, traffic accident, and pollution;
2) Improve mass mobility services conveniently and comfortably;
3) Support the movement of resources for economic growth;
4) Realizing the Banda Aceh as a Green City.

2.2 Public Attitudes
There have been wide-ranging studies endeavoring to understand the determinant factors that influence public attitudes in the transport policy arena. For instance research by [6] pointed out that determinants such as problem awareness, policy fairness, and perceived effectiveness are important factors affecting the acceptability of transport pricing proposal in Jakarta, capital of Indonesia. More evidence by [8] found that infringement of freedom, policy fairness, problem awareness, and perceived effectiveness are essential determinants that significantly contribute to the acceptance of transport pricing policy. Research in the emerging world conducted by [7, 8, 9, 10] examined respondents’ psychological motivations to assess the effects or observable and unobservable attributes of respondents’ choice behavior. They found that determinant factors such as recognition, fairness, and consciousness of congestion problems and inhibition of freedom of movement have the most substantial encouragement on causal acceptability to transport measures in Jakarta.

2.3 Structural Equation Modelling (SEM)
Structural Equation Modeling (SEM) is a multivariate statistical analysis technique that combines aspects of factor analysis and path analysis with the aim of confirming measurement models and structural models built on specific theoretical studies [11]. SEM has become one of the most popular methods in multivariate analysis, especially in the social sciences. SEM has typical characteristics which include: 1). There are two types of variables: latent variable and observed variable (manifest); 2). There are two models: the structural model and measurement model, and 3). There are two types of errors: structural error and measurement error.

The SEM is consist of latent variable and observed variable. The latent variable is the critical variable of concern is the latent variable, latent variables are abstract concepts, such as people's behavior, attitude, feeling, and motivation. Latent variables can be observed indirectly and imperfectly through their effects on the observed variables. While the observed variable is variables that can be observed or measured empirically and are often called indicators or manifest variables, observed variables are effects or measures of latent variables. In the survey method using a questionnaire, each statement on the questionnaire represents an observed variable.

2.4 Multiple Indicators Multiple Causes (MIMIC) model
Multiple Indicators Multiple Causes (MIMIC) is one of the branches of SEM modeling. The MIMIC has two part modeling such as exploratory factor analysis (EFA) and confirmatory factor analysis (EFA).
The SEM is a flexible linear-in-parameters multivariate statistical technique that allows handling a large number of endogenous and exogenous variables. The latent constructs (factors) represent theoretical, abstract concepts or phenomena such as attitudes, behavioral patterns, cognition, social experiences, and emotions that cannot be observed or measured directly [12]. There are two types of analysis based on common factors namely exploratory factor analysis (EFA) and CFA. The Multiple Cause Multiple Indicator (MIMIC) model is combined both EFA and CFA [13, 14]. The MIMIC model as initially proposed by [14] systematically consists of a structural equation model and a measurement model, respectively given by:

\[ \eta_i = B \eta_i + \Gamma z_i + \zeta_i, \text{ and } y_i = A \eta_i + \xi_i \]  

(1)

Where \( y_i \) is a vector of observable psychological indicators variables, \( z_i \) is a vector of explanatory variables that cause \( \eta_i \), \( B \), \( \Gamma \) and \( A \) are matrices of unknown parameters to be estimated, and the terms \( \zeta_i \) and \( \xi_i \) are vector or of measurement errors. The MIMIC modeling approach has been widely applied in travel behavioral analysis, for instances can be seen in the previous studies done by [7, 8, 9, 10].

3. Data Collection and Empirical Setting

Primary data was obtained from a field survey by distributing questionnaires that were carried out stratified random sampling to the public transport and private mode users within line 3 and 4 of TK lines, that is City Center - Mata Ie and City Center - Ajun – Lhoknga lines. Respondents were commuters or people who carry out daily activities in the area with the proposed activities such as work, trading activities, school or college, and others. Questionnaires used stated preference techniques distributed manually and collected by eight surveyors and distributed within seven sub-distRICTS such as Kuta Raja, Baiturrahman, Jaya Baru, Banda Raya, Darul Imarah, Pekan Bada, and Lhoknga. The secondary data used in this study included technical data on Trans Koetaradja, Map of regional location for the introduction of the area and location of sampling, population data, previous studies, related literature from related agencies.

A MIMIC framework is applied to model and analysis the collected data. The regression parameters were calibrated by applied maximum likelihood estimator (MLE) and performed using Lisrel 9.2. This method aimed to test a model hypothesis and find out the vector of indicator variables \( y \) connected by a latent variable \( \eta \) with a covariate \( x \) included in the analysis calculation. The MIMIC model tested the consistency of structural theory and measurement through data and had the purpose of estimating parameters (coefficients, variances) and assessing the fit of the model.

The variables set were defined as attributes of a person or object that had a variation between one person to another or one object with another object. There were five variables that were built representing latent variables (unobserved variables) such as suitability of Trans Koetaradja (\( \eta_1 \)), Familiar or understanding of Trans Koetaradja policies (\( \eta_2 \)), dependence on private modes (car and two wheeled-vehicle) (\( \eta_3 \)), awareness of private mode problems (car and two wheeled-vehicle) (\( \eta_4 \)), and inhibition of freedom of movement caused by Trans Koetaradja (\( \eta_5 \)) which represented fourteen observed questions (observed variable) related to psychological perception (indicator). Socio-demographic attributes and travel behavior (\( x \)), indirectly affected the indicator (\( y \)).

4. Result and Discussion

4.1 Measurement model (confirmatory factor analysis/CFA part)

The results of the measurement model calibration are presented in Table 1 using the MIMIC approach. The latent variables such as policy suitability, familiarity, and understanding of policies, dependence on private cars, awareness of transportation problems and inhibition of freedom of movement are measured by using several indicators. As expected, most of the indicators in this latent constructs group have a significant factor loading (t-value > 1.96; at a significant error of 5%) to the measured latent constructs.
There are five latent variables built and represent fourteen indicators. In Table 1, there are twelve observed variables with loading factors ≥ 0.5 and t-value ≥ 1.96. The twelve measurement models are explained that the calibrated parameters are standardized (standardized loading factor) by adding a value of 1 for the first indicator within a group of a latent construct.

**Table 1.** Calibrated parameters of the measurement model (CFA part)

| Latent Variable | Indicators                                      | Coefficient | t-value |
|-----------------|------------------------------------------------|-------------|---------|
| Latent1         | Conformity of TK policy                        |             |         |
|                 | TK is the right policy                         | 1.00        |         |
|                 | TK is a policy that is accepted by the community | 1.61        | 3.64    |
| Latent2         | Familiar/understanding about TK policy          |             |         |
|                 | Good government and community interaction      | 1.00        |         |
|                 | TK can reduce environmental problems           | 0.68        | 3.74    |
| Latent3         | Cars or Motorcycles dependency                 |             |         |
|                 | Private vehicles are needed in everyday life   | 1.00        | 3.53    |
|                 | Public transportation is needed in everyday life | 1.33        |         |
|                 | Public transport is difficult to use in everyday life | 3.54  | 5.13 |
| Latent4         | Awareness of problem with Cars or Motorcycles dependency in the society |             |         |
|                 | Heavy traffic is in the city area              | 1.00        | 2.87    |
|                 | Walking and cycling are difficult and dangerous in the city area | 0.87  |         |
| Latent5         | Inhibition of freedom of movement/activity      |             |         |
|                 | TK can prevent freedom of driving, especially at bus stops | 1.00  | 2.88    |
|                 | Like driving a car & motorcycle                | 1.03        |         |
|                 | TK has limited accessibility                   | 1.38        | 3.01    |

Table 1 illustrates the correlation between individual perception as indicators and the latent constructs such as “Conformity of TK policy (latent1)”, “Familiar/understanding about TK policy (latent2)”, “Cars or Motorcycles Dependency (latent3)”, “Awareness of problem with Cars or Motorcycles Dependency in the society (latent4)” and “Inhibition of Freedom of Movement (latent5)”. Looking to the latent variables of latent1 & latent2, the indicators of the TK is a policy that is accepted by the community and good government, and community interaction has a significant positive sign to both of latent variables. It seems that the government has given an understanding of policy to the public and people believe that this policy could be appropriate policy to reduce traffic congestion in the city centers of Banda Aceh. The latent variable of “Cars or Motorcycles dependency” has significantly influenced by two indicators such as public transportation is needed in everyday life and public transport is difficult to use in everyday life. People are dependent on their vehicles due to public transport challenging to use. Furthermore, the latent5 revealing that the indicators of like driving a car & motorcycle and TK has limited accessibility have significant manifested to the latent variable of Inhibition of freedom of movement/activity. These sign representing the attitudes of the people in Banda
Aceh would be dependence on their vehicles and directly affected the rejection to use proposed bus system of the proposed policy.

4.2 Structural model (Exploratory Factor Analysis/EFA part)
Table 2 reveals the correlation among observed variable of socio-demographics to the latent constructs. The variable of dummy commuter shows us a positive correlation to the all latent variables except latent 4 has signed a negative magnitude. The dummy variable of male, the dummy variable of education and the dummy variable of low-income households have also a negative alerted to the latent variable 4 “Awareness of problem with Cars or Motorcycles dependency in the society”. This means that a commuter, a male, has lower education and has a lower income household more likely to less awareness about a problem with Cars or Motorcycles dependency in the society. While those variables have a positive correlation to the latent variable of “Cars or Motorcycles dependency and “Inhibition of freedom of movement/activity”. It seems that they are more likely to autos dependency people and has feeling inhibition of freedom of movement/activity if they use public transport.

| Observed Variables | Variable Setting | Path Loading Coefficients |
|-------------------|-----------------|--------------------------|
| Var1              | Dummy commuter: 1 yes, 0 otherwise | 0,10 0,16 0,49 -4,47 0,80 |
| Var2              | Dummy gender: 1 male, 0 otherwise | - - - -0,30 - |
| Var3              | Dummy age; 1 ≥ 30 years, 0 otherwise | - - -0,06 0,83 -0,07 |
| Var4              | Dummy education; 1 certificate ≤ College, 0 otherwise | 0,06 0,13 0,39 -3,72 0,67 |
| Var5              | Dummy job status: 1 working, 0 students | - -0,01 - -0,14 - |
| Var6              | Dummy income; 1 if ≤ 3 million, 0 if ≥ 3 million | - 0,08 0,29 -3,30 0,51 |

* variables are significant at 5%

5. Conclusion
Our work discussed in this research contributes to an investigation of the impacts of TK policy proposed by the Aceh Government. We examine the social impact in mainly related to the behavioral travel analysis by focusing on the public attitudes toward evaluating the proposed policy. The result of this research highlight that people in Banda Aceh has revealed that people in Banda Aceh agree to the adoption of TK but the TK itself has limited accessibility concerning the route services. Therefore, they tend to use their vehicles to travel.

Our modeling result using the MIMIC modeling approach reveals that the indicators of the TK are an accepted policy by the public and good communication among public and government have a significant positive sign to the latent constructs of “Conformity of TK policy”, “Familiar/understanding about TK Policy”. It appears that the government has given an understanding of policy to the public and people believe that this policy could be appropriate policy to reduce traffic congestion in the city centers of Banda Aceh. The latent variable of “Cars or Motorcycles dependency” has significantly influenced by two indicators such as public transportation is needed in everyday life and public transport is difficult to use in everyday life. People are dependent on their vehicles due to public transport challenging to use. Furthermore, the indicators of like driving a car & motorcycle and TK has limited accessibility have
significant manifested to the latent variable of Inhibition of freedom of movement/activity. These sign representing the attitudes of the people in Banda Aceh would be dependence to their vehicles and directly affected the rejection to use proposed bus system of the proposed policy.

Regarding the structural equation results, the observed variable of dummy commuter shows us a positive correlation to the all latent variables except to the latent variable “Awareness of Problem with Cars or Motorcycles Dependency in the Society”. The dummy variable of male, having primary education, and having low-income households also have a negative alerted to the latent variable of “Awareness of Problem with Cars or Motorcycles Dependency in the Society”. While those variables have a positive correlation to the latent variable of “Cars or Motorcycles dependency” and “Inhibition of freedom of movement/activity”. It seems that male commuters who have low education level and income households more likely to autos dependent and more feeling inhibition of freedom of movement/activity if they use public transport. Above empirical findings suggest that the attitudes of people have significant influencing in adopting and changing people travel behavior. Moreover, the empirical result from this study could provide valuable insight related to the people behavior concerning the such proposed policy. These findings suggest that mobility management measures would be appropriate to change the behavior of private-mode users toward public transport use based on public attitudes in responding to urban bus system policy. This effort might be of precise assistance in designing a more efficient policy by encouraging a bus ridership in Banda Aceh which is private vehicle dependency (cars & motorcycles) is severe in the recent years [15, 16].

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