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Invited Paper

Special Conventional Transport Model for a New BRT Line Passenger Demand Prediction

The General Modeling Method

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Abstract. The BRT is one of the most appropriate first mass transit to be developed in Indonesian big cities. Therefore, a New BRT Line Passenger Demand Prediction Method need to be developed. The research were conducted in Makassar City. A survey on the existing BRTs indicated that the BRT Users are the previous public transport user (75%) and motorcycle user (25%). Therefore, a Special Conventional Transport Modelling is considered the most appropriate to make a New BRT Line Passenger Demand Prediction. This modeling method incorporates Special Steps Sequence, Limited Modelling Area and Special Four Steps Calculation Method. The modelling primary and secondary data collection indicate that this Special Conventional Transport Modelling is the most appropriate, regarding the variety of Potential Users. This can be considered as a proof that this Special Conventional Transport Modelling is the most appropriate for this purpose.

1. Introduction

Indonesian big cities need implementation of mass transit. Urban Public Transport must be part of Public Service Obligations. As a developing country, Indonesian government budget is considerably limited. Therefore, the easiest and the cheapest mode to be developed is the BRT [1-3]. Implementation of the BRT has been done in several metropolitan cities. A lot of New BRT Lines are still to be implemented in other big cities [1-3]. However, the Ministry of Transports Guidance for Bus Line Planning, Design and Operation is still too simplified in passenger demand prediction aspect. A method to predict the BRT Ridership in developed countries, such as in Los Angeles County, is not appropriate at all for Indonesia [4,5]. Direct modelling method based on Public Transport Users Onboard Interview Survey (OIS) is quite used several times for New BRT Passenger Demand Prediction, but this method is already several times considered as not well enough considering the entire potential demand [1,2]. Therefore, a more appropriate Demand Prediction Method, better adapted to the real potential demand, need to be developed.

It can be imagined easily that Modelling Method design should be developed in two level : the general modelling method and the each four steps modelling method. The general method, in principal, covers the modelling type and the steps sequence should be used. The general method must be defined first and it must be adapted to the case condition. The each four step modelling calculation method can only be defined afterward.

Several principals aspects have to be defined concerning the general modeling method. First, the Modeling Area extension depends on the BRT Infleuence Area [1,2]. Second, the potential BRT User [1,2]. Third, the modeling type should be choosen among the three basic modelling type : the direct model, the conventional model and the unconventional model [6-11]. Fourth, if the conventional model is used, what sequence of the modelling steps should be used. In general, there are four types of Steps sequences : Sequence Type 1 : (TG+MS) - TD - TA, Sequence Type 2 : TG - MS - TD - TA, Sequence Type 3 : TG - (TD+MS) - TA, and Sequence Type 4 : TG - TD - MS - TA.

TG is the trip generation step, MS is the modal split step, TD is the trip distribution step, while TA is the trip assignment step [6].

Only after the general modeling method will have been determined and will have been proofed that it is appropriate, that each four steps model can be carefully designed.

Regarding the characteristics of the Potential Users and the varied Modelling Method, a Special Demand Modelling method for a New BRT Line Passenger Prediction Demand need to be developed. This paper discuss only the development of the General Modelling Method, together with a proof that the method is the most appropriate one.

2. Research Method

Papers Scope of Discusions. The entire Demand Modelling Method is long enough to be written in a paper. This paper discuss only the general aspect of the Demand Modelling Method development together with a proof that the method is the appropriate one for a New BRT Line Passenger Demand Prediction. Other more in detail discusions, on each of the four steps modelling, will be written in the other following papers.

Research Objective. The research objective is to develop a Special Demand Model for a New BRT Line and is to proof that the method can be used and the most approriate one to cover the entire variety of potential BRT user.

Research Method. The research was done by following these steps : research objective statement, research steps design, BRT users trip characteristics, demand modelling method development, method trial and appropriatness proof, conclusions.

Research Location. The research was done in Makassar City having 3 BRT in operation, i.e Mamminasata BRT Corridor 2, Corridor 3 and Corridor 4. Corridor 2 and Corridor 3, operated inside the Makassar City, were taken as references for BRT Passenger Trip Characteristics. Coridor 1, to be opened, is taken as Passenger Prediction Case. The map of Makassar City is presented in Figure 1 below.

Figure 1 Mamminasata BRT Network

3. Development of Demand Modelling Method

3.1. Modelling Objective

The main Modelling Objective is to predict hourly passanger demand in morning peak hour calculated by segment and by direction for the New BRT Line. Therefore, these passenger demand must be calculated based on Bus Stops based BRT Passenger Origin Destination Matrix (OD Matrix). So, several principal questions have to be answered on this research.

- Who are the potential BRT Users ?
- How large is the modeling area extension ?
- What modelling type must be used ?
- What modelling step sequence should be used ?

3.2. Modelling Method Considerations

In defining the Modelling Method, among the three principals Modelling Type, these following considerations must be taken into account :

- cover the whole potential demand – identify the potential users
- logical – choose among modeling main types.
- easiness of data collection – previous modes are public transport and motorcycle.
- easiness of calculation – direct method and conventional model is easy to calculate.
- accuracy assurance – several sample size guidance for conventional model.

3.3. Mamminasata BRT User Trip Characteristics

A small research to reveal the BRT User Trip Characteristics during morning peak hour was done in Makassar. The research gives the following main characteritics. The morning peak hour BRT are used practically only by working trip and schooling trip. Thus, morning peak hour BRT utilisation can be considered as stable in number and even in user. The existing BRT Users are the previous public transport users (75%) and the previous motorcycle users (25%). Trip Origin Influence Area cover a strip of 2 km to the left and to the right of the BRT Line. While Trip Destination Influence Area cover a strip of 1 km to the left and to the right of the BRT Line [2].

3.4 Development of Demand Modelling Method

The most important considerations, in demand modelling method development, are the potential passenger demand and the influence area mentioned above.

The modelling method basically will be choosen among the three basic modeling type : direct model, conventional model and unconventional model [1,2,6].

Unconventional Model. The Unconventional Model is definitely can not be used for this passenger prediction. The BRT is not yet in operation, so the existing passenger flows to be observed and counted are not yet exist.

Direct Model. The Direct Model theoritically can be used for this modelling. The potential public transport user are collected and identified on-board the Public Transport which are in-line with and which are across to the New BRT Line. The potential motorcycle user are collected and identified also on the streets which are in-line with or which are across to the New BRT Line. But this method having major difficulty, doing Road Side Interview Survey (RSIS) for motorcycle is very laborious and not easy at all, besides it needs an important funding. More than that the adequate sample size is also difficult to be achieved. Thus, the Direct Model is decided not to be used.

Conventional Model. The remaining one has to be used is Conventional Model. For this Conventional Model, two types of data collection method must be choosen : a home based data collection or a mixture of office-based & school-based data collection.

- A Mixture of Office & School Based. The influence area for trip origin and destination are known. But this method is still not easy, due to the office and school population data.
- Home Based. This is a very classical one, incorporating the Household Interview Survey (HIS) data. This method can be done.

Decision. From the reflexion above, the Conventional Model based on HIS is the most appropriate one. This method is simple and yet accuracy can be managed. This lead us to several new technics which has to be defined : the Modelling Steps Sequence, the BRT Demand Modelling Area, the BRT Trip Generation technique, the BRT Trip Distribution technique, the BRT Modal Split technique, and also the BRT Trip Assignment technique.

3.5. Conventional Model Special Steps Sequence

Even if it is a conventional model, this is not an ordinary conventional model. The ordinary conventional model step sequence type 1 follows this four steps sequence : TG/MS – TD – TA, while the ordinary conventional model step sequence type 4 follows this four steps sequence : TG – TD – MS – TA [6]. On the other hand, this special model must incorporate the BRT modal split after the trip distribution is done. In accordance, a step sequence must be added and be named conventional model type 1+4, a mixture of type 1 and type 4. The four steps sequence must be as follows : $(TG+MS)^{MA}$ (only for the modelling area) – TD^{MA} (only for the modelling area) – MS^{1BRT} (special MS for BRT choice in a matrix form) – TA^{1BRT} (special TA for BRT). The modal split step must be done twice.

3.6. Special Demand Modelling Area

The demand modelling area must cover the BRT Line influence area.The influence area for embarking passenger cover a strip of 2 km to the right and to the left along the BRT Line. While the influence area for the disembarking passenger cover a strip of 1 km to the right and to the left along the BRT Line [2]. By using this influence area principal, the traffic zone is designated as Kelurahan. Therefore the demand modelling area cover all Kelurahan in the influence area.

3.7. Special Trip Generation Model for the the Modelling Area

The first step that must be done very carefully is the trip generation. The trip generation step should be calculated based on the zonal regression trip production and proportional trip attraction [1,6]. The two must be done for the modelling area only, which is very limited. The trip production data must be considered are only those in-which the destination is in the attraction modelling area. Data collection is executed based on HIS method.

The trip production model must be developed very carefully, this must incorporate the trip toward the attraction modelling area from the entire production area against the entire related zonal data.

3.8. Special Trip Distribution Model for the Modelling Area

This special trip distribution model should be modeled by the ordinary gravity model [1,6]. The OD Matrix cover the entire Modelling Area. Special attention must be taken since the Production Zones and the Attraction Zones can be different.

3.9. Special Modal Split Model toward a New BRT Line

Another technic has to be well thought is the Modal Split Model toward the New BRT Line. It has been decided that this Special MS Model will be used after the Trip Distribution step to get the BRT OD Matrix out of the Motorcycle and Public Transport OD Matrix. Hence, the Modal Split toward the New BRT must be presented in a Modal Split Matrix Form, which must be developed based on a Mathematical MS Model, which is turn developed based on the Trip Maker Stated Preference of the BRT Model Choice. The mathematical model is a regression of Modal Choice Coefficient data against Travelling Distance. An appropriate regression model must be used for this case, since the dependent variable is a catagorical data [1,2,12,13].

3.10. Special Trip Assignment for a New BRT Line

In this case, the Trip Assignment is not about assigning the trips into several BRT Lines, but merely assigning the trips into a New BRT Line. This means assigning the OD Matrix into Embarking and Disembarking Passenger Volume on each bus stops. This needs several following steps [14].

After the Modal Split Toward the New BRT Line, the Traffic Zone based BRT OD Matrix will be gotten. The next step must be getting the Bus Stop based BRT OD Matrix. It can be easily calculated by assigning bus stops to each traffic zone. After this only, the Trip Assignment can be made. Trip Assignment is basically an All-or-Nothing, so it will be very easy and special. It can be done directly to get the Embarking and Disembarking for each Bus Stop and for each Direction, and afterward to calculate directly the Number of Passenger for each Segment and for each Direction. The BRT OD Matrix must be devided into two across the diagonal cells to get the BRT OD Matrix for each direction.

4. Demand Modelling Method Testing

4.1. Trial Case

Mamminasata BRT Corridor 1 : Airport – Mall GTC, which is will be soon implemented were taken as a Method Trial Case to implement the designed Modelling Method. The map is shown in Figure 1 above.

4.2. Notes on Modelling Method Trial

The BRT Corridor 1 has a long line with a lot of crossing street. In term of street segment, the BRT line has more than 20 segments and more than 30 crossing street. Thus, the existing public transport which are in-line and across-line is also quite alot, more than 20 lines. Therefore, doing OIS and RSI for the public transport users and the motorcycle userd is enormous. The direct modeling is not practical, it needs a enormous effort.

The Modelling Method implementation is not yet finished completely. But it can be concluded that, in principal, the “Conventional Transportation Modelling with Special Steps Sequence” can be used and this is the appropriate method to cover the entire potential demand, consisting of 75% public transport users and 25% motorcycle users.

Thus, a paper on General Modelling Method can already be written. Special paper on each four steps model calculations will be written separately.

5. Conclusions

Research objective has been succesfully achieved. Several principal conclusions can be drawn as follows :

- The most appropriate demand modelling method to cover the entire variety of potential demand is is a conventional model with a special steps sequence : $(TG+MS)^{MA} – TD^{MA} – MS^{1BRT} – TA^{1BRT}$.
- The each four steps calculation must be well designed.

This modeling method should be considered as new, since it deals with a new four steps sequence, modeling area definition, sampling definition, four steps special calculation method, validation method and sample accuracy measuring method. Reflexion on these aspects cannot be found in existing modeling textbook and papers. These all should be refined and written in separate papers.

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This paper present a part of a Research to Develop a New BRT Line Passenger Prediction Demand Modelling Method. Mamminasata BRT Network, in Makassar City, is taken for the Case Study.

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