The 7th Indonesia Japan Joint Scientific Symposium (IJJSS 2016)
Chiba, 20-24 November 2016

Redesign of Small Vehicles into a Safer Public Transit Transport Supporting Major Transport Lines

Ismail Alif Siregar, Hari Nugraha, Jaya Dikusuma

Universitas Pembangunan Jaya, Jl Cendrawasih Sawah Baru, Ciputat Tangerang Selatan Banten 15413, Indonesia

Abstract

Public transport is needed in cities as well as urban areas, For a developing country such as Indonesia, the rapid growth of infrastructure especially in the urban areas makes public transport as a vital part of the public needs. The transportation systems used in large cities such as Jakarta are city busses (Trans Jakarta), Electric trains (Commuter line trains) that could carry passengers in large numbers. This public transport carries passengers to major destinations inside the city.

Other mode of transportation that functions as a transit system to carry passengers from their homes to the major public transport lines, are small and under developed. These small transportations are made of smaller vehicles with a capacity of no more than 10 people and are not made and designed to high standard, such as ergonomic and safety standard of the larger transportation systems . Looking at these conditions, there is a need to redesign the small transportation system of these small vehicles so that it fulfils the basic ergonomic, comfort and safety standards. With the redesign it is hoped that this will to make passengers to be more comfortable and safe in using these public transport vehicles.

Keywords

Public Transport; City; Ergonomics; Design; Transportation Design

1. Introduction

According to a report done by Jeff Turner (2013), Jakarta, as the capitol city of Indonesia, faces increasing challenges in its transportation system. Especially with the growth of sattelite cities, the amount of traffic influx to Jakarta is presenting a problem to its transportation infrastructure. With a population of 9,6 million people, Jakarta transportation system has to also support its surrounding sattelite city Bogor Depok Tangerang and Bekasi which brings the total population to 26,6 million people. With this much people, transportation is needed for the daily commute of people from the surrounding cities of Jakarta. Wismadi, A., J. Soemardjito and H. Sutomo (2013) states that if nothing is done there would be a significant change for the worse in the volume and capacity ratio of the traffic.

Table 1 The road based transportation performance in DKI Jakarta Province. Source JAPTraPis Report (2012)

Indicators	2010 (Existing)	2020 (Do nothing)	2020 (masterplan do-something)
Cars	20%	28%	24%
Motorcycles	53%	50%	42%
Public Transport	27%	22%	34%
Traffic Performance Travel Speed	23.6 km/hour	15.2 km/hour	24.3 km/hour

To alleviate the problem, the goverment has deviced a masterplan to revitalize the transportation system with Mass Public Transport systems. The major ones are the construction of the LRT (Light Rapid Transport), MRT (Mass Rapid Transport) and the Specialized Bus corridors which are projected to be completed by 2018 (Globe Asia Magazine, March 30 2016)

Figure 1 Jakarta Traffic.

2. Material and Methods

2.1 Research Object

Besides the main transportation systems, there is an overlooked segment which are the secondary transportation systems which connects the smaller towns in the sattelite cities to the main transportation hubs. These are mainly provided by small vehicles that has been converted to be a passenger carrying vehicle. These are called AngKot (Angkutan Kota) and are the main transport systems of the smaller towns. They are made from commercial vehicles thats has been modified by local coach builders.

According to an interview conducted with Mr Azas Tigor Nainggolan the head of the Jakarta Transportation Board, there are no minimum standard and so the AngKot are not regulated, which results in AngKot's that are not safe for the public (Metropolitan, December 25th 2011)

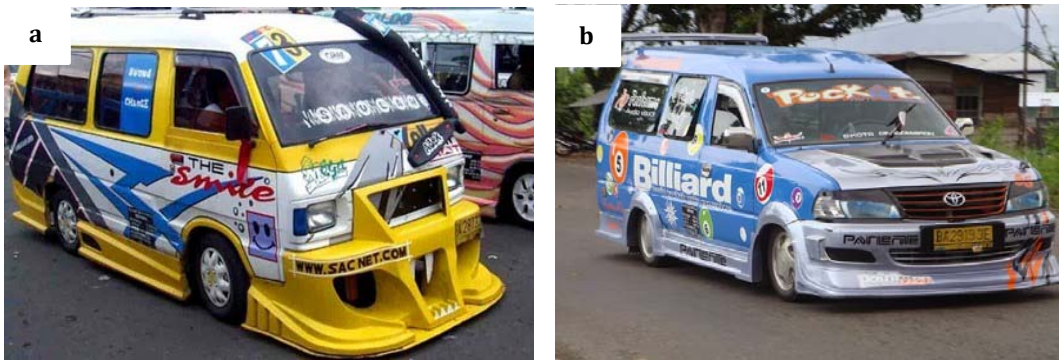

Figure 2 (a) Suzuki Carry based AngKot with exterior body modifications (b) Toyota Kijang with exterior body modifications

Besides the unauthorized modifications done to the exterior of the vehicle, the interior of the AngKot is also really unsuitable because of the small interior dimension. One of the main concern is the safety of passengers. There is a risk of crimes happening to female passengers because of the cramped seating positions. Because there is no space between sitting passengers it is possible for molestation and groping to happen because of the cramped interior (Megapolitan, June 22nd 2015). The interior space is further diminished by the installation of audio systems made by the drivers that does not adhere to any safety or good ergonomic standards.

Figure 3 (a) AngKot interior with Passengers. (b) AngKot interior modified with audio system.

Because Indonesia has no standards for small public transport, the researcher has based his guidelines on available regulations for public transport vehicles provided by the Ministry of Transportation (Peraturan Pemerintah Republik Indonesia No 55. 2012). As stated by Green (1999) There is a misconception that being a human being makes on a human factors/ergonomics expert, so non-experts often engage in professional practice, including standards development. This paper is an attempt by the researcher to provide an alternative design to the current practice that is made by the local coach builders.

The methode that will be used for this research will be qualitative as stated by Yin (2015), where the design of the previous vehicle will be compared to the proposed new design and then assessed. The design process will be as follows. Study of existing design

and problems, ergonomic considerations for the new design, application of ergonomic principles for the new AngKot design. The result of this design research can be applied to future AngKot design and production. The researcher will analyze the data available and do the following:

- Analyze the current available AngKot
- Identify Key issues
- Come up with design solution for the issues.

2.2. Design Issues of AngKot

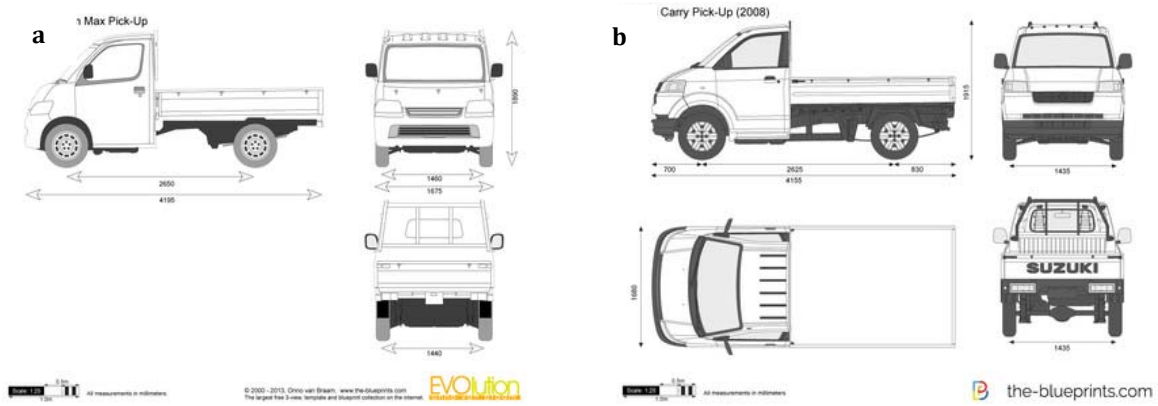

Figure 4 (a) Daihatsu Gran Max pickup. (b) Suzuki Carry pickup. Source: the-blueprints.com

Because the AngKot is based on a commercial vehicle which has been converted to a passenger vehicle with no basic or minimum design guide, the interior of the AngKot does not adhere to any standards at all. The commercial vehicles used are usually cargo vehicles, whose rear is converted. From the year 2010, the chassis that is widely used is the Daihatsu Gran Max Pickup and the Suzuki Carry

This type of vehicle is chosen because they are small, cheap, easy to maintain and run, and also of the load carrying capacity. Also because of the body on chassis construction, it is easy for coach builders to modify and build a body on top of the chassis.

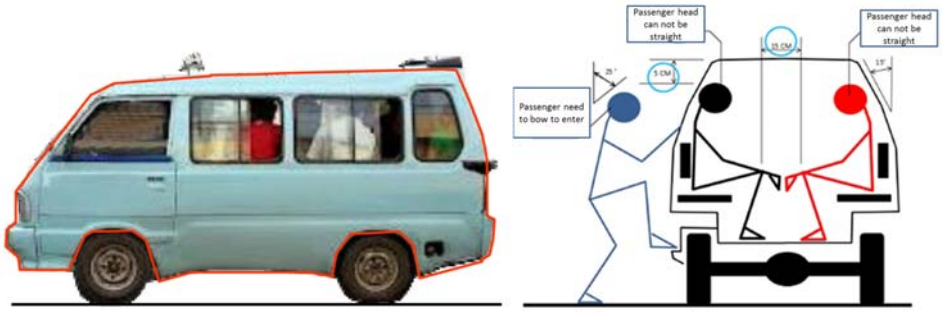

Figure 5 Analysis of current standard of AngKot interior

With the current AngKot, we can see that the interior does not adhere to any ergonomic or safety standards. With the unauthorized modifications made, even less room is available for the passengers, In the figure above, we can see how the passenger

has to bow their head up to 25º to enter. And inside the passengers have to keep their head down at an angle of 15º during the duration of their travel. The interior space also only leaves 5cm in space on the top of the passengers head with only 15 cm of space between opposing passengers. The Passengers capacity is 8 but is often over loaded to 12-14 passengers. This has resulted in situations where the passengers are sitting in an uncomfortable position, and the chance of crime such as theft and mollestations to happen increases

2.3 Redesign of AngKot Passenger Cabin

According to Márquez and Garcia (2004) there are basic factors that must be considered when designing for passengers requirements, which are:

- Access and exit stairs of the transport units.
- Easy of displacement within the unit.
- Access to the seats.
- Space available in the seat for the user.
- Form of the seats and rakes of seat, and the back rest.
- Distribution of the seats.

Kogi (2007) states that a prolonged sitting in a confined space as a passenger increases the discomfort of passengers. The proposed design is aimed to improve the ergonomic standard of the interior space to make the passengers more comfortable and to redesign the entrance of the vehicle so that passengers can easily get in or out of the vehicle. Another concern is the ease of movement of the passengers. In order to fulfill these requirements, a larger space is needed so that the size and placements of the seats can be arranged more ergonomically. To be seated comfortably, the passenger chair must adhere to ergonomics standards for a chair, which according to Dreyfuss (1993) are:

a. Seat height
b. Seat Depth
c. Seat Width
d. Backreast Height
e. Backrest Width
f. Backrest Lumbar

According to Nurmianto (2008) the anthropometric data of Indonesians differs from anthropometrical data of Dreyfuss. The new design proposed will be based on the anthropometrical data of Indonesians based on recent data compiled by the Indonesian Ergonomics Society to fulfill these needs. To fulfill these criteria, the size of the interior compartment must be widened to allow space between passengers, and to heighten the interior compartment so that passengers no longer have to bend their neck. To allow easy access to the entrance and exit of the vehicle, the door size needs to be adjusted too, so that the passengers can enter and exit more comfortably. The sizing for these improvements will be set as a standard for the proposed AngKot regardless of the type of vehicle chassis used.

a b

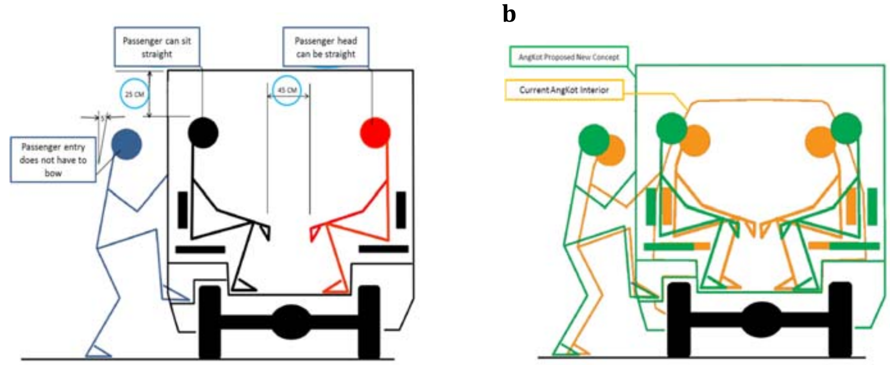

Figure 6 (a) Illustration of Proposed Redesign of the AngKot interior layout. (b) Comparison of interior space between current AngKot and redesign concept

Figures 6 (a) and (b) shows the comparison between the current AngKot interior space and the proposed redesign. The proposed design has a larger space to acomodate seats that are more ergonomic and allows for space to be available between facing passengers. This space would allow the ease of movements when a passenger enters the AngKot, also to allow them to move to find a seat easier and also make the movement to exit the vehicle easier. To do this we need to look at the anthropomorphical data of the Indonesian people when seated. Table 2 shows the current data that has been compiled by the Indonesian Ergonomic Society when it is applied to car seat.

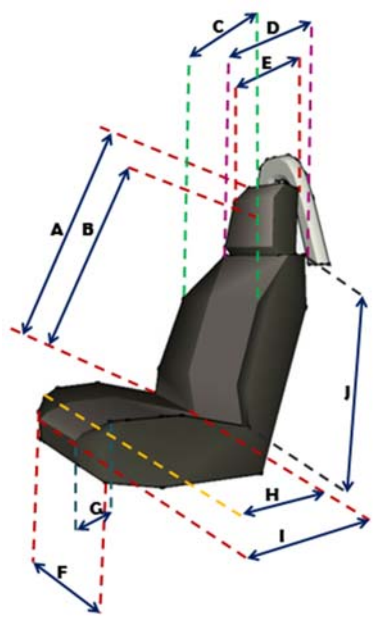

Figure 7 Seat Anthropometrical requirements Source: Indonesia Ergonomic Society

Table 2 Indonesian Anthropometrical Seat Requirements Source: Indonesia Ergonomic Association

Symbol	Part	5th	50th	95th
A	Height of Car Seat	64.89 cm	81.54 cm	98.18 cm
B	Eye Height while sitting	54.87 cm	71.34 cm	87.81 cm
C	Shoulder Width	57.11 cm	69.61 cm	82.1 cm
D	Upper Shoulder Width	45.97 cm	62.12 cm	78.28 cm
E	Width of Head	42.42 cm	46.07 cm	49.72 cm
F	Width of Seat base	52.52 cm	63.15 cm	73.78 cm
G	Length of Popliteal to	68.96 cm	90.32 cm	111.67 cm

	Knee			
H	Length of Seat to Popliteal	31.5 cm	40.9 cm	50.3 cm
I	Length of seat to Knee	38.97 cm	50.92 cm	62.88 cm
J	Height of Shoulder while sitting	41.36 cm	58.53 cm	75.71 cm

To standardise the design of the AngKot, the redesigned passenger compartment is designed as a modular system so that it can be fitted onto different type of small commercial vehicle chassis. With this modular design, the passenger compartment can be standardised and hopefully be better regulated by the goverment. Even if the coach builder is diferent.

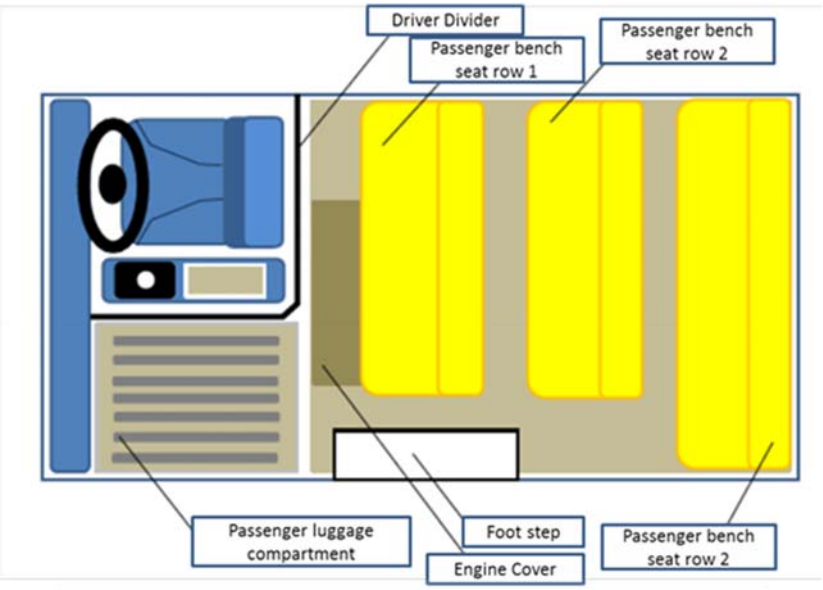

Figure 8 Illustration of Proposed Interior Layout for regular AngKot

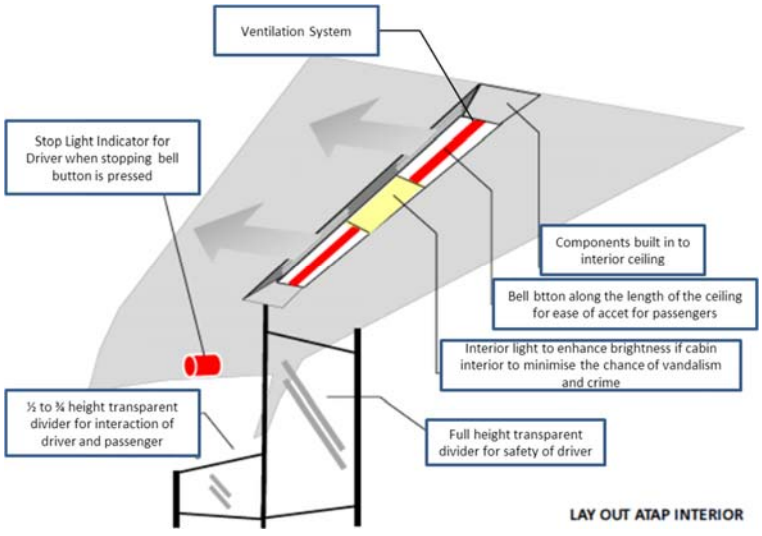

Figure 9 Illustration of Interior Design Concept

3. Result and Discussion

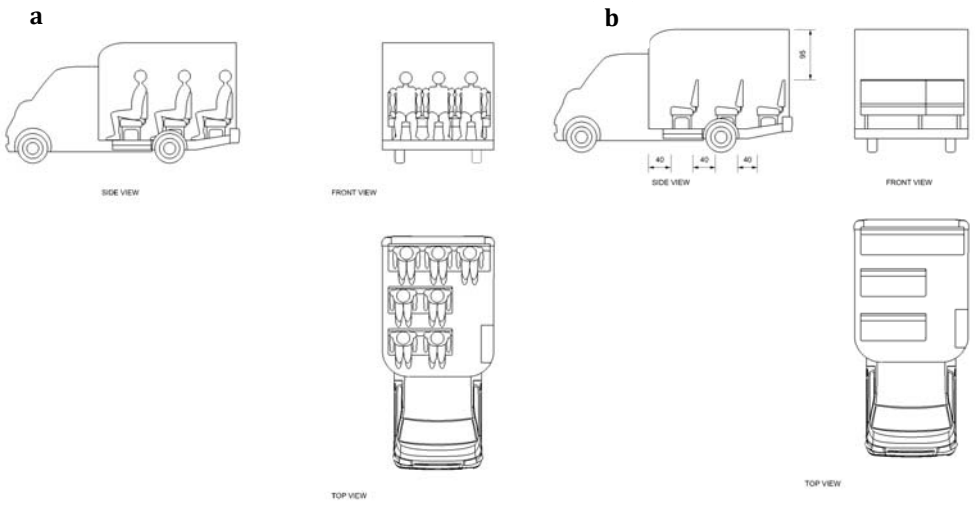

Figure 10 (a) Interior Layout with passengers. (b) Interior dimensions

The main focus of this research is the passenger cabin. Using the anthrophomorphic and ergonomic standards set by Nurmianto (2008) and the latest data from the Indonesian Ergonomic Society as seen in table 2. Using the 5th-95th% percentile of the population as base numbers. The researcher used 3d modelling software to input the required anthropometric numbers for the proposed design to come up with the measurements of the passenger seats and interior space requirements of the proposed passenger cabin. The size of the cabin is only slightly larger than the base of the pick up cargo space. Figure 10 shows the design layout proposal,which maximizes seating position which can hold 7 passengers plus 1 standing for a total of 8 passengers. The front passenger space next to the driver is converted into extra luggage space so that passengers luggage does not interfere with the sitting space.

With this redesign, In comparison with the current AngKot, the designs main difference is the way the passengers are facing. The passengers is now facing forward instead of each other. The leg area is now 40cm apart, which allows easy movements for the passengers to get in and out of their seats. The design issues such as the high entry of the current AngKot is solved by using low floor entrance. Using the anthropometric data available, the dimensions of the seats and interiors are designed to be more suitable for Indonesian requirements. Passengers head space is now sufficent so that they do not have to bend their body and neck anymore. There is also space for passengers luggage to be palced on overhead compartments. With the space created to separate the passengers, it is hoped that unwanted criminal activities such as theft and molestation can be reduced. The large window openings also gives the effect of an airy interior and also improves lighting conditions of the interior space. The design of the AngKot cabin in this paper is hoped to be a base for the goverment of Indonesia as a starting point to develop a standard for small commercial vehicles that has been converted into passenger carriers (AngKot). With the suggestion made by the author, during the development of the AngKot, consultants who understand safety and ergonomics factor can be involved by the local coach builders, and the resulting design can be standardised by the goverment and implemented so that passengers can feel more comfortable and the safety issues regarding crime can be further minimised.

Because the design of the passenger cabin is designed to be modular. The cabin can be mounted on different type of small commercial vehicle chassis. With the modular design, it will be more easy to supervised by the goverment if any changes has been made illegally.

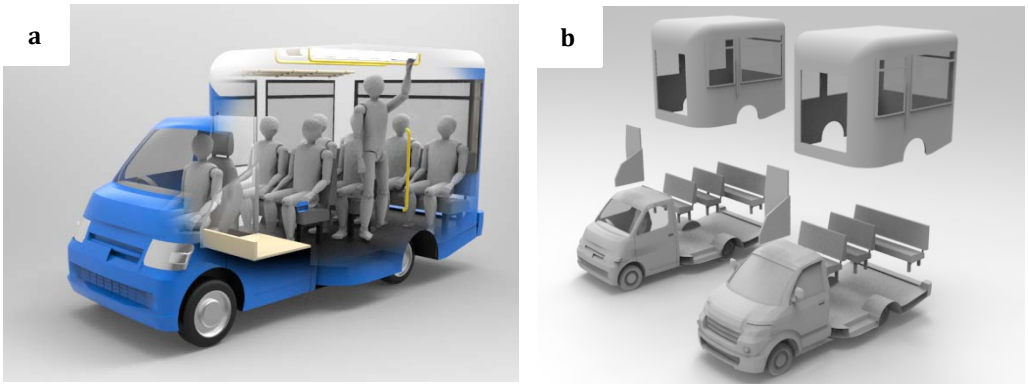

Figure 11 (a) 3D render of cabin on Daihatsu Gran Max pickup chassis. (b) Modular cabin design can be fitted on different chassis

Acknowledgements

This research is made as one of the three pillars of university program, which is the Universitas Pembangunan Jaya Tri Dharma Universitas. It is hoped that this research will gain new insight into the development of transportation design, in this case public transport in Indonesia. Also it is hoped that this research can be used as a reference for further research in the future and also as an educational material. This research can be applied by the goverment as an input for making a standard for public transport based on small vehicles. Any input and critique would be appreciated by the research team so that we may better our research in the future. We also would like to thank all the other parties that has helped the research team during this research

Reference

Green P. (2014) Why safety and Human Factors/Ergonomics standards are so difficult to establish www.hfes-europe.org/wp-content/uploads/2014/06/2-tc.pdf Last Accesed 10th November 2016

JICA (2012) Final Report. Volume 2. PROJECT FOR THE STUDY ON JABODETABEK PUBLIC TRANSPORTATION POLICY IMPLIMATATION STRATEGY IN THE REPUBLIC OF INDONESIA (JAPTraPIS)

JICA (2013) Final Report. REPUBLIC OF INDONESIA JAKARTA INTEGRATED URBAN TRANSPORT HUB DEVELOPMENT

Kogi. K (2007) Passenger Requirements and Ergonomics in Public Transport. The Official Journal of the Chartered Institute of Ergonomics and Human Factors. P. 631-639 | Published online: 27 Mar 2007

KOMPAS (2015) Ini Kasus-kasus Kejahatan Seksual yang Pernah Terjadi di Angkot Ibu Kota http://megapolitan.kompas.com/read/2015/06/22/05035291/Ini.Kasus-kasus.Kejahatan.Seksual.yang.Pernah.Terjadi.di.Angkot.Ibu.Kota?page=all Last Accesed 5th November 2016

INILAH (2011) Standar Pelayanan Minimum Angkutan Umum Diperlukan http://metropolitan.inilah.com/read/detail/1811616/standar-pelayanan-minimum-angkutan-umum-diperlukan Last Accesed 5th November 2016

Miguel, M.A (2004) Ergonomics of Urban Public Passangers Transportation. SCT Venezuela

Nurmantio. E (2008). "Ergonomi : Konsep Dasar dan Aplikasinya, Edisi Kedua". Guna Widya, Surabaya, Indonesia

Yin, Robert K. (2015) Qualitative Research from Start to Finish. 2nd edition. New York: Guilford,

Wisaksono, R. (2013). Pengembangan Desain Angkutan Kota Sebagai Transportasi Umum Terintegrasi di Kota Bandung. Jurnal Tingkat Sarjana Senirupa dan Desain No.1