

Safety Analysis of Light Rail Transit in Palembang

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Abstract- As the first rail-based mass transportation means for moving and transporting passengers / goods, the additional function of Light Rail Transit is as a tourist attraction. People flocked to try to use Light Rail Transit. This study aims to analyze the safety of Light Rail Transit in Palembang. Method: This research is a quantitative study with a cross sectional approach. Questionnaires were given to 100 Light Rail Transit passengers. The questionnaires were distributed to 25 people each day within 4 days.

The results showed that the risks / dangers of the Light Rail Transit according to respondents are engine breakdown; slip; fell on the escalator; stuck in an elevator; slipping, falling on the toilet, waiting room and prayer room; derailment, electric shock and collision. However, most respondents felt safe riding the Light Rail Transit, because they believed that the officers would maintain and provide adequate safety information. A small number of respondents still don't know not to use the elevator if there is an emergency and to not push prams when riding the escalator. A small portion of respondents are still standing over the safety lines while waiting for the Light Rail Transit, letting children running around and looking under the railroad. The passengers are still putting luggage on the train corridor and sitting using the priority bench. Dissemination through safety videos, not only in the form of posters by including safety information on the use of public facilities such as toilets, waiting rooms, prayer rooms, escalators and elevators. Knowledge, Trust, Travel Process is related to Light Rail Transit passenger alertness.

Keywords: safety, accident, light rail transit

I. INTRODUCTION

In recent years, the issue of energy price rise and environmental issues has come to the attention of researchers and practitioners in the energy efficiency of urban rail transit. Mass transportation contributed greatly in reducing energy use (Xin Yang, 2016). There are several types of mass transportation that are commonly used such as Rapid Transit Bus, Heavy Rail Transit System, Commuter Line, Monorail and Light Rail Transit (Andriansyah, 2015). One of the facilities that might meet the needs for public transportation in terms of the quality of the trip is the Integrated Railroad / Light Rail Transit (LRT). Light Rail Transit is a metropolitan electric rail system that is characterized by its ability to run carriages or short trains one by one along special lanes exclusively on terraced land, hanging structures, subways, or usually on the road, as well as picking and dropping passengers on the track or car parks (Kittellson, 1999).

Some studies about Light Rail Transit (LRT) discussed about schedule optimization and energy-efficient (Xin Yang, 2016); Automatic train control system (ATC) is a safety system which role is to control safe train operations and increase operation efficiency in train speed control through investigation, design, testing, and analysis, of the system, and the method of allowing improvements and other technical methods used in the design (Li-bo, 2017); Driverless train operation (DTO) systems are increasing globally and are expected to triple in the next 10 years. Opportunities provided by the DTO systems are lower operating costs, increased capacity, and energy efficiency. However, the challenges faced by the DTO system are safety issues, train control technology, and emergency situations (Zhou, 2016).

Transportation safety is a condition that is realized from the smooth operation of transportation in accordance with operating procedures and technical feasibility requirements for facilities and infrastructure and their supports. During the operation of the South Sumatra Light Rail Transit (LRT), several technical constraints caused the Light Rail Transit (LRT) to experience machine breakdown. The AC in the ER room is turned off so that an overheating occurred which caused the signal aspect remained red. At that time, most passengers felt overheated and some even experienced shortness of breath and the passengers had to stay in that condition for up to 2 hours.

There are passengers carrying out dangerous actions such as trying to escape the carriage without listening to the instructions of the officers. Furthermore, the evacuation of passengers is carried out by walkway, which is walking on the rails with officers' supervision with electrically powered rails are in a position turned off. Efforts to make Light Rail Transit (LRT) truly safe and secure are operating continuously which includes information dissemination to the public regarding emergencies. Therefore, this study is carried to examine the safety of Light Rail Transit (LRT) from passengers' point of view as an effort to prepare everything related to mitigation measures.

II. METHOD

This research is a quantitative study with cross sectional research. Questionnaires were given to passengers who have previously used Light Rail Transit at least 5 times. Taking differences of respondents into account, 25 questionnaires were distributed within 4 days on Monday, Wednesday, Friday and Sunday with 100 questionnaires collected in total.

III. RESULT

Respondents are people aged 15 to 59 years. Occupation of respondents ranges from government employees, private employees, students, traders and housewives. Respondents reside in Palembang as South Sumatera capital city, South Sumatera's regencies, as well as in different provinces. Their reasons for using Light Rail Transit include avoiding traffic jams, saving money, being more safe and comfortable, reaching their destination quickly, and just hanging out with friends and family. The society does not merely require the provision of mass transportation infrastructure. It is also about how effective and efficient the travel time, safety and comfort that passengers receive. Table 1 shows some of the concerns of Light Rail Transit passengers.

TABLE 1.
POTENTIAL RISK DURING LIGHT RAIL TRANSIT USE

No	Question: The following are the risks / hazards that may occur while using LRT in your opinion:	Answer			
		Yes		No	
		n	%	N	%
1	Machine breakdown	70	70%	30	30%
2	Slip and fall on the escalator	46	46%	54	54%
3	Trapped in the lift	44	44%	56	56%
4	Slip and fall in toilet/ waiting room/prayer room	39	39%	61	61%
5	Light Rail Transit derailed	34	34%	66	66%
6	Electrocution	28	28%	72	72%
7	LRT crashing	23	23%	77	77%

From the questionnaire, the type of hazard that respondents think most likely to happen with the Light Rail Transit is machine breakdown and the list goes down in the same order as displayed in table 1 with LRT crash being the least likely to happen according to respondents..

TABLE 2
RESPONDENTS KNOWLEDGE ON LIFT USE

No	Questions :	Answer			
		Yes		No	
		n	%	N	%
1	In a hurry	65	65%	35	35%
2	There's an emergency and disaster (such as earthquake, tornado and other emergencies)	13	13%	87	87%
3	Carrying heavy loads/luggage	55	55%	45	45%
4	Bringing children, elderly, disabled	64	64%	36	36%
5	Are you going to read the lift use	69	69%	31	31%

	regulation and direction ?				
7	Question : Where will you read that direction ?				
7.a	Before getting on the lift	50	50%	50	50%
7.b	Inside the lift	56	56%	44	44%
8	Question : What information can you get inside the lift ?				
8.a	Lift use direction	59	59%	41	41%
8.b	Regulation when you are trapped	60	60%	40	40%
8.c	Number to contact	50	50%	50	50%

The most notable result in table 2 is the part where most respondents know that they are not allowed to ride the elevator during an emergency situation. However, 13% of respondent does not have the knowledge.

TABLE 3
RESPONDENTS KNOWLEDGE ON ESCALATOR USE

No	Question :	Answer			
		Yes		No	
		n	%	n	%
1	Children stands in front of adults	64	64%	36	36%
2	Not in a hurry and standing on the left side of escalator	79	79%	21	21%
3	You may ride escalator with baby in baby carriage	27	27%	73	73%
4	May bring pets but must be hold	27	27%	73	73%
5	Holding onto escalator handle when escalator is running	50	50%	50	50%
6	Not holding onto the handle when escalator is not running	29	29%	71	71%

Most respondents who choose to use escalators understand that children must stand in front of parents. However, the concern is that only a small portion understands to stand on the right side, so as not to disturb others who want to go faster; not riding the escalator with a baby stroller; may bring pets by holding; may hold on to the handle when the escalator is running; and not hold on to the handle when the escalator isn't running. Some things that also should be a concern is not to stand over the yellow lines that are on the escalator and forbidden to lean on the hand handle.

TRAVELLING WITH *LIGHT RAIL TRANSIT*

TABLE 4
RESPONDENTS' UNSAFE ACTION WHILE WAITING FOR LIGHT RAIL TRANSIT

No	Question : While waiting for LRT :	Answer			
		Allowed		Not Allowed	
		n	%	n	%
1	Is there a crew to help leading you to waiting room?	96	96%	4	4%
	Question : The following is the allowed/not allowed things to do while waiting for the LRT:				
2	Crossing the safety line	25	25%	75	75%
3	Letting children running around	18	18%	82	82%
4	Inspecting the rail line below	19	19%	81	81%
5	Are you walking to the train by following the green direction arrows?	91	91%	9	9%

Table 4 shows that majority of respondents know not to commit unsafe action with at least 75% of respondents answered correctly. However, no matter how small the percentages, there still are respondents or passengers who potentially would consider do the unsafe actions because of the lack of understanding on the matter.

TABLE 5
RESPONDENTS BEHAVIOURS WHEN ENTERING THE LIGHT RAIL TRANSIT

No	Questions : When entering Light Rail Transit :	Answers			
		Yes		No.	
		n	%	n	%
1	Is there any crew that helps you enter the train	96	96%	4	4%
2	Do you follow the crew direction	96	96%	4	4%
3	Are you getting on the train with order	98	98%	2	2%
4	Are you letting people get off before entering the train	96	96%	4	4%

Table 5 shows that the majority of passengers already know the rule on how to get on and off the train and who to prioritize when they have to enter or exit the train with 98% respondent answering "yes" to question if they let people getting off the train first before they enter.

TABLE 6
RESPONDENT BEHAVIOUR DURING TRIP WITH LIGHT RAIL TRANSIT

No	Questions : While in Light Rail Transit :	Answers			
		Yes		No.	
		n	%	n	%
1	Are there any crew during the trip	97	97%	3	3%
2	Do you follow the crew directions	95	95%	5	5%
3	Are you leaving your bags, luggage on the train corridor	44	44%	56	56%
4	Are you using priority seat	34	34%	66	66%
	Questions :				
5	Do you let children running inside the train	1	1%	99	99%
6	Do you let children hanging around on the train	0	0%	100	100%
7	Do you eat or drink inside the train	5	5%	95	95%
8	Do you leave trash inside the train	1	1%	99	99%
9	Do you pay attention to information relayed by crew through loudspeaker	98	98%	2	2%
10	Do you watch the information video relayed on the screen inside the train	73	73%	27	27%
11	Do you see the writing "emergency door open"	47	47%	53	53%

TABLE 7
RESPONDENT BEHAVIOUR WHEN GETTING OFF THE LIGHT RAIL TRANSIT

No	Questions : When you get off the train :	Answers			
		Ya		No.	
		n	%	n	%
1	Doe the crew give directions when the train stops	100	100%	0	0%
2	Are you letting people get on the train before getting off	49	49%	51	51%
3	Are you going down the stairs by following the red direction arrows	91	91%	9	9%

Table 1.6 and table 1.7 indicate that there are respondents who take unsafe actions during the Light Rail Transit trip. Placing luggage in the corridor of the train will disturb the comfort of other passengers, disturb the spatial layout, and most importantly obstruct the evacuation route and endanger other passengers during emergency situations. Place the items in the space provided, usually at the top. But it should be noted also the location of the place of goods must be safe as to not risking the goods falling and injure people below.

The priority seats are reserved only for pregnant women, the elderly and

disabled. There are symbols on the priority seating area to indicate who can sit there. The Light Rail Transit crew, who is on the road, has the duty to ensure the safety of passengers. One of them will always remind the passenger of passenger luggage placement; priority seat use; for adults to always supervise and stay alert to children; remind passengers not to eat and drink during the trip and not to throw garbage in the Light Rail Transit.

Crew would also remind passengers to be patient and be orderly, even in a rush to enter and exit the Light Rail Transit, passengers must still prioritize those who want to get off. This action by the train crews will continue to be done, considering that at this time, the use of Light Rail Transit is not only as a means of transportation for residents of the city of Palembang and surrounding area, but also used as a means of transportation for athletes and official sports teams when there are local, national and international sports competitions in Jakabaring Sport Center. Light Rail Transit is also a tourist attraction to satisfy people's curiosity; what about this Light Rail Transit as the first modern transportation in Palembang.

Information on trips and emergency response, provided through loudspeakers and television on Light Rail Transit. Information about some unsafe conditions regarding risks and impacts in the Light Rail Transit area, as well as unsafe actions, has not been socialized, especially to answer people's curiosity.

IV. DISCUSSION

Specifically for the Light Rail Transit trains, more operational disruptions occurred in the Non Train Accident (NKKA). Because the operation of LRT trains is different from ordinary trains, so for accidents such as train collisions and train roll over, there is less risk for LRT. LRT has different lanes for each train, which has 2 separate lanes. Therefore it is no possibility of a collision on the train. LRT trains are more at risk of experiencing disruptions for Non Railway Accidents (NKKA) such as infrastructure, technology and security problems. From the technology side it is known that in operation LRT trains use a lot of electricity and sensor signals which are at risk of interference and cause a danger to passengers.

In terms of security, the LRT is also very wary of the risk of sabotage on trains which is feared to disrupt the train travel process and endanger passengers. However, based on observations made by researchers, it is found that there are other emergencies that must also be considered, which is the risk of passengers to be falling into the railroad tracks. It can be seen that South Sumatra LRT in its operation uses sensors in opening and closing doors. There is a written statement on the door which is a prohibition to lean on it, it is intended for the safety of the passenger itself because if there is interference with the door sensor and suddenly the door is open when the train has not arrived, the passenger leaning on the door have risk of falling into the rail. It must also be noted by security personnel to be more stringent in their supervision of passengers standing near the door.

Same thing with trains, identification of risk profiles at the stations is also done in the same way. The process of identifying the risk profile at the station is carried out routinely with patrols from the Internal Security Officer and also every day there are maintenance officers who check and maintain and identify the train's feasibility before it will operate normally. This is in accordance with the Decree of the Directors of PT. Kereta Api Indonesia (Persero) Number. KP.501 / 1 / 4 / KA-2011 dated January 12, 2011 concerning the safety commitments of leaders in the

PT. Kereta Api Indonesia (Persero) which contains information about efforts to improve safety at PT. Kereta Api Indonesia (Persero), a method for identifying hazards and efforts to prevent accidents, mechanisms for reporting potential hazards and their follow-up, and how to create a risk profile of a Daop / Divre. All of that must be understood and implemented by all employees of PT. Kereta Api Indonesia (Persero) in order to realize safety, timeliness, service and comfort in the operation of the train. From this risk profile, it can be estimated that there are various types of emergencies that can occur. Types of emergencies also differ between those that occur on trains and also at the station. Each station has a risk profile determined that can result in an emergency. This is also consistent with the statement in ISO 14001, clause element 4.4.7 which states that an organization or company must establish, implement and maintain procedures to identify emergencies and potential accidents. The organization must respond to emergencies and accidents. However, the LRT itself does not yet have full authority to regulate SOPs based on the specified risk profile.

During the trial run of the South Sumatra Light Rail Transit (LRT), it experienced two technical problems which resulted in the Light Rail Transit (LRT) experiencing a breakdown. The AC in the ER room is turned off so that overheating occurred which resulted in signal aspect remaining red. Most respondents choose the risk of a breakdown which followed by slipping, falling and trapped in the escalator infrastructure, elevators, toilets, waiting rooms and prayer rooms.

Light Rail Transit uses electricity on rails with a voltage of 750 VDC and an electric current of 700 ampere. The high electricity use is a risk that is feared by a small number of passengers, but it was ignored with the assumption that this modern technology must have solutions to overcome any electricity risks. Transportation safety is manifested in the smooth operation of transportation in accordance with operating procedures and technical feasibility requirements for facilities and infrastructure and their supports. Some Standard Operating Procedures (SOPs) that have been carried out by the Light Rail Transit are:

1. Track Access Management SOP, used when an emergency occurs such as a passenger falling on the track, for security when someone is required to get off the track, because it is very risky to go down on an electric voltage track.
2. SOP of disturbance of facilities and infrastructure, used when there are disruptions of facilities and infrastructure, for example when a train breaks down, or a railroad has interference such as broken and so forth.
3. SOP for using Emergency Power Off, is a button that is used to turn off the electric current in the Light Rail Transit.

USE OF LIFT AND ESCALATOR

Most respondents choose to use the elevator when they are in hurry, carrying heavy goods or luggage, bringing children, elderly and disabled. It is a concern, even though it's a small portion of respondents, that they do not know they are not allowed to ride the elevator during emergency situations. Respondents who use the elevator will read the information inside the elevator about the rules of using the elevator, the rules when trapped and the number that can be contacted.

TRAVELLING WITH LIGHT RAIL TRANSIT

The most important element in an LRT train emergency response is the procedure. The procedure carried out in an emergency is something that is immediately applied when an emergency occurs. South Sumatra Light Rail Transit (LRT) already has an emergency response procedure compiled based on Permen No.23 of 2007 as well as an official service regulation from the directors of PT. Indonesian Railways in the Standard Operating Procedure (SOP) document. This procedure was made by taking into account that in the operation of light railroad there are various risks of emergencies so that an emergency response procedure is needed to find preventive measures for effective and appropriate evacuation so as to minimize casualties and the amount of loss that will be borne by the company. This is in line with statement in PERMENAKER No. PER. 05 / MEN / 1996 concerning the Occupational Safety and Health Management System (SMK3) that companies must have procedures to deal with emergencies or disasters, which are tested periodically to determine the reliability of the actual event. For emergency response at the station is based on Standard Operating Procedures (SOP) infrastructure builders, namely PT. Waskita Karya, a construction contractor who designs how safety facilities such as emergency stairs, gathering points and so forth.

Described in the SOP of the station that is accommodating about how to evacuate passengers in a safe place. In addition, there are also SOPs regarding the actions of railroad crews in the event of an interruption in travel which contains delays in the departure of light railroad, disruption of door means, air conditioning and traction in facilities. This is in accordance with the emergency response, Article 27 explains the Standard Operating Procedure (SOP) regarding handling emergency conditions as referred to in Article 25 letter b including: a. train delays; b. train cancellation; c. train delays and how to overcome delays; d. diversion of train travel; e. handling train accidents; and f. evacuation of train passengers.

All SOPs have been made and have been socialized to the community and school children. In addition there is also cooperation with the transportation department and the Basarnas team because the evacuation method on the walkway has been carried out simulations and various kinds of repairs, so at the time of evacuation there were machinists and PKD as helping to direct passengers to the station. So there is a leader who ensures that no passenger falls / lags from the track. It was during this evacuation that electricity of 750pdc would not be turned on, so it was completely free of electricity and evacuation of passengers became more flexible. Besides, emergency procedures are also regularly delivered on a small television that is on the train. The video explained what passengers must do during an emergency. In terms of passenger preparedness, they should be more prepared in the event of an emergency that requires evacuation and no panicking during an emergency because it is expected that passengers already understand the information about the procedure both delivered via television and loudspeakers as well as emergency instructions that can be read directly at any time.

Table 1.4 shows that even though only a small portion, it should be noted by the Light Rail Transit crew that some passengers has tendency to commit unsafe action while waiting for the train. The dangerous actions taken by passengers are crossing the boundary line, leaving children unattended so that children can run away from parents, also passengers has tendency to be curious and trying to check and see the rails below, not knowing and disregarding the electricity hazard and other potential hazards that could befall onto them.

The yellow line between the platform and the rail is intended so that no one is allowed to cross it. Things that can happen if you pass are hit by LRT train or fall onto the rails. The waiting area is in quite high position above the rail. If an adult falls it is not easy to go back up with that height. In addition, the rail is powered with a voltage of 750 VDC and an electric current of 700 Amperes. After falling onto the rail, people may get electrocuted. The Light Rail Transit crew always accompanies passengers from getting to the waiting room, entering the train, during the trip and dropping off passengers. However, crew may not be able to pay attention to all passengers during rush hour as the volume of passengers during this time would increase. It would be hard to supervise if any passengers, adult or children would be curious about the rail and unconsciously crossing the yellow line, risking themselves. Another kind of safety measure needs to be taken to prevent this from happening.

As seen in table 5, most respondents took safe actions when entering the Light Rail Transit. However, in table 7, almost half of respondents ignoring the exiting rule. That means there is a possibility that a lot of passengers would ignore the safety and order of getting on and off the train if the situation allows.

During the trip with Light Rail Transit, almost half of respondents answered that they would leave their goods or luggage in the middle of train corridor. This behavior would hinder the evacuation process in emergency situation and might cause risk of trip and fall for other passengers as it is blocking the way. It proves that a lot of passengers do not know the danger of this behavior. It is possible that they are not getting this information about unsafe situation and unsafe action that would lead to emergency situation. Warning needs to be given in larger scale. Therefore, besides the information about evacuation method after emergency situation happen, the management could use the loudspeaker and the television inside the train to inform passengers about unsafe situation and unsafe action around them that might cause emergency situation. The information needs to be relayed, for example, are how to use lift and escalator safely, safe behavior while waiting for the train in the platform, safe and orderly way to get on and off the train and safe behavior during trip with LRT train such as where they can put their luggage safely and to pay attention to children they bring with them. Crew on duty can supervise passengers regarding this issue.

V. CONCLUSION

Unsafe conditions on Light Rail Transit occur during breakdown; derailment; train collision; slipping and falling on the escalator, waiting room, prayer room, and toilet; trapped in the elevator. Unsafe actions taken by passengers are rushing when entering and exiting Light Rail Transit; not prioritizing people getting off the train; putting luggage in the train corridor; leaving children unattended; crossing the safety line.

This study suggests that Light Rail Transit management to build platform screen doors (PSDs) or platform edge doors (PEDs) to prevent passengers from falling onto the electrified rails. Dissemination of information on unsafe condition and unsafe action should also be given to passengers aside from emergency procedures.

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