Train Accidents at Level Crossings in Indonesia – A Preliminary Study

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ABSTRACT

Accidents involving passenger trains in Indonesia are still prevalent. Accidents at level crossings, in particular, have not been declining. In 2013, for example, a major accident at a level crossing occurred that resulted in a number of fatalities and significant financial implications. The impacts of such accidents ranged from property damage to fatalities. This study aimed at understanding the statistics of accidents at railway level crossings in Indonesia. This was achieved by conducting a survey to a couple of government institutions responsible for managing the railway transportation. Furthermore, this study will describe factors related to the accidents by employing Human Factors Analysis and Classification System (HFACS). A total of 81 cases out of 134 accidents (between 2006 and 2011) were studied and classified. Results of this study indicated that the majority (97%) of the accidents were caused by *"outside factors"*, particularly vehicles trying to pass the crossings while the barriers and warnings have been activated. A small percentage of these accidents dealt with operators or technical aspects of the warning/barrier system. Existing road safety regulations specifically indicated, in a large number of cases, that the company operating the railway train might not be responsible for the accidents. Nevertheless, this company (and relevant ministries) could offer a more proactive approach in minimizing the accidents. This includes understanding driver behaviors at level crossings and designing a more effective warning/barrier system.

Keywords: Train Accidents, Level Crossings, Human Factors Analysis and Classification System.

INTRODUCTION

Railway train accidents in Indonesia are still prevalent, despite varying efforts to minimize the statistics. In 2013, for example, a major accident at level crossing occurred in Jakarta (the capital of Indonesia) that involved a commuter train and a truck carrying 24,000 liters of gasoline. Some speculated that the truck tried to run the crossing, even after the warning system and the barrier had been activated. The truck further stalled, and eventually was hit by the oncoming train. Some of the carriages rolled to the side and caught fire. At least seven were pronounced dead, and many more were injured in this accident. Accidents at level crossings typically affect road users as well as train drivers and passengers.

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A number of strategies and programs have been conducted by the Indonesian State-Owned Railway Company (PT. KAI) in order to reduce the likelihood of train accidents. The development of parallel railway tracks connecting major cities in Java is underway, and is supposed to finish by mid of 2014. Railway safety is also done by improving infrastructures and facilities, and maintaining competent human resources. Accidents at crossings, however, are a complex issue since they usually involve a number of different stakeholders. The Indonesian Ministry of Transportation is responsible for providing safe and appropriate level crossings. It should be noted that, according to the Ministry of Transportation, train accidents at level crossings are classified as “road accidents” and, thus, are within the jurisdiction of the General Directorate of Land Transportation (as opposed to the General Directorate of Train Transportation). Furthermore, under the applicable laws crossing barriers are provided only as part of a warning system. They are not designed as a physical barrier that can withstand any running vehicles. Road users will, consequently, assume responsibility when an accident occurs after the barriers have been activated.

A number of investigations have noted that human errors are often the contributing factors in transportation safety (Scarborough and Pounds, 2001; Wiegmann and Shappel, 2003). At many railway crossings, incidents usually involve vehicle drivers (Tey et al., 2011), and studies have been conducted to investigate the effects of warning systems on driver behavior (Anandarao and Martland, 1998). Investigations that explore how accidents at railway crossings occur have been conducted in Indonesia (e.g., Findiastuti et al., 2010), but more comprehensive studies are needed that address the accidents from different views. The main aim of this study was to understand the statistics pertaining to railway accidents at level crossings in Indonesia. Another objective of this study was to identify various factors believed to be associated with the accidents.

METHODS

A main method employed in this study was the Human Factors Analysis and Classification System (HFACS), a taxonomy approach suggested by Wiegmann and Shappel (2003). This approach has received a wide attention as an investigating tool in transportation safety, and is believed to be structured and comprehensive. One of the major benefits in utilizing this approach is that it points where interventions should be directed. Its application has been reported in the railway industry [6,7], and major factors leading to railway accidents could be pointed out.

A total of 134 accidents (during years of 2006 to 2011) were examined, resulting 81 cases (~60%) of accidents that could be analyzed using HFACS. Each of these cases came with a description of how the accidents happened. These cases were obtained from reports published by the General Directorate for Railway Transportation, under the Indonesian Ministry of Transportation. For each case, all factors possibly related to an accident were discussed and classified into HFACS levels. The levels were Outside Factors, Organizational Factors, Supervisory Factors, Preconditions for Operator Acts, and Operator Acts. Each of this level was further classified into corresponding sub-levels, which were used as the final classification of the factors associated with the accidents. Classifications were conducted by three research associates who had been trained in using the technique.

In addition, surveys were conducted at three major rail regional areas with the highest number of accidents. Videotapes were used in observing the phenomena occurred at level crossings, such as traffic complexity, behaviors of vehicle drivers, and local activities occurring at the crossings. Additional activities included interviews with railway officers responsible for controlling train schedules and those who were stationed at level crossing posts. The latter were individuals who were responsible for activating crossing signals and barriers.

RESULTS

Between the years of 2006 and 2011, there were 635 railroad accidents, which consisted of collisions between trains (3%), train derailments (58%), accidents at level crossings (21%), and miscellaneous incidents (18%). These accidents resulted in more than 1,600 victims; about 26% were fatalities. Specific to accidents at level crossings, 17 were killed and 28 were injured during accidents in 2012. Financial burdens associated with these accidents are relatively high. Costs for a locomotive after a collision, for instance, could amount up to 2.5 million dollars. Financial implications were also substantial due to delays and cancellations (at least $5,000/hour). There were also additional costs that affected passengers, drivers, or local communities.

The number of level crossings was more than 5,200 across various operational regions in Indonesia. Of these, crossings that were guarded were roughly 22%. It is interesting to note that more than 66% were level crossings that were not equipped with warning system and barriers. The rests were crossings that typically were in the form of access to pedestrians or small motorized vehicles. These access were not developed by the government, but were built by the locals as for their activities.

As mentioned previously, only 81 cases were examined in this study, and these were cases, which were accompanied by descriptions of the accident. Of the 81 cases examined, 97.6% of all potentially contributing factors were classified under the level of Outside Factors. Specifically, the sub-level of Social Environment dealt with vehicle drivers who were reckless or run against the barriers on purpose. There are also descriptions where they did not pay attention to the alarms and warnings that were active prior to the accidents. Some other contraventions done by vehicle drivers included running through the barriers, immediately after a train passed the crossing. The accidents occurred when another train from a different direction (on a different track) also passed the crossing at almost the same time. Accidents also occurred due to vehicles illegally (and on purpose) driven on the opposite side of the road (with no barrier). In some cases, vehicles were trapped between the railroad tracks and the barriers. Apparently, the vehicles had a chance to beat the closing of the barrier, but not fast enough to completely pass the crossings. There were also cases where a trailer suddenly stopped at the crossing due to engine problem. In this case, the operator who controlled the barriers did run towards the train and notify the train driver. About 2.4% of all contributing factors were classified into Operator Acts. This included cases where an operator did not immediately respond to a signal that required him to activate the barriers. It was also reported that an operator did not know that the indicating signal was on. Why this phenomenon occurred might need further explanation.

There were a number of phenomena during surveys and interviews that are worth noting. First, it was fairly common to see drivers who tried to pass the crossings, even after the system had been activated. In a number of circumstances, the wooden barrier was manually lifted by motorists. Second, vehicle drivers breaking traffic regulations were a common phenomenon. Lastly, traffic conditions at the crossings were typically very poor. Traffic density was usually very high, and the locals often performed their business activities at or around the crossings.

DISCUSSION

One of the objectives of this study was to understand the magnitude of the issue on accidents at level crossings in Indonesia. The results noted earlier certainly indicated that the prevalence of the accidents. In addition, financial implications were fairly substantial, and solutions to the issue should be sought carefully. The solutions, however, may not be straightforward. This issue is complex, and the solutions should involve various stakeholders. These include the train operator, the ministry of transportation, and local government. Breaking traffic regulations were found to be a common phenomenon, and enforcement should be applied with probably stringent penalties. In sum, unlike similar accidents reported in industrialized countries, such accidents in Indonesia were strongly related with many contributing factors. This demonstrates that the solutions should be very comprehensive and involve many different stakeholders.

Another objective of this study was to understand how accidents at railway level crossings occurred by employing HFACS as an analysis tool. Findings of this study indicated that the majority of factors associated with the accidents fell under the category of Outside Factors. This implied that road users and vehicle drivers were those who need to be studied further. A number of questions could be explored including, for instance, why they run safety barriers, how they perceive safety risks, or which warning systems are more effective than others. It is critical to comprehend behavioral characteristics of these road users, and whether these characteristics match with the design of the warning/barrier system.

With respect to the reckless behavior of the road users, obeying traffic rules and regulations has been cited as an important factor in minimizing accidents at a crossing (Rudin-Brown et al., 2011). This is certainly true for many Indonesians. It is generally agreed that traffic violations could, in many cases, go unpunished. Poor driving behaviors are not usually sanctioned, unless these result in accidents. Law enforcement is probably the first thing to address. Therefore, road users need to be disciplined when passing railway crossings. Penalties should be given to those who violate existing traffic regulations.

It should also be noted that there are other factors worth studying. It is not exactly known, for example, how road design, maintenance, and traffic density near a crossing affect driver behavior. This has been noted earlier (Tey et al., 2011), as factors that can potentially improve safety. Additionally, design of warning signs and alarms could influence driver behavior (Anandarao and Matland, 1998). Considering that differences in culture are associated with different behavior, it is interesting to see if the Indonesian government should implement different warning/alarm designs in regions with different culture. Demographics of road users could also be an interesting subject (Tey et al., 2013). It is not clear whether older (more experienced) drivers are associated with fewer accidents. Gender differences, if any, should be studied and incorporated into the design of warning/alarm system.

This study, again, acknowledged that other stakeholders were involved in the accidents, such as railway authorities and local government agencies. They could provide a more effective system, and build a barrier system that is less likely to be damaged during operations. This is, obviously, another topic for further studies. Different barrier mechanisms are currently in place, and their effectiveness could be investigated. It should also be examined if there are structures that visually block warning signs (e.g., advertisements, trees, electrical poles, road signs, etc.). The time duration between the activation of alarm and barrier and the passing of the train could also be investigated. Longer duration is often related to traffic jam, and could possibly motivate road users to take a shortcut. This, however, should be addressed together with the current standard procedures.

CONCLUSIONS

The present study was the first preliminary effort in Indonesia that more comprehensively sought factors that were associated with accidents at railway level crossings. Based on analysis using HFACS, the majority of factors could be classified under Outside Factor category. This means that road users are typically at fault, and it is their sole responsibility to act safe and avoid accidents at crossings.

It is worth to note that different stakeholders should also bear the responsibility toward minimizing the accidents. Local government agencies and institutions can manage and restrict local activities at and around level crossings. The police department can (and should) enforce traffic laws and regulations, particularly to motorists who willfully break the regulations. The Ministry of Transportation, along with the railroad operator, can design and install a better warning and barrier system.

Another highlight in this research is that direct and indirect financial implications associated with these accidents are great, though the exact figures are not clearly known. Even if the costs are marginal, the accidents frequently result in loss of human lives. This study suggests, therefore, that all stakeholders (such as local governments and related agencies within the Ministry of Transportation) should take part in reducing the likelihood of the accidents.

This study also suggests further investigations that seek to understand driver behavior when passing railway crossings. A number of critical research questions are still unanswered. Studies leading toward the design of effective warning/alarm and barrier systems are warranted.

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