Safety considerations for railway crossings in a post-COVID world

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Abstract

The COVID-19 pandemic has greatly changed how people live, work, and commute. Indeed, a significant proportion of individuals now work (at least partially) remotely; others continue to commute and are more likely to avoid using public transport to reduce their exposure to potential illnesses. With safety at railway crossings largely contingent on road traffic, such changes impact the safety at level crossings. Investigations are therefore necessary to understand whether the level crossing risks have changed.

This study observed road traffic and non-compliance at two urban railway crossings in Australia before the pandemic started (September 2019) and after the end of the first national lockdown in Australia. Counts of road and rail traffic was recorded on a tablet, and non-compliance with the rules of the level crossing.

A total of 14,048 road and 94 train movements were observed at the railway crossings. After the lockdown, road traffic at both crossings increased by 15% and 36%, respectively, while train traffic remained similar. Such traffic increase represents a risk increment of 10% and 15%, respectively, using the Australian Level Crossing Assessment Model (ALCAM). There was also an increased proportion of cars, reflecting a reduction in pedestrian and bus traffic. In terms of non-compliance, there was an increase in the number of vehicles that could not proceed through the crossing and were stopped immediately after or on the rail tracks. This increase was up to 3 times at the first crossing, largely over what would be expected due to traffic increase.

To the knowledge of the authors at the time of submission, this research is the first to look at the effect of COVID-19 on traffic at railway level crossings in Australia. It aligns with what is known for other parts of the road network and identifies an increase in safety risks at railway crossings.

Keywords: Safety, Road users, Pandemic

1. Introduction

The COVID-19 pandemic has dramatically changed how people live, work, and commute. Indeed, a significant proportion of individuals now work (at least partially) remotely; others continue to commute and are more likely to avoid using public transport to reduce their exposure to potential illnesses.

Commuting to work in developed countries relies primarily on private vehicles due to their greater accessibility, flexibility and convenience compared to other transport modes. For instance, in Australia, the last census conducted in 2016 showed that 9.2 million people commute to work every day; 79% of them travelled by private vehicle, 14% took public transport and 5.2% either cycled or walked [1]. Historically, these proportions have not significantly changed or have seen a slight increase in public transportation since 2011 [1].

The COVID-19 pandemic has, however, changed this status quo. The effects of the pandemic do not only result in reduced traffic during lockdowns, with a reduction of the use of public transport by 80% [2], but also has longer-term effects, such as the reduction in the use of public transport due to health and safety concerns. For instance, public transport has reduced by 21% in Australia's three major cities post-pandemic [3]. In Brisbane, public transportation is currently operating at 63 per cent patronage compared to pre-pandemic levels, with about 90 per cent of services less than half full [2].

While until 2022, the COVID-19 pandemic has been less acute in Australia than in other parts of the world, a number of restrictions have been experienced. At the end of January 2020, the first cases of COVID-19 were reported in Australia, leading to the introduction of quarantine requirements and testing in February. In March, the WHO declared a global pandemic, Australia's borders were closed to all non-residents, and Queensland closed its borders to other States. On 23rd March, Australia entered a nationwide shutdown (lockdown). At the end of April, there was a first-round of easing of restrictions in Queensland. It was followed on 31st May by the end of the lockdown, with Queenslanders allowed to travel around the State [4].

This research aimed to provide insights into safety challenges at level crossings in a post-COVID world. Therefore, this study consisted of observations of road traffic and non-compliance at two urban railway crossings in Australia before the COVID-19 pandemic and after the first national lockdown in Australia.

2. Methodology

2.1 Study design

Observations of two railway crossings within the city of Brisbane, Australia, were conducted before the pandemic (September 2019) and after the first national lockdown in Australia in May 2020. Three time points were taken after lockdown: one week (3rd June 2020), three weeks (17th June 2020) and two months (22nd July 2020) after the first Australian national lockdown was relaxed. Observations occurred on the same day of the week (Wednesday) at the same time of day. The first level crossing (Coopers Plains) was observed for two hours in the middle of the day. The second (Coorparoo) was observed during the afternoon peak for one hour.

An app was developed to dynamically record data on site. Field-based observations of road and rail traffic counts were recorded on a tablet, as well as non-compliances with the rules of the level crossing. The status of the crossing (flashing lights and boom gates status) was also recorded. Video recordings of the level crossing were taken and used to confirm data recorded by the observer.

2.2 Observed sites

The two study sites are busy active level crossings with boom gates in Brisbane Australia. The two crossings were selected due to their high road traffic and known congestion issues [5] leading to high levels of non-compliances [6] and near-miss with trains. The data was collected as part of another study, which is reported in Larue, et al. [7]. Observations were subsequently repeated three times at these two level crossings during the COVID-19 pandemic.

Both level crossings (Figure 1) allowed road vehicles and pedestrians to traverse the rail tracks and were located next to the train station. They were equipped with flashing lights, steady pedestrian lights (green/red man), barriers, and audible warning devices (bells), all of which were activated before and during the passage of a train through the level crossing.

2.2 Materials

The app for recording data on site was developed using AndroidStudio version 3.5 and used on a Samsung Tab S5e tablet. A GoPro Fusion camera was used to record videos with a continuous 360-degree field of view, allowing confirmation of level crossing status and non-compliance during data analysis.

Figure 1: Views of the level crossings (Left: Coopers Plains, pedestrian's side; Right: Coorparoo, motor vehicle's side)

2.3 Procedure

Two researchers were present for all field observations. The first researcher was responsible for installing the camera at a safe position to allow for optimal visibility of the complete intersection/crossing, as well as a view of the approach of the intersection on the side where the camera was installed. The camera was installed on a tripod unobtrusively, either on the side of the pedestrian path or on fences delineating the path and the rail corridor to ensure pedestrian movement was not affected. This researcher was also responsible for monitoring the continuous operation of the camera. The other researcher was responsible for recording road, pedestrian, and rail traffic using the tablet.

2.3 Data analysis

Road and rail traffic counts were collated from the app. The types of road users were taken into consideration when reporting such counts: cars, heavy vehicles, pedestrians, cyclists and motorcyclists. The resulting change (in percentage) compared to the baseline for each of the time points after the lockdown is reported.

The resulting expected number of collisions (over five years) was then estimated based on the adjusted Peabody Dimmick formula. This formula has been shown to best fit Australian historical crash data [8]. It is used in the Australian Level Crossing Assessment Model (ALCAM) model, which is one of the tools used by the Australian rail industry to assess level crossings risks [9]. This model provides an estimate of how much collisions are likely to increase at level crossings based on the increase of traffic, given that the formula depends principally on road and rail traffic levels and level crossing protection (see [8] and [9] for details). Baseline Annual average daily traffic (AADT) estimates from previous research at the two crossings were used [5]. Changes in traffic conditions during observations were then assumed to represent changes in AADT values during the pandemic. This is likely given that the observations were conducted during peaks of the daily travel patterns at these crossings.

Changes in observed non-compliance was also assessed. The non-compliance types considered in this research included stopping on the level crossing (on the yellow road marking which delinates where the vehicle must stop), whether the level crossing lights were activated or not, entering the level crossing when the lights were on, whether the boom gated were already down or not. This analysis provides additional information about the changes in risk profiles at the crossings, beyond changes in traffic.

3. Results

A total of 14,048 road and 94 train movements were observed at the railway crossings (see Table 1): 2,914 movements were observed at the railway crossings in the baseline data collection (pre-pandemic). Traffic at the first level crossing (Coopers Plains) was primarily light vehicles, followed by trucks. At the second crossing

(Coorparoo), road traffic was mainly light vehicles, followed by buses. There was also pedestrian traffic at the second crossing due to its proximity to a train station.

After the lockdown, road traffic at both crossings increased compared to the baseline data. The increment was 28%, 38% and 43% at the first crossing for 1-, 3- and 8-weeks post-lock down, respectively. At the second crossing, traffic increase was by 9%, 18% and 17% for each time point after easing of the lockdown, respectively. Notably, the proportions of road user types did not change at the first crossing; at the second crossing, the proportion of cars increased from 73% to 85% on average, reflecting a reduction of both pedestrian and bus traffic.

Rail traffic did not change between the different observations, with the same number of trains being observed for each crossing: 15 at the first crossing, and 9 at the second crossing. Change of rail traffic was always within one more or one less train. Rail traffic was therefore unchanged, being largely composed of passenger trains with unchanged timetables, the difference being due to the randomness of the presence of freight trains.

Site	Metric	pre-COVID	after lockdown relaxed		
			1 week	3 weeks	2 months
Coopers Plains	*Road traffic*				
	light vehicle	1,446	1,871 (+29%)	2,008 (+39%)	2,081 (+44%)
	heavy vehicles (trucks)	234	276 (+18%)	291 (+24%)	314 (+34%)
	pedestrians	9	17 (+89%)	17 (+89%)	15 (+67%)
	cyclists	1	4 (+300%)	7 (+600%)	4 (+300%)
	two wheelers	13	18 (+38%)	24 (+85%)	18 (+38%)
	Total	1,703	2,186 (+28%)	2,347 (+38%)	2,432 (+43%)
	Rail traffic	14	15 (+7%)	15 (+7%)	15 (+7%)
	Change in collision likelihood based on changes in traffic[1]	-	+8.8%	+8.4%	+7.5%
	Non-compliance				
	stopped on crossing	18	32 (+78%)	46 (+156%)	58 (+222%)
	average duration (s)	5.4	13.2 (+144%)	21 (+289%)	20.9 (+287%)
Coorparoo	*Road traffic*				
	light vehicle	886	1,119 (+26%)	1,242 (+40%)	1,198 (+35%)
	heavy vehicles (buses)	73	37 (-49%)	38 (-48%)	37 (-49%)
	pedestrians	241	145 (-40%)	120 (-50%)	166 (-31%)
	cyclists	2	6 (+200%)	10 (+400%)	8 (+300%)
	two wheelers	9	12 (+33%)	18 (+100%)	13 (+44%)
	Total	1,211	1,319 (+9%)	1,428 (+18%)	1,422 (+17%)
	Rail traffic	9	10 (+11%)	8 (-11%)	8 (-11%)
	Change in collision likelihood based on changes in traffic	-	+8.1%	+15.8%	+15.3%
	Non-compliance				
	stopped on crossing	0	0	4	6
	average duration (s)	-	-	41.2	9

Table 1: Observed traffic and non-compliances

[1] Derived from the ALCAM model

Using the ALCAM equations detailed in Wullems, et al. [8], the overall likelihood of collisions with trains increased by 9.5% at the Coopers Plains level crossing, and by 15.1% at the Coorparoo level crossing. Changes in likelihood for each time point are presented in Table 1. Note that the likelihood has a bell shape, resulting in higher traffic not necessarily resulting in higher risk.

In terms of non-compliances, the main difference that was observed was an increase in the number of vehicles that were not able to proceed through the crossing and were stopped on immediately after or on the rail tracks. This increase was up to 3 times at the first crossing, largely over what would be expected due to traffic increase. Also, this issue was not observed at the second crossing in 2019 but was observed after the lockdown. Such an increase is not only a concern with the number of times this occurs but also relate to these conditions occurring for longer durations. During baseline, vehicles were stopped on the crossing for 5 seconds on average. This duration increased to 20 seconds after lockdown.

4. Discussion

This field-based observational study confirms that commuting patterns changed during the COVID-19 pandemic, with increase usage of vehicles, increase in heavy vehicle traffic (trucks) likleky due to increased delivery needs. This study also suggests a reduction in buses at the site observed. This reduction is likely to be a result of the early pandemic and lockdowns, as buses services have increased later in the year [2].

This increases the risk of collisions at level crossings, as level crossing risk is largely based on exposure. The modelling used in this study suggests that collisions could increase by 10 to 15% at these crossings due to changes in traffic patterns during the pandemic. These estimates do not even take into consideration changes in types of road vehicles traversing the crossings. Increases in heavy vehicles are also likely to further increase the likelihood of collisions.

Risk at level crossing is not only based on exposure, as shown in the ALCAM model, which considers three components when assessing level crossing risks [9]: the consequence model (expected outcome when a collision occurs, i.e. equivalent fatalities per collision; this is a fixed parameter in the model), the exposure model (based on the adjusted Peabody Dimmick formula) and the infrastructure model. The infrastructure model considers how physical properties at each site affect human behaviours. This modifies the collision probability per year to reflect unique site conditions.

It has been shown that some level crossing characteristics have a great influence on the ALCAM infrastructure model [2]. These characteristics include a limited sighting of trains at passive crossings, limited approach sighting, queuing and short stacking, proximity to shunting yards and stations, high percentage of heavy vehicles and a hump or dip across the tracks.

Our study has shown that increased road traffic can lead to a significant increase in the number of vehicles being stuck on the crossing. Further, vehicles stuck on the crossing tend to remain on the crossing for longer times. Given the influence of this factor on the likelihood of collisions, our study suggests that the risks at level crossings are further increased through the infrastructure model.

It is therefore vital for the rail industry to update its risk estimates at level crossings. The key parameters that should be updated include AADT values, changes in types of road vehicles traversing the crossing (heavy vehicles) and changes in factors known to lead to more collisions, such as vehicles stuck on level crossings, as this is likely to increase with increased road traffic.

5. Conclusion

The COVID-19 pandemic has increased the use of private cars when commuting to work. With safety at railway crossings largely contingent on road traffic, such changes impact the safety at level crossings. To the knowledge of the authors at the time of submission, this research is the first to look at the effect of COVID-19 on traffic and compliance at railway level crossings in Australia. It aligns with what is known for other parts of the road network and identifies an increase in safety risks at railway crossings. The observed changes in traffic increased the likelihood of a collision by 10 to 15% at the two observed sites. Collision risks were also indirectly increased through an increase of heavy vehicles traversing the crossings, and an increase in vehicles being stuck on the crossing. This research suggests the need to review risk at level crossing given the current changes in commuting patterns.

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