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Abstract | Despite support from police for the use of CCTV, and its popularity in public places, there has been limited research into the use of CCTV by police for investigative purposes.

The current study attempted to better understand police demand for CCTV footage from the NSW rail network. Results showed the police made an average of 17 requests per day for footage, mostly for criminal investigations. On both the metropolitan and intercity network, requests were more common for stations that recorded a higher number of incidents, had more cameras, and had fewer patrons. Once station characteristics were taken into account, the findings suggested that CCTV footage was more likely to be requested from those stations with lower levels of public surveillance.

This research can help to inform the design, layout and management of CCTV systems on public transport and in other locations.

Police use of CCTV on the rail network

Anthony Morgan and Maggie Coughlan

There is good reason to believe that police value closed-circuit television (CCTV) as an investigative tool. A small body of international research has shown that police frequently use CCTV as part of criminal investigations, for both minor and more serious offences (Ashby 2017; La Vigne et al. 2011; Levesley & Martin 2005; Piza, Caplan & Kennedy 2014). Several Australian police agencies have published online their general policies on the use of CCTV, which show they are supportive of the CCTV schemes operated by other organisations and the benefits they offer to law enforcement (eg NSW Police Force 2010; Victoria Police 2011). Other police agencies, along with the Australia New Zealand Policing Advisory Agency (ANZPAA) and National Policing Improvement Agency (NPIA) in the UK, have produced information guides for system operators to increase the likelihood that camera footage can be used by police (ANZPAA 2014; NPIA 2011; SA Police nd; Tasmania Police nd). More recently, police agencies have embraced new forms of video surveillance, including body-worn cameras (Cubitt et al. 2017).

Yet, despite this apparent interest in and use of surveillance footage, and frequent debate regarding the crime prevention benefits of CCTV, there has been limited Australian or international research on the use of CCTV footage by police as part of criminal investigations. Given the significant growth in CCTV (see Hulme, Morgan & Brown 2015), the substantial financial investment in CCTV by Commonwealth, state, territory and local governments and the private sector, and the commentary that exists around the merits of CCTV (eg Carr 2016, 2014; Taylor 2010; Taylor & Gill 2014), it is vital that this aspect of CCTV performance be better understood, particularly as it may help inform the design, layout, technical capabilities and monitoring and sharing arrangements for new and existing camera networks.

This paper explores the use of CCTV camera footage by police, with a specific focus on the use of footage from a major Australian rail network.

Background

Maintaining the security of a city's public transport network is important. The accessibility of buses, trains and other forms of public transport provides a means of connectivity and mobility for all members of the community. While crime rates are typically lower on the rail network than in other public locations (Burgess & Grech 2011), the volume of people that use public transport and unique criminal opportunities that train stations and carriages can provide mean that crime can cluster at certain locations and times (Ceccato, Uittenbogaard & Bamzar 2013; Irvin-Erickson & La Vigne 2015; Newton 2014). This can cause anxiety among public transport users at levels that are not commensurate to actual risk, influencing patronage (Cozens et al. 2004; Currie, Delbosc & Mahoud 2010; Smith 2008), and can also affect the safety of transport staff (Lincoln & Gregory 2015). More recently there has been growing recognition of the need for measures to reduce the risk of terrorism (Loukaitou-Sideris & Fink 2009). In response to these issues, a range of strategies have been employed to improve security. These include the application of crime prevention through environmental design principles, as part of broader urban planning and in the design of rail infrastructure, target hardening measures, the deployment of security personnel, high visibility policing, and CCTV.

CCTV has become particularly prominent on public transport. NSW Trains now operates more than 11,000 cameras on the rail network, while Queensland Rail (2016) reports having more than 9,000 cameras state-wide, Public Transport Victoria (2015) reports having access to 5,500 CCTV feeds, and the WA Public Transport Authority (nd) reports having thousands of cameras across the bus and rail network. Unlike camera systems in many other public areas (Hulme, Morgan & Brown 2015), footage from these camera networks is actively monitored during the day and night. This means that CCTV on rail networks may serve multiple purposes: preventing certain crimes through deterrence, enabling the rapid deployment of security and police personnel to incidents identified by camera operators, and capturing footage that may be requested by police for use in criminal investigations.

There is some evidence to suggest that CCTV may help to reduce certain types of crime on the rail network, particularly in car parks adjacent to train stations. A systematic review of more than 40 studies concluded that CCTV has a modest but significant desirable effect on crime, but that it is most effective in reducing crime in car parks when targeted at vehicle crimes and when used in conjunction with other initiatives as part of an integrated approach (Welsh & Farrington 2009).

More recent studies have tended to reinforce these findings, although the results continue to be mixed (Caplan, Kennedy & Petrossian 2011; Cerezo 2013; La Vigne et al. 2011; Piza et al. 2015). However, no published Australian research has employed experimental or even quasi-experimental approaches to measure the crime prevention effects of CCTV.

There has been some research into the benefits of CCTV for the rapid deployment of police. Wells, Allard and Wilson (2006) conducted research into CCTV use on the Queensland rail network. During their 100-hour observational study of the control room, 181 incidents were observed by camera operators, half of which had been identified by police. The same proportion of incidents were observed as a result of police specifically requesting footage. These incidents resulted in 51 arrests; however, it was found that only 14 percent were the direct result of the camera network. More recently, Piza, Caplan and Kennedy (2014) found that incidents detected using monitored CCTV were significantly more likely to result in arrest than incidents identified through calls for service for almost all crime types (excluding violence). However, CCTV-initiated police attendances were much less common, largely because of the lack of resources required to actively monitor the footage.

Researchers have also examined the use of CCTV by police as part of criminal investigations, although the impact on investigation outcomes is less clear. A recent national survey of local councils on the use of CCTV in public places found some evidence that police were using the footage recorded by CCTV systems operated by local councils (Hulme, Morgan & Brown 2015). The majority of councils (81%) had received at least one request from police for footage in the previous year—and two in five councils reported having received requests from police at least monthly. Further, more than two-thirds of councils (69%) who had received a request for footage from police reported that it had been used to successfully identify an offender 'sometimes' or 'often', and 55 percent of councils reported that the footage had been used to prosecute an offender 'sometimes' or 'often'. However, these findings are largely anecdotal, since many councils also reported that it was difficult to access information on the impact of footage supplied to police for law enforcement purposes. Nevertheless, councils have reported considerable pressure to meet police expectations regarding the availability of CCTV footage in public spaces (Carr 2016, 2014).

Research into police use of CCTV in the UK found that CCTV has become a regular part of everyday policing in that country:

> Images are regularly seized by officers, a weekly occurrence for many, for identifying offenders, witnesses, proving or disproving alibis and versions of events, and providing evidence for trials. (Levesley & Martin 2005: iv)

Levesley and Martin also observed that reviewing CCTV footage was extremely time consuming, but that police ultimately viewed the benefits as outweighing the costs involved:

> At its best, CCTV was said to be a cost-effective tool, which could help speed up investigations and encourage offenders to plead guilty, saving police and court time. (Levesley & Martin 2005: iv)

Likewise, La Vigne et al. (2011) conducted a study into the impact of CCTV in several US cities and, while primarily focused on the deterrent effect of public surveillance, found strong support among police and prosecutors for the use of CCTV in aiding arrests and supporting investigations and prosecutions.

The most recent study by Ashby (2017) provides the strongest indication of the benefits of CCTV to investigators and, specifically, transport police in the United Kingdom. Based on the analysis of more than 250,000 crimes recorded on the British railway network over a five-year period, CCTV was available to investigators in almost half of all cases, and useful in two-thirds of those cases where it was available. Cases in which the available footage was assessed as being useful were significantly more likely to be solved—for instance, because there was sufficient evidence to send the case to court. Given the limitations of the data, this research was not able to determine exactly how CCTV was used, nor the generalisability of the findings to CCTV in other public areas. Recent Swedish research suggests the results are unlikely to be as positive in city centres, for example, where the level of coverage is likely to be much lower (Kindgren & Marklund 2014). Kindgren and Marklund (2014) found that police sought access to CCTV footage for one in eight incidents that occurred in two night-time entertainment districts, and that the footage was useful in one in four cases in which it was accessed.

Importantly, research has identified several factors that can limit the benefits derived from CCTV. These include the level of coverage in public areas, the ability of cameras to capture entire incidents (particularly where cameras have a fixed position or pre-programmed pattern of movement), the impact of inclement weather or buildings and vegetation that obscure camera vision, the resolution and quality of the images captured, the amount and type of monitoring in place, and the relationships between police and camera operators (Ashby 2017; Brown 1995; Carr 2014; Hulme, Morgan & Brown 2015; La Vigne et al. 2011; Levesley & Martin 2005). Further, police have reported the 'CSI effect', as with DNA evidence, whereby jurors expect that footage of incidents in public places will be available and the absence of such footage is detrimental to a successful prosecution (La Vigne et al. 2011). Increased use of footage of criminal incidents in the media (and expectations regarding the availability of footage) have also placed growing pressure on camera operators and police to install, operate and access CCTV in areas where the level of crime, and therefore the potential for benefits to be realised, is low (Carr 2016, 2014).

Overall, this prior research has provided some evidence of the potential benefits of CCTV footage, while highlighting the importance of ensuring the correct technology, monitoring arrangements and placement of cameras. It also points to the need for much more research into the use of CCTV by law enforcement, particularly in an Australian context.

Aims and methodology

Building on the existing literature, and to address the largely anecdotal evidence around the use of CCTV by Australian police, the current study aimed to address the following research questions as an important first step in developing a better understanding of the impact of CCTV footage on criminal investigations:

- How often do police request footage from CCTV cameras on a major rail network?
- How does the rate with which police request footage vary by crime type?
- How does the presence of other forms of surveillance influence the likelihood that police request footage?

The current study involved the secondary analysis of data collected by Sydney Trains on requests for CCTV footage and security incidents recorded on the NSW rail network. Sydney Trains runs 11 suburban rail lines in the Sydney CBD and greater metropolitan area. Intercity and regional train services are operated by NSW TrainLink. As at December 2014, there were 176 stations (including the airport line) in the metropolitan network, 132 stations in the intercity network, and a further 67 stations in the regional train network. In 2014–15, there were 328 million passenger journeys across the three networks, 89 percent of which were on the metropolitan network (Transport for NSW 2015).

Alongside other security measures, including security officers and help points, Sydney Trains operates approximately 11,000 cameras across the metropolitan and intercity train networks. Cameras cover the train stations, including platforms, and are also directed at station entry gates and ticket machines. Cameras are also located outside many train stations directed at adjacent areas, such as car parks and bus interchanges. The number of cameras at each station varies from a single camera in smaller regional stations to almost 400 cameras in the largest metropolitan stations ($\bar{x}$=32.1, s=43.0).

The camera network is actively monitored from a security control room, which enables the deployment of NSW Police Force (NSWPF) and Sydney Trains security personnel when incidents are detected. While monitoring CCTV cameras is one of the primary roles for staff in the security control room, they also spend a significant amount of time retrieving footage when it is requested by internal and external parties, including NSWPF.

New guidelines were introduced after 2012 such that, with the exception of major incidents, internal and external agencies were restricted to requesting footage of incidents that occurred on or immediately adjacent to rail network infrastructure. This excluded those requests that involved looking for persons who were involved in incidents that occurred elsewhere, but who may have travelled by train immediately before or after the event. This reduced the burden on camera operators and ensured they had capacity to provide footage in a timely manner for events that were captured on camera.

Sydney Trains manages a database that records information on all requests for CCTV footage received by the agency since 2011. Between 2011 and 2014, more than 40,000 requests for CCTV footage were recorded in the database (across metropolitan, intercity and regional train services).
For the current study, these data were analysed alongside information from security incident reports recorded by Sydney Trains in the security reporting system (also managed at the security control centre, based on information from Sydney Trains staff, members of the public, security alarms and police) and information on the characteristics of the stations in the metropolitan network (primarily sourced directly from Sydney Trains and other online sources). Together, these data were analysed using bivariate and multivariate statistical methods to develop an understanding of the patterns, characteristics and predictors of requests for CCTV camera footage, primarily from NSWPF.

Results

Patterns and characteristics of footage requests

Sydney Trains received 10,793 requests for footage in 2014. These requests were categorised according to the major incident type, which is based on the description recorded by staff in the security control room (Table 1). Sixty-one percent of requests received by Sydney Trains in 2014 related to crime, criminal justice and antisocial behaviour incidents, while 17 percent related to accidents, injuries and safety incidents and a further 17 percent related to equipment management and general station management. While CCTV is often regarded as a crime control measure (whether that be as a crime prevention or detection tool), more than one-third of rail network footage requests were for non-criminal matters.

Table 1: Requests for CCTV footage, by major incident category, 2014

	n	%
Crime, criminal justice and antisocial behaviour	6,607	61
Accident, injury and safety	1,818	17
Equipment and general management	1,789	17
Other	579	5
Total	10,793	100

Source: Sydney Trains 2015 [computer file]

Footage may be requested by a variety of internal and external agencies, including NSWPF, other sections within Sydney Trains, other government agencies and members of the public. Importantly, Sydney Trains has a close working relationship with NSWPF, particularly the Police Transport Command, and has developed an online portal that enables police to request footage and for that footage to be provided within a relatively short time frame. It also enables police requests to be distinguished from requests from other sources. Fifty-nine percent of all requests for camera footage came from NSWPF—6,324 requests in 2014, equivalent to 17 requests per day. Seventy-eight percent of police requests related to crime, criminal justice and antisocial behaviour incidents (ie criminal investigations), which is equivalent to 14 requests per day from police for criminal investigations. These results demonstrate that rail network CCTV footage is frequently requested by police for the purpose of criminal investigations.

Further analysis of these data was undertaken to determine the types of incidents for which police requested footage (Table 2). Besides a broad category of general police inquiries (19%, n=953), the most common incident type for which footage was requested was assault (19%, n=934), followed by robbery (n=10%, n=477), graffiti (9%, n=431), malicious damage (9%, n=428) and theft (8%, n=400). This is consistent with research by La Vigne et al. (2011), in which police reported being more likely to request footage for violent crime, and research by Ashby (2017), which suggests CCTV footage is more useful for serious offences.

Table 2: Police requests for CCTV footage, by incident type, 2014		
	n	%
Police inquiry/search	953	19
Assault/affray	934	19
Robbery	477	10
Graffiti	431	9
Malicious damage	428	9
Theft	400	8
Indecent/unruly/antisocial behaviour	362	7
Stealing from person	298	6
Sexual offence	158	3
Other	508	10
Total	4,949	100

Source: Sydney Trains 2015 [computer file]

Relationship between security incidents, station characteristics and footage requests

The next part of the study attempted to determine what factors influenced the number of police requests for footage from each train station (for crime, criminal justice and antisocial behaviour incidents only). This is important, because understanding what variables are associated with an increased likelihood of footage being requested by police can help to inform decision making with respect to the design and layout of CCTV cameras and networks.

The first step was to examine the correlation between the number of security incidents that were recorded at each station by Sydney Trains and the number of requests for CCTV footage. To better understand the relationship, a ratio of requests to incidents was calculated, based on the average number of requests and incidents at each train station. A ratio less than one indicated that there were fewer requests than incidents, while a ratio greater than one indicated there were more requests than incidents. Importantly, police may request footage for incidents that were not recorded by Sydney Trains, or may not request footage for incidents that were recorded.

To assess the correlation between the number of requests and incidents per station, and given that the data were not normally distributed, Spearman's rank correlation coefficient was used.
The relationship between the number of requests and number of incidents was statistically significant for all incident categories. The strongest overall correlation was between the total number of requests and total number of incidents ($\rho=0.76$, $p<0.05$), equivalent to one request for every three recorded crime, criminal justice and antisocial behaviour incidents. The next closest was assault ($\rho=0.74$, $p<0.05$), although in this case there was the equivalent of three requests for every four incidents. These results generally support the hypothesis that the higher the number of security incidents at a station, the more likely police are to request footage.

Table 3: Relationship between requests and incidents, by incident type (n=303)				
	Requests	Incidents	Ratio	ρ
Assault	2.85	3.99	0.71	0.74
Robbery	1.44	0.31	4.65	0.51
Theft	2.56	2.50	1.02	0.69
Property damage	2.30	9.41	0.24	0.46
Antisocial behaviour	1.43	16.37	0.09	0.60
Total	14.55	41.30	0.35	0.76

ρ=Spearman's rank correlation coefficient
Note: Mean requests and incidents per station. Limited to requests for footage recorded at a station (as distinct from carriages, rail yards and surrounding areas)
Source: Sydney Trains 2015 [computer file]

Given the high number of requests, and past research that suggests CCTV footage is more likely to be used for serious, violent offences (Ashby 2017; La Vigne et al. 2011), the rest of this paper focuses on police requests for footage of assault incidents. The following variables and hypothesised relationships with CCTV requests were examined:

- network (metropolitan vs intercity)—stations on the metropolitan network were expected to receive a higher number of requests;
- the number of cameras at each station—incidents are more likely to be captured on CCTV at stations with a higher number of cameras, and police may be more likely to request footage from stations where they know there are more CCTV cameras;
- passenger footfall (based on barrier counts)—busier stations are more likely to record a higher number of security incidents and are therefore expected to receive a higher number of footage requests;
- accessibility after hours (based on whether they have 24-hour staffing)—stations that are accessible to patrons after hours (including when trains are not operational) may be more likely to record incidents at times when other forms of surveillance (ie other patrons) are less prevalent, meaning police may be more likely to request CCTV footage;
- interchange stations (compared with non-interchange stations)—interchange stations are busier and therefore record a higher number of security incidents and are expected to receive a higher number of footage requests; and
- whether any part of the station is above or below ground level—at stations where some part of the structure is not on ground level, natural surveillance may be less prevalent, meaning police may be more likely to request footage of incidents.

First, the bivariate relationships between the number of footage requests per station and different station characteristics were examined. Results are presented for all stations in the metropolitan and intercity networks, and for those in the metropolitan network only (Table 4). Information on interchanges, accessibility after hours and whether part of the station was above or below ground level was only available for metropolitan stations. There was considerable variation in the number of footage requests for each station, which appears to be closely associated with the characteristics of stations:

- Metropolitan stations recorded significantly more footage requests than intercity stations (z=–7.10, p<0.001).
- Stations with more cameras recorded significantly more footage requests (all stations: $\chi^2(4)=136.06$, p<0.001; metropolitan only: $\chi^2(4)=69.65$, p<0.001).

- Stations with higher average daily passenger footfall recorded significantly more footage requests (all stations: $\chi^2(4)=140.03$, $p<0.001$; metropolitan only: $\chi^2(4)=68.94$, $p<0.001$).
- Interchange stations recorded nearly five times the number of footage requests as non-interchange stations ($z=-5.81$, $p<0.001$).
- Stations that are accessible after hours (based on having 24-hour staffing) recorded more than five times the number of footage requests as stations that were not ($z=-6.94$, $p<0.001$).
- Stations where part of the structure is above or below ground level recorded nearly three times the number of footage requests as single-level stations ($z=-3.16$, $p<0.01$).

These results suggest that, on average, busier stations on the metropolitan network with more security cameras installed, multiple connecting lines and multiple levels that are accessible after hours receive a higher number of requests for CCTV footage from police. Given that stations are likely to possess a number of these characteristics (and some stations all of them), and that some of the characteristics may also be associated with a higher number of actual assault incidents, it was necessary to conduct further analysis.

Table 4: Mean number of footage requests per station, by station characteristics (assault incidents)						
	All stations			Metropolitan network only		
	n	$\bar{x}$ (M)	*s*	n	$\bar{x}$ (M)	*s*
Network* **						
Metropolitan	172	4.14 (2)	8.90			
Intercity[a]	131	1.14 (0)	3.36			
Number of cameras* **						
10 or less	104	0.36 (0)	0.67	17	0.41 (0)	0.71
11–20	79	1.24 (1)	1.83	53	1.55 (1)	2.04
21–50	64	2.42 (2)	2.84	49	2.18 (1)	2.63
51–100	30	5.97 (4)	4.39	29	5.62 (4)	4.03
101 or more	26	15.11 (9)	19.24	24	14.75 (8.5)	19.78
Footfall* **						
Less than 100	55	0.40 (0)	0.40	1	0.00	
100–999	94	0.71 (0)	1.11	29	0.69 (0)	1.42
1,000–2,499	59	2.10 (1)	3.11	49	1.39 (1)	1.88
2,500–9,999	71	4.79 (3)	5.33	69	4.36 (3)	4.41
10,000 or more	24	13.5 (5)	19.96	24	13.5 (5)	19.96
Interchange* **						
Yes	–	–	–	44	9.89 (5)	15.63
No	–	–	–	128	2.17 (1)	2.94
Accessibility after hours[b]**						
Yes	–	–	–	52	9.69 (5)	14.44
No	–	–	–	120	1.80 (1)	2.49
Above or below ground level**						
Yes	–	–	–	25	8.96 (4)	19.01
No	–	–	–	147	3.33 (1)	5.37
Total	303	2.85 (1)	7.21	172	4.14 (2)	8.90

**p<0.01; ***p<0.001
a: 1 station excluded from the intercity network due to missing data
b: Based on whether the station had 24-hour staffing
Note: Excludes metropolitan stations that are part of the airport link and stations that were not operational for all of 2014
Source: Sydney Trains 2015 [computer file]

To determine which of these station characteristics were most strongly associated with the number of requests for CCTV footage, a zero-inflated negative binomial regression was used. Negative binomial regression was chosen for this analysis because the dependent variable, the number of requests, is a count variable and there was evidence of over-dispersion. A zero-inflated negative binomial regression was used because of the large proportion of stations that did not record any police requests for footage. The suitability of this approach was confirmed through appropriate model fit diagnostics.

The benefit of the regression model is that it allows for the independent effect of each variable on the number of requests to be estimated, controlling for other variables. Two different models were specified. The first model included all stations, including metropolitan and intercity stations (Table 5). This was limited to the number of security incidents, network type, footfall and number of cameras. The zero-inflated negative binomial regression model was significant ($\chi^2(4)=223.59$, $p<0.001$), and McFadden's Adjusted R^2 was 0.234, indicating the model is a good fit for the data. Variance inflation factors (VIF) were calculated to check for the presence of multicollinearity, but the VIF for all coefficients and the mean VIF fell well within the acceptable range (<4).

Table 5: Zero-inflated negative binomial regression predicting number of requests per station (assault incidents)

	IRR	95% CI (lower)	95% CI (upper)
Number of security incidents (assault)	1.11***	1.09	1.13
Network (metropolitan versus intercity)	2.00***	1.50	2.65
Footfall (per 1,000 passengers)	0.98**	0.97	0.99
Cameras (per 10 cameras)	1.05**	1.02	1.09
Model chi square	223.59		
p	<0.001		
n	302		

**$p<0.01$; ***$p<0.001$
Note: IRR=incident rate ratio; CI=confidence interval. The predictor of the excess zeros in the distribution, number of security incidents per station, was statistically significant (IRR=–1.43, CI=–2.28/–0.58, $p<0.001$); McFadden's Adjusted $R^2=0.234$. Excludes Central station, which was identified as an outlier on the basis of a visual inspection of the data, because its studentised residuals exceeded acceptable limits, and because it exerted excessive influence over the model coefficients
Source: Sydney Trains 2015 [computer file]

Based on the incident rate ratios (IRR) presented in Table 5:

- For each additional assault incident recorded at a station, the number of footage requests increased by 11 percent (IRR=1.11).
- The number of footage requests received at metropolitan stations was twice (IRR=2.00) that of intercity stations, controlling for other variables.
- For every additional 10 cameras installed at a station, the number of footage requests for assault incidents increased by five percent (IRR=1.05), controlling for other variables.
- Once these other variables were controlled for, an increase in footfall was associated with a small decrease (2%) in the number of requests for footage for assault incidents.

The second model attempted to account for the impact of station design and layout on requests for CCTV footage (Table 6). This was limited to metropolitan stations only, because information on intercity stations was not readily available. In the first iteration, the effect of excluding intercity stations was examined. This model was significant ($\chi^2(4)=146.18$, $p<0.001$), and McFadden's Adjusted R^2 was 0.209, indicating that the model remained a good fit for the data. Footfall and the number of cameras were no longer significant predictors of the number of footage requests—the only significant predictor was the number of assault incidents recorded at the station (IRR=1.10).

The next iteration included additional variables for interchanges, after-hours accessibility and stations with multiple levels. This model was significant ($\chi^2(4)=154.93$, $p<0.001$), and McFadden's Adjusted R^2 was 0.213. The VIF for all coefficients and the mean VIF fell well within the acceptable range. Based on the results for the full model presented in Table 6:

- For each additional assault incident recorded at a metropolitan station, the number of footage requests increased by eight percent (IRR=1.08).
- The number of footage requests was 32 percent higher at interchange stations (IRR=1.32), controlling for other variables.
- The number of footage requests was 39 percent higher at stations that were accessible after hours (IRR=1.39), controlling for other variables.

As with the first iteration, passenger footfall and camera numbers did not predict the number of footage requests, while the presence of multiple levels at a station was no longer significant once the effect of other variables was taken into account.

Table 6: Zero-inflated negative binomial regression predicting number of requests per station, metropolitan stations only (assault incidents, n=171)

	Iteration 1[a]			Iteration 2[b]		
	IRR	95% CI (lower)	95% CI (upper)	IRR	95% CI (lower)	95% CI (upper)
Number of security incidents (assault)***	1.10***	1.07	1.12	1.08***	1.06	1.10
Footfall (per 1,000 passengers)	0.99	0.98	1.00	0.99	0.98	1.00
Cameras (per 10 cameras)	1.03	0.99	1.06	1.00	0.97	1.04
Interchange (vs no interchange)*	–	–	–	1.32	1.05	1.66
Accessible after hours (vs not accessible after hours)*	–	–	–	1.39	1.03	1.87
Above or below ground (vs ground level only)	–	–	–	0.95	0.68	1.31
Model chi square	146.18			154.93		
p	<0.001			<0.001		
n	171			171		

*$p<0.05$; ***$p<0.001$

a: The predictor of the excess zeros in the distribution, number of security incidents per station, was statistically significant (IRR=–2.12, CI=–2.80/–1.44, $p<0.001$); McFadden's Adjusted $R^2=0.209$

b: The predictor of the excess zeros in the distribution, number of security incidents per station, was statistically significant (IRR=–1.19, CI=–1.83/–0.54, $p<0.001$); McFadden's Adjusted $R^2=0.213$

Note: IRR=incident rate ratio; CI=confidence interval. Excludes Central station, which was identified as an outlier on the basis of a visual inspection of the data, because its studentised residuals exceeded acceptable limits, and because it exerted excessive influence over the model coefficients

Source: Sydney Trains 2015 [computer file]

Discussion

It is possible to draw several conclusions from the results presented in this paper. First, while it is not possible to determine from this study how the footage was used or its impact, it is evident that rail network CCTV footage is frequently requested by police—with an average of 17 footage requests per day, and 14 requests per day for criminal investigations. At the very least, this volume of requests suggests that police in New South Wales see enough value in CCTV footage as a source of information for criminal investigations into incidents on the rail network to regularly request it from Sydney Trains. It also reflects the strong partnership that has been established between Sydney Trains and NSWPF (Sydney Trains 2016).

This high demand highlights the importance of careful planning of CCTV systems and management of footage by camera operators, particularly when cameras are installed in relatively high crime areas. Camera operators must be adequately resourced to meet this demand; otherwise their capacity to support investigators can be negatively affected (Piza, Caplan & Kennedy 2014). There are clear protocols that must be followed to enable camera footage to be used for evidentiary purposes, including legislative requirements, technical specifications, storage provisions and the access to and handling of footage in ways that ensure the integrity and continuity of evidence (ANZPAA 2014; NPIA 2011).

Regression analysis identified a number of station-level characteristics associated with a higher number of police requests for footage relating to assault incidents. As expected, the actual number of recorded incidents is an important predictor of the number of requests for footage, and remained significant once other station variables were taken into account. This highlights the importance of ensuring that, where they are designed to assist police, cameras are installed in higher crime areas (not limited to public transport), informed by data on the number of recorded incidents in those areas.

There are a number of possible explanations for why metropolitan stations recorded a higher number of footage requests than intercity stations, even controlling for the number of security incidents. There may be variation in the propensity of different police command areas to request footage. Variation between Police Transport Command areas in the number of requests for footage can be largely explained by local arrangements for access to footage (ie some intercity stations have local monitoring which enables police to review footage prior to submitting a request). In addition, those officers working at metropolitan stations, where incidents are more common, are more likely to have previous experience investigating crime at train stations and therefore greater awareness of the availability of CCTV footage. Officers responsible for investigating crime at metropolitan stations may have greater capacity to request and analyse footage or, conversely, seek camera footage because it may save valuable investigation time. Finally, it is possible that there are qualitative differences in the types of assault that occur at different stations—assaults at metropolitan stations may be more serious or more likely to involve multiple parties.

The number of cameras was a significant predictor of the number of requests for footage across metropolitan and intercity stations, controlling for both passenger footfall and the number of recorded incidents. This is consistent with the hypothesis that the more cameras there are (relative to patronage), the more likely it is that an incident will be captured and, in turn, the more likely it is that police will request footage. However, once the analysis was limited to metropolitan stations, the number of cameras was not a significant predictor of footage requests, either before or after the physical characteristics of train stations were taken into account. This may reflect the high degree of CCTV coverage that metropolitan stations have on the Sydney rail network—there may be little actual variation in the proportion of station area that has surveillance. Further research should explore the influence of camera dosage, measured in terms of the amount of space covered by CCTV, on the benefits of footage to criminal investigations.

Across the entire network, busier stations recorded a higher number of footage requests; however, once other variables were taken into account, an increase in patronage was actually associated with a decrease in the number of footage requests. Quieter stations may have fewer passengers around when incidents occur, particularly in the evening, providing fewer opportunities for other forms of surveillance (ie witnesses who may assist with an investigation). As with the number of cameras, this variable was not significant when the analysis was limited to metropolitan stations, either before or after the physical characteristics of stations were taken into account. It is possible that passenger numbers have a more significant influence on other forms of surveillance at quieter intercity stations.

In terms of station characteristics, stations that were accessible after hours and interchange stations (with two or more lines) recorded a higher number of footage requests for assault incidents, controlling for other variables. Stations that are accessible after hours—specifically, those with 24-hour staffing—will have periods of low footfall, as distinct from low footfall overall (already accounted for within the model). These stations may be more likely to record incidents at times when there are fewer passengers around and therefore fewer witnesses who can assist in a police investigation, such as late at night, including when the trains are not running. This suggests a need to target CCTV at locations which are accessible during periods of low patronage and which therefore lack other forms of public surveillance, but which may attract a higher number of incidents.

There may be several explanations for the high rate of requests at interchange stations, even once patronage is taken into account. Research into crime at train stations has found that the connectedness of a station—including whether it is an interchange—is associated with a higher rate of violent crime, because it provides opportunities for victims and offenders to come together in certain locations at specific times (Irvin-Erickson & La Vigne 2015). At interchanges, passengers spend longer periods waiting for connecting services, or moving between connecting services (eg trains, buses and ferries). It might be that these same properties lead to incidents in locations where other forms of public surveillance may not be present, such as pedestrian tunnels, or where other forms of public surveillance may be less effective, such as in particularly crowded areas or areas where large groups of passengers converge. It may be that CCTV cameras installed at interchanges provide surveillance of these locations, and that police request footage knowing there is coverage. Another explanation is that interchanges, often located in city centres and entertainment precincts, may have assault incidents that are qualitatively different to the assault incidents at other stations—the same could also be said for stations accessible after hours. These stations may have more alcohol-

related assaults, which are more likely to involve serious injury and which may therefore involve closer inspection of available CCTV footage. Finally, given research has shown that police frequently use CCTV footage to verify witness accounts (La Vigne et al. 2011), police may request footage at interchanges because there are multiple, conflicting witness statements about an incident.

This research is not without its limitations. Incidents recorded by police at stations may have provided a better measure of the potential demand for CCTV footage, given police would be likely to seek footage only for incidents that come to their attention. However, police recorded crime data were not readily available with the same precision in terms of the location of incidents at train stations. In any case, the relationship and data-sharing arrangements between Sydney Trains and NSWPF mean that there is likely significant overlap between recorded criminal incidents and recorded security incidents.

Further, in-depth analysis of footage requests is limited to assaults—largely because of evidence that police are more likely to request footage of violent crime—but there may be some variability between offence types that has important implications for planning CCTV systems. In addition, there are many other variables that may influence a police officer's decision to request CCTV footage of a security incident. For example, the placement of cameras and coverage at each station may have a much greater impact on this decision than the design of the station itself. Similarly, it was not possible to account for the characteristics of security incidents as part of the analysis—including when and where they occurred and how this might vary between stations—which might also influence requests for footage. Further, it was not possible to account for police officer preferences—US research has shown that police vary in their support for CCTV as an investigative tool (La Vigne et al. 2011).

Finally, further research into the use of CCTV footage by police is necessary, including research into the impact of footage on police investigations. While UK research by Ashby (2017) demonstrated the value of CCTV footage to British Transport Police, other research has shown that often the footage accessed by police does not assist with an investigation (La Vigne et al. 2011), and that outcomes can vary from country to country (Welsh & Farrington 2009). The rail network is also relatively unique in its level of CCTV coverage and monitoring arrangements, limiting the generalisability of results from this study to other locations. Therefore, future research should examine the use of CCTV in other settings, such as entertainment precincts, for investigative purposes.

Conclusion

While relatively modest in scope, this study represents one of the first attempts in Australia to measure the use of CCTV footage by police in criminal investigations. Overall, this study provides some empirical support for the argument that, to aid in investigations (especially for assault incidents), surveillance cameras should be installed at locations where there are higher levels of crime and lower levels of public surveillance, and at stations and locations that have crime-generating properties. Importantly, footage from cameras should be regarded as complementary to other forms of evidence that might be available from offenders, victims and witnesses. While further work is required to measure the impact of CCTV on investigation outcomes, this research demonstrates the frequency with which police use CCTV footage on a major rail network, and can help to inform the design and layout of CCTV systems both on public transport and in other locations.

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