

A Space-time Analysis of Crime at Train Stations: the Importance of Passenger Presence and Environmental Context

PhD Student: Hexia Zhang¹
Advisory Team: Professor Jonathan Corcoran¹, Dr Renee Zahnow², Associate Professor Yan Liu¹

1 School of Earth and Environmental Sciences, The University of Queensland, St Lucia, QLD, Australia
2 School of Social Science, The University of Queensland, St Lucia, QLD, Australia

Introduction

Background

Public transit stations are often considered as criminogenic places that generate opportunities for crime and attract would-be offenders. Challenges such as safety concerns caused by crime arise, which may lead people to abandon public transit system, hindering the sustainable development of cities. Given this, crime at public transit stations should be viewed as an area of paramount importance requiring scrutiny and attention.

Problem statement

Extensive evidence has highlighted that the vulnerability of public transit stations to crime varies over space and time. Spatially, certain stations are easier to be targeted for specific types of crime due to the environmental attributes, including the internal settings of the stations, features of the external environs around the stations, the sociodemographic and socioeconomic characteristics of surrounding neighbourhoods in which the stations embedded. Temporally, even at the same station, the risk for specific types of crime may change hourly, daily, weekly and seasonally, as the passenger flows at public transit stations fluctuate all the time.

Whilst a number of studies have identified the environmental attributes associated with different types of crime at public transit stations, few have explicitly explored the relationship between passenger presence and different types of crime at public transit stations.

- The existing studies only examined the impact of passenger presence on theft. It is unclear whether passenger presence exerts a different impact on other types of crime.
- Data on the number of passengers in presence used in these studies are average daily ridership, which is inadequate for explaining the association between passenger presence and the level of crime at public transit stations during different time windows.
- The single-level models adopted in these studies can not account for the nested nature of the multi-scale conditions that influence the level of crime at public transit stations.

Research objective

To address the gaps in the literature, in this study, we draw on smart card data to capture a direct measure of hourly ridership to investigate how passenger presence together with environmental context influences the occurrence of different types of crime at public transit stations, based on multi-level models.

Method

Case study area

This study takes Greater Brisbane (it is referred to as Brisbane in the rest of this poster), Australia as a case study. As a low-density city in Oceania, Brisbane is an interesting case because it contributes to the current evidence in crime at public transit stations which is mostly comes from studies in high-density cities in North America and Western Europe.

Brisbane is well connected by an extensive and efficient public transit system comprised of buses, ferries and trains. In this study, we focus on crime at train stations in Brisbane. For the period 1 July 2015 through to 30 June 2016, there were 125 train stations in Brisbane. Figure 1 shows the most three common types of crime were public nuisance, drug offence and theft. Figure 2 depicts the average hourly train ridership, which were quite different on weekdays and on weekends and holidays due to people's obligatory and discretionary routine activities. Therefore, in this study, the differences in the importance of passenger presence together with environmental context for predicting drug offence, public nuisance and theft will be respectively assessed on weekdays and on weekends and holidays.

Method

- Dependent variables

Dependent variables are counts of drug offence, counts of public nuisance and counts of theft at train stations, obtained from Queensland Police Service.

- Independent variables

Hourly ridership, generated from the Queensland Department of Transport and Min Road's *go* card system, is the key independent variable that indicates the number of passengers present at train stations. Other independent variables are environmental attributes that are selected on the basis of previous literature. These attributes are multi-scale, involving the internal settings of the stations, the features of the external environs around the stations, the sociodemographic and socioeconomic characteristics of surrounding neighbourhoods in which the stations embedded. Accordingly, the independent variables in this study can be divided into three levels (Table 1).

- Analytic strategy

Negative binomial regression model is employed as crime counts are involved in this study. In addition, since the independent variables have a multi-scale structure, the negative binomial regression model is further extended to multi-level negative binomial regression model to adequately handling the nested nature of the data.

Overall, a series of 6 multi-level negative binomial regression models are set up to estimate the impact of passenger presence and environmental context on drug offence, public nuisance and theft at train stations on weekdays and on weekends and holidays respectively.

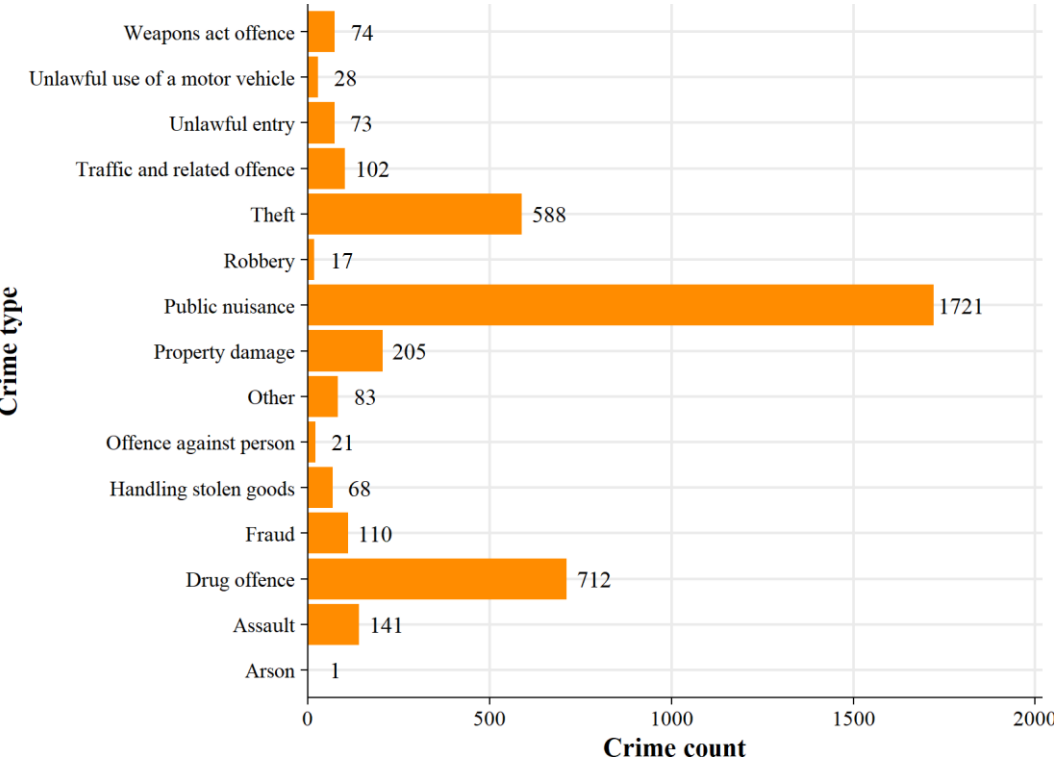


Figure 1 Count of different types of crime at train stations in Brisbane

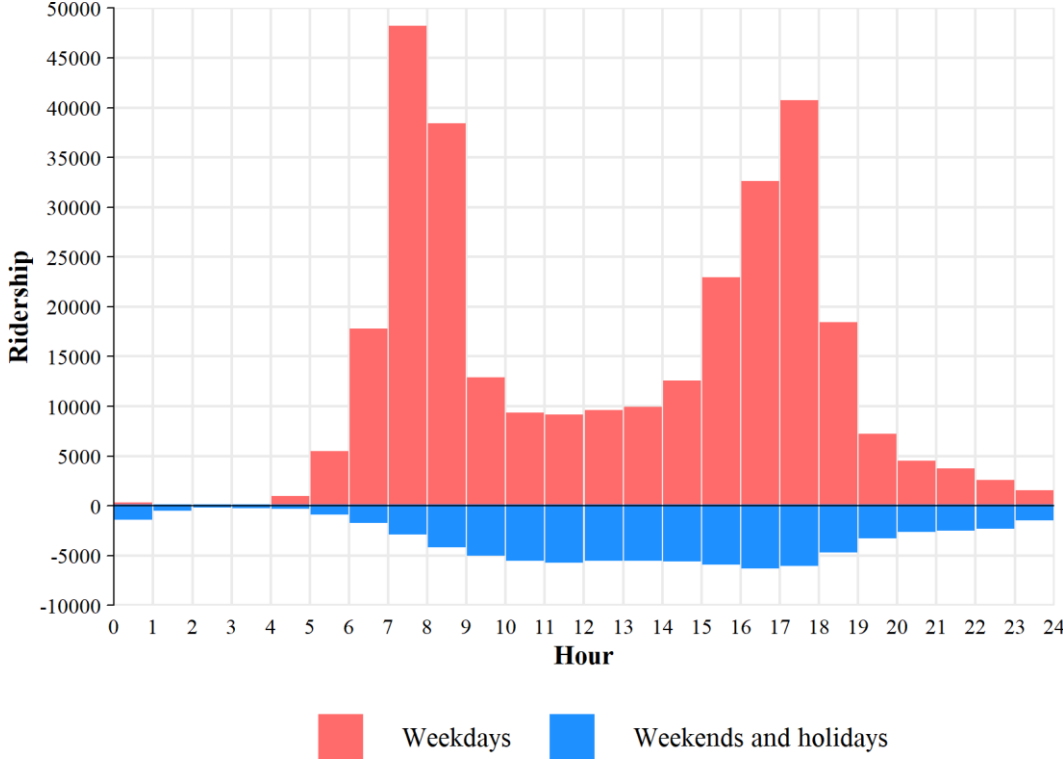


Figure 2 Average hourly train ridership in Brisbane

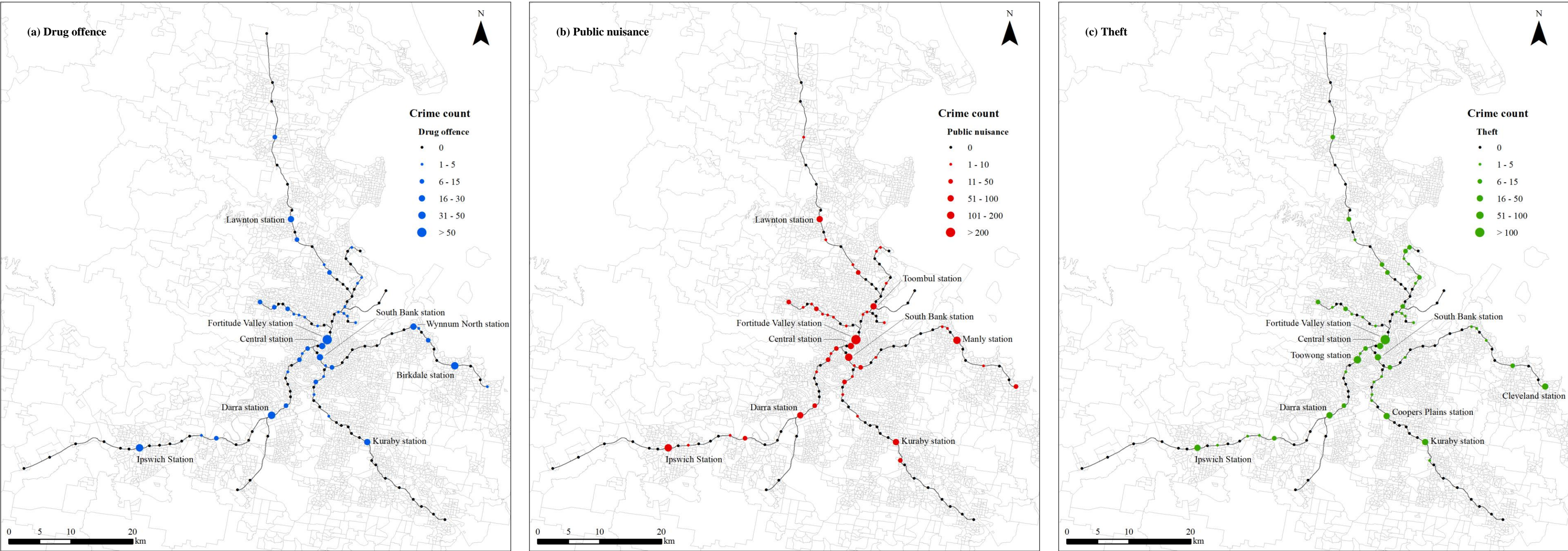


Figure 3 Spatial distribution of different types of crime at train stations in Brisbane

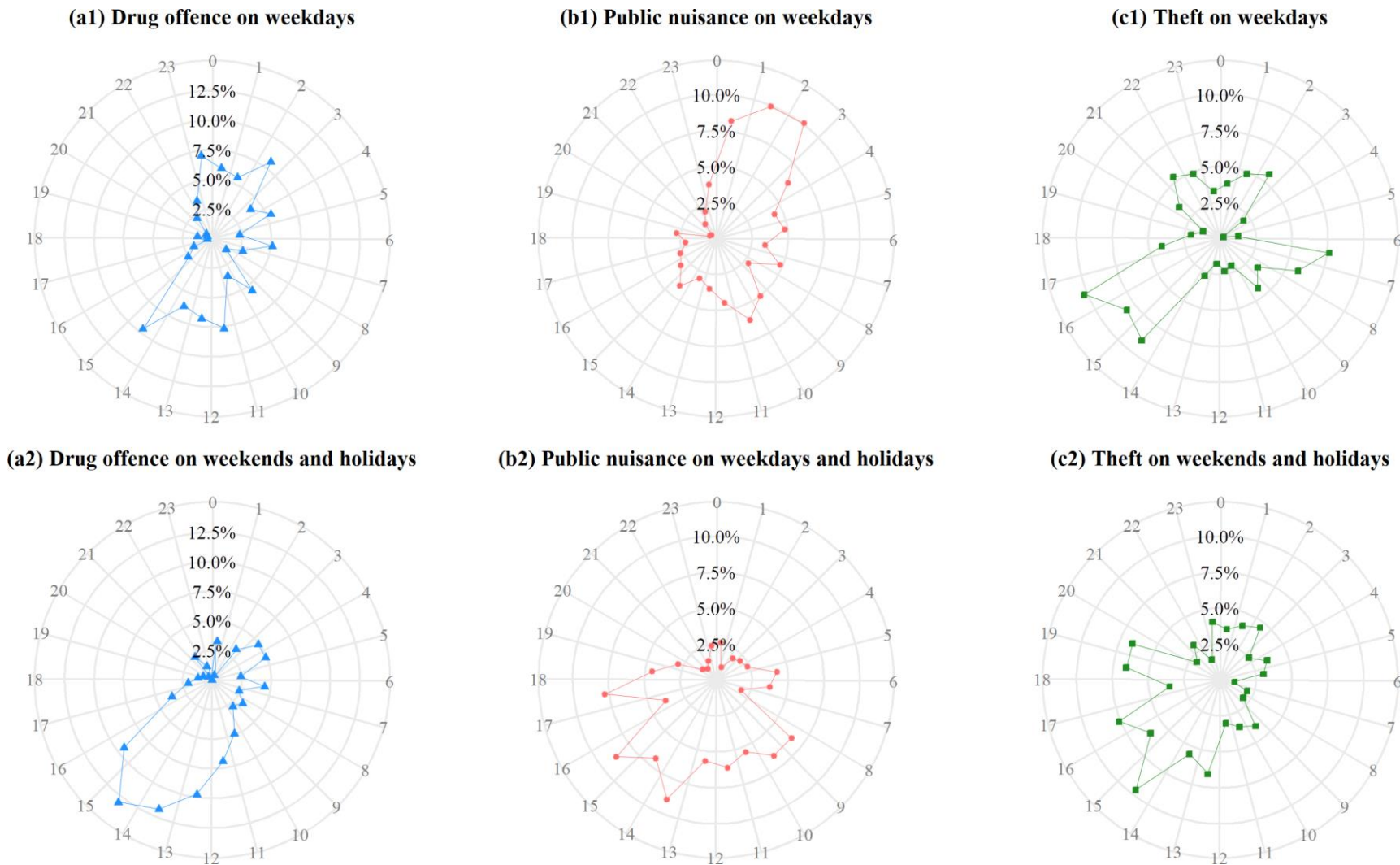


Figure 4 Temporal distribution of different types of crime at train stations in Brisbane

Table 1 Result of multi-level negative binomial regression models

			Drug offence				Public nuisance				Theft			
			Weekdays		Weekends & holidays		Weekdays		Weekends & holidays		Weekdays		Weekends & holidays	
			Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig
Internal station level		Hourly ridership	-0.0037	*	0.0007		-0.0231	***	0.0027	*	0.0012	***	0.0032	
		Fare zone	-2.3783	***	-1.4204	**	-1.8727	***	-1.0391	***	-1.1639	***	-1.1580	***
		Number of platforms	-0.2853		0.5589		-0.1470		-0.0785		-0.5160		0.2019	
		Number of carpark bays	0.0060	***	-0.0024		0.0022	**	0.0015		0.0013		0.0006	
External station level	Risky facilities	number of liquor stores	0.2622		1.3780	*	0.5948	***	0.4905	***	0.1265	**	0.2823	*
		number of ATMs	-0.6084		-0.2019		-0.1293		0.2423		0.5720	**	0.4375	**
	Land use	% commercial land use	0.2590	***	0.1166	**	0.0509	*	0.0394	*	0.0085	*	0.0144	
		% education land use	0.1061	*	0.0530		0.1410	*	-0.0604		0.0217		0.0209	
		% industrial land use	-0.0589		-0.0124		-0.0268		-0.0284		-0.0473		-0.0483	
	% residential land use	0.1148	***	0.0329		0.0482		0.0440		0.0144	*	0.0085		
Surrounding neighbourhood level		Neighbourhood crime count	0.0041		0.0314	*	0.0056	***	0.0054	**	0.0008		0.0055	
		Population density	-0.0008	***	-0.0002	**	0.0003	*	0.0002	***	0.0002	***	0.0002	**
		% 10-19 years	0.2416	*	-0.0215		0.3478	**	0.1904		0.1351		0.3265	**
		% residents who speak English only	-0.0814	**	-0.0648	*	-0.0001		-0.0152		-0.0004		-0.0107	
		% residents below Secondary Education	0.0398		0.0885		0.0207		0.0284		0.0772		0.1071	
		Unemployment rate	-0.5713		0.5795		-0.3547		-0.1829		0.0726		-0.4856	
		% rented dwellings	0.0650		0.0949		0.0146		0.0082	*	0.0659		0.0371	
	Median weekly household income	-0.0046	***	-0.0059	***	-0.0058	***	-0.0055	**	0.0023	***	0.0044	***	
R ²			0.678		0.576		0.719		0.550		0.604		0.476	

Results

Spatial and temporal patterns of crime

Spatially, only 54 of 125 train stations were affected by drug offence, public nuisance or theft. This closely follows the '80-20 principle', as 75.5% of the crime incidents occurred at 20.4% of the 54 stations. Furthermore, certain stations were often targeted by specific types of crime (Figure 3).

Temporally, drug offence and public nuisance were more likely to occur in the night time on weekdays, whereas they tended to occur in the day time on weekends and holidays. Thefts were committed mainly during the time periods when people are going out (6-8 am) or getting back (2-5 pm) on weekdays as well as from noon to 5pm on weekends and holidays (Figure 4).

Role of passenger presence and environmental context in crime causation (Table 1)

On weekdays, the number of passengers in presence is negatively associated with drug offence and public nuisance, while that is positively associated with theft at train stations. On weekends and holidays, public nuisance increased with the rising number of passengers in presence.

Fare zone of train stations has a significant negative impact on all three types of crime both on weekdays and on weekends and holidays, demonstrating that drug offence, public nuisance and theft are all tend to concentrate at train stations in city centre.

Regardless of the types of days, environmental features that increase the risk of drug offence at train stations include more commercial land use around, and surrounding neighbourhoods with lower population density, lower percentage of residents who speak English only and lower household income. Train stations co-located with liquor stores and commercial land use, situated in neighbourhoods with higher population density and lower average household income are at high risk of public nuisance. Theft is more likely to occur at train stations located near liquor stores and ATMS, situated in neighbourhoods characterised by higher population density and higher average household income.

On weekdays, some additional environmental features play a role in predicting the risk of drug offence, public nuisance and theft at train stations. For instance, train stations with joined carparks located nearby educational facilities and those situated in neighbourhoods with higher percentage of teenagers experience more drug and public nuisance, and the residential land use around train stations is positively related to drug offence and theft at train stations.

Conclusions

Drug offence, public nuisance and theft tend to occur at particular train stations during particular time windows, and both passenger presence and environmental context can be complementary in explaining the spatial and temporal patterns of different types of crime at train stations.

Limitations

- There may be probable underreporting and time lag in the crime data.
- The number of passengers present at train stations, which is calculated from *go* card data, may be less than the actual number of passengers there, because passengers who use paper tickets or transfer at the train station can not be recorded.

Future study

Crime is generated across space, the impact of passenger presence and environmental context on different types of crime at public transit stations may show a spatial variation. In order to better assess the spatial heterogeneity, a follow-up study should analyse how the impact of passenger presence and environmental context on different types of crime at public transit stations varies across space.