

URBAN CONTEXT AND MOTORCYCLIST COMPLIANCE: A BIVARIATE ANALYSIS OF TRAFFIC SIGNAL VIOLATION BEHAVIOUR ACROSS LAHORE, FAISALABAD AND MULTAN, PAKISTAN

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DOI: <https://doi.org/10.5281/zenodo.22707112>

Keywords

Motorcyclists, traffic signal violation, urban comparison, Punjab.

Article History

Received: 04 June 2026

Accepted: 26 August 2026

Published: 11 September 2026

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Abstract

Signal violation in urban intersections is one of the most prevalent traffic control shortcomings in low and middle income countries, but the frequencies of signal violations across cities within a single national or provincial jurisdiction have not been extensively analysed. The current paper presents a bivariate analysis of the self-reported violation of traffic signals among 450 motorcyclists sampled in three major cities of Punjab, Pakistan (Lahore, Faisalabad and Multan) in a larger doctoral study using a mixed method approach. Measures of self-reported violation frequency and traffic awareness, perceived enforcement, infrastructure quality, social influence and psychological factors were obtained on a structured questionnaire, along with a battery of socio-demographic factors. Bivariate procedures were Pearson correlation, Welch's robust F test and Kruskal-Wallis test (as parametric tests) followed by Tukey and Games-Howell post hoc tests, and chi-square tests on categorical enforcement, infrastructure and attribution items. The results show that there is a significant difference in the violation behaviour between the three cities ($F(2, 447) = 10.14, p < .001, \eta^2 = .043$) with riders from Faisalabad reporting the highest and those from Lahore the lowest frequency of violation. The bivariate level associations between the variables revealed that only psychological factors correlated significantly with violation, $r = .11, p = .020$. The three different urban regimes revealed by chi-square analyses are: personal, on-street enforcement environment in Faisalabad; camera-mediated, low-personal-enforcement environment in Lahore; and infrastructure-deficient environment in Multan. The findings validate the notion that the city can be considered to be an autonomous behavioural environment and cast doubt on the individual level informational model that has been used for many road-safety interventions in Pakistan.

Introduction

Road safety is one of the most significant public health problems of the 21st century. Road traffic crashes are estimated to kill about 1.19 million

people every year (as reported in Jiang et al., 2021, and as reflected in the thesis background), with over 90 per cent of these deaths attributed to road traffic crashes in low- and middle-income

countries where there is approximately 60 per cent of the world's vehicles. Signalised intersections are a specific hotspot as they are found to be a quarter to a third of all crashes in large urban networks, with examples of red-light running, wrong-way entry and delayed-phase crossing, which are among the most common and severe types of offences (Jiang et al., 2021).

In Pakistan, the combination of a high rate of urbanisation, high dependence on motorcycles for travel and the lack of even distribution of infrastructure and enforcement has created a unique urban traffic environment (Pakistan Bureau of Statistics, 2023; Hyder et al., 2000; Waseem et al., 2019). Motorcyclists are significantly over-represented in signal-related violation, injury and fatality incidents, and nearly half of the growing vehicle fleet in this country is comprised of motorcycles. Although the individual-level literature, which focuses on attitudes, perceptions and knowledge as the main factors influencing violation (Ajzen, 1991; Reason et al., 1990; Batool & Carsten, 2017), has been weak in explaining the persistence of signal violations despite high perceived levels of knowledge about the rule, this is not to deny its utility in driving the field forward.

Despite the increasing evidence that there are systematic differences across urban settings in terms of enforcement regime and infrastructural maturity and social composition within a single provincial jurisdiction, the between city patterning of signal violation in Pakistan has yet been under analysed. The classic urban sociological argument (Wirth, 1938; Milgram, 1970; Sampson et al., 1997) sees the city as a behavioural environment, rather than just a space where individual behaviours are set. This paper addresses the question of whether the city in this sense understands explains variation in signal violations across the city, and whether institutional and infrastructural profiles are associated with certain patterns of violation.

The analysis is both empirical and applied. Empirically, a bivariate account sets the basic contours of the city-violation association prior to the use of more complex multivariate models, and

thus offers a map of diagnosis of the consequences of individual-level predictors. When applied, it helps to determine which parts of a road-safety intervention are going to get the biggest bang for their buck in which city? It makes an important operational difference in the context of the province-wide policy frameworks that shape enforcement and infrastructure.

This research gap has three parts: First, there is very little published bivariate work on signal violation in cities of Pakistan and the bivariate work available across different cities is limited. Secondly, previous analyses often focus on the individual level of the theoretical predictors (awareness, enforcement, infrastructure, social influence and psychological factors) and fail to account for the potential for these factors to act at the city or intersection level. Third, the consistency of the enforcement of categorical items of infrastructure, and of attributing them to cities has not yet been systematically documented in the peer-reviewed literature.

The paper's contribution is to provide that bivariate description, on a stratified random sample of 450 motorcyclists from three cities chosen for contrast in the level of urbanization, the maturity of the urban transportation system, and the technology used for enforcing bicycle laws. The analysis retrieves and restructures the bivariate findings that are presented in the doctoral thesis from which the paper is derived, and highlights in particular the city comparison as an analytic focus.

Literature Review

The literature review brings together those strands of the bivariate analysis that follows that come closest to the thesis.

The theory of planned behaviour (Ajzen, 1991; Armitage & Conner, 2001; Parker et al., 1992) and errors-and-violations tradition (Reason et al., 1990; Elliott et al., 2007) have been used consistently in international scholarship to specify attitudinal predictors of unsafe conduct. Similarly, in the Pakistani context, Batool and Carsten (2017) also found that there are clear dimensions of violation and error to aberrant driving

behaviour and that balance shifts depending on the local context. These traditions suggest individual level linkages between attitudinal predictors and violation behavior that provide the impetus for the first block of the present bivariate analysis.

The affective dimension of violation is best illustrated by the driving-anger research by Deffenbacher et al. (2001), affect and violation studies by Lawton et al. (1997), and traffic congestion as a stressor study conducted by Hennessy and Wiesenthal (1999). Inattention and fatigue have been found to be predictors of unsafe driving in the South Asian context (Sadeek et al., 2019). All these types of work provide the theoretical foundations of the psychological-factors index discussed below.

Theory of classical deterrence (Beccaria, 1986; Becker, 1968) suggests that there should be a negative relationship between perceived enforcement and violation, but more recent syntheses (Nagin, 2013; Paternoster, 2010; Pratt et al., 2006) argue that it is the certainty of detection rather than the severity that is most important, and Stafford and Warr (1993) differentiate between general and specific deterrence. Empirical research on red-light cameras (Retting et al. 2003, Aeron-Thomas & Hess 2005, Erke 2009, Høye 2013) confirms the certainty argument. A second explanation is provided by procedural-justice theory (Tyler, 1990; Tyler & Huo, 2002; Sunshine & Tyler, 2003; Jackson et al., 2012; Mazerolle et al., 2013; Walters & Bolger, 2019), which posits that legitimacy, not fear, is the basis for voluntary compliance. Stanojević et al. (2013) demonstrate that the attitudes are affected by traffic enforcement along with the behaviour.

The broken windows approach (Wilson & Kelling, 1982; Keizer et al., 2008; Braga et al., 2015; Skogan, 1990) and the traffic-engineering literature (Elvik et al., 2009; Long et al., 2011; Lum & Halim, 2006; Brosseau et al., 2013) have been used to examine infrastructural determinants. The urban sociological tradition (Wirth, 1938; Milgram, 1970; Sampson et al., 1997) provides the underpinning for the emergence of the predictor, the city. Kayani et al.

(2012) place these dynamics in a Pakistani cultural context, and cross-national studies (Nordfjærn et al., 2014; Özkan et al., 2006; Lund & Rundmo, 2009; Ihueze & Onwurah, 2018) find support for the plausibility of systematic variation across cities. The prevalence of violation behaviour has been well established globally in terms of socio-demographic factors. Males are consistently more likely to be victims of violations than females; and riding experience and frequency of exposure are strong indicators of opportunity for violation (Reason et al., 1990; Porter & England, 2000; González-Iglesias et al., 2012). The following is a demographical bivariate analysis, which is guided by these findings.

Research Objectives

The paper aims to accomplish three objectives:

This study aimed to explore the bivariate relationship between location of residence (Lahore, Faisalabad, Multan) and the reported traffic signal violation behaviour of motorcyclists in urban Punjab.

To define the bivariate relationships between each of the theoretical predictors (traffic awareness, perceived enforcement, infrastructure quality, social influence, psychological factors) and violation behaviour, and between key socio-demographic variables and violation behaviour.

To report on the categorical distribution of enforcement and infrastructure and attribution items to the three cities and to explain the findings in terms of urban profiles.

Research Methodology

4.1 Research Philosophy and design

This paper is based on a pragmatist research paradigm (Tashakkori & Teddlie, 2010; Creswell & Creswell, 2018) and a convergent parallel mixed-methods design. The quantitative strand is presented in the present paper in its bivariate aspect. The design of the study is cross-sectional, descriptive and correlational as described in Bryman (2016).

4.2 Population

The quantitative strand of the research aimed at motorcyclists who use their bikes regularly within the boundaries of the city Lahore, Faisalabad or Multan. Motorcyclists were chosen as the focus of analysis, as they form the largest single vehicle class in urban Punjab and are overrepresented in signal-related violations and are particularly sensitive to the variables of awareness, infrastructure and enforcement under study.

4.3 Sample size and sampling technique

A stratified random sampling technique (Cochran, 1977) was used to obtain 450 motorcyclists (150 per city). There was balanced representation across theoretically relevant subgroups (city, gender, and riding experience). The sample size is greater than the minimum required for a 95 per cent confidence level with a ± 5 per cent margin of error at the estimated population size (Krejcie & Morgan, 1970) and it is adequate for follow up multivariate analysis (Hair et al., 2019).

4.4 Variables and measurement

Self-reported frequency of traffic signal violations on a four-point ordinal scale (1 = never, 4 = more than 5 times) was used as the dependent variable (traffic signal violation behaviour). The theoretical predictors were five composite scales: (a) traffic awareness (five items concerning self rating of knowledge, rules communicated, exposure to campaigns, safety training and experience with license); (b) perceived enforcement (six items relating to warden presence and behaviour, reasons communicated, perceived equal treatment and adequacy of fines); (c) infrastructure quality (three items concerning signal functionality, position and timing); (d) social influence (three items concerning peer/family transmission, presence of other crossing vehicles, absence of warden as a cause for violation); (e) psychological factors (four items concerning anger/impatience, environmental strain, hurry and misjudgement as reasons for violation). All items were re-scored on a metric of 1 – 5, with 1 representing less of the construct and 5 representing more of the

construct, and averaged to create indices. Attitudinal and perceptual items were rated on a five-point Likert scale (Likert, 1932). The demographic variables included were gender, age, education, employment, income, residence, riding experience and riding frequency.

4.5 Data collection

Face-to-face data collection took place at and around the major signalised intersections and surrounding waiting areas in each city, using instruments in Urdu and local vernacular, if necessary. Informed consent was obtained, and interviews were carried out. The instruments were pretested before being used at full scale.

4.6 Statistical techniques

The following bivariate procedures were used: Pearson product-moment correlation (parametric tests of heteroscedasticity: Spearman rank correlation analysis), one-way analysis of variance (parametric test) for between-city differences in the study variables (where Levene's test indicated heteroscedasticity, Welch's robust F was calculated; Kruskal-Wallis H was computed as a non-parametric test; Tukey and Games-Howell post-hoc tests were conducted). IBM SPSS Statistics (Version 26) was used for conducting all analyses.

4.8 Academic research and reading skills

The validity of the composite indices was explored by Cronbach's alpha, but formative indices constructed from items of mixed response format do not require high internal consistency as do reflective scales (Diamantopoulos & Winklhofer, 2001; Wanous et al., 1997). Items were derived from the theoretical framework and previous validated instruments, and reviewed by experts to ensure content and face validity. The study received ethical clearance from the Department of Sociology. Consent was freely given and anonymity and confidentiality were respected at all times.

Core Data Analysis

5.1 Descriptive statistics

There were far more men than women in the sample (93.1 per cent) and most of the sample were young (mean age 25.6 years, SD = 9.0; 70 per cent under age 25). The level of education was relatively high with 40.2 per cent having an intermediate (FA/FSc) educational qualification, 17.6 per cent a graduate degree and 20.7 per cent a master's or four years bachelor's degree. The students comprised 54.7 per cent of the respondents and 54.2 per cent had monthly income less than Rs. 25,000. Two-thirds (66.9 per cent) resided in urban areas. There was a wide range of riding experience, from less than one year

(14.7 per cent) to over ten years (12.0 per cent), with 59.6 per cent reporting riding every day.

Descriptive statistics for the six study variables (Table 1) showed that the sample had violated at a mean frequency of 1.92 (SD = 1.05) on a four-point scale, with 46.4 per cent reporting that they never violated a signal and 13.3 per cent reporting that they violated more than five times. Three of the indices were below the midpoint and one was above: The awareness index (M = 2.64, SD = 0.76), the perceived-enforcement index (M = 3.20), the infrastructure-quality index (M = 3.60), and the social-influence and psychological-factors indices (M = 1.87, 2.39, respectively).

Table 1. N = 450 main study variables (descriptive statistics)

Summary of variables: M = mean, SD = standard deviation, Min = minimum, Max = maximum, Skewness = skewness, Kurtosis = kurtosis.

Variable	Items	M	SD	Min	Max	Skewness	Kurtosis
Traffic awareness	5	2.64	0.76	1.20	5.00	0.63	−0.08
Perceived enforcement	6	3.20	0.82	1.00	5.00	−0.16	−0.15
Infrastructure quality	3	3.60	1.02	1.00	5.00	−0.45	−0.49
Social influence	3	1.87	0.90	1.00	0.54	−0.74	
Psychological factors	4	2.39	0.71	1.00	4.00	0.25	−0.37
Traffic signal violation behaviour	1	1.92	1.05	1.00	4.00	0.85	−0.55

Note. All indices scored 1–5 with higher scores indicating more of the construct. Violation scored 1 (never) to 4 (more than five times).

5.2 Reliability of measurement scales

The five predictor indices did not always have positive Cronbach's alpha coefficients; they ranged from a negative value for social influence ($\alpha = -0.185$) to a value of .340 for traffic awareness (Table 2). None were above the traditional cut-off of .70 (Nunnally & Bernstein, 1994). The low coefficients are due to the formative nature of the indices, which means that items with mixed

response format were aggregated to form the distinct aspects of a construct rather than parallel manifestations of a single latent attribute (Diamantopoulos & Winklhofer, 2001). The analytical implication is that any bivariate associations observed are likely to be underestimated because of measurement attenuation (Wanous et al., 1997).

Table 2. Use of composite indices is limited by their lack of reliability.

Index	Items	n	Cronbach's α	Standardised α	Mean inter-item r
Traffic awareness	5	446	.340	.299	.079
Perceived enforcement	6	436	.338	.346	.081
Infrastructure quality	3	440	.114	.106	.038
Social influence	3	450	−.185	−.212	−.062
Psychological factors	4	449	.078	.039	.010

5.3 Bivariate correlations

The Pearson correlation between violation behaviour and the theoretical predictors were all small in size (Table 3). The psychological-factors index was the only one to be significantly and positively related to violation, $r(448) = .11$, $p = .020$. There was a positive, but non-significant,

relationship with traffic awareness ($r = .07$, $p = .154$). The perceived enforcement ($r = .01$), infrastructure quality ($r = .01$) and social influence ($r = -.02$) were virtually non-existent. Spearman rank correlations, which varied by no more than .02 from Pearson values in any cell and did not affect conclusions, were not used.

Table 3. Selected Pearson correlations with violation behaviour (N = 449–450)

Predictor	r	p
Traffic awareness	.07	.154
Perceived enforcement	.01	.796
Infrastructure quality	.01	.860
Social influence	-.02	.753
Psychological factors	.11	.020
Age	.05	—
Male (1 = male)	.17	< .001
Education	-.02	—
Income	.13	.007
Riding experience	.17	< .001
Riding frequency	.16	< .001

All but one of the demographic variables—age ($r = .09$)—were significantly and positively correlated with violation: male ($r = .17$); income ($r = .13$); riding experience ($r = .17$); and riding frequency ($r = .16$). There was very little bivariate correlation between violation and education or age.

The data were processed using a 5.4 one-way analysis of variance by city.

The significant differences in the violation behaviour between the cities were found using a one-way ANOVA: $F(2, 447) = 10.14$, $p < .001$, $\eta^2 = .043$ (Table 4). Homoscedasticity was suggested by Levene's test ($W = 8.76$, $p < .001$) and a robust F statistic was calculated ($F(2, 16) = 11.59$, $p < .001$), as was a Kruskal-Wallis H statistic ($H(2) = 14.40$, $p < .001$), all of which supported the parametric results. Tukey post-hoc comparisons revealed significantly more violation by Faisalabad riders ($M = 2.17$, $SD = 1.17$) than Lahore riders ($M = 1.63$, $SD = 0.81$; mean difference = 0.53, $p < .001$) and significantly more violation by Multan riders ($M = 1.95$, $SD = 1.09$) than Lahore riders

(mean difference = 0.32, $p = .021$). There was not any significant difference between Faisalabad and Multan ($p = .174$). The results of games-Howell comparisons were similar.

There were also significant differences in the psychological factors between cities, $F(2, 447) = 7.67$, $p < .001$, $\eta^2 = .033$, with the Multan riders' psychological factors reporting less strain than the Faisalabad and Lahore riders, who did not differ. Infrastructure quality was marginally different ($F = 3.15$, $p = .044$) and the Faisalabad riders were more satisfied than Multan riders. The perceived enforcement was approaching significance ($F = 2.66$, $p = .071$). There were no significant differences in awareness and social influence by city.

Table 4. Study variables were compared between cities using one-way ANOVA.

Variable	Faisalabad M (SD)	Lahore M (SD)	Multan M (SD)	F (2, 447)	p	η^2	Post- hoc (Tukey)
Violation behaviour	2.17 (1.17)	1.63 (0.81)	1.95 (1.09)	10.14	< .001	.043	F > L**; M > L; F = M
Traffic awareness	2.59 (0.79)	2.74 (0.75)	2.59 (0.73)	1.93	.146	.009	—
Perceived enforcement	3.33 (0.81)	3.15 (0.84)	3.13 (0.81)	2.66	.071	.012	—
Infrastructure quality	3.72 (1.11)	3.64 (1.03)	3.43 (0.90)	3.15	.044	.014	F > M*
Social influence	1.77 (0.88)	1.90 (0.92)	1.95 (0.89)	1.55	.213	.007	—
Psychological factors	2.45 (0.70)	2.50 (0.70)	2.21 (0.70)	7.67	< .001	.033	F > M; L > M*

The ANOVA result was further confirmed by the frequency distribution of violation behaviour. 53.3 per cent of riders said they never crossed a signal and 4.0 per cent crossed more than five times in Lahore. In Faisalabad, the corresponding figures were 40.0 per cent and 20.7 per cent; in Multan, 46.0 per cent and 15.3 per cent, $\chi^2(6) = 24.87$, $p < .001$, Cramér's $V = .17$. The

reoccurrence of the violation occurred about five times more in Faisalabad than in Lahore.

5.5 Chi-square tests of enforcement, infrastructure and attribution items

The results of chi-square tests on selected categorical items by city are shown in Table 5. Three patterns emerge.

Table 5. Selected items of enforcement, infrastructure and attribution by city (percentages)

Item	Faisalabad	Lahore	Multan	χ^2	df	p
Has received an e-challan for a signal violation	50.7	44.7	36.0	6.63	2	.036
Warden conduct: polite and professional	25.3	30.7	22.0	24.41	6	< .001
Warden conduct: strict but fair	52.7	32.7	36.0	—	—	—
Warden conduct: rude or disrespectful	17.3	26.7	25.3	—	—	—
Warden conduct: demanded a bribe	4.7	10.0	16.7	—	—	—
Current fines sufficient to deter: yes	63.3	40.0	55.3	20.00	4	< .001
Signals in area always functional	38.7	27.3	18.7	18.24	4	.001
Signals in area rarely functional	16.0	27.3	30.0	—	—	—
Main infrastructure problem: no countdown timer	32.0	16.0	16.0	36.05	12	< .001
Main infrastructure problem: signal malfunctioned	30.0	41.3	39.3	—	—	—
Reason for last violation: no police present	10.7	26.0	21.3	68.19	28	< .001
Reason for last violation: signal out of order	17.3	20.7	28.0	—	—	—
Reason for last violation: other vehicles crossing	25.3	10.0	21.3	—	—	—
Reason for last violation: in a hurry (any)	24.6	25.3	11.3	—	—	—
Best remedy: public awareness campaigns	43.3	51.3	66.0	37.89	14	< .001
Best remedy: strict enforcement	21.3	14.0	10.7	—	—	—

The nature of the enforcement regime is different across cities. The percentage of Faisalabad riders who received an e-challan for a signal violation was 50.7 per cent, 52.7 per cent of them described wardens as “strict but fair”, 63.3 per cent believed the current fines were enough to deter the violation of the signals while 4.7 per cent reported

bribe demands. The Lahore riders were least likely to get an e-challan, and they were also the most likely to say that wardens were “polite and professional” (30.7 per cent). The percentage of those who have faced bribe demands was highest in Multan (16.7 per cent), whereas the percentage

of the respondents who have received e-challan was lowest in Multan (36.0 per cent).

There are also variations in infrastructures. The Faisalabad riders were most likely to say that signals are always functional (38.7 per cent) followed by Lahore (27.3 per cent) and Multan (18.7 per cent). The major infrastructure-related issues in Faisalabad were countdown-timer absence (32.0 per cent), in Lahore it was signal malfunction (41.3 per cent) and in Multan it was (39.3 per cent). The most frequently mentioned reason for the last time of riding violation was “signal out of order” (28.0 per cent) among the Multan riders.

There are also differences in the way attribution is conceptualized. The “other vehicles crossing” reason for the last violation was cited most often by riders from Faisalabad (25.3 per cent), while the “absence of police” (26.0 per cent) and “hurry” (25.3 per cent) were cited most often by the Lahore riders. The Multan riders were most likely to cite an out-of-order signal (28.0 per cent), the Lahore riders were most likely to cite “absence of police” (26.0 per cent) or “hurry” (25.3 per cent), and the Faisalabad riders were most likely to cite “other vehicles crossing” (25.3 per cent) as the reason for their last violation. The three patterns of violations describe, respectively, a conformist, a pressured, and an infrastructural pattern in Faisalabad, Lahore, and Multan.

The preferred remedies also divide by city, $\chi^2(14) = 37.89, p < .001$. 66 per cent of Multan riders said that the most effective remedy was public awareness campaigns, as opposed to 51.3 per cent in Lahore and 43.3 per cent in Faisalabad. Strict enforcement (21.3 per cent) emerged as the most popular option among the Faisalabad riders.

Results

There are four bivariate results, which give the paper analytical heft.

It is found that there are significant differences across the three cities in terms of self-reported traffic signal violation behaviour. Violations rates are calculated at the mean frequency and Faisalabad riders have the highest violations rate at $M = 2.17$, Lahore riders have the lowest

violations rate at $M = 1.63$ and Multan have $M = 1.95$. Among all the variables analyzed at the bivariate level, the between city effect ($\eta^2 = .043$) is the largest.

Second, at the individual level, only the psychological factors correlate significantly with violation frequency ($r = .11, p = .020$), in line with the affective-determinants literature. There is no significant correlation with perceived enforcement, awareness and infrastructure quality and violation behaviour at the bivariate level.

Third, there are large differences in categorical variables of the enforcement, infrastructure, and attribution profiles between cities (χ^2 tests, all at $p < .05$, most at $p < .001$). Three different personal, on-street, camera-mediated and infrastructure-deficient environments can be seen: personal, on-street enforcement regime in Faisalabad; low-personal-enforcement but camera-mediated regime in Lahore; and infrastructure-deficient regime in Multan.

Fourth, socio-demographic variables are also associated with violation as predicted by international literature; being male ($r = .17$), income ($r = .13$), riding experience ($r = .17$) and riding frequency ($r = .16$) are positively and significantly related to violation, while being educated and being older are essentially null at the bivariate level.

Discussion

The bivariate results corroborate a reading that the city is the unit of behavioural variation in violation of signals for Pakistani motorcyclists. The between city difference in violation frequency is, by far, the biggest bivariate effect in the analysis, with a magnitude ($\eta^2 = .043$) higher than any of the individual predictors. This is in line with the tradition of urban sociology (Wirth, 1938; Milgram, 1970; Sampson et al., 1997) which views the city as a behavioural environment.

It is also important to carefully interpret the near-null bivariate relationships between the attitudinal and perceptual constructs and violation behaviour on an individual level. In terms of the method, the composite indices are formative (Diamantopoulos & Winklhofer, 2001) and are multifaceted in

terms of response format (Wanous et al., 1997), which leads to an underestimation of the true relationship. There is, however, no substantive evidence to suggest that a rider who believes that enforcement exists does not come out worse for wear than a rider who does not believe it exists; or that a rider who reports functional signals comes out worse than a rider who reports broken signals within the same city. This is not to say that enforcement or infrastructure is not important – it is as demonstrated in the city-level chi-square results (Table 5) – but it is to say that they are not at the level of individual perception (Sampson et al., 1997) but at the level of the regime.

Sketching three sociologically differentiated urban profiles using the Chi Square analyses (Table 5). The profile of Faisalabad is a personal on-street policing environment (highest number of e-challans received, highest number of “strict but fair” endorsements from wardens, and highest fine adequacy) and a relatively well-functioning infrastructure with a working class riding population. Violation pattern is conformist (“other vehicles crossing”) and pressured (“in a hurry”). Lahore is a low-personal-enforcement city with a lowest e-challan receipt, highest “polite and professional” warden endorsement, and lowest fine adequacy of all cities (which is consistent with the literature on camera enforcement: Retting et al., 2003; Aeron-Thomas & Hess, 2005; Erke, 2009; Høye, 2013), and a lowest violation frequency. It has opportunistic violation pattern (“no police present” and “in a hurry”). Multan has an infrastructural profile (lowest signal-always-functional endorsement, highest bribe demands, highest “signal out of order” attribution) and an attribution pattern that is infrastructural.

The results of the bivariate analyses of the socio-demographic data (male, higher income, more riding experience and higher riding frequency associated with more violation) generally support international patterns (Reason et al., 1990; Porter & England, 2000; González-Iglesias et al., 2012; Shinar, 1998). It is also interesting to note that income and experience are positively related to violation; this contradicts the informational-model prediction that violation is a function of

disadvantage or inexperience. In the bivariate level, notably, there is no correlation with education and violation, which directly challenges the awareness-based intervention paradigm.

The association between the psychological factors and violation ($r = .11$) is small, as Cohen (1988) defines it, but is the only theoretical predictor to be significant in the direction predicted at the bivariate level. It passes all multivariate controls for subsequent analyses (see a companion paper) and matches the driving-anger literature (Deffenbacher et al., 2001; Lawton et al., 1997; Hennessy & Wiesenthal, 1999). The between city ANOVA for psychological factors – riders in Mutan reported significantly less strain than those in Faisalabad and Lahore riders – indicates that the affective dimension of the urban traffic environment itself is a scaled aspect of the city.

Conclusion

The bivariate analysis presented here makes three main empirical claims. First of all self-reported signal violation behaviour is not the same in Lahore as compared to Faisalabad and Multan and highest in Faisalabad and lowest in Lahore. Second, at the personal rider level, psychological strain is the only factor that correlates significantly with violation, with no relation to awareness, enforcement, infrastructure or social influence. Third, the patterning of the categorical items of enforcement, infrastructure and attribution across the three cities represents three distinct regimes of the city – personal-enforcement/conformist-pressured in Faisalabad, camera-mediated/opportunistic in Lahore and infrastructure-deficient/infrastructural in Multan. Combined, the bivariate findings suggest that the city is a behavioural environment unto itself, one that is enforced at the regime level, and that is shaped by the infrastructure conditions, rather than by the rider's perception of them.

9. Suggestions and Recommendations

The following three recommendations are based on the bivariate analysis. First, the nature of the interventions for road-safety programmes should be adapted to the specific urban regime rather

than programmed to be delivered uniformly across the province; enforcement escalation is likely to have differential returns in Faisalabad, Multan, and elsewhere, while certainty through cameras is likely to have rolled down from the existing road-safety infrastructure in Lahore. Second, if the overwhelming majority of Multan respondents consider awareness programme as the most effective solution, then infrastructural repair is needed in Multan, as signal malfunction is the major reason for violation in that city. Thirdly, warden-conduct training should be emphasized when the bivariate pattern is that of Multan (which has the highest number of bribe demands and second highest number of rude conduct).

Limitations and Future Studies

The analysis was limited by three constraints. First, the composite indices are formative rather than reflective and their low internal consistency (Table 2) attenuates observed bivariate associations (Wanous et al., 1997). The development of validated multi-item scales for enforcement legitimacy and infrastructure trust and normative influence in the Pakistani riding context would be of significant value, on its own. Second, self-reported violation is prone to social-desirability effects (Lajunen & Summala, 2003) that were not completely eliminated in the larger study by field observations, but are present. Third, the cross-sectional design does not allow causation to be inferred and the three cities were chosen for analytic contrast, not for their representativeness. The future studies include extending the bivariate design to other cities, measuring within rider changes using the longitudinal measurement and, developing validated scales of the predictor constructs in the Pakistani context.

Funding Statement

The study presented in this paper was a part of a Doctoral programme in the Department of Sociology, Government College University Faisalabad, Punjab. No specific funding agency, in the public, commercial or not-for-profit sectors, made any specific grant to fund this research.

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