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Two data collection methods were used to gather information on cyclists in Dublin City - an observational survey and an online questionnaire. The observational surveys examined cyclist compliance with different traffic signal systems and the impact of on-road and off-road cycle infrastructure. An online questionnaire was used to get direct feedback from cyclists in Dublin City on the reasons (if any) they decide to commit infringement at traffic lights.
With the recent growth of cycling in Dublin City (as well as many other international cities) it is vital to accommodate and manage this growing demand by ensuring the safety and road discipline of cyclists. The next few years will be crucial for the continued development of cycling in Dublin, particularly due to the increasing investment by transport planners in cycle infrastructure. It is therefore important to identify now the main factors which influence cyclist's decisions to break red lights in order to guide local traffic authorities in their efforts to reduce such transgressions.

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Investigating traffic light violations by cyclists in Dublin City Centre

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Abstract

This research examines the behavior of cyclists in Dublin City with specific regard to red light running. A number of specific research questions are raised by this study. These questions address the impact of different infrastructure types on red light running, as well as the behavioral patterns and demographics of offending cyclists.

Two data collection methods were used to gather information on cyclists in Dublin City - an observational survey and an online questionnaire. The observational surveys examined cyclist compliance with different traffic signal systems and the impact of on-road and off-road cycle infrastructure. An online questionnaire was used to get direct feedback from cyclists in Dublin City on the reasons (if any) they decide to commit infringement at traffic lights.

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1. Introduction

Cycling in Dublin has become increasingly popular in recent years. Results from the previous Census in 2011 show a large increase in cyclist numbers in the Dublin between 2006 and 2011 (Caulfield, 2014). The Dublin City Council Canal Cordon Counts recorded 4,839 cyclists crossing the Canal inbound between 7-10am in 2006. In 2011, 6,870 cyclists were recorded during the same peak morning period of 7-10am (DCC and NTA, 2014). This represents a considerable increase of 42% in cycling in the City Centre over the five-year period.

While there has been an increase in cycling in the city, there has also been an increase in the number of accidents. Short and Caulfield (2014) demonstrated that cycling in the city is not as safe as some of the statistics report and that for the total number of days spent in hospital per transport accident for cyclists are over 13% of total days spent in hospital (in 2011), while cycling modal share of approximately 5% in 2011. Figure 1 shows that the number of cyclist deaths in Dublin City had been gradually decreasing since 2005. There were no deaths in 2012 and 2013. In 2014 there were three cyclist deaths in Dublin including one death in Dublin City. Figure 2 shows similar a trend in Dublin City in that the numbers of cyclist accidents are increasing at a considerable rate, despite the decreasing numbers of fatalities. The annual figures for total cyclist casualties (including fatal, serious and minor injuries) in 2013 and 2014 are yet to be released by the Road Safety Authority.

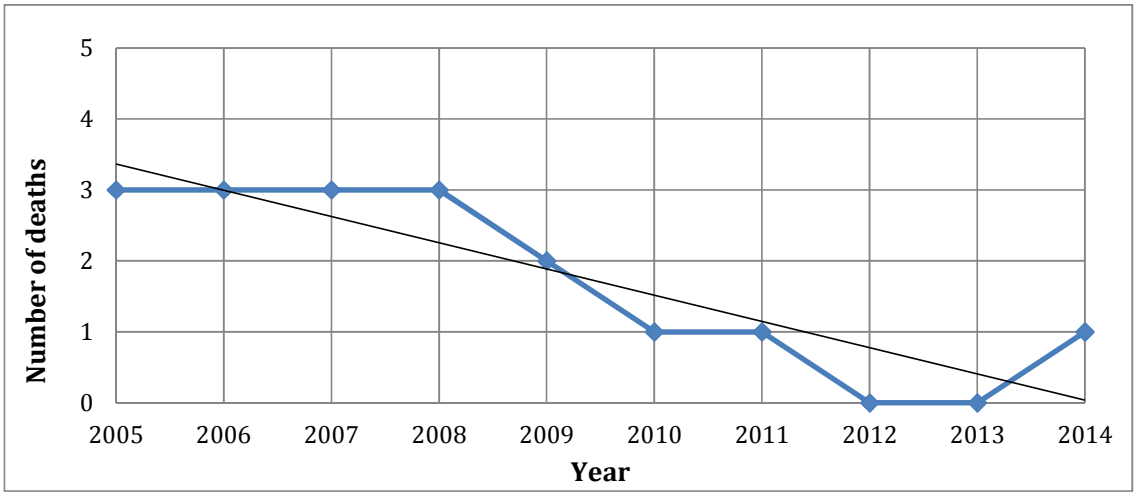

Figure 1 Number of Cyclists Deaths in Dublin City (Road Safety Authority, 2015)

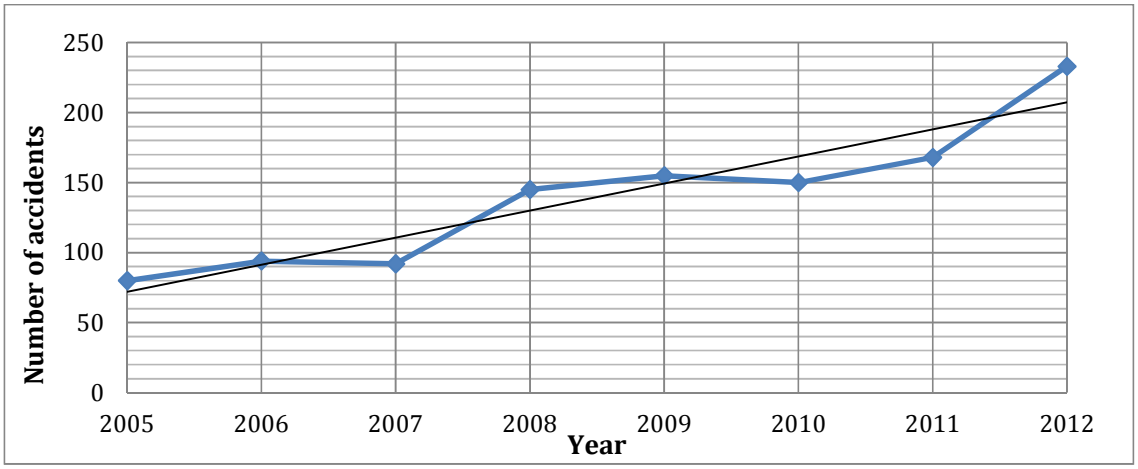

Figure 2 Cyclist Accidents in Dublin City (Road Safety Authority, 2015)

This paper adds to the field of research on cyclist behavior at signalised junctions. The research adds to the field in a number of unique ways, firstly the paper examines two cycle facilities in Dublin City Center, which are in close proximity, allowing for comparisons to be made between the two facilities. Secondly, this research is to the best of the author's knowledge one of the first papers to examine behavior at signalised junctions by shared bike users. The rationale for this research is that Dublin, like many other international cites is experiencing a large increase in cycling numbers, this has lead to increased cycle accidents by new and experience cyclists. This research seeks to determine behavior at junctions and to ascertain how and if the gender, cyclist facility type, shared bike users and weather impact upon behavior at junctions. The hypothesis tested in this paper cyclists behavior at junctions is not safe and that action is needed to address current levels of red light running in Dublin.

The paper is structured as follows. The second section presents a literature review that examines this field showing similar studies and outlining how the research presented in this paper adds to the field. The third section of the paper details the methods used to conduct the analysis presented in this paper and the data collection

tools used. The last two sections of the paper describe the results of the analysis conducted and a discussion and conclusion section describing the main contributions of the paper.

2. Literature Review

This section of the paper presents a summary and discussion of previous studies that have examined red light running and cyclists.

It is currently illegal in Ireland for cyclists to turn left at an intersection during a red light. However, this cycling scheme is already in operation in cities throughout the Netherlands, Belgium, Germany, France and America and has proven to be a success. Allowing left-turning cyclists to proceed during the red light phase can improve the safety of the junction. Instead of cyclists and motorists making the turn together during the green light phase, cyclists can proceed separately during the red light without potential conflict from other road users. Though, cyclists must still be cautious of pedestrians.

A later study carried out in Australia (Johnson et al, 2013) investigated the behaviour patterns of cyclists as well as the traffic conditions, which contribute to red light infringement. A total of 2,061 cyclists, all aged 18 or older, completed an online survey with questions regarding the frequency with which respondents stopped at red lights and the reason(s) for cycling through a red light. Six demographic variables were considered: gender, age, marital status, work status, income, and educational level.

Pai and Jou (2014) carried out a study in Taoyuan County, Taiwan, reached similar conclusions about student cyclists. Pai and Jou (2014) conducted an observational survey using video recordings of a number of junctions to investigate cyclists' compliance with red lights. An analysis of the collected data showed that cyclist behaviour was most risky at T-junctions and intersections with short red light durations. As identified by the Johnson et al. (2013), Pai and Jou (2014) also found that a large proportion of students in uniform regularly broke the lights, as well as un-helmeted cyclists and electric bike users.

The research by Johnson et al. (2013) provides a strong indication of the characteristics associated with cyclists who commonly break red lights at intersections in Australia, where young, single males are the biggest offenders. It also identified the predominant reasons why cyclists commit infringement. As identified in both their studies (2011 and 2013), Johnson et al. found that male cyclists and left-turning cyclists were least likely to comply with traffic regulations at intersections. Yet, the type of cycle infrastructure leading to the intersection has not been considered in either study. It would be of particular interest to policy-makers to identify whether infringement occurs more at junctions where cyclists and motorists share the road (i.e. a cycle lane) or at junctions where cyclists and motorists approach from their own segregated routes i.e. a cycle track.

Table 1 details a summary of several studies that have looked at the issue of red light running from the current literature. The findings in Table 1 also show a wide range of red light running at that one could not infer any "average red light running" from the published literature, more these studies are used as a guide to the amount and type of red light running that occurs.

Table 1 Summary of similar studies

Percentage red light running	Author(s)	Location	Data collection
6.9%	Johnson et al., 2011	Melbourne, Australia	Observational study
9%	Daff and Barton, 2005	Melbourne, Australia	Observational study
10.3%	Monsere et al., 2011	Oregon, America	Observational study
11%	Johnson et al., 2008	Melbourne, Australia	Observational study
16%	RNPR, 2007	London, UK	Observational study
17%	Allen et al., 2005	London, UK	Observational study
27.4%	Van der Meel, 2013	Delft, Netherlands	Observational study
28%	Rogerson et al., 2012	Santa Cruz, America	Observational study
32%	Dewar, 1978	Michigan, America	Observational study
37%	Johnson et al., 2013	Melbourne, Australia	Questionnaire response
50%	Thom and Clayton, 1992	Washington D.C., America	Observational study
50%	Wu et al., 2012	Beijing, China	Observational study
56%	Cole et al., 2011	Oregon, America	Observational study
61.5%	Tuckel and Milczarski, 2013	New York City, America	Observational study
64.3%	Yang et al., 2012	Beijing, China	Observational study
87.5%	Lawson et al., 2013	Dublin City	Questionnaire response

The research presented in this paper adds to the field of literature in several ways. Combines both observational and survey data to determine the perceived amount of red light running and the actual amount. The study also examines different types of cyclist infrastructure in similar parts of the city for a comparison to ascertain if red light running is reduced by providing more segregated infrastructure. Finally, the study is one of the first (to the best of the authors knowledge) that examines the amount of red light running undertaken by those using a bike share scheme.

3. Methodology

This section details the data collection procedures used in this research study. Both an observational survey and online questionnaire were used to maximise the amount of data for analysis. Included in this section is a breakdown of the methods used to identify the most suitable sites and timings for the observational surveys and a discussion on the preparation and distribution of the online questionnaire. The research approach taken was to collect both observational and survey data to get a holistic overview of behavior at junctions in the city.

3.1 Observational Surveys

Observational surveys were used to assess the behaviour of cyclists on different types of cycle infrastructure, namely cycle lanes and cycle tracks. Due to the close proximity of the cycle lane and cycle track along either side of the Grand Canal (a canal route that traverses Dublin City), it was decided to survey cyclists on each infrastructure type at several different junctions/bridges along the Canal. Table 2 details the survey sites used in the observational survey. A cycle track is defined as a segregated cycling facility with bicycle lights that give cyclist right of way when they interact with other traffic. A cycle lane is a lane adjacent to vehicular traffic and cyclists and cyclists get no priority at traffic lights (See Figure 3).

Table 2 Survey Sites

Site	Location	Cycle infrastructure	Traffic Signals
Site 1	Baggot Street Bridge	Cycle track	Bicycle lights
Site 2	Baggot Street Bridge	Cycle lane	Regular lights
Site 3	Charlemont Bridge	Cycle track	Bicycle lights
Site 4	Charlemont Bridge	Cycle lane	Regular lights

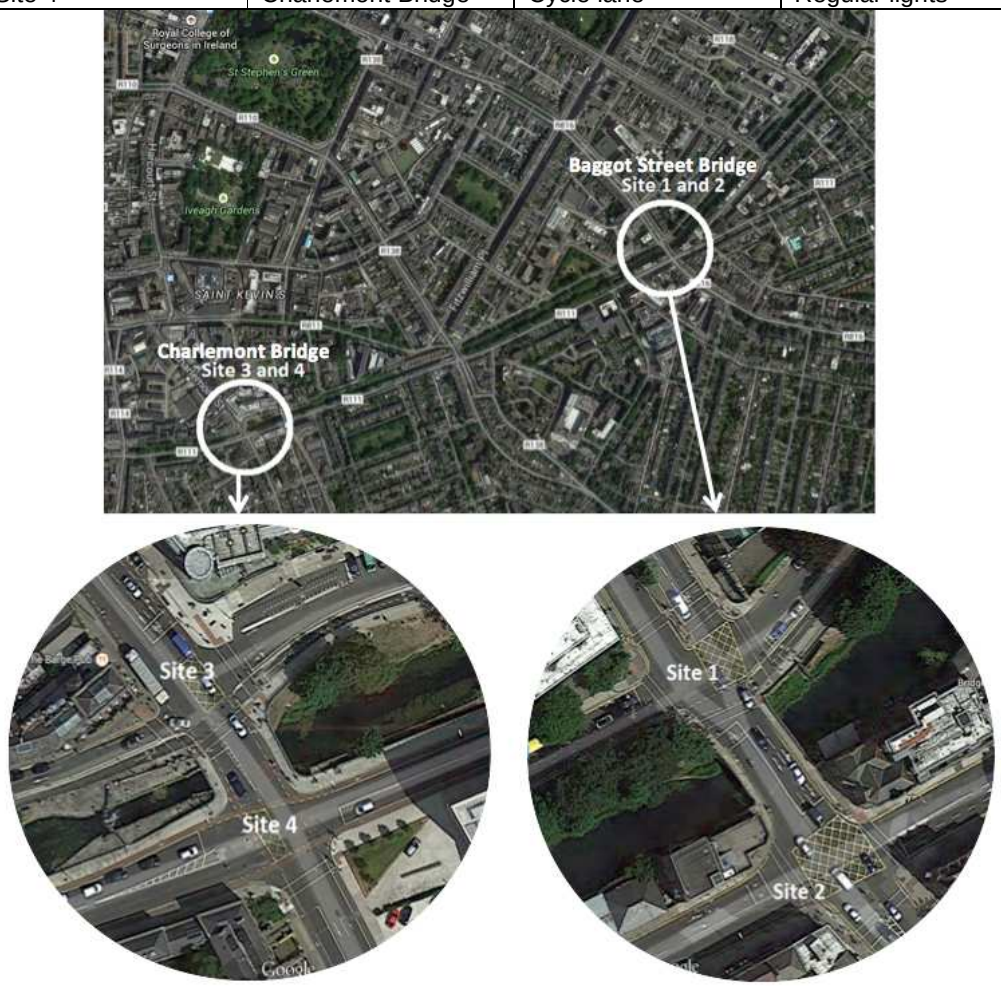

Figure 3 Map of survey sites

The observational surveys were carried out using the camera monitoring screens in the traffic control room in Dublin City Council (DCC) Civic Offices. Dublin City Council has approximately 240 cameras positioned on major roads throughout Dublin, which are linked to the centre in Wood Quay using the largest fibre optic communications system in the country. This allows real-time footage of these roads to be displayed at the touch of a button on the monitoring screens. The observational surveys were completed over eight non-consecutive days. The survey plan is shown in Table 3.

Table 3 Survey dates and sites

Survey	Date	8:00-8:30 am	8:30 – 9:00 am	9:00-9:30 am	9:30 – 10:00 am
1	27/10/2014	Site 1	Site 2	Site 3	Site 4
2	31/10/2014	Site 2	Site 1	Site 4	Site 3
3	3/11/2014	Site 3	Site 4	Site 1	Site 2
4	12/11/2014	Site 4	Site 3	Site 2	Site 1
5	20/11/2014	Site 1	Site 2	Site 3	Site 4
6	28/11/2014	Site 2	Site 1	Site 4	Site 3
7	5/12/2014	Site 3	Site 4	Site 1	Site 2
8	15/12/2014	Site 4	Site 3	Site 2	Site 1

All four sites were surveyed on the same days to take into account varying daily conditions e.g. traffic volumes and weather. It was important to rotate the order in which each site was surveyed to consider the varying cyclist volumes over the two hour survey period i.e. volumes were highest at site each between 8:30-9:00am and lowest between 9:30-10:00am. Overall, the four sites were each observed twice from 8-10am in half-hour intervals spread out over the eight surveys. Thus, each site was surveyed for a total of four hours.

Throughout the observational surveys, male and female cyclists were studied separately. It was also recorded whether or not they were using a rented bicycle (Dublin Bikes). On rare occasions it was difficult to distinguish between male and female cyclists due to the image quality of Dublin City Council's cameras. If there was any uncertainty the cyclist was counted in the survey results. Cyclists using the Dublinbikes were easy to identify due to the bikes distinctive colour, front basket and white LED lights, which are always on at the front and rear of the bike. The following observational data was collected.

Cyclist behaviour

- What is the overall percentage of cyclists who break the lights?
- Are cyclists running straight through the red lights or do they wait and measure the risk before violating the lights?

Cyclist demographics

- What percentages of male and female cyclists break the lights?
- What percentages of Dublinbike users break the lights?

Junction layout/design

- How does cycle infrastructure (on-road and off-road) impact on red light running by cyclists?
- At junctions where they are provided, do cyclists comply with the bicycle traffic lights?

3.2 Survey design and data collection

Where the observational surveys could be used to directly examine cyclist physical behaviour, the online questionnaire could be used to evaluate the mental attitude of cyclists and establish the reasons why they commit traffic light infringement. The survey sought to answer the following questions

Cyclist behaviour

- What is the overall percentage of cyclists who break the lights?
- Are cyclists more likely to break the lights when they are in groups or as individuals?

Cyclist demographics

- What percentages of male and female cyclists break the lights?
- What percentages of Dublinbike users break the lights?
- What is the most common age profile of cyclists who break the lights?

Junction layout/design

- What is the impact of the waiting time at a junction on red light running by cyclists?
- What impact does the crossing distance at a junction have on red light running by cyclists?

Traffic conditions

- Does the volume of cross-traffic impact on red light running by cyclists?
- Does the speed of cross-traffic impact on red light running by cyclists?

The online questionnaire was designed to be answered by both cyclists and non-cyclists of all ages to reach a larger market and minimise bias in the results. The survey was also trialed to ensure the survey was easy to answer and to remove any bias or leading questions. The majority of questions were aimed at cyclists to ascertain the significance of various factors on their decision to break the traffic lights.

The questionnaire was emailed to a number of contacts who work in the City Centre. Many of the contacts work in offices located along the Grand Canal and, along with many of their colleagues, are regular users of the cycle infrastructure along the Canal. The contacts were asked to circulate the questionnaire around their office and to send it on to any third-party, particularly cyclists, who may be interested in filling it out. This created a 'snowball' effect whereby the number of responses continued to grow due to the increasing involvement of third-parties.

The questionnaire was first made available to the public at the end of January 2015 and responses were collected up until the middle of March 2015. In total, 485 people responded to the questionnaire, of which 445 have cycled in Dublin City Centre. The authors recognize this method of sampling does not represent the most accurate method and is subject to bias – however it is a large sample of cyclists that cycle in the study area. This should be taken into account when interpreting the survey results.

3.3 Data Analysis

Statistical analysis of the data was carried out using SPSS. *SPSS* Statistics is a software package used to turn raw data into statistical values, which can then be used as predictors. A number of steps were taken to prepare the data for statistical use, including importing the raw data from an excel spreadsheet and defining the different variables using numerical values e.g. cyclists who faced a red traffic lights were defined as '1' (waited for the green light) or '2' (broke the red light). Multinomial logistic (MNL) regression was used to analysis the data since some of the dependent variables examined had more than two outcomes e.g. cyclist behaviour. MNL regression measured the extent to which each independent variable (e.g. age, gender) played a part in predicting the likely value of the dependent variable e.g. cyclists who broke the lights. The MNL regression model used for this study can be expressed mathematically using Equation 1.

$$logit(p) = \log_e\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n \beta_n \qquad \text{Equation 1}$$

Where;

p = probability that the event of the dependent variable occurs e.g. that cyclists will break the lights.

β_0 = intercept value

$\beta_{1\text{-}n}$ = beta coefficients (slopes) associated with the independent variables

$X_{1\text{-}n}$ = independent variables e.g. gender, age.

A MNL model was also used to analyze the survey data using a similar choice variable and examined the impacts various factors had on running red lights.

4. Research Results

4.1 Observational Results

This section of the paper details the findings from the observational studies. Table 4 shows the number of cyclists observed at each site who were faced with red light i.e. disregarding cyclists who arrived during the green phase. The results in Table 4 show that those cyclists on the cycle tracks were had much fewer instances of obeying the traffic lights.

Table 4 Rate of red light running by cyclist at each site

Site	Infrastructure type	Traffic signal type	Faced with a red light	Law-abiding	Law-breaking
Site 1	Cycle track	Bicycle	1,017	2.9%	97.1%
Site 2	Cycle lane	Regular	567	79.5%	20.5%
Site 3	Cycle track	Bicycle	660	1.1%	98.9%
Site 4	Cycle lane	Regular	820	82.7%	17.3%
Overall			3,064		
N			3,064		
Chi-squared statistic (sig = 0.000)			2021.633		

Table 5 compares each of the factors considered in the observational surveys in terms of their significance to red light running. The multinomial logistic (MNL) regression model is based on the overall data collected from all four survey sites. As shown in Table 5, the most significant predictors of red light running were infrastructure type and cyclist gender. Since Dublinbike users, Survey time and Weather conditions were not significant factors, they have been omitted from the following MNL model (Table 6), which examines the different behaviour types of red light running cyclists. The results in Table 6 show that Dublinbike were not significant factors in the model measuring red light running. However, the results do show that approximately 27% of those that ran the red lights were Dublinbikes users. As no data exists on the proportion of cyclist trips in Dublin that are Dublinbikes trips, one can not say if this proportion is above average.

Table 5 MNL model of observational data

		N	B	Std. Error	Sig.
Intercept			-2.062	0.463	.000
Gender	Female	3,196	-0.572	0.146	.000
	Male	1,460	0[b]	.	
Dublinbike user	No	3,381	0.501	0.335	.135
	Yes	1,275	0[b]	.	
Survey time	8:00-8:30am	792	0.133	0.227	.557
	8:30-9:00am	1862	0.117	0.199	.554
	9:00-9:30am	1397	0.115	0.201	.567
	9:30-10:00am	605	0[b]	.	
Weather conditions	Dry and calm	1,921	0.136	0.293	.643
	Dry and windy	1,164	0.156	0.273	.566
	Wet and calm	1,571	0[b]	.	
Infrastructure type	Cycle track and bicycle traffic lights	2,474	5.563	0.254	.000
	Cycle lane and regular traffic lights	2,182	0[b]	.	
N		4,656			
-2 log likelihood at convergence		158.654			
Nagelkerke R^2		0.739			
Chi-squared statistic (sig = 0.000)		2400.93			
Degrees of freedom		8			

b. This parameter is set to zero because it is redundant

Table 6 suggests that infrastructure type and gender were both highly significant predictors of each of the different red light running behaviours. Male cyclists were much more likely than females to illegally cross the road during a motorist red phase, which is high risk behaviour. However, females were more likely to break the lights during the pedestrian phase. In terms of infrastructure type, cycle track users were

much more likely than cycle lane users to engage in each type of red light running behaviour i.e. during pedestrian and motorist phase.

Table 6 Behaviour at traffic lights

			N	B	Std. Error	Sig.
Crossed during pedestrian green phase	Intercept			-2.638	0.129	0.000
	Gender	Female	418	0.275	0.163	0.042
		Male	862	0[b]	.	.
	Infrastructure type	Cycle track	1,206	6.222	0.206	0.000
		Cycle lane	74	0[b]	.	.
Crossed during red phase without stopping (excluding pedestrian green phase)	Intercept			-3.050	0.165	0.000
	Gender	Female	26	-1.322	0.268	0.000
		Male	123	0[b]	.	.
	Infrastructure type	Cycle track	109	4.472	0.252	0.000
		Cycle lane	40	0[b]	.	.
Temporarily waited before crossing during red phase (excluding pedestrian green phase)	Intercept			-2.125	0.106	0.000
	Gender	Female	100	-0.558	0.168	0.001
		Male	297	0[b]	.	.
	Infrastructure type	Cycle track	282	4.341	0.202	0.000
		Cycle lane	115	0[b]	.	.
Turned left during red phase (excluding pedestrian green phase)	Intercept			-3.402	0.195	0.000
	Gender	Female	10	-1.095	0.335	0.001
		Male	62	0[b]	.	.
	Infrastructure type	Cycle track	43	3.857	0.295	0.000
		Cycle lane	29	0[b]	.	.
N	4,656					
-2 log likelihood at convergence	84.721					
Nagelkerke R^2	0.629					
Chi-squared statistic (sig=0.000)	2621.971					
Degrees of freedom	8					

b. This parameter is set to zero because it is redundant

4.2 Survey results

This section of the paper reports the findings of an online survey that was conducted in conjunction with the observational study. Table 7 details the characteristics of the

sample collected. As stated in the methods section this sample doesn't claim to be a fully representative sample, but rather it gives an indication of cyclists' behavior in Dublin City. Table 7 shows that the majority of respondents were male and aged 24 – 49. The findings also show that the majority of the sample cycled frequently in Dublin City and had more than 3 years experience. Interestingly 67% of the sample indicated they felt that cycling in the city wasn't safe enough or unsafe.

Table 7 Demographics of Survey Sample

	N	%
Gender (N=485)		
Male	315	65
Female	170	35
Age group (N=485)		
13 – 18 years	4	1
19 – 23 years	63	13
24 – 35 years	161	33
36 - 49 years	170	35
50 – 65 years	80	16
66 + years	7	2
How safe do you think it is to cycle in Dublin City Centre (N=485)		
Very safe	9	2
Safe enough	149	31
Not safe enough	267	55
Unsafe	60	12
Have you ever cycled in Dublin City Centre (N = 485)		
No	40	8
Yes	445	92
How many years have you been cycling in Dublin City Centre (N = 445)		
Less than a year	40	9
1-2 years	64	14
3-5 years	138	31
6 + years	203	46

To provide more context for the observational, respondents were asked how often the broke the lights and how often they think others break the lights. Out of the total 424 respondents who have cycled in Dublin City Centre, just 18% said they have 'never' broken the traffic lights. The majority of cyclists 'rarely' (30%) or 'occasionally' (33%) violate traffic signals.

Table 8 also compares the rates of which cyclists said they break lights with the rates of which all respondents (cyclists and non-cyclists) said the majority of cyclists break the lights. The results found that the public's perception of red light running by cyclists in Dublin City is far worse than the situation actually is.

Table 8 Instances of red light breaking

	How often cyclists said they break the lights	How often respondents (both cyclists and non-cyclists) think the majority of people break the lights
Never	18%	4%
Rarely	30%	11%
Occasionally	33%	33%
Frequently	15%	47%
Always	4%	5%
N	424	454
Chi-squared statistic	36.232 (sig = 0.003)	15.599 (sig – 0.004)

Table 9 compares the different cyclist variables considered in the online questionnaire to evaluate their significance in terms of red light running. In the model the dependent variable is if cyclist ran the red lights or not and the results presented demonstrate the factors that impact upon red light running. The model is based on the results of those who said they have cycled in Dublin City. Again, results are considered statistically significant if the value of Sig. is less than or equal to 0.05. Table 9 shows that, with the exception of Dublinbike users, all factors were significant predictors of red light running.

Table 9 MNL model results

		N	B	Std. Error	Sig.	Exp(B)
Intercept			.202	.922	.001	
Gender	Female	314	-.600	.269	.026	.549
	Male	169	0[b]	.	.	.
Age	18-23 years	67	2.826	1.011	.005	16.879
	24-35 years	161	2.148	.944	.023	8.565
	36-49 years	170	1.935	.920	.035	6.927
	50-65 years	80	1.179	.925	.203	3.251
	66 years +	7	0[b]	.	.	.
Dublinbike user	Yes	172	.178	.283	.529	1.195
	No	276	0[b]	.	.	.
Number of years cycling in Dublin City	Less than a year	40	-.996	.460	.030	.369
	1-2 years	64	-.836	.408	.041	.434
	3-5 years	138	-.326	.344	.044	.722
	6 years +	202	0[b]	.	.	.
How often do you cycle in Dublin City	At least once or twice a year	39	-.996	.460	.030	.369
	At least once or twice a month	101	-.727	.354	.040	.483
	Between one and three times a week	121	-.440	.366	.230	.644
	At least four times a week	188	0[b]	.	.	.
Ever been involved in a collision	Yes, with a motorist	67	1.643	.629	.009	5.172
	Yes, with a pedestrian	69	.961	.473	.042	2.616
	Yes, with another cyclist	21	.747	.785	.341	2.110
	No	362	0[b]	.	.	.
N						450
- 2 log likelihood						344.596
Nagelkerke R^2						.202
Chi-squared statistic (sig=0.000)						59.768
Degrees of freedom						15

b. This parameter is set to zero because it is redundant.

5. Discussion and Conclusions

The overall results from the observational surveys suggest that an average of 61.9% of cyclists break the lights in Dublin City Centre. This figure is similar to results from other observational studies internationally (Yang et al, 2012; Tuckel and Milczarski, 2013 and Cole et al, 2012). It is important to note that the rate of red light running was substantially higher along the Grand Canal cycle track than the cycle lane. An average of 97.8% of cycle track users broke the lights with the large majority of violations occurring during the pedestrian green phase. The average rate of red light running by cycle lane users was significantly lower at 18.6%, with the majority breaking the lights during a motorist phase. In comparison with other studies around

the world which have examined red light running behaviour on cycle lanes, the results of this research are most similar to studies in the UK. Two studies in London found that 16% (RPNR, 2007) and 17% (Allen et al., 2005) of cycle lane users break the lights. These percentages are comparable to the results along the Grand Canal cycle lane. The results also show that males were the most likely to break lights which concurs with previous research conducted in London (Christmas et al, 2010).

The cycle network in the City Centre primarily consists of on-road cycle lanes. However, the observational surveys focussed on an even number of junctions with cycle lanes and cycle tracks. For this reason, the overall rate of traffic light infringement observed (61.9%) is not a fair representation of cyclists throughout the entire City Centre. It is expected that the actual rate of infringement across the City is slightly less due to the under-represented amount of cycle lane users in the surveys.

Approximately half (49%) of the cyclists who responded to the online questionnaire said they never or rarely break the lights in the City Centre (all cycle facilities included). Unlike the observational survey results, this figure (49%) is based on the responses by cyclists across the entire City and therefore better represents the general rate of traffic light compliance in Dublin City Centre. Thom and Clayton (1992) and Wu et al. (2012) similarly found that approximately half the cyclists in Washington D.C. and Beijing respectively, comply with traffic lights. This is still an alarmingly low rate of compliance which, compared with research findings in other major cities (see Table 1) ranks cyclist behaviour in Dublin quite poorly. Due to the sizable proportion of ill-disciplined cyclists, it is therefore unsurprising that the majority of questionnaire respondents (55.1%) think it is 'not safe enough' to cycle in the City Centre.

Findings by other researchers show that cyclists who violate traffic signals were more likely to travel straight through a red light than wait for a 'safe' opportunity (Johnson et al., 2008; Wu et al., 2012; Zeibots et al., 2012, Monsere et al., 2013). However, these studies did not examine the red light running behaviour of cyclists during a motorist and pedestrian phase separately. This research study found contrasting results in terms of the red light running behavior of cyclists during the pedestrian and motorist phases. Since the overall majority of traffic light violations occurred during the pedestrian phase, most red light running cyclists were therefore seen to travel straight though the junction without stopping first. This corresponds with the findings of the aforementioned studies which did not examine cyclist behavior separately for different traffic light phases i.e. pedestrian and motorist phase.

This study has several limitations. One such limitation is the lack of existing research on cyclist traffic light violations in Dublin or any other Irish cities. Thus, due to cultural differences, it is difficult to directly compare the findings of this study with that of similar studies carried out in foreign cities.

Red light running has clearly become part of Dublin's cycling culture. It is vital to address this issue now since the volume of cyclists in the City is higher than ever and continues to rise. First of all, there needs to be more awareness raised and education for cyclists on the fact that breaking the lights, although may seem safe to do so in certain situations, is against the law. The lack of enforcement to date has allowed a culture develop where red light running is acknowledged by many as acceptable

cyclist behaviour. There is an urgent need for more police involvement to deter illegal cyclist behaviour and punish offenders. When on-the-spot fines for cyclists are introduced later this year, police should regularly conduct random spot checks at busy junctions along popular cycling routes. Recently this schem of on-the-spot fines for red light running has been announced in Ireland and the success of this measure is something that will need to be measured once the legislation is enacted and the fines applied.

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