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An Evaluation of the Safety of the Cycling in Dublin City for DIT Students

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AN EVALUATION OF THE SAFETY OF THE CYCLING IN DUBLIN CITY FOR DIT STUDENTS

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Abstract

Cycling as a mode of transport offers many benefits including a cheap, cost effective, healthy, fast, mainly congestion free and environmentally friendly means of getting to and from places of employment and education. Given the central location of Dublin Institute of Technology campus buildings this would seem an ideal option for its third level students, but on the contrary, a DIT online travel survey conducted in March 2014 found that only 7% of students chose cycling as their primary mode of transport. Concerns about cyclist safety were a major factor cited by students who chose alternative modes of transport. Based on this feedback, DIT BSc Spatial Planning and Environmental management students undertook a study to evaluate the safety of cycling in Dublin City for DIT students

As DIT campuses are located throughout Dublin City, the extent of the study area included all of the local areas managed by Dublin City Council. Historical cyclist collision data for years 2006 to 2012 was provided by the Road Safety Authority (RSA) and used with visualisation cluster analysis tools available in Geographical Information Systems (GIS) technology to identify spatio-temporal hot spot areas more susceptible to cyclist collisions. Based on preliminary results focus was placed on collisions that had occurred between small motorised vehicle and pedal cyclist, with emphasis on roads with on street cycle lanes as these were identified as being major contributors for a large percentage of cycle collisions during the study period.

Introduction

The Dublin Institute of Technology (DIT) caters for c.10% of all third level education in Ireland and has a student population of approximately 21,000 and a staff of approximately 1700. Currently, DIT has its campus buildings spread across Dublin City at 39 buildings which are centred at 6 main campuses, Angier Street, Bolton Street, Cathal Brugha Street, Kevin Street, Rathmines and Mount Joy Square. The future plan is for all DIT activities to be relocated to a single campus in Grange Gorman. In September 2014 the first group of students relocated there, and it is expected that by 2019, 50% of all DIT students will be based there. Figure 1 shows the locations of DIT campus buildings across Dublin city, together with the available cycle network available for its students in Dublin City. As the time span of this study was for years 2006 – 2012, all DIT buildings have been included although some no longer accommodate DIT staff and students due to this relocation.

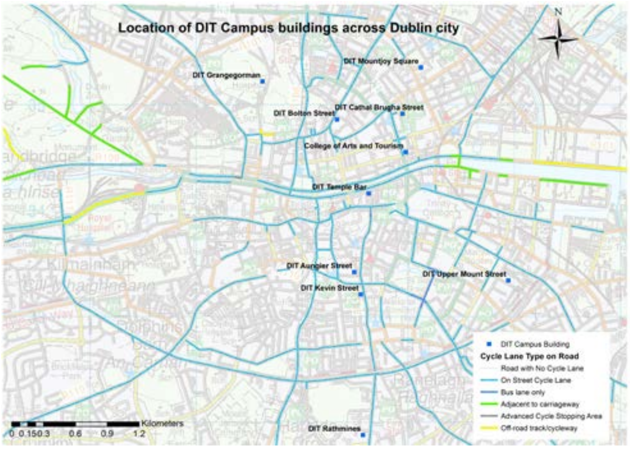

Figure 1: Location of DIT campus buildings with cycle network in Dublin City

DIT is a Smarter Travel work place partner (RSA), an initiative promoted by the National Transport Authority (NTA). One of the primary aims of this initiative is to promote sustainable modes of transport. The DIT Green Campus committee is responsible for ensuring that the correct actions have been put in place to achieve this aim and has set a target to move 4% of students and 6% of staff to more sustainable modes of transport, primarily cycling.

As a travel smarter partner, the DIT periodically carries out an on line travel survey to its staff and students to determine the modal split, distance travelled and willingness to use more sustainable modes of transport. The most recent of these surveys was conducted in March 2014 and found that 7% students and 16% staff chose cycling as their primary mode of transport. Feedback provided from the survey identified cyclist safety, lack of knowledge of cycle lane network and bicycle theft as key deterrents to cycling. Based on this information BSc Spatial Planning and Environmental Management students undertook a study to evaluate the safety of cycling in Dublin City, to determine if this was a valid reason to discourage cycling as a mode of transport for the student body.

Using historical collision data for years 2006 to 2012 provided by the RSA, the spatial (Geographic) location for each collision was plotted as a layer using Geographical Information Systems software. Other data layers including the Dublin cycle network, Dublin road network together with an Ordnance Survey small scale base map which were all based on the same Irish Transverse Mercator co-ordinate reference system were added to the GIS and enabled the location of collisions to be analysed in relation to their location and proximity with the other data layers such as existing cycle network (Burrough & Mc Donnell 2000). Other non-spatial data (attribute information) including time of collision, type of junction, traffic control system was included in the RSA dataset and was used for subsequent analysis purposes. Visualisation cluster analysis tools available in ArcGIS enabled spatio-temporal hot spot areas more susceptible to cyclist collisions to be identified and analysed, a technique which has proven useful in a number of similar studies investigating road collisions and collision hot spots (Anderson 2009; Coll, Moutari & Marshall 2014). Based on preliminary results focus was placed on cyclist collisions that had occurred with small motorised.

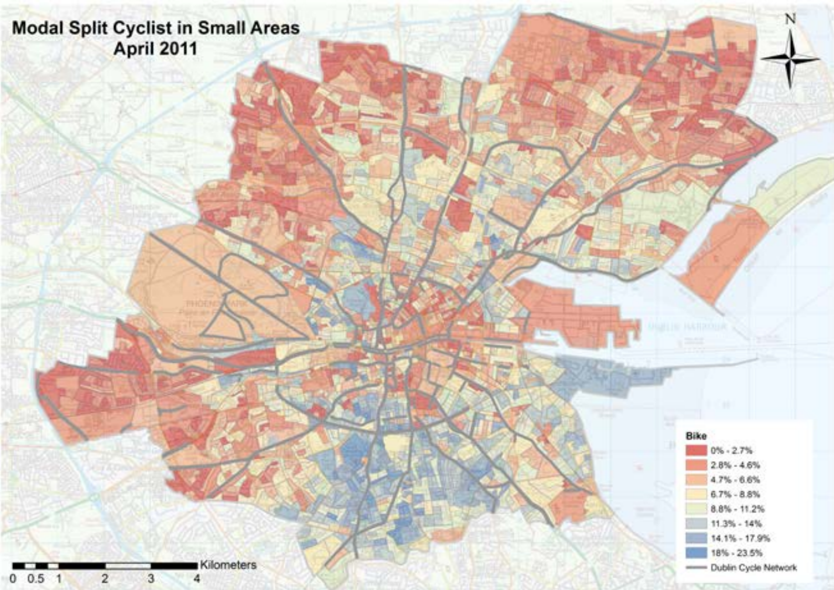

Figure 2: Census 2011; CSO 2011 Small areas showing percentage of population using cycling as a mode of transport with cycle network

A previous study undertaken by the group using CSO 2011 '*Door to Door commuting in Ireland; Means of travel data*' together with CSO small areas spatial data the modal share for cycling in Dublin City in April 2011 is shown on a thematic map, figure 2. In Ireland in 2011 the national average modal split for cycling was 2.2% (CSO 2011), however the study highlighted that in some parts of the city the modal share was well in excess of this national average, rising to 23.5% for some parts of the city, particularly in the south of the city. When considered in relation to proximity to the cycle network, it was observed that the cycle network run through or very close to areas with a higher than average modal share of cyclist. This was particularity noticeable in the south of the city.

Given the observations made on modal share in areas with a good cycle network, and the concerns raised about cyclist safety, it was decided that the study would focus on issues related to cyclist safety with emphasis on evaluating the safety of the cycle network and safety, driver actions when turning left or right and also the safety at junction with traffic lights.

Methodology

Given the central location and spread of DIT campuses, the study area extended to the boundaries of Dublin City Council.

A number of spatial datasets were used for the research, some of which although dated were already available in DIT; others were available as open source layers through DubLinked, collision information was provided by RSA. The time available to undertake the work was limited to one semester, in which time students had to become familiar with the fundamental concepts of GIS and using ESRI ArcGIS software. Therefore it was only possible to prepare and clean the available datasets, and create a new DIT campus location layer. Although having information about the actual width of on street cycle lanes and identifying those on bus lanes would have been useful, there was no time available to collecting this information on the ground. A summary of the main datasets used in provided in table 1.

Data Set	***Classification***	***Comments***
Dublin Roads	Motorways; National Primary, Regional, Third Order and Fourth order roads	Extracted from OSi road dataset of Ireland
Dublin Cycle network	Adjacent to highway; advanced cycle stopping area; Bus lane only; Off road track; on street cycle lane	Sourced from Dub Linked, created by Dublin Transportation Office 2007
Cycle Collisions	67 variables available with dataset, a number of which were relevant for cyclist collisions.	Historical road collision data in CSV format for 2006 to 2012 provided by Road Safety Authority (RSA)
CSO data	Travel mode data extracted from CSO database.	CSO data from 2011 census and shown using the Small Area Population Statistics (SAPS)
Base Map	No classification	Small scale OSi Raster map for study area
DIT Campus Locations	Created by digitising location of all DIT campus buildings	Included all DIT campus locations listed on the DIT website.

Table 1: Datasets used for the analysis

The cyclist collision data available was in CSV format, for years 2006 to 2012. Depending on the year, there was up to 67 different variables recorded about each collision point. Positional information for each collision point was provided in Irish Grid co-ordinates, which allowed the location of each collision to be plotted in a data layer in ArcGIS. This was then overlaid with other spatial datasets including roads and the cycle network.

The original RSA dataset included collisions for all of Ireland, the first step in the process was to extract cyclist collisions for Dublin City; this was done using Excel and ArcGIS 10.3. Using the data dictionary provided by RSA values were in the spread sheet were converted into meaningful information that could be used in the subsequent analysis. Of significance to the study a new field identifying the type of vehicle the cyclist collision was with was created. It is important to point out that this new field did not put any responsibility on either party but aimed to identify the two vehicle types involved with the collision.

A spatial join between the road and cycle network dataset enabled a new data layer to be created which was classified with the type of cycle network on the road. Cyclist collision points within a distance of 20 metres were spatially joined to this new dataset to determine the type of road with or without a cycle track that the collision had occurred on. This process was validated visually and limitations with the locational accuracy for collisions noted.

When undertaking any form of spatial analysis data quality must be considered. Prior to using the data an assessment of the data quality of each dataset was undertaken, as this would play a key role in the interpretation of the results produced from the analysis. The currency of the OSi datasets was deemed to be an issue as these had been produced circa 2008, and certain features including newer roads in particular forth order roads were not shown on them. This issue could be dealt with when preparing the data for analysis. The location accuracy for collisions was unknown, but the assumption was made that locational information was collected with a hand held GPS unit which has an expected accuracy of c±10m in good conditions where there are no overhead obstacles blocking the signal to the orbiting satellites, this was confirmed through conversation with a Garda Siochana. The effect of this on the data used for the analysis is that it cannot be established if a collision has occurred on the actual cycle track or on a road which has a cycle track.

The cycle network data set used in the analysis is an open source dataset created in 2007 by the Dublin Transportation Office and downloadable from the DubLinked web site. There is a disclaimer stating that changes to the network have taken place since the dataset was produced, a point which had to be kept in mind in the subsequent analysis.

Once all datasets had been prepared they were brought into ArcGIS, using Irish grid projected co-ordinate reference system. The workflow diagram in figure 3 outlines the successive steps taken in ArcGIS.

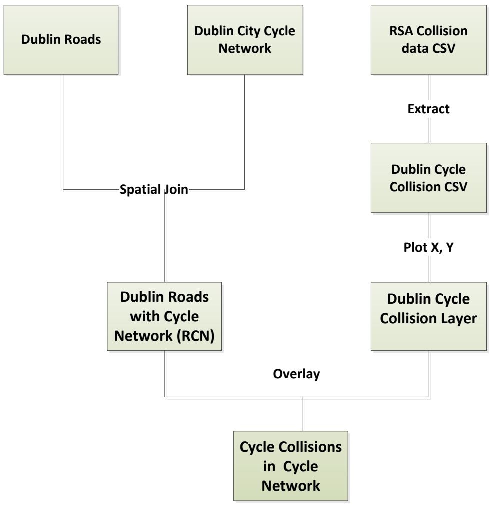

Figure 3: Workflow outlining stages for preparation of datasets for analysis in ArcGIS.

Results

Preliminary Study.

A preliminary examination of the RSA data showed that between 2006 and 2012 the rate of cyclist collisions had risen steadily each year. In this time period there was an overall increase of 173% in collisions, but most notably the steepest increase of 55% had occurred between 2011 and 2012. These results are shown in Figure 4.

In 2006 the modal share for cyclist in Dublin city was 5.5%, and in 2011[1] was 7.3% amounting to an increase of 32.7%. Given that the modal share for Ireland was 2%, this was

[1] Figures were calculated using CSO data from 2006 and 2012, available at cso.ie

well above average and would suggest that if numbers increased steadily at this pace the government's target of 10% modal share of cyclist by 2020 would be met.

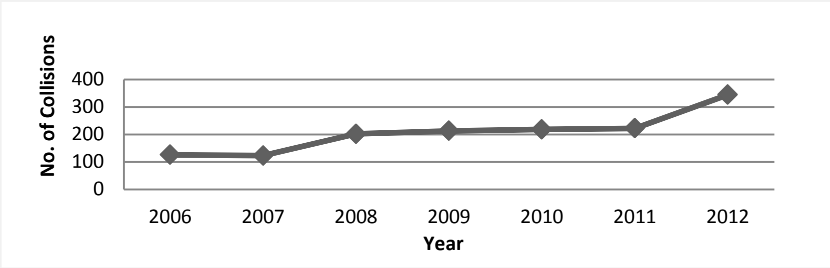

Figure 4: Number of cycle collisions per annum in the Dublin City 2006 – 2012

The canal cordon count data taken during November every year, at 33 locations between the Royal and Grand Canals, provided further evidence on the increase of cyclists in Dublin City, figure 4 shows this information and reveals a consistent increase in cycling between 2006 and 2012, with an overall increase of 39% in the period.

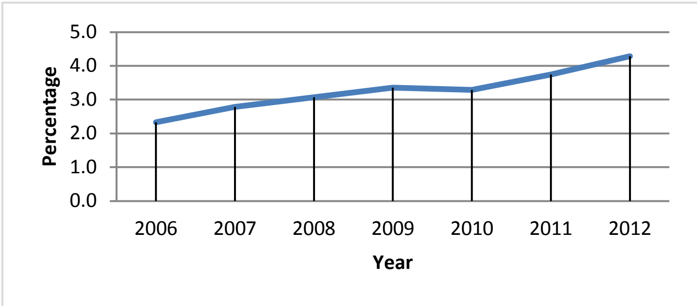

Figure 5: Percentage cycling at annual canal cordon count

Looking at these figures it appears that as cyclist numbers increased, so too did the numbers of cyclist collisions. Other cities have experienced similar trends when their cyclist modal share increased. In the Netherlands faced with a similar situation, they put in place a number of measures that decreased the number of cyclist collisions by 80%.(Schepers et al.)

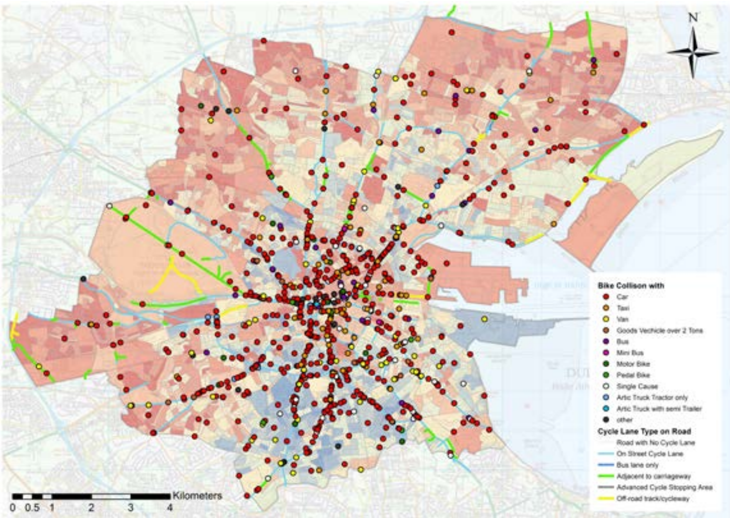

Figure 6: Map showing location of bike collision and type of vehicle involved with it

An initial breakdown found 62.4% of collisions occurred with cars; this was followed by other small motorised vehicles taxis and van. When grouped together collisions with small vehicles accounted for 79.3% of all collisions. Collisions where there was no other contributing factor except the cyclist themselves were classified as 'Single cause collisions' and accounted for 6.5% of all cyclist collisions. Table 2 provides a breakdown of all figures.

Cyclist collision with	Percentage	Cyclist collision with	Percentage
Car	62.4%	Goods Vehicle over 2 Tons	2.2%
Taxi	9.5%	Pedal Bike	2.1%
Van	7.4%	Motor Bike	1.6%
Single Cause	6.5%	Articulated Truck Tractor only	1.2%
Bus	4.0%	Mini Bus	0.2%
Other	2.9%		

Table 2: Breakdown of Cyclist collisions with type of vehicle occurring in Dublin City 2006 - 2012

Locations of cycle lanes and cycle tracks were included on cycle network dataset. As collisions occurred also on roads with no cycle network, a new dataset was created which spatially joined the cycle network with the Dublin roads dataset. This enabled the location of collisions in relation to their location on the network to be determined. A classification for this new dataset together with overall distance is given in table 3.

Class of road with cycle lane	Overall Distance (Kms)	Percentage of Collisions
Class 1 - Road with no cycle lane	1,062km	38.4%
Class 2 - Road with on street cycle lanes	122km	57.6%
Class 3 – Road with bus lanes only	1km	0.4%
Class 4 – Road with Cycle lanes adjacent to highway	25km	2.5%
Class 5 – Road with Advanced cycle stopping area	0km	0%
Class 6 – Off road cycle track / Cycleway	9km	1.1%

Table 3: Breakdown of cycle network in Dublin City 2007

Given that the locational accuracy and completeness of the cycle network was unknown it was not possible to accurately determine if a collision had occurred on a cycle lane or the road itself. Accordingly, in further discussion collisions refer to the class of cycle lane that was on the road but does not necessarily mean that the collision occurred on the cycle lane itself.

The data in table 3 also includes a breakdown in percentages of cyclist collisions occurring on each class of road. The figures indicate that 57.6% of cycle collisions occurred on roads with on street cycle lanes, while roads with no cycle lanes were responsible for 38.4%. Using the overall distance for each class, the ratio for cycle collisions occurring on roads with on street cycle lanes in kilometres was calculated as 1:4.9 whereas on roads with no cycle lane it was 1:0.4.

The results presented in the chart in figure 7 show a summary of cycle collisions in relation to where there occurred in the cycle network. These would indicate that the primary cause of cyclist collisions during the study period were cars, followed by taxis and vans. The majority of collisions occurred on roads with on street cycle lanes, however it must be emphasised that these figures do not take into account cyclist preferences for using roads with cycle facilities, nor do they factor in the under reporting of cyclist collisions to the Gardaí Siochana.

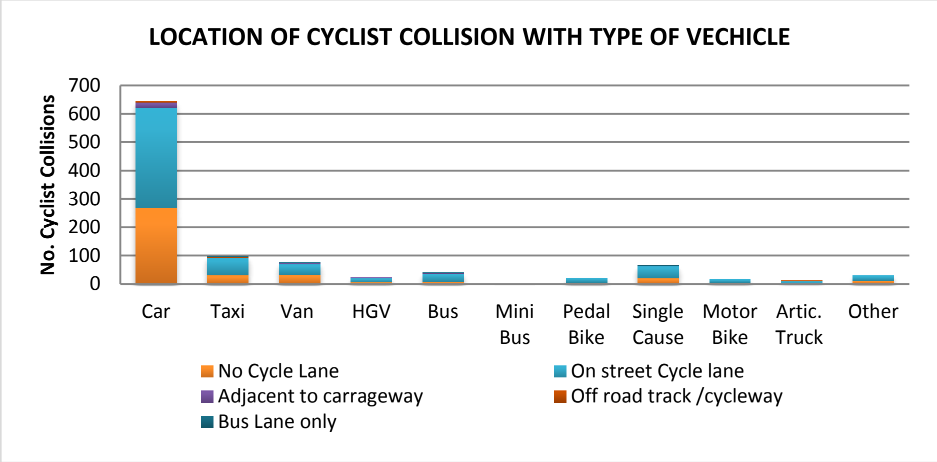

Figure 7: Breakdown of location of cyclist collision with type of vehicle involved

Methodology to identify areas of high cyclist collision density

Once the preliminary research was completed the next step in the research was to identify if any particular spatio – temporal factors were influential in these collisions. The RSA dataset recorded 67 different variables about each collision, some of particular relevance to cyclist collisions. For the analysis a number of variables specific to cyclist collisions were selected including time of day to help determine if cyclist were more vulnerable at certain times of day, spatial data including junction type, junction control and driver action at the time of the collision. Other variables would also be relevant but given the time limits for the research they were not included in the analysis.

These variables when treated in isolation and viewed in a spread sheet do not provide any meaningful insight into the cause of collisions, however when these are plotted on a map hidden patterns in the date begins emerge. ESRI ArcGIS 10.3.1 offers a number of spatial tools including kernel density estimation that enables the spatial pattern of points to be analysed. Kernel density estimation provides a way for clusters of points to be visualised as hot spots, by giving an estimate of local intensity for an collision across a continuous surface. A smooth curved surface known as a kernel is placed over each collision point and a value is given to the surface ranging from 1 at the collision point, decreasing the further away from it reaching zero at the search radius distance. The search radius, also known as the bandwidth does affect the resulting density surface. When choosing a search radius for the density maps the default value calculated by the software was used, which was calculated specifically to the dataset itself and based on its linear unit and projection. Parameters affecting outcome are the bandwidth (search radius) and cell size. Larger the bandwidth the larger the hot spot, Somewhat subjective when selecting these parameters.

Based on a number of relevant themes identified in the initial study as important, a series of kernel density estimation maps were created. As the preliminary results had identified a large percentage of cyclist collisions occurred with small motorised vehicles and that collisions were most likely to occur on roads with on street cycle lanes emphasis was placed on these factors when creating some of the kernel density estimation maps.

The themes chosen for the kernel density estimation maps were-

- Cyclist collisions occurring between all vehicle types on roads with on street cycle lanes
- Cyclist collisions occurring between all vehicle types at traffic lights
- Collisions between cyclists and drivers of small motorised vehicles
- Collisions between cyclists and drivers of small motorised vehicles turning right
- Collisions between cyclists and drivers of small motorised vehicles turning left

The resulting kernel maps are shown in figures 8 to figures 13.

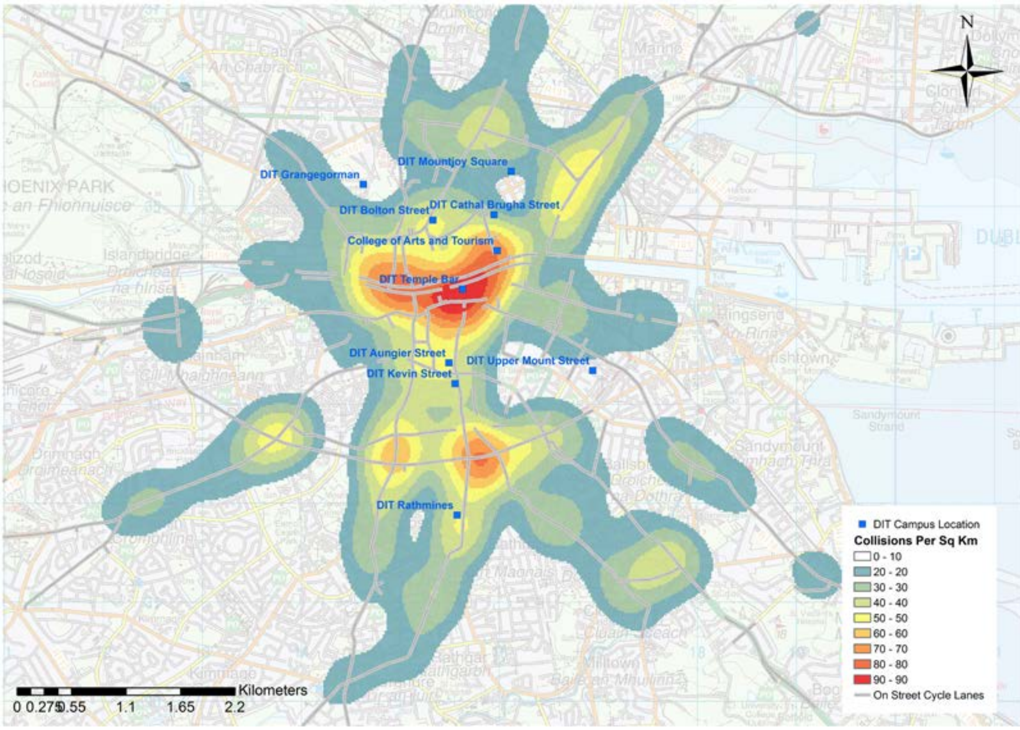

Figure 8: Kernel Density map of cycle collisions between all types of vehicles on roads with on street cycle lanes

Roads with on street cycle lanes were responsible for the majority of collisions. The KDE map created found the most dangerous places for cyclist were at major junctions and intersections, particularity in Dame Street and along the quays. Along the Grand Canal hot spots areas were located around the bridges at Rathmines, Portobello and Harolds Cross. Gaps or breaks in the cyclic lane also appeared in the hot spot areas.

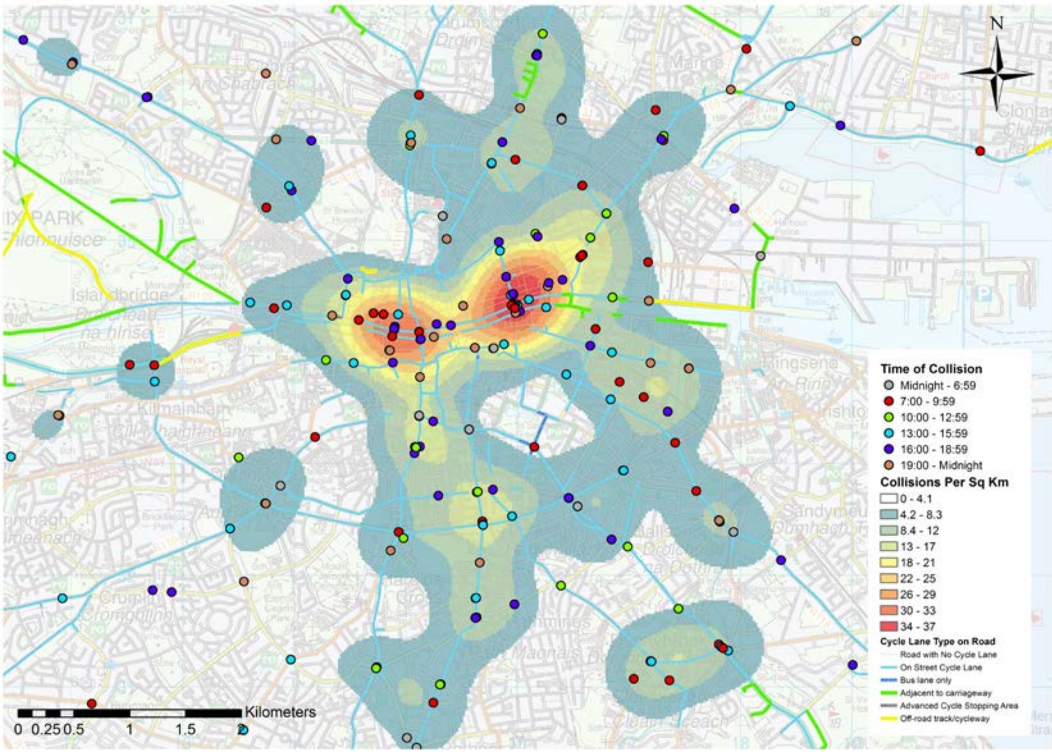

Figure 9: Kernel Density map of collisions occurring at traffic lights

Major hot spot areas for collisions occurring at traffic lights were found mainly in the centre of the city, and in particular at Christ Church and O' Connell Bridge / Street areas. Collisions were categorised according to the time of day of their occurrence, but no significant patterns were observed from this.

As already stated 79.3% of all cyclist collisions were with small motorised vehicles, a KDE was generated to identify hot spot areas. This is shown in figure 10 below. When compared to the previous KDE maps it can be seen that the hot spot areas have expanded further out from the city centre and encompass areas around Rathmines, Angier Street and Connolly Station. When considered in relation to the location of DIT campuses it was noted that most campuses were located within these hot spot danger areas. Exceptions to this are at DIT Grange Gorman and DIT Mount Street, although it must be remembered that data is for years 2006 – 2012 before students relocated to Grange Gorman.

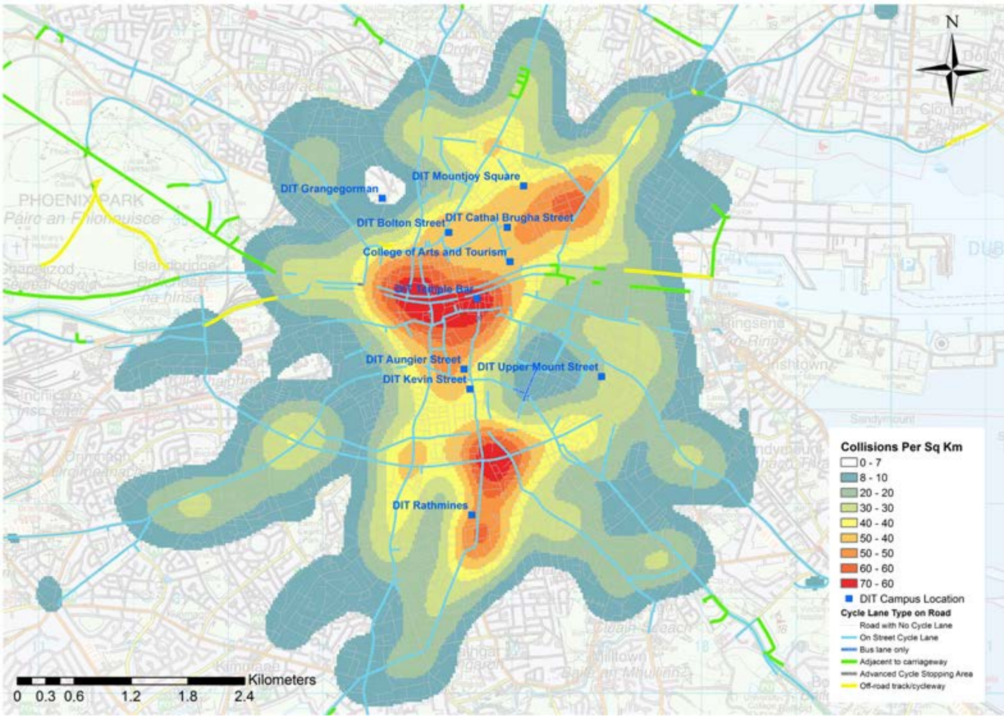

Figure 10: Kernel density map of cycle collisions with small motorised vehicles

Driver Action

The RSA dataset included information about driver action and was used in conjunction with small motorised vechicles collisions to determine if particular roads or areas were more prone to a particualr driver actions than others, and if there were particular times when these collisions occured. In total there were 819 cyclist collisions between small motorised vechicles, 162 occurred when drivers took a right turn and 113 when drivers took a left turn turn.

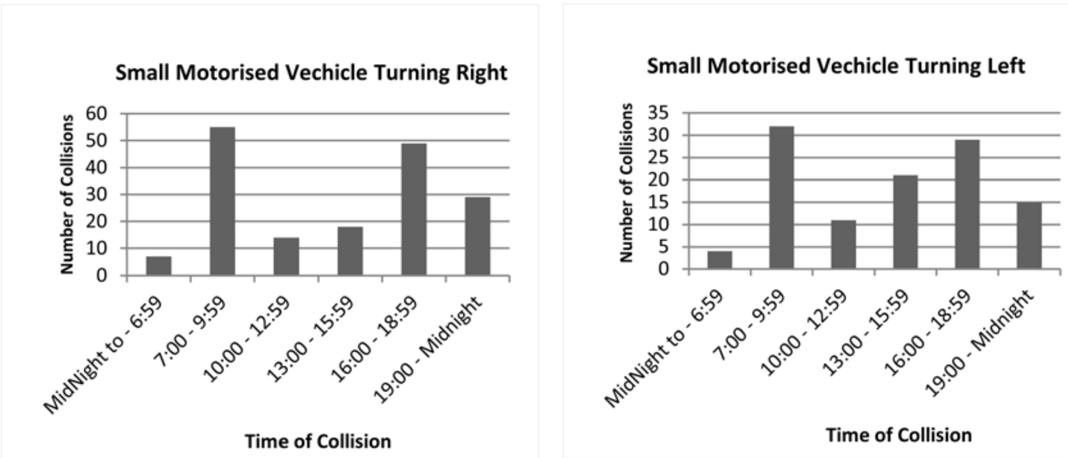

Figure 11: Bar charts showing times collision occurred and driver action

A further 364 collisions were recorded as '*other*' so could not be used in this part of the analysis. A breakdown for both types of driver action and the time period that they occurred in is provided in the bar charts in figure 11. The resultant kernel density maps for driver action are shown in figure 12 and figure 13. By categorising collisions based on the time of day they occurred at it was possible to visalise paticualar parts of the study area that are more prone to collisions occuring in morning and evening time rush hour periods.

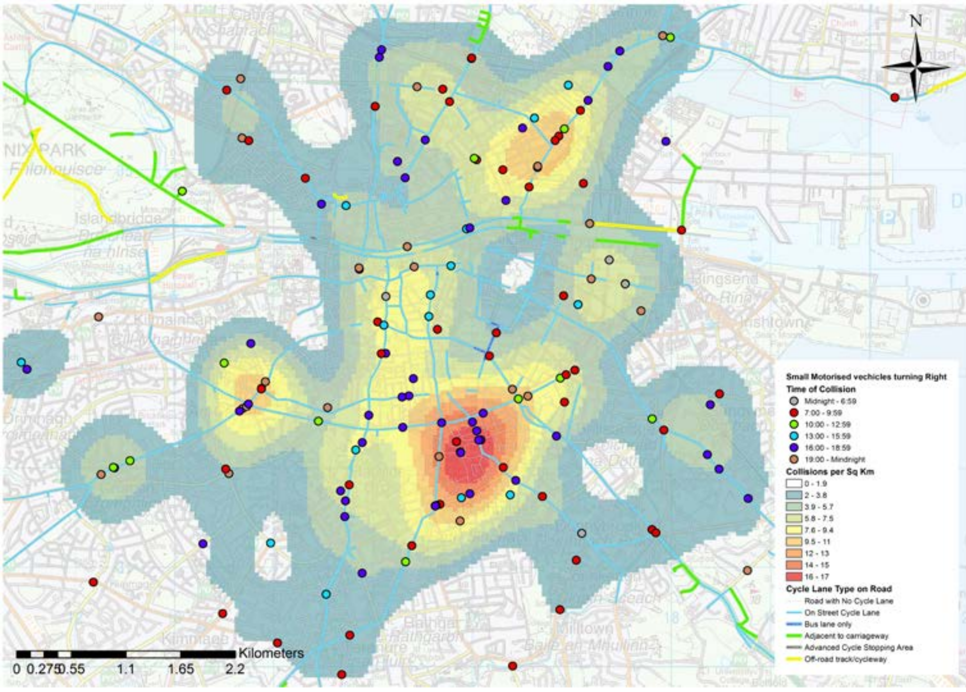

Figure 12: Kernel density map of collisions caused by small motorised vehicles turning right.

Hot spot areas identified when drivers took a right turn for collisions were located around Ranelagh and Rathmines and away from the appeared to be more on streets away from the canal and with no cycle lanes. Along the Ranelagh road in the evening rush hour there was also a high concentration of collisions occurred when drivers took a right turn.

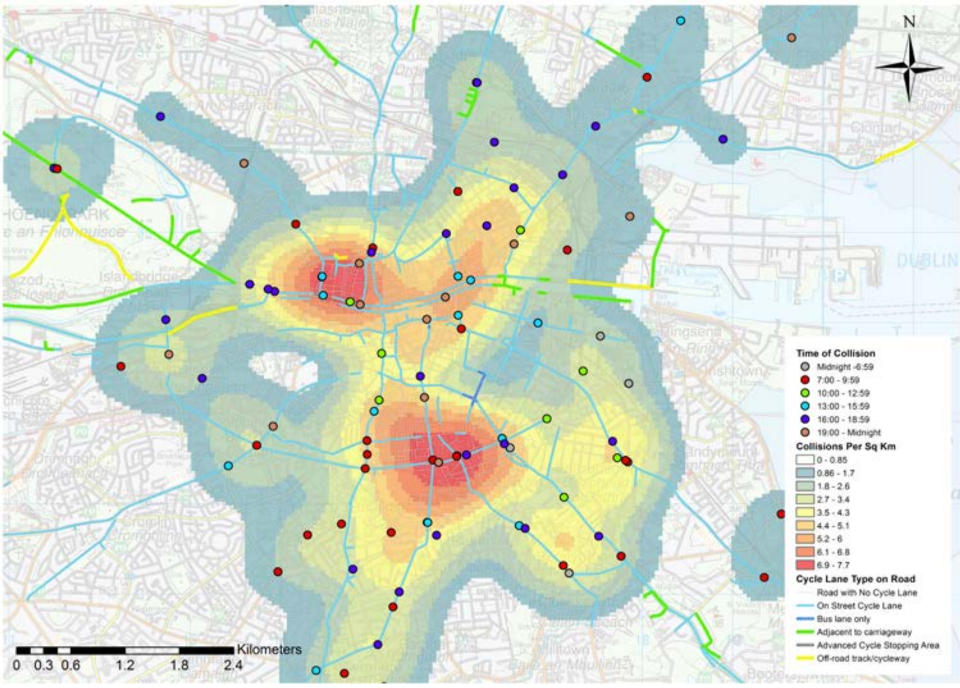

Figure 13: Kernel density map of collisions caused by small motorised vehicles turning left

Other hot spot areas identified were Dolphins Barn Bridge on the canal where there was a high concentation of collisions occuring during evening rush hour traffic. A similar trend was also observed around Connolly station and the five lamps where morning time rush hour appeared be a factor.

Figure 13 shows the KDE maps for collisions occuring with drivers turning left. Although the number for this type of collisions is less that those caused by drivers taking a right turn, the hot spot areas have moved and are located in the centre of the city around the Christ Church area and also around the Portobello and Rangelagh Bridge area.

Looking at the temporal aspect of collisions, the map shows that cyclist coming from the south side of the city in the morning rush hour are more susceptible to collisions where drivers are turning left. In the evening rush hour period commuters leaving the city and heading north appear to be more prone to this type of collision.

Discussion

When examined with hot spots it was shown that collisions were more likely to occur at cross roads and T junctions where there was a need for cyclist to reduce speed. Areas most susceptible to collisions were found to be along the quays in the centre of the city, the Temple bar and the Dame Street areas. This was followed by the Grand Canal on the south side of the city, in particular, Rathmines Bridge, Ranelagh Bridge and also Harold's Cross Bridge.

Results presented in the previous section indicate that based on the information available, cycling in the cycle network did not provide a safer place for cyclists. The figures presented show that during the study period 57.6% of cyclist collisions occurred on roads with cycle lanes, whilst 38.4% of collisions occurred on roads with no cycle facilities. These figures need to be considered carefully for a number of reasons. Firstly, it is unknown whether or not cyclist are more likely to use a cycle network when available rather than using roads without these. Secondly, the data presented only represents collisions that have been reported to a Garda.

Small motorised vehicles including cars, taxis and vans were identified as the primary type of vehicle to be involved with cyclist collisions and accounted for 79.3% of collisions. The kernel density map created for these collisions showed that collisions hot spot areas were spread out and included the Rathmines and Ranelagh areas together with areas around Connolly station in the north of the city.

Conclusion

This study was brought about from results of a DIT on line travel survey to staff and students in March 2014, which found they were reluctant to cycle to their respective DIT campus for reasons including cyclist safety, bike security and knowledge of the cycle network. The focus of the study was to evaluate the safety of cycling in Dublin city to ascertain if these perceptions were valid.

Using RSA historical cyclist collision data from years 2006 to 2012, together with a number of other spatial datasets a number of conclusions were made. The majority of cyclist collisions occurred with small motorised vehicles and were more likely to occur on roads that had on street cycle lanes. These collisions on roads with on street cycle lanes tended to be at cross roads and junctions, predominantly at bridge crossings along the Grand Canal and the River Liffey.

Drivers turning left and turning right were responsible for a large number of accidents. Using a kernel density estimation method it was possible to identify hot spot areas where these types of accidents were more predominant. By identifying these contributory factors, preventative measures can be made to reduce and eliminate the cause of these collisions in the future. Simple measures as introduction of a no left turn at times of day when cyclist are most likely to be in a collision with a motorised vehicle would seem a reasonable action to take.

The study demonstrated the importance of historical collision data. The recording and maintenance of such data is essential in understanding the nature of collisions. This type of knowledge is essential in understanding cyclist collisions and can be used to strategically put in place counter-measures to avoid or reduce these in the future.

Recommendations

Data used in this study was taken from 2006 – 2012. In recent years a number of pro cycling policies have been implemented by government. Further research into the pattern of collisions since these implementations should be undertaken to determine their effectiveness.

The RSA data used for the research provided an excellent insight into the nature of cyclist collisions in Dublin city and spatial factors that can influence them. One of the limitations of these datasets is that they only record collisions that have been reported to a Garda, which does not include all collisions. Alternative ways for recording collisions should be considered which include using hospital casualty lists and using voluntary self-reporting through mobile apps specifically designed for record cyclist collisions which would enable cyclist to report their collisions after the event.

Given the time scale available for this research a number of important factors have not been considered. It would be recommended for future research other factors affecting safety of the cycle network be considered; these include width of on street cycle lane, proximity to bus lane, time of free- way if appropriate, condition of road surface and on location of on street parking needs to be included in any further research. In addition spatial data for traffic lights and other types of junction controls would help to yield some insightful results.

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