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Can geodemographics be used effectively to improve public service delivery using an example of road traffic safety in London?

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Abstract

Propensity to be involved in a road traffic collision in Greater London depends on many factors, including personal mobility, lifestyle, behaviour, neighbourhood characteristics and environment. This paper addresses the merits of using a spatio temporal approach to the analysis of road traffic collision casualties using post code data of home addresses for drivers and casualties involved. Recently geo-demographic classification has begun to be used with GIS and as a socio-economic tool for both the public and private sector. This research will be using 'MOSAIC', geodemographic software from Experian. This study seeks to analyse driver and casualty post code data for road collision in London, over a period of five years from 1998 to March. Results suggest distinct spatial and temporal patterns of geodemographic populations that are more likely to have a high propensity to be involved in a collision either as a casualty or a driver. The results also highlight that certain geodemographic groups have a higher collision involvement propensity at different times of the day. Overall, the study depicts that geodemographics can assist in determining a better understanding of the risks of collision involvement on London's population.

Introduction

In the domain of road safety science there has been continued efforts to identify factors that contribute to increased collision propensity. The possible casual factors range from road surfaces and road curvature to human factors such as behaviour, economic deprivation, unemployment and lifestyle choices. These two types of factors fundamentally have two different geographies. The first concentrates on the collision location and the second revolves around the home location of the driver or casualty. In this study the aim is to identify the people who have a higher propensity than others, in terms of their socio economic status and lifestyle choice based on where they reside. Research in this field has often been confined to analysing poverty and social exclusion with reference to particular vulnerable road user groups (for example, children). This analysis will be conducted on the casualties and drivers of past collisions and their wider socio-economic status (rather than one aspect, such as poverty). This study will be conducting geodemographic and collision propensity analysis in the area of Croydon within outer London. The aim is to profile the population of Croydon using previous collision data and highlight areas where certain types of population are deemed more ‘at risk’ than others.

Introduction to the study area

Between 1998 and 2003 there were 188401 collisions in London (Inner and Outer London). Of these collisions 7205 occurred in the London borough of Croydon. For an outer London borough this is a considerably high number with boroughs such as Barking and Dagenham experiencing 3586 during the same time frame and Sutton 3232 collisions (see Table 1). Table 1 below summarises the population, road safety spending, total road length in metres and number of collisions. It shows Croydon having the 13th highest road collision budget (out of 32 boroughs), it has the highest population, the 4th highest borough in terms of total road length and the 6th highest collision rate. These statistics do show however that the road safety spending for 2005 and collision rates for 1998 to 2003 so it is worth noting these discrepancies.

The aims of this study are to determine ways in which road user propensity can be identified with relation to the socio economic and lifestyle indicator and historical collision data. By creating index scores for the geodemographic groups based on the casualty and driver postcode data, it is possible to establish how much more at risk certain groups are than others. This data can then be mapped and interpreted using postcode centroid data and an associated ‘risk index’ from the historical data. This process will be explained in subsequent sections of the paper. Both datasets derive from the STATS19 database collected by the Metropolitan

Police on every road collision to result in injury in the London area. These two particular datasets are the total collisions over five years (January 1998 – December 2002) whereby postcodes have been recorded for both the drivers and the casualties involved[1]. Appended to each postcode is a geodemographic classification code[2] based on a range of data including Census 2001, MORI surveys and lifestyle information.

Borough	Road safety spending 2005 (£s)	Population	Total road length (m)	Number RTC 1998 - 2003
Barking and Dagenham	600000	163944	370237	3586
Barnet	540000	314564	939766	7568
Bexley	850000	218307	668757	3698
Brent	1100000	263464	522411	6909
Bromley	600000	295532	1070086	5692
Camden	1000000	198020	331172	7011
Croydon	900000	330587	886201	7205
Ealing	870000	300948	665487	7998
Enfield	890000	273559	805586	7065
Greenwich	1100000	214403	605912	5509
Hackney	1000000	202824	307810	6044
Hammersmith and Fulham	520000	165242	255881	4576
Haringey	865000	216507	395953	5754
Harrow	675000	206814	550625	3657
Havering	986000	224248	823333	4840
Hillingdon	523000	243006	907575	5809
Hounslow	745000	212341	662736	6198
Islington	935000	175797	263849	6321
Kensington and Chelsea	623000	158919	232344	5092
Kingston-Upon-Thames	628000	147273	417024	2622
Lambeth	1267000	266169	454926	9353
Lewisham	1008000	248922	484402	6616
Merton	865000	187908	426427	3643
Newham	872000	243891	503513	5666
Redbridge	920000	238635	648029	5871
Richmond	390000	172335	505948	3259
Southwark	1000000	244866	447598	7881
Sutton	326000	179768	509796	3232
Tower Hamlets	670000	196106	357914	5750
Waltham Forest	1600000	218341	481607	4936
Wandsworth	557000	260380	500996	6421
Westminster	1000000	181286	424832	12619

Table 1: Table to show London boroughs and their associated road safety spending budget

[1] It is worth noting that drivers could also have been injured in the collision and their details are recorded in the 'casualty' dataset as well.
[2] See section on 'Geodemographics and collision risk: Is there a relationship?' for a detailed explanation of geodemographics with reference to this study

For the purpose of this study, it is important the reader understands what is being implied when the term 'risk' is mentioned as it means many different things to different people (see Heino *et al* 1996, Summala 1996, Adams 1999, Lonero 2002). For the purpose of this research the term risk will be kept simply to 'the likelihood of being involved in a collision' this definition will overlook the severity of the collision which is sometimes used as an indicator of increased risk, however because this paper does not differentiate between the severity of collisions there is no meaning for it. As basic as this definition may imply to some, it is clear that a more in-depth discussion of whether risk can be measured, an argument held by 'hard; scientists or whether it is culturally constructed (a social scientists view) is not necessary here (see Adams 1995, Adams 1999).

The relationship between static and dynamic risk: why it is important?

Some kinds of people are more at risk of being involved in a collision than others (Standish 2003). For example a strong implication of whether someone is more likely to be involved in a collision is their age. In particular, children aged between 12-16 are high at risk from being involved in a road collision (www.thinkroadsafety.gov.uk, 2005). The reasons for this increased risk are subject to debate, as it is difficult to underpin the exact causes for collisions, however one in ten teenagers across the UK involved in a collision say they were not paying attention (www.thinkroadsafety.gov.uk, 2005). Road use is highly prone to risk consciousness because other people are perceived as a threat in what have been dubbed our 'risk societies' by Ulrich Beck (1992). The development of risk consciousness is an outcome of profound social change implying that society has problems that cannot be resolved only managed (Furedi 1997). People tend to think that the risks of driving come from other road users. However transport safety does not exclude our own roles as road users. The key issue surrounding this notion of risk is that when choosing a mode of transport, individuals look towards their own 'perceived risk level' instead of the objective risk level when making their decisions.

The traffic environment is constantly changing. It has been suggested that the greatest factor contributing to collision severity is an underestimation of the level of risk a traffic environment presents. All road safety research places a static risk level or understanding on individuals or areas in what is a dynamic traffic environment. In other words someone's chances of being involved in a road collision regardless of who they are, where they are from can change within seconds. At an urban city wide scale this static measurement is useful in determining a wide ranging understanding of the risk patterns in a spatial environment.

Often when measuring and trying to manage risk, road safety analysts categorise road collisions and those involved in terms of severity of the collision. This method however according to Adams (1995) does not provide the best allocation of risk measurement. This is partly due to the small numbers of actual fatal collisions that occur, since they are both infrequent and scattered across space and time. Thus in this study, data concerning both fatal and non fatal collision victims have been merged together in order to create a better indication of the patterns of risk. Another risk inherent in using only fatal or severe collision victim data is the uniqueness of London as an urban road network. Adams (1995) summarises the argument that there is a higher proportion of minor collisions in London compared to the rest of the UK urban road network, and attributes this to the fact that London is so congested and traffic speeds are so slow that there are large numbers of minor collisions but that high speed crashes resulting in more serious injury are more rare. Adams also notes the uniqueness of London's road user risk, as it presents the highest urban UK proportion of cyclist and pedestrian related collisions (1999). This presents a strong rationale for a broad societal risk analysis and evaluation.

Attempts to define road user risk

Road user risk has been defined in a variety of different contexts (see Fin *et al* 1986, Lawson 1990, Rolls *et al* 1992, Cathey *et al* 1995, McKenna *et al* 1998, Alder 1999, Dobson *et al* 1999, Akerstedt *et al* 2001, LaScala *et al* 2003, Hall 2004, Hasselberg *et al* 2004, Moller 2004). What we are concerned with in this study is attempts to define road user risk in terms of disaggregated groups within society, whether that is male or females, the elderly, children or young male drivers. Four different studies are discussed here; young male drivers driving at night, locally born people and immigrants, gender differences and young and old drivers. Each will be discussed in term their how the author or authors have contributed to defining road user risk how it should be defined in terms of social groups. It terms of identifying these high risk road user groups, much of the literature has concentrated on demographic groupings such as 'new' drivers (see Gregerson *et al* 1994), however little attention has been focused on the spatial dimension of this issue. For example there are likely to be high risk user groups being present at certain times and at certain locations within an urban area. An example of this somewhat neglected spatial and temporal perspective defined a high risk road user as one (or more) of the following:

- New drivers
- Drivers with the infringements that are tracked by the loss of points (e.g. speeding)

- Drivers with criminal convictions
- Drivers with an unusual number of crashes or crash type, in a particular time period or location
- Drivers with certain medical conditions

(Pietro 2001)

Each of these categories is defined by one main phenomenon and that is the notion of risk. There are different types of risk within road safety that range from intentional risk taking to unintentional risk taking, each of which plays a part in determining certain types of accidents and profiling of the type of people that cause them in certain spatial locations.

Let us first consider the research conducted into discriminating between different age groups and the types of different counter measures are required to reduce collisions (see Massie *et al* 1995). Research in Western Australia has concluded that the age group most at risk (from past collision analysis) to be involved in a collision is the under 20 year olds, however it did emphasize that the rates of collisions for people aged between 70-79 were comparable (Ryan *et al* 1998, see also Keskinen *et al* 1998 and Zhang *et al* 2000). It supports the findings from Dulisse (1997) that although older drivers have different types of collision from young drivers, they do not actually pose any more risk on the road to other road users. This information is important when developing an accident taxonomy that seeks to identify similarities in the types of collisions that different aged people are involved in and from different social backgrounds.

There is a certain presumption that there is a predetermined risk groups in the traffic environment. This predetermination is somewhat influenced by our society, in other words the term 'stereotype' could be used in order to sum up these groups of society which are believed to have a higher risk of being involved in collision. These include perhaps more general groups within society such as young male drivers (Corfitsen 1999), women drivers (Dobson et al 1999) and older drivers (Ryan et al 1998) or pedestrians (Keall 1995) to the not so obvious stereotypes but have been identified in the literature and other public services as being of at a higher risk of being involved in a collision. These groups include older male motorcycle riders, children from ethnic backgrounds (Christie 1995), and elderly pedestrians of an ethnic minority origin.

In the earlier section it was mentioned that there has been little direct evidence concerning the relative road safety of immigrants. Recent American studies have identified race as an important road safety issue. A study by Dobson *et al* (2003), focusing on the increased accident rate among the immigrant population in New South Wales broke road users into drivers, passengers, pedestrians and other road users. However the results were inconclusive, indicating that there was no evidence to suggest that drivers born in other countries were more likely than Australian born drivers to be involved in collisions resulting in death or injury requiring hospitalisation. As with the majority of literature in this area of determining road user risk groups, there was little no spatial dimension which looked at the neighbourhood variations at a local level

Geodemographics and road collisions: Is there a relationship?

The role of geodemographics for road safety is relatively original. Its influence is supported by research linking socio economics variables such as unemployment, low income, area of residence, educational level and road collision risk, race and marital status (for example Lawson 1990 and Haepers and Pocock 1993, Christie 1996, Kposowa *et al* 1998, Murray 1998, Abdalla 1999, Road Safety Report No 19 2001 Department of Transport). Most of the reports and research conducted in this field have been focused on children and only a handful of studies have bridged the notion of road collisions and geodemographics, the studies that have been done are loosely relating an aspect such as urban and rural differences that attribute to changing collision risk (see Blatt *et al* 1998 and Lu *et al* 2000).

Road collision analysis has been slow to acknowledge the relationship between area social characteristics and road collision drivers and casualties. Social class as a discriminator for road collision risk has been addressed only by a minority of research papers (see Hasselberg *et al* 2004, Hasselberg *et al* 2005, Laflamme 2005). Research in Scotland (see Abdalla 1997 and Abdalla *et al* 1997) has considered deprivation indicators[3] from the 1991 Scottish Census as an indicator for road collision involvement. One of the key findings concluded that child casualties who came from families in social class IV or v (semi skilled or unskilled jobs) were overrepresented in the total number of child casualties (Abdalla 1997). The influence and effect of certain residential layouts and housing types has also been found to cause an overrepresentation in collisions involving children (Christie 1996). Furthermore research undertaken by Hasselberg *et al* (2005) generates results for Swedish young adults and their findings show that drivers with a basic and secondary education show a greater risk of crashes of all types than drivers with a higher education. In addition, the study found children of manual workers showed a 60% greater risk to be involved in any time of collision. These

[3] Variables included; proportion of unemployed people, proportion of people with no car, proportion of people at pensionable age, proportion of people in a lower social class.

findings support the potential use of geodemographics as being a good indictor for understanding the ‘who’ and the ‘where’ of the people experiencing increased road user risk.

Two leading geodemographic providers dominate the UK markets, Experian Ltd (Mosaic) and CACI Ltd (Acorn. For this analysis Mosaic will be used to categorise the unit postcodes (of the drivers and casualties) into neighbourhood types. These types are based on social and demographic proximity and built environment characteristics. Geodemographic classifiers cluster small areas on the basis of social similarity rather than locational proximity (Webber and Longley 2003). The core of this paper lies in the relationship between geodemographic attributes used to create the neighbourhood types and how they can assist the profiling of high risk road users. Mosaic classifies 1.6 million British unit postcodes into 52 ‘lifestyle’ types. These types describe socio-cultural and socio-economic behaviour. There are more than 350 variables taken from sources such as the 2001 Census, Family Expenditure Survey’s, MORI’s financial surveys and Experian Lifestyle Surveys. This data are used in statistical cluster analysis to build the 52 neighbourhood types which can be aggregated to 12 Mosaic groups.

Existing approaches to understanding road user risk in area social terms has been centred on using Census data, specifically deprivation indicators to determine a relationship between those people who have an increased level of deprivation and their overrepresentation in road collision statistics. This paper uses geodemographics instead of Census data primarily due to the large potential geodemographics offers in terms of the wide ranging data sources which are included in the cluster analysis. Using geodemographics for road collision research enables the user not only to create a more succinct profile of the high risk user but also to target reduction strategies more effectively due to the inclusion of information regarding the most commonly used media outlets and preferred retail chains used by each Mosaic type.

In a wider context, since 1997 there has been a renewed interest in academia and government in the use of neighbourhood classifications (Longley 2005). In policy terms, these developments have arisen due to the opportunity to improve efficiency by targeting preventative communication programmes to those most at risk (Longley 2005). In recent years, these programmes have centred on policing and health needs (see Ashby & Longley 2005), and with these public service applications comes the opportunity and methodological feasibility to apply geodemographics to road safety research. In response to the narrow research base is the issue that nearly all research in this domain is restricted to children and their socio-economic risk as been shown in the previous discussions. There has been limited work achieved understanding the risks faced by adults within neighbourhoods and what can be deemed their ‘risk exposure’.

Hauer (1980) gives a formal definition of exposure (related to the risk of a collision) as follows:

'A unit of exposure corresponds to a [probabilistic] trial. The result of such a trial is the occurrence or non occurrence of an accident (by type, severity etc). The chance set up is the transportation system (physical fatalities, users and the environment) which is being examined, and the risk is the probability (chance of an accident occurrence in a trial) and this describes the safety property of the transportation system examined'

Thus the ideal measure of exposure is one which is closely related to the opportunity of a road collision i.e. exposure is 'a condition which must be present in order to have an accident' (Tobey et al 1983).

Research by Julian *et al* (2002) stated that the majority of people (study was based in Paris) who travelled on foot during the day were children, those not in paid work and the elderly, and she concluded that these pedestrians were at higher risk of being involved in a collision than other types of pedestrian. This study indicates that different levels of risk exposure do prevail between different groups in society, predominantly associated with mobility. Mobility and constraints on mobility have often been referred to with respect to the elderly and children. A person's mobility will in effect influence their exposure to traffic collision risk. Scheiner *et al* (2003) summarises that certain lifestyle groups (based on employment and income) have specific forms of mobility. Mobility here refers to 'short term' mobility (travel) rather than long term mobility (for example housing mobility) and in turn we can relate this mobility to have different risk exposures.

From this section it is clear there is a clear need for a greater understanding of the effect of socio-economic factors as discriminators of road collision risk. However there is a need to progress to a more rounded conception of driver and casualty lifestyles in order to appreciate the nature of risk.

Determining geodemographics groups and associated collision propensity: analysis and findings

The predominant aim of this project was to assess the potential for geodemographics for determining the 'risk population' likely to be involved in road traffic collisions. Accordingly, MOSAIC geodemographic codes were appended to the postcode records for the all the casualties and drivers involved in collisions in London from 1998 to 2003. Each person involved in a collision automatically has their postcode recorded into the STATS19 database, this enables the geodemographic code to be easily appended to the postcode. The geodemographic system was then used to analyse propensity London wide and then further aggregated to Croydon. Index values for the total population of London and then Croydon were determined and calculated for each MOSAIC group to highlight the differences in the population dynamics between London and Croydon. Index scores where then created for different types of collisions for example, the dataset was subdivided into drivers and casualties and pedestrians and then subsequent scores were made for one particular MOSAIC group throughout a twenty-four hour period in order to highlight the changing propensity over time. By standardised the index score at 100 it meant comparisons could be made more easily between London and Croydon, and the potential to compare between other London boroughs. A value above 100 indicates a higher than average risk propensity whereas values below 100 highlight areas which are less likely to be involved in that particular type of collision compared to the whole of the study region.

Tables 2 and 3 indicate the population of London and associated geodemographic scores, not all the 52 Mosaic types were used as some of the groups only cover a very small percentage of the actual population and the result would be misleading. Therefore only ten groups with the highest proportion of the London population were chosen. With regard to Table 4, D27 'Settled Minorities' are twice as likely to be involved in a collision and be a casualty, whereas H46 'White Van Culture' and C19 'Original Suburbs' are only slightly more likely to experience an over representation in being involved as a casualty in a collision. Table 5 shows the propensity for drivers and a clear pattern emerges, with D27 'Settled Minorities' having a high propensity in Croydon to be involved in collisions as a driver followed by H46 'White Van Drivers' which has a index score of 134, closely followed by C19 'Original Suburbs' and C20 'Asian Enterprise'.

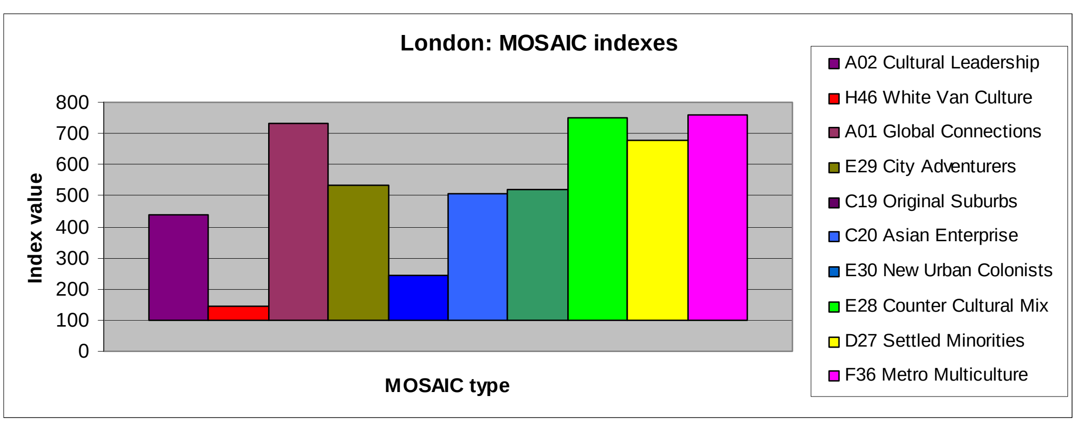

Table 2: Population of London and associated MOSAIC geodemographic groups and scores

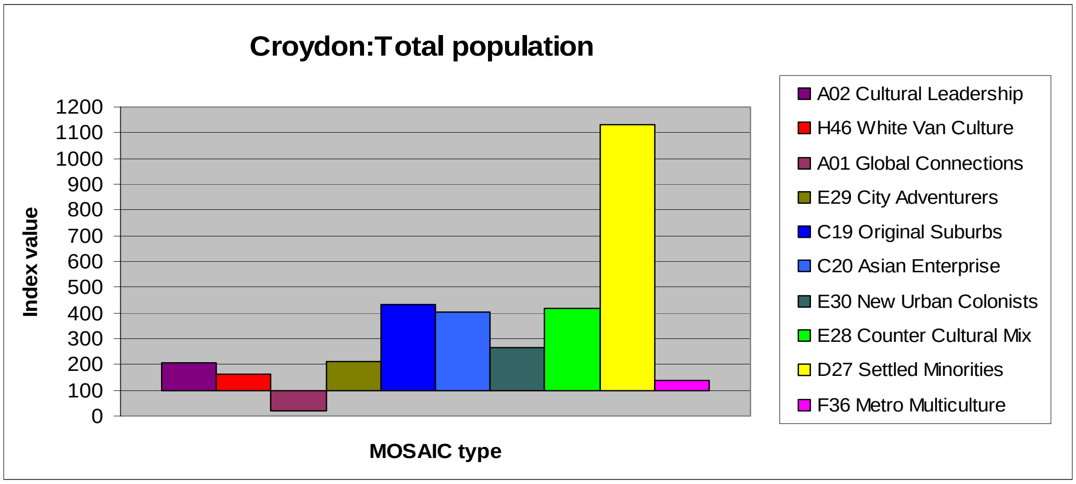

Table 3: Population of Croydon and MOSAIC geodemographic groups and index scores

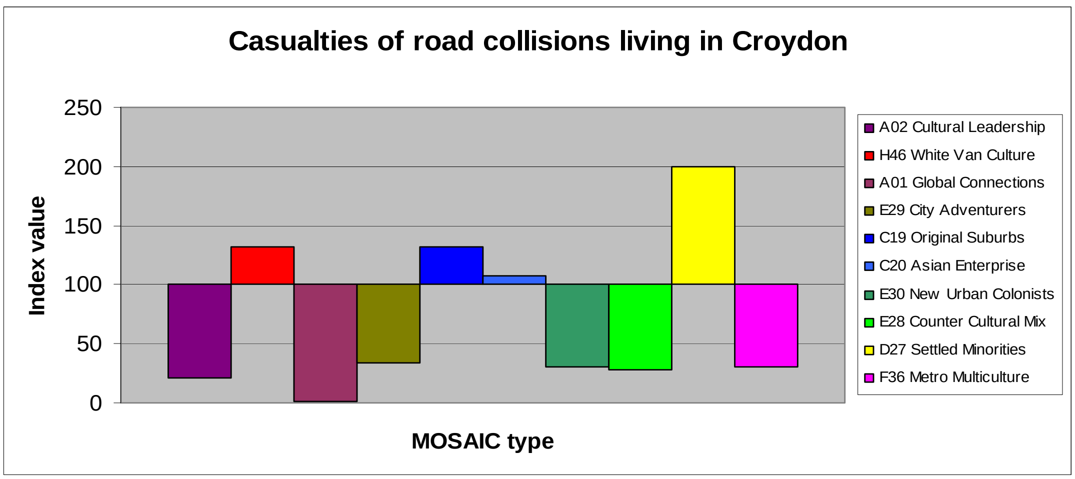

Table 4: Casualties in Croydon and MOSAIC geodemographic index scores

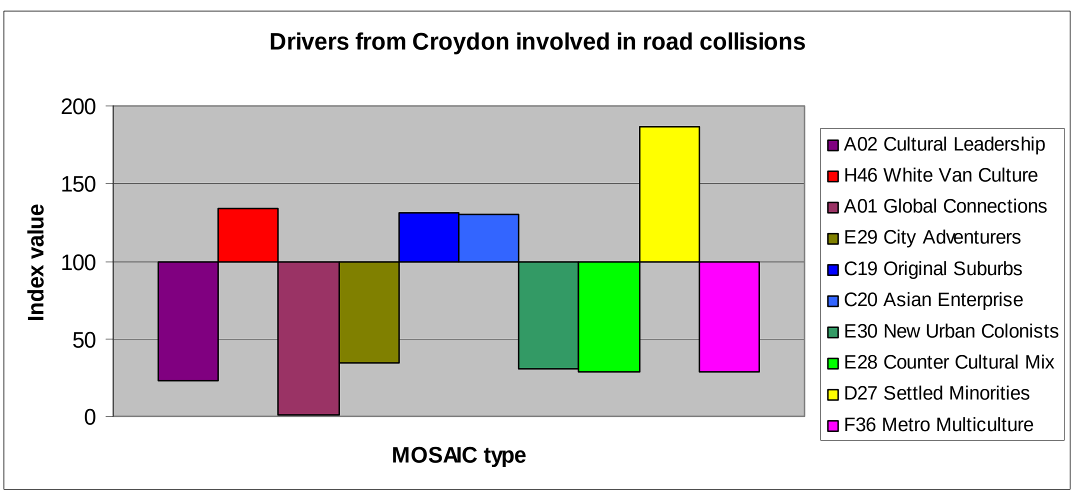

Table 5: Drivers in Croydon and MOSAIC geodemographic index scores

The temporal analysis used two different groups firstly H46 ‘White Van Drivers’ as casualties (which includes whether the driver was injured in the collision) for both Croydon and all of London. The temporal analysis was achieved by aggregating the casualty dataset into nine time bands which can be seen below in Table 6.

Time	Brief description	Code
0000 - 0359	Night - reduced number of crashes due to low traffic density	1
0400 - 0659	Early commuters - high no of heavy goods vehicles	2
0700 - 0959	Commuters - increased traffic and pedestrians	3
1000 - 1159	Mid morning - couriers, increased pedestrians	4
1200 - 1459	Lunch - Increased number of pedestrians	5
1500 - 1659	School finish - high numbers of school children	6
1700 - 1859	Work finish - increased number of traffic and erratic behaviour	7
1900 - 2059	Early evening - less number of vehicles, reduced pedestrians	8
2100 - 2359	Late evening - less vehicles but faster speeds and drunk pedestrians	9

Table 6: Time bands for temporal analysis for risk propensity analysis

The second analysis used C20 ‘Asian Enterprise’ and their propensity as drivers to be involved in collisions throughout the day. Both of these index graphs are compared to London in order to highlight the differences in propensity. Table 8 indicates that H46 ‘White Van Drivers’ have their highest risk propensity to be involved in a collision between midday and three o’clock. This time, according to Transport for London (2002) is considered to be ‘off peak’ with less traffic on the roads. Table 7, which shows H46 ‘White Van Drivers’ for the whole of London shows a more unvaried pattern with a slight peak between 4am and 7am and then again at lunchtime. This highlights the need for borough aggregation in order to depict clearer patterns throughout the day as each borough as different traffic flows and road designs which make them all unique in terms of analysing temporal involvement in traffic collisions. Table 10 shows C20 ‘Asian Enterprise’ and their propensity to be involved in a collision as drivers based on the time of day. This table shows a very different pattern from the previous temporal analysis. Table 10 indicates a higher risk propensity between midnight and 4am, decreasing until 10am and then a significant increase at lunchtime. This varies considerably from the London average index scores which hardly show any variation during the day, there is only a slight peak between 9pm and midnight.

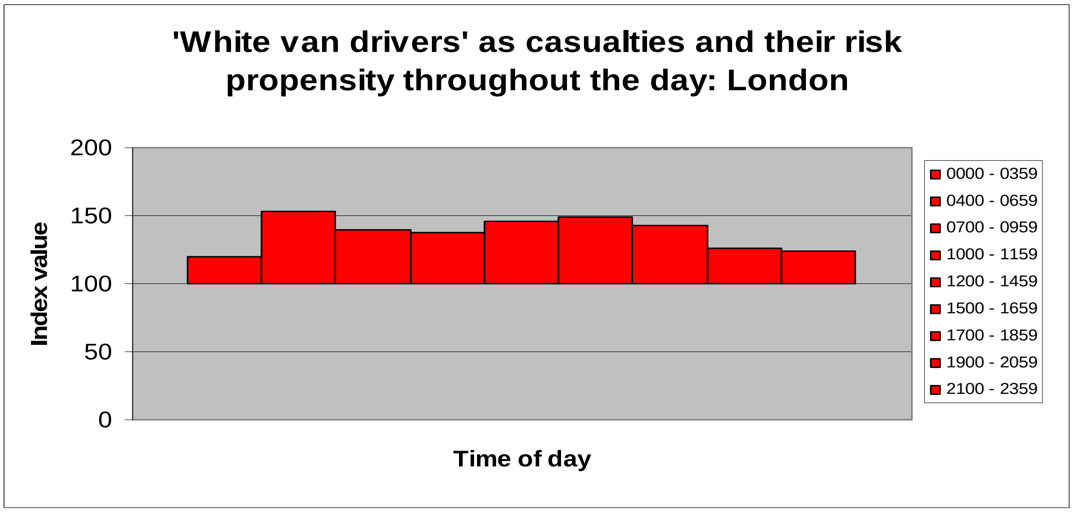

Table 7: H46 'White Van Drivers' for London based on time of day

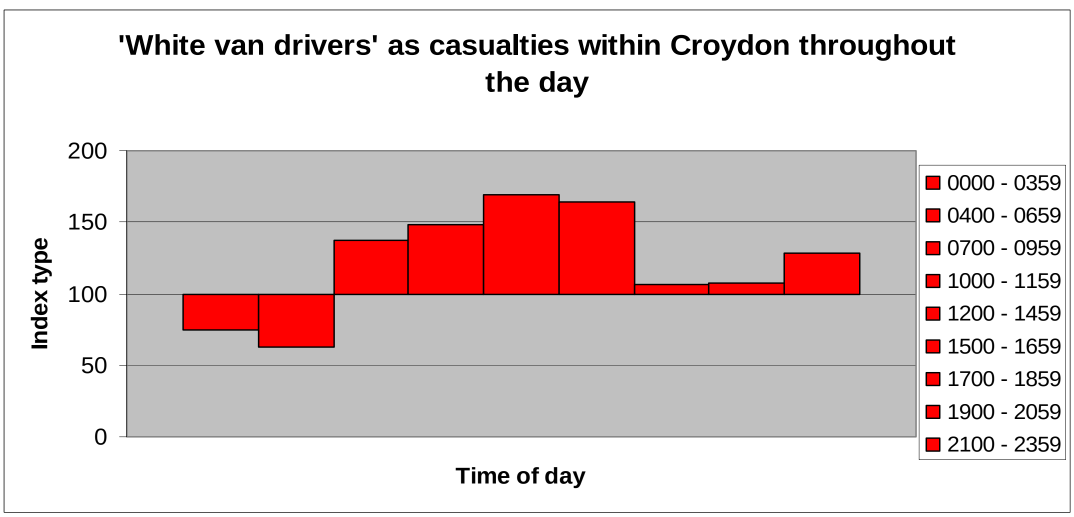

Table 8: H46 'White Van Drivers' for Croydon based on time of day

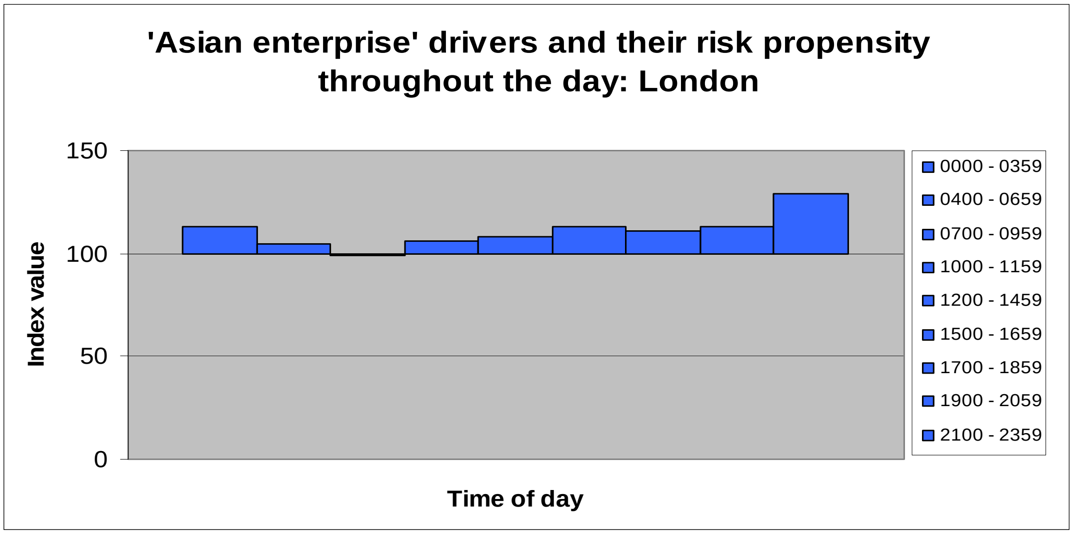

Table 9: C20 ‘Asian Enterprise’ as drivers for London based on time of day

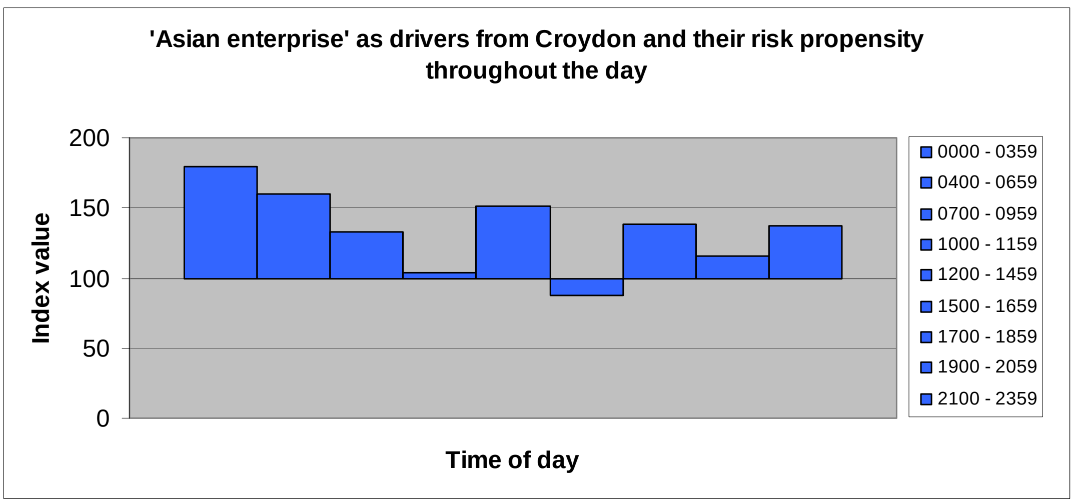

Table 10: C20 ‘Asian Enterprise’ as drivers in Croydon based on time of day

Spatial analysis: where are the people at risk?

The previous section was predominantly focused on who had higher propensities to be involved in certain types of collisions. This section endeavours to show where these people live and the locations of neighbours where the residents are more likely to be involved in a collision. The following figures aim to demonstrate the usefulness of geodemographics for road safety practitioners. By highlighting the neighbourhoods with a high propensity for collision involvement, the results could assist community road safety policy and educational work in the local area, by understanding the risks certain types of people of the population are facing. Not everyone in a neighbourhood will have the same risk as others and by differentiating these people, better care can be taken to address the needs of those people more at risk. Figure 1 below shows the locations (in red) of high index scores for postcode

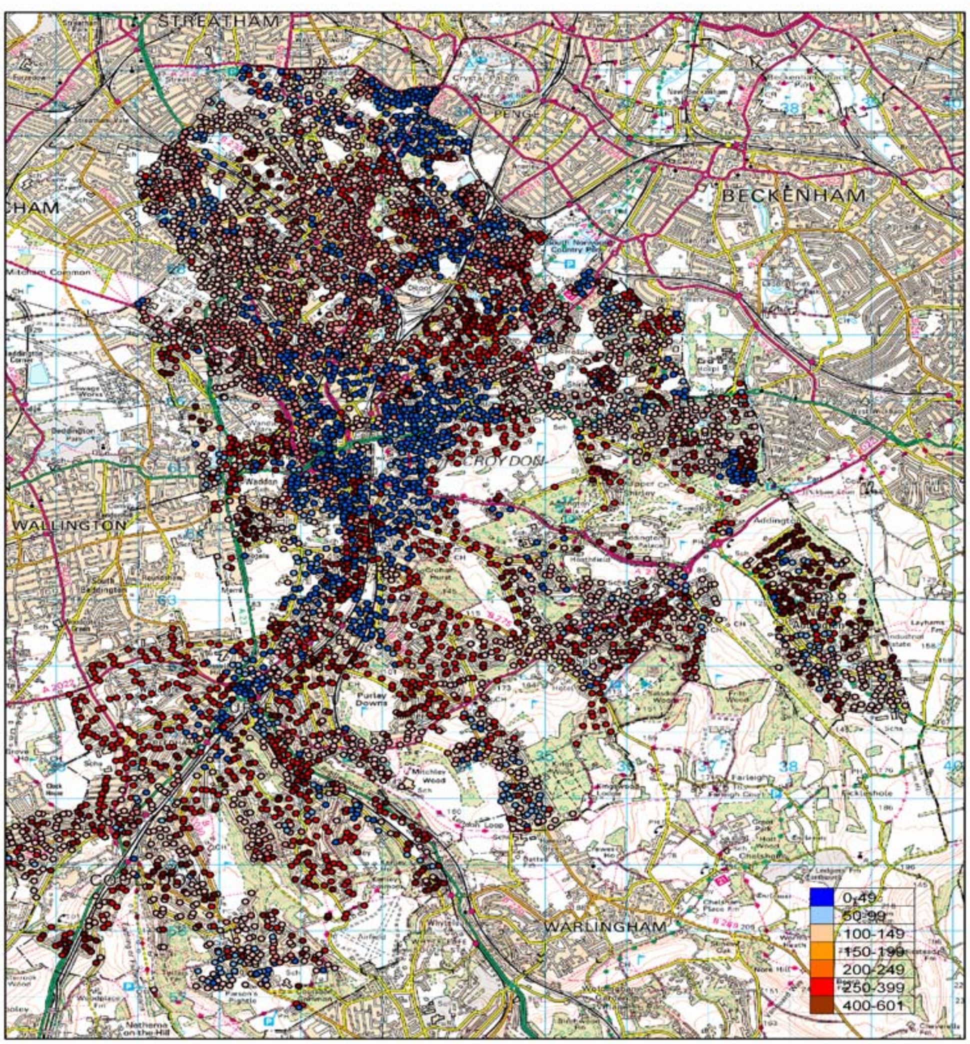

Figure 1: Croydon and the location of propensity of driver risk

data. This analysis is based on the base population of Croydon and gives each postcode an index score based on what MOSAIC category they are in and therefore their risk propensity (based on the previous sections analysis).

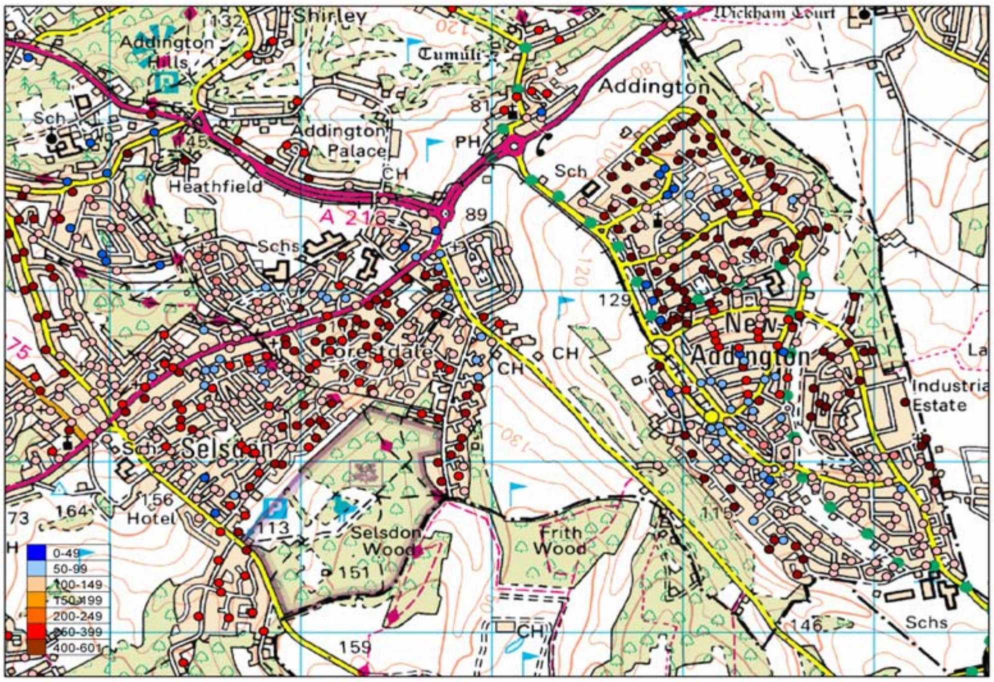

Figure 2: Croydon, driver propensity based on residential postcode.

Figure 2 (above) shows a smaller area within Croydon to give a clearer interpretation of the clusters of postcodes where the residents could be more involved in a collision as a driver. Figure 3 shows an area of Croydon based on casualties, from this map there are clear clusters of areas where the residents may have a higher propensity. In the lower left hand corner of the map there is a strong pattern of an area with a less likely propensity to be involved in collisions compared to the centre of the map where there is strong collection of ‘high propensity’ postcodes.

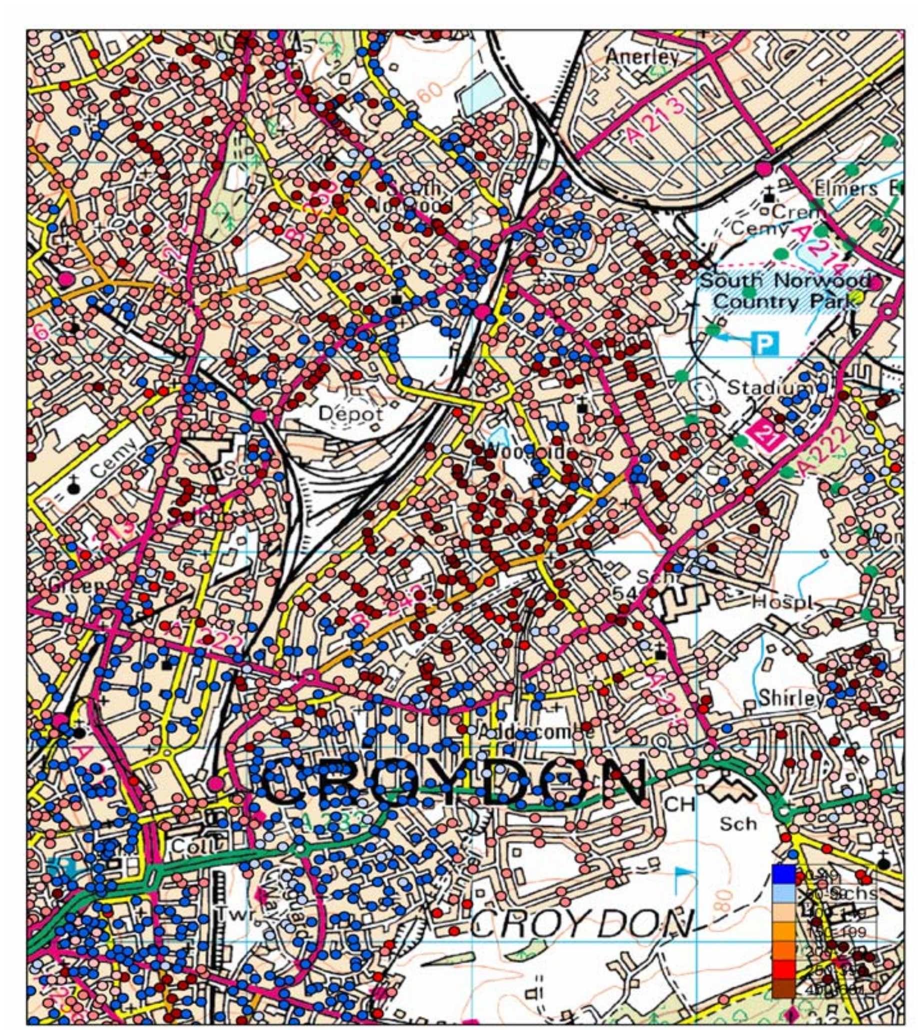

Figure 3: Figure to show the possible high propensity residential locations for casualties in Croydon

Summary

From the results it is apparent that using geodemographic classifications for road safety analysis does enhance the study of demographics and road collision involvement which in the past has a lacked a spatial dimension. There is considerable scope for further research into both the effects of a more disaggregated dataset in terms of severity and age. Furthermore, regional effects across boroughs would benefit from analysis to determine a more disaggregated London wide collision involvement propensity pattern. Therefore borough road safety practitioners would be able to conduct and compare analyses to be able to the most appropriate methods for education and reduction of collisions involving certain types of people for particular areas in London. As road safety engineering reaches a level of saturation with reference to speed cameras, road chicanes and other engineering devices, more community based methods are being sought in order to educate to people the risks of being involved in collisions. What is most important in this circumstance is the level of aggregation with this to append the postcode data. For the purpose of this study borough level has been used because unlike the police and education there are no specific boundaries for analysis, such as catchment areas or basic command units. Roads and their safety are managed on a borough level, therefore this was deemed as the most appropriate scale to analyse postcode data for the drivers and casualties. The aim of this study was to assess the merits of using geodemographics to understand the people who are more risk than others to be involved in a collision in London, namely Croydon. Geodemographics offers a useful tool for borough practitioners who want to implement community wide schemes and use it to understand the nature of the risk population within their borough and the best methods for trying to communicate these risks across most efficiently.

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