Geographical Accessibility for the Elderly to General Practitioner Surgeries
(Case Study: Cardiff Metropolis)

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ABSTRACT

Primary care is paramount in the health care sector in both developed and developing countries as this helps to maintain a healthy life style for not only the elderly populace but also plays a huge role in the general health upkeep for the entire population because it is quite economical when compared with other secondary care health providers.

Numerous academic works have highlighted that a certain populace that resides in unfair areas have accessibility constraints and as such lag behind in getting medical aid.

The overall correlation coefficient results from findings showed an overall weak correlation and that the elderly with 40%-78% in the output area and 26%-41% in the lower super output area have relative fair access to General Practitioner surgeries in Cardiff.

Keywords: GIS, Elderly, Accessibility, Primary Health Care

1. INTRODUCTION

The care of the aged can be a herculean task, coupled with the fact that medical services in existence (GP surgeries, health care centers and hospitals etc.) don't have similar services they provide. Aday *et al* (1984) clearly states that the aged disproportionately are large users of health services and will tend to multiply both in numbers and in population which will have a rippling effect and further stipulate highest rate of admittance into any of these medical services provided. The elderly population is mainly referred to in most developed countries around the world as an age bracket of 65 years and above.

The common trend in today's public health issues is of the opinion that it has now been regarded as more than the avoidance of untimely mortality but as proportion convenience indices (Gatrell and Loytonen, 1998). Previous studies involving geographical accessibility indicate that the aged encounter diverse chaotic issues in accessing medical services, however, schemes in place by the NHS and the strategy for older people in Wales warrant a proper and well organized planning and execution of operations that are properly interwoven together such that the operational framework in existence for older people in Wales is imminent.

In Cardiff, the National Service Framework for older people has attempted to put in place national standards for the best evidence-based practice and to also ensure fair and high quality medical attention/services for the aged (older people) and where the weightiness of safe guarding the entry of old people to medical services is and therefore cannot be over emphasized (Welsh Assembly Government, 2003). It must clearly adhere to the NSF standard stating that aged people that require medical assistance must be under the supervision and responsibility of its ideal staff with the right expertise or acquisition skills to ensure sound and effective health care service provision (Dept. of Health, 2001).

The advancement in information technology and the readily obtainability of GIS data layers has become a prominent and ideal variable in the geographical accessibility and further paved way for giant strides in modeling accessibility measures as regards various dimensions of medical services available for the aged (Brabyn and Skelly, n.d.).The development, integration and inclusion of a Geographical Information Systems model in the health sector has made it attain advancement due to the standardized rich GIS functionality and features which are evident in its series of software packages. This has equipped it so much in quantifying and further deducing spatial inequalities that abound and exist in primary health care service providers (Higgs, 2004). This feat has become so beneficial for health researchers and planners despite the fact that health can be distorted by a variety of life styles and environmental factors (Scholten and Lepper, 1991). It can be unequivocally noted as a widespread in its usage for several health scenarios for a number of years and has come to stay in helping to measure accessibility for the aged.

2. ROLE OF DISTANCE AND MOBILITY IN THE ELDERLY

Accessibility generally becomes crucial with increase in age as mobility dwindles which warrants in mobility issues which in turn becomes a limitation experienced by elderly people. Therefore, distance travelled to the nearest health care facility forms an integral part in the accessibility measures to GP surgeries for the elderly. The tradition involving primary health care patterns degenerates with increasing distance thereby enforcing distance as a vital criterion to be considered in the utilization of health amenities in provincial areas in under developed countries (Muller et al. 1998; Tanser et al. 2006; Thaddeus & Maine 1994). It is therefore imperative to state that travel is of principal importance for man in his daily liveliness and movement while mobility is

also solely dependent on man's capability and capital: car availability and physical strength etc. It is one that is also dependent on the spatial distribution of the GP surgeries for the aged. A survey on access to general practitioner services in East Anglia was analyzed where the norm for transportation is usually by cars and buses (Lovett, 2002). The analysis carried unfolded under-deserved areas having low transportation and mobility problems and thus opted for measures that were going to help improve health care service utilization. However, in a bid to curtail these challenges, Health Care facilities or GP surgeries will have to be situated in centric location that is not too far away from residents' location in order to add great worth and sustenance in their bid to live longer and to also register declination in mortality rate if the issue of accessibility is to be addressed.

3. AIM OF THE RESEARCH

The aim of this research is to estimate the geographical accessibility of elderly people to General Practitioner Surgeries in Cardiff Metropolis. The presence of the standard analytical tools/facilities that are embedded in the proprietary GIS will help a lot in visualizing the effects of difficulties in primary care for the aged and further strategies that will help in its advancement.

3.1 Objectives

(a) To ascertain the population to GP surgery ratio for the elderly using the Lower Super Output area scale.
(b) To ascertain the role of straight line distance as it plays a crucial role in investigating whether the elderly are in close proximity to these GP surgeries and the respective services they render.
(c) To calculate the closest General Practitioner surgery using road network analysis.
(d) To make recommendation on both the development and advancement that can help reduce back log in the health services delivered for their upkeep.

4. RESEARCH METHODOLOGY

4.1 Study Area

The latitude and longitude of Cardiff is 51° 31' N, 03° 12'W', which is one of the industrial cities in South Wales and is the capital city of Wales. This study is carried out in Cardiff and focuses mainly on the aged. The Population records of 1999 indicate that there is an estimation of 47,300 people over the age of 65 in Cardiff and it is expected that aged people's population will also increase between 2001 and 2016 to about 10% (4,654) *(OlderPeopleNeedsAssessment n.d.)*. The research undertaken shows Cardiff has seventy general practitioner surgeries within its environs.

4.2 Data Considerations

Cardiff Output Area boundaries was gotten from the output Area shape file (Wales_oa_2001 area.shp) which is the spatial dataset used in this research derived from EDINA UK Boarders website http://edina.ac.uk/ukborders while the socio economic data/attribute data that have a record of census/population details used in this research work was downloaded from Casweb, 2001 aggregate statistics datasets (http://casweb.mimas.ac.uk). The census variables which was used to in this research include; Age gender, Cars or vans, Economic Activity, Household Composition

as well as Households with Limiting Long Term Illness particularly target at the aged from 65 and over.

4.3 Software

The GIS software used was ArcGIS 9.3 *ArcView* a leading GIS software solution in the field of Geospatial technology. Accessibility calculations were carried out using some of its sophisticated tools namely: the 'Network Analysis' tool and the 'Analysis Tool'. Microsoft Excel Spread sheet was also used to edit and convert downloadable files gotten from Casweb search engine in order to enable geo-referencing in Arc Map.

4.4 General Practitioner Surgeries - CARDIFF

The records and listing of the GP Surgeries in Cardiff used for this research was gotten from NHS free downloadable website interface (http://www.nhsdirect.wales.nhs.uk/) which had both their opening times, variations in services they offered and the number doctors & nurses.

Figure 1: Map of output area of Cardiff showing the locations of GP surgeries

Figure 2: Attribute data of the GP surgeries in Cardiff showing variations in their services

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5. DETERMINING THE POPULATION TO GP RATIO

Computed the number of each GP surgery individually for each lower super output area in an excel spread sheet. This was possible by first identifying how many GP surgeries were present in the several lower super output areas using the select feature tool in Arc Map. This was done by then opening the attribute data table and by specifying each one individually out of the 203 super lower super output areas Cardiff had.

Out of the 70 GP surgeries records I had, a total number of 64 GP surgeries were evident on my map display. This was as a result of some GP surgeries that had been duplicated but still possessed different easting and northings and which could also be seen as a branch of a GP surgery's head office. A relational join was performed between my lower super output area; GP surgeries attribute data and the aged population census variable distribution.
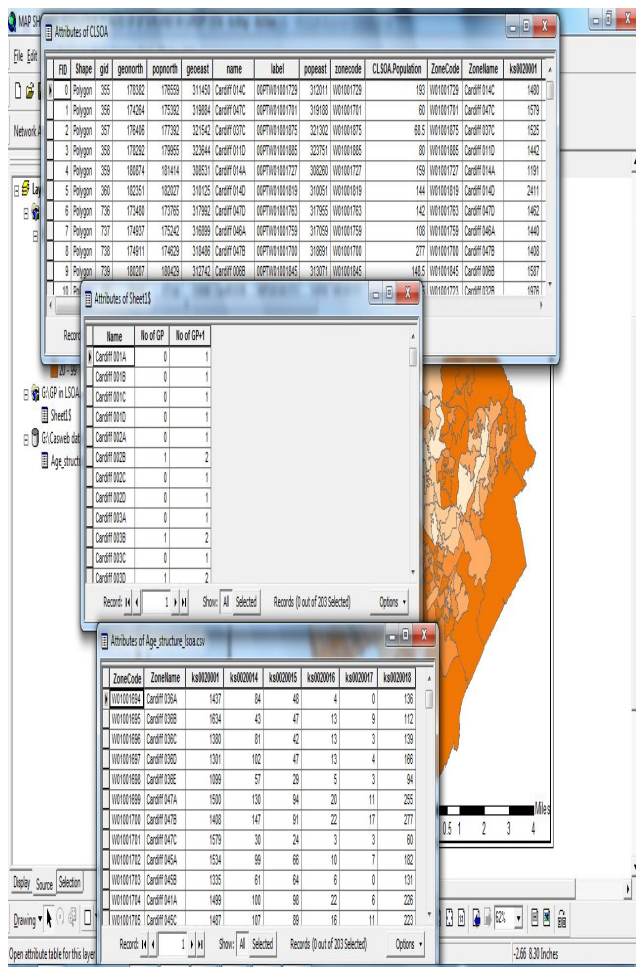

Figure 3: Showing a screenshot of the relational join performed between CLSOA, the number of GPs and census variable for the aged.

While computing the number of each GP surgery present for each lower super output area within my excel spread sheet. A large number of lower super output areas had the presence of a zero which was as a result of the non-existence of a GP surgery within that area.

However, determining the ratio/ proportion fraction was going to be expressed as the total number of aged people as the numerator over the number of GP surgeries as the denominator. The normalization numeric process was made using the symbology tab to show the range or proportion/ ratio fraction.

Furthermore the output result gotten resulted in some part of the map layout been chunked out as a result of those zones/output areas that did not have the presence of a GP surgery within its geographical location as a result of the zero value which was computed for in the excel spread sheet used to denote for those zones/output areas that were lacking. Though through mere visualization based on the output map layout one could easily denote that the chunked part of the map could be expressed as those zones that were lacking a GP surgery practice. However, the population to GP ratio/normalization numeric expression was then expressed as the total number of aged people using my census variable divided by the total number of GP surgeries present within Cardiff which was achieved using the symbology tab and the quantities to show a class range of values.

Population of Elderly to General Practitioner surgery Ratio

$$= \frac{\text{Total number of aged people}}{\text{Number of GP surgery}}$$
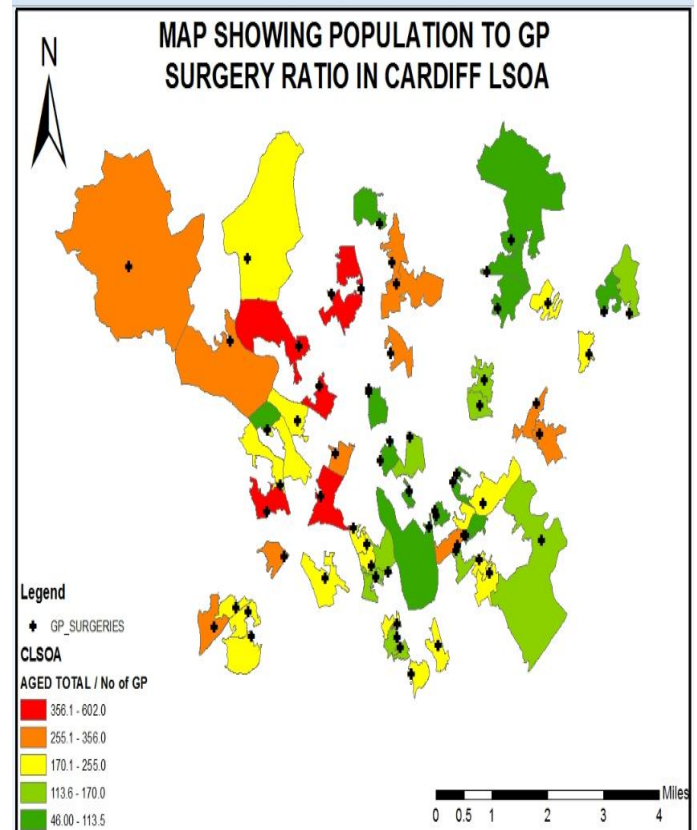

Figure 4: Map showing population to GP surgery Ratio in Cardiff

6. ACCESSIBILITY CALCULATION MEASURE USING ROAD NETWORK ANALYSIS (USING THE CLOSEST FACILTY ANALYSIS)

This was carried out by loading in the centroids for Cardiff output areas well as the various GP surgeries locations in Arc map. Then the created network ITN coverage dataset was explored using Arc catalog which was imported into Arc map by dragging it into my map display table of content panel. The ITN network dataset was clipped which had the road link feature to restrict my accessibility calculation methods for my preferred chosen study area only. Since my accessibility calculation was based on getting the closest GP surgery (fastest routes) to mostly populated areas that the elderly were more predominantly present. The new closest facility was specified in my network analysis whose layer consisted of different parameters that was to be set up which includes facilities, incidents, routes and barriers categories. The GP facilities (surgeries)was loaded that had seventy records following the incidents which then was loaded in after the facilities that had the value of 991 which was as a result of the wards the output area possessed. The closest facility layer was opened to be able to edit the property window to suit the type of analysis that was carried out. The impedance unit value chose was in length as a result of the physical distance analysis that had been carried out previously which had its length measured in meters, so went ahead and ticked the parameter that had length in meters under the accumulation attributes in the layer properties. Specification of facilities to find was done, and using find one closet facility to each centroid. Proceeded to solve by clicking on the solve button on the network analyst window pane. Finally, the outcome of the closest facility brought out 991 routes and no barriers were recorded. The same process was repeated for the Lower super output area of Cardiff though the number of incidents that were loaded for the analysis was different due to the number of zones/labels they possessed. Furthermore, a color ramp map was shown of both the length/distance which was expressed in meters as well as the time which was expressed in minutes. The resultant attribute table had to be exported to an excel worksheet to enable some manual editing which Arc map could not permit. The excel worksheet which had the attributes of the closest facility analysis in Arc map and made a relational join to the output areas using common labels that existed between them was loaded. A symbology showing the class range was performed to show the various distributions.
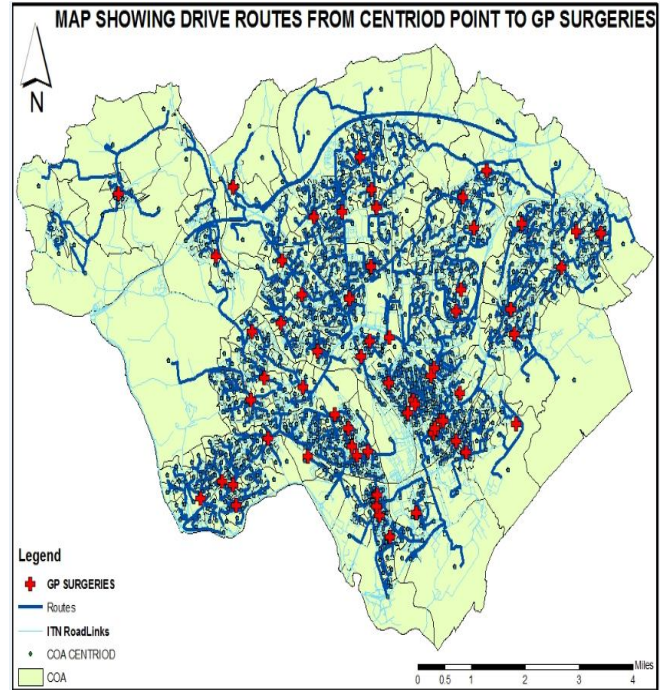

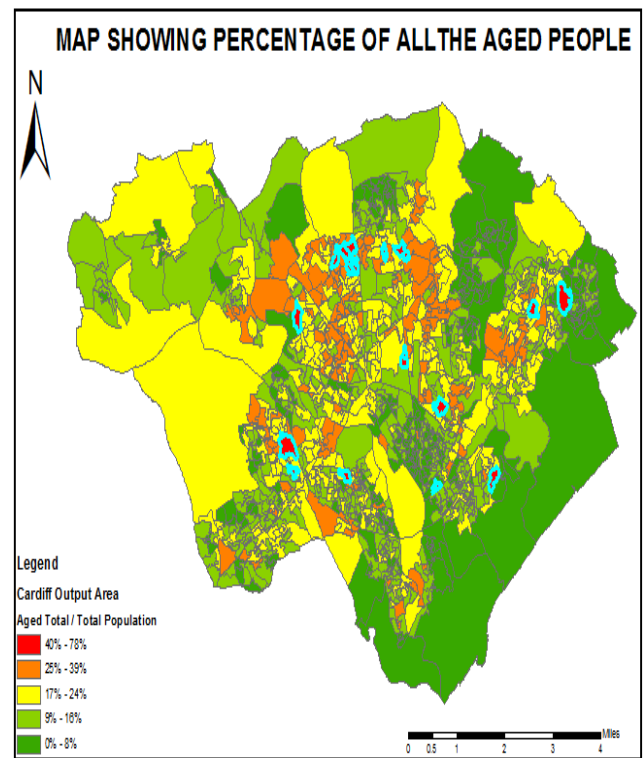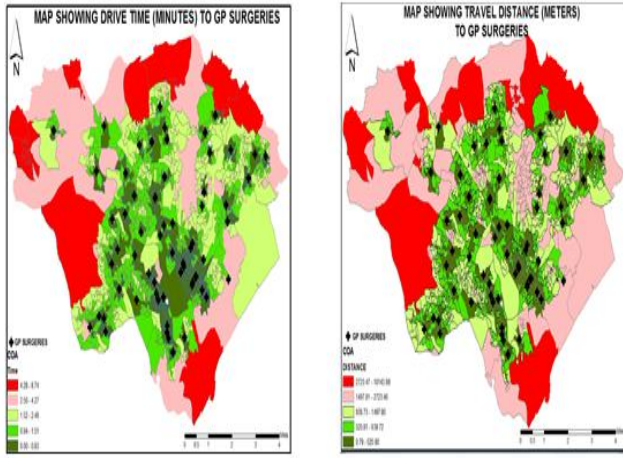**Figure 5: Map showing drive routes from centroid point to GP surgeries**

Figure 6: Map showing percentage of all aged people

MAPS SHOWING ACCESSIBILITIES

CARDIFF OUTPUT AREA

Figure 7: Map showing accessibility for Cardiff output area
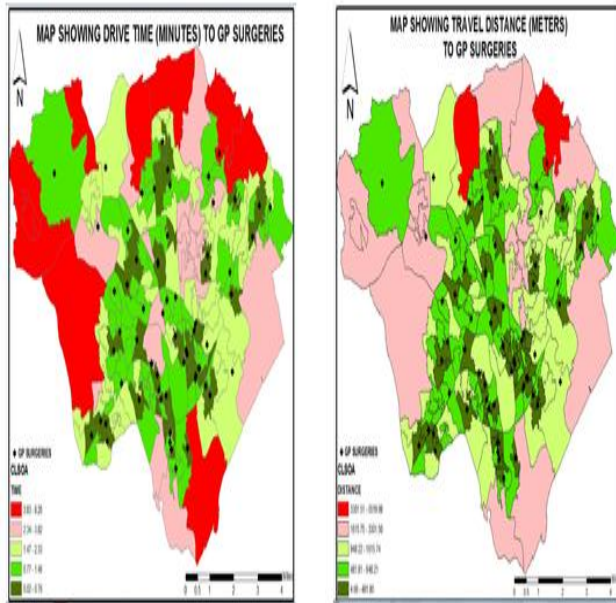
CARDIFF LOWER SUPER OUTPUT AREA

Figure 8: Map showing accessibility for Cardiff Lower Super output area

6.1 Statistical Analysis (Pearson Correlation)

Pearson product moment correlation is a measure of correlation between two variables which gives a value of between +1 (perfect correlation) and -1 (weak Correlation). It is represented by *r*. it is used in this analysis to correlate the census data with the shortest distance derived from the centroids points and it goes as follows:

Table 1. Statistical Analysis (Pearson Correlation)

Negative Class	Positive Class	Description
0.00	0.00	None
-0.19 – -0-01	0.01 – 0.19	Very Weak
-0.39 – -0.20	0.20 – 0.39	Weak
-0.69 – -0-40	0.40 – 0.69	Moderate
-0.89 – -0.70	0.70 – 0.89	Strong
-0.99 – -0.90	0.90 – 0.99	Very Strong
-1.00	1.00	Perfect

The end result of the Near distance range of GP surgeries with respect to all the elderly people. The census variable used here was strictly the summation of all the people aged 65 and over termed the aged gotten from Casweb which was expressed as a percentage over the total number of people in my study area for both the output area and lower super output area. Then the near distance to all the GP surgeries was plotted against the age bracket 65-over. The Pearson's coefficients where r = 0.049916 and where r = 0.057308 both show a very weak positive association. Thus indicating that as the percentage of the elderly increases, the near distance to the GP surgeries also increases.
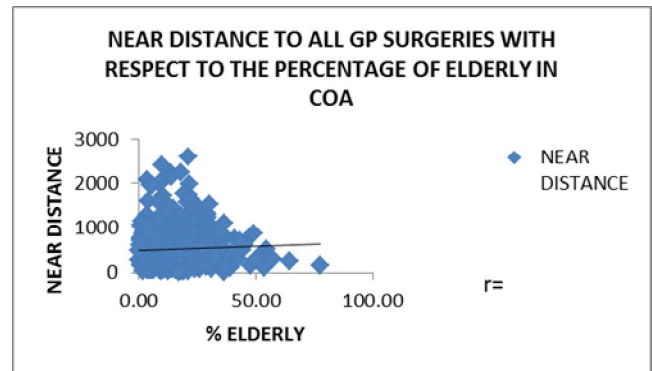

Figure 9: Near distance of all the GP surgeries against the percentage of elderly in Cardiff out put area

6.2 Discussions

The study designed describes two different areal unit scale use to estimate geographical accessibility for the elderly in Cardiff. Firstly, based on the output area of Cardiff city using the straight line distance to where these GP surgeries are situated and where the elderly are more clustered. The outcome of the closest facility analysis to all the GP surgeries present in Cardiff as shown in fig (7) and fig (8) thus portray that those who fall in areas or zones which possess a higher record of time-taken to travel based on drive time as well as the distance covered with which they travel to access these GP surgeries closest to them while those who fall within zones that have minimal time-taken to access these GP surgeries have a record of lower values in both time-taken and distance covered. My assumptions were then based on the elderly been transported to these GP surgeries by cars or vans and not taking into consideration those that don't have cars, or have to

either walk to a bus stop, and even wait for a bus which can be a big hitch to their accessibility means to these GP surgeries.

However scenarios which warrant in an output area or zone having the presence of a GP surgery in closer proximity but yet still possessing the longest meters or distance covered to attain access to a GP surgery could amount to a reason been as a result of the road conditions as well as the variations in speed limit. With respect to an assumption based on travel time that people may travel at uniform speed on different road types. For instance areas or zones that only permit low emission protocols based on travel time would definitely distort the time taken to reach a desired or deserved GP surgery. However this itself is ambiguous and so therefore a good consideration or option which could be of much beneficial importance is to consider a more quicker route which could however lead to having to travel on the motorway known as the high speed road which may not possess as many restrictions as compared with the primary routes which are more predominant within a city environment which will definitely aid in getting to these GP surgeries quicker.

7. KEY RESEARCH FINDINGS

Based on the case study analysis carried out, below is a summary of findings to yield a better understanding of the research;

(a) The study equally gathered that the correlation coefficients demonstrated for all the near distance using straight line distance with respect to all the GP surgeries as well as the services they render plotted against the census variables show no strong positive relationship and no strong negative relationship either and as such implies that the associations are thereby weak giving a denotation that the availability of care caters for the deserving population.

(b) Findings show based on the population to GP surgery ratio using the Lower super output area that those areas lacking the presence of a GP surgery appear as the chunked part on the map display layout and also some areas where the elderly are clustered don't have the presence of a GP surgery in that zone but they are at least adjacent to a GP surgery with respect to where they are clustered.

(c) Based on the physical distance, findings show the trend taking into considerations where the elderly are clustered that the absence of a particular surgery in proximity to where they reside will therefore warrant in seeking for the closest GP surgery within their reach and as such they would have to cover more distance which is crystal clear in the near distance range to these GP surgeries and their service variations across the city.

(d) Findings showed that where the proportion of the elderly are more clustered and having recorded an upward value of 48%-78% in Cardiff output area and also 26%-41% which was also the highest value in the percentage range of elderly in Cardiff lower super output area with respect to the accessibility map which depicts drive time in both minutes and near distance covered (meters). It however indicates that the elderly fall in areas that utilise lesser time taken (0.00 - 1.51mins) and near distance covered (0.79 - 938.72m) to get to the closest GP surgery facility within its environs and thus show that they have fair access to at least one GP surgery based on the closest facility analysis and as a result of this shows overall fair access to these GP surgeries distributed in Cardiff with respect to the elderly population.

8. LIMITATIONS OF THE STUDY

(a) Due to ethical concerns and time constraints, further issues concerning investigating further about the succour framework in Cardiff in place for the deteriorating elderly people could not be properly achieved.

(b) The centric points assumption which resulted in the adoption of centroid points that doesn't take into consideration the exact residential locations the elderly are clustered but rather focuses more on a central point of view which doesn't really denote the exact representation of the proximities to the various GP surgeries across Cardiff.

(c) Assumptions based on travel time for the elderly considering only the cars or vans transportation as a means of how the elderly are been ferried to these several GP surgeries and not considering mobility issues as well as other health impairments or even those that have to either walk to a bus stop, and then wait for a bus which can be a big hitch to their travel time to these GP surgeries.

9. CONCLUSION

Majority of the problems the elderly are up against, with respect to access to primary health care services (General practitioner surgeries) arise from the aftermath of both their deterioration and mobility issues which affects their general health status. However, with the recent reconditioning of the primary care sector in UK which has the new reformation and reintegration scheme in place that includes both the commencement of the NHS Direct (a 24-hour telephone/Internet advice service), walk-in centers, increased private provision of general practice, complementary, alternative medicine, and physiotherapy and counseling services (Peckham 2004, 2006) and as well with the help of centers like the Elderly Care Support unit which encompasses North, South and West Cardiff in support of majorly the deteriorating elderly people, it would therefore reduce the clamor for further secondary care assistance needed by the elderly populace. Undoubtedly, the role of GIS has the wherewithal to be able to understand geographical health related trends and as such also propound positivity within the health sector. Therefore, its role has come to stay and will continue to evolve in trying to reshape our daily lives and make things easy and clearer for mankind.

Hence, the overall research work undertaken and findings have established that the elderly have fair access to the GP surgeries within Cardiff metropolis and this would further justify the policy been created by the National Health Service plan (UK) and the Strategy for Older People in Wales that the elderly should have adequate access to Primary care (GP surgeries) which may prevent future hospitalizations.

Must do Recommendations

(a) Additional studies that would not only focus on the elderly population and their respective access to GP surgeries but a more comprehensive study that will compare both the access to care for the elderly and non-elderly with respect to access to their own GP surgeries.

(b) A more appropriate ethnographic study and survey will be more required to derive more in-depth description of centres like ECAS and their everyday affair for the deteriorating

elderly people in Cardiff in relation to accessibility constraints and access issues.

(c) A more recent database having all the domains updated should be created because the availability of the census variables data selection which are been disseminated at both Output and lower Super Output areas scale are limited to variables which occurred in the 2001 census of UK which is more like a drawback.

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