MAPPING SOCIAL EXCLUSION AND PUBLIC TRANSPORT NETWORK CHANGE IN GIS; A CASE STUDY OF BELFAST

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Abstract

The issue of the integration of location and travel is central to urban design and is a key policy objective in terms of measuring accessibility. Social exclusion is a function of accessibility to activity spaces. The public transport network in Belfast city has been transformed from 'City Bus' to 'Metro Service' by introducing quality bus corridors and night service for better service and connectivity. The aim of this transformation is to provide better access and target social need to minimize the effects of societal inequalities and communal segregation which the city has historically experienced. The role of the transport in social exclusion is important as it can either exacerbate social exclusion or can initiate the phenomena. Different methodologies and approaches used to measure social exclusion are reviewed and a methodological tool for transport and urban planners is provided to analyze the transport disparities. GIS based analysis integrating socio-economic, demographic data can be used to highlight deprived areas due to change in transport network, but to assess the impact of change in transport network in terms of trade offs made by social groups and penalties faced by them, a qualitative assessment is necessary. An integrated qualitative and quantitative approach is proposed to measure social exclusion and role of transport in social exclusion. Further more the paper looks at the application of the methodology in Belfast city.

1. Introduction

The concept of Social exclusion is highly ranked in UK transport policy after the formation of the Social Exclusion Unit in Prime Minster Office in 1997. The Transport White paper published in the following year of 1998 affirmed that transport helps in developing a fairer society (Hine et al., 2003). Different studies (NISRA, 2001; Pennycook et al., 2001) were initiated to assess and address the issue of social exclusion. The development of Noble index of deprivation (2001) in Northern Ireland's revealed the level of economic and social deprivation by defining key domain measures which had several indicators. These domains were income, employment, health and disability, education, skills and training, geographical access to services, social environment and health. Deprived areas were identified and measures were suggested to reduce the social exclusion. One of these measures was to improve access and provide better connectivity among the activity spaces and residential blocks. The transport network of Belfast city was therefore transformed from City Bus to Metro Service. 60 routes of City Bus were replaced by 12 quality bus corridors (QBC) served by Metro Service as shown in figures 1 and 2. The aim of the transformation was to provide better access, connectivity and service to reduce social exclusion thus allowing the city inhabitants to participate fully in activities.

The paper examines the affects of the network transformation on the level of social exclusion. Furthermore it reviews the existing methodologies and approaches used to measure social exclusion and provide a comprehensive methodology based on both quantitative and qualitative

analysis. This will help in assessing whether the aimed benefits of the transformation have been achieved or not.

This paper is an interim part of the research project under progress. The feedback from this paper will help in improving the research work.



Figure 2:- City Bus Route Map



Figure 3:- Metro Service Map

2. Social Exclusion

Social exclusion is a process, which causes individuals or groups, who are geographically resident in a society, not to participate in the normal activities in that society (Burchardt et al, 1999). Social exclusion is a dynamic and multi-dimensional process, in which various forms of exclusion are combined; whereas these different forms of exclusion are participation in decision-making and political processes, access to employment and material resources, and integration into common cultural processes (Madanipour et al., 1998). The different dimensions of social exclusion are physical exclusion, geographical exclusion, exclusion from facilities which is based on the location or on the nature of the facilities themselves, economic exclusion, time based exclusion, fear based exclusion, and space exclusion (Church et al. 2000; Graffon et al, 2001). Kenyon et. al., (2002) described more wide range of dimensions which are economic, living space, mobility, organised, personal, personal political, social networks, societal, and temporal. Department for Transport (DfT, 2000a) has defined this term as people are excluded from the activities they wish to undertake either spatially, temporally, financially, and personally.

People also experience exclusion on the basis of the failure of public service or due to their expectations and capacity i.e. the gap between what they want to do and what they can do and on the basis of the spectrum of deprivation. Spectrum of deprivation highlights relative exclusion i.e., it is not just an individual with a society that experience social exclusion, but in fact everybody within the society may experience some level of segregation on multi dimensional scales of social exclusion. Public service failure refers to the failure of a system due to which individuals or communities experience social exclusion (Lyon, 2003). Systems impose externalities on other individuals and system due to actions which they take. These externalities are due to inefficiency of the system because they do not minimise the social cost of their actions (Ferrari, 1999).

3. Role of Transport in Social Exclusion

Public transport is highly significant in influencing the extent of social exclusion (Hine et al., 2003; SEU, 2003) as it serves several critical functions for individuals and communities (Solomon, 2000).

Transport can serve socially, economically and have direct mental, health and symbolic benefits for the individuals and communities (Miller, 2005). Transport not only contributes to provide access to work, education, healthcare, food shops, social, cultural and sporting activities but also highlights the impact of traffic on deprived communities, particularly on the numbers of road traffic accidents and child pedestrian casualties (SEU, 2003). Social exclusion is a function of transportation system designed to help people participate in activities distributed over space and time.

Public transport manipulates social exclusion in two ways. Inadequacies in transport provision create barriers and limits individual and groups to participate in the activities such as employment, health, education, etc. inadequacies can be due to network link between transport provision and activity participation and are strengthened by the constraints imposed by transport system. The second aspect refers to the operation of the transport system which generates detriments in terms of environmental, aesthetic and social externalities on certain individuals or group as compared to others (SEU, 2003; Witter, 2007; Miller, 2005).

The quality of a public transport system depends mainly on the configuration of its network. Change in transport network affect the level of social exclusion (Witter, 2007). Three types of process influence the relationship between transport and social exclusion. These are 1) nature of time-space organisation in households, 2) the nature of transport system and 3) the nature of time-space organisation of the facilities and opportunities individuals are seeking to access. Nature of these processes differs with respect to gender, age, cultural background, level of accessibility and economic circumstances (Hine et al., 2003). Different categories of exclusion associated with transport are identified by Church et al. (2000, 2003) are;

a. Physical exclusion when physical barriers inhibits the accessibility of services

b. Geographical exclusion when poor transport provision and resulting inaccessibility can create exclusion both in urban areas and in rural areas

c. Exclusion from facilities when distance of facilities is not adequate

d. Economic exclusion due to high monetary cost of travel which prevent or limit access to transport

e. Time based access which refers to the time constraints both in terms of availability and affordability

f. Fear based exclusion which refers to insecurity due to worry, fear or terror influencing the usage of public transport and spaces related to it

g. Space exclusion when security space management can discourage excluded individuals from using public transport spaces

The process of social exclusion is coupled with urban design and transport whereas these links depend on accessibility, spaces that exclude and on the facilities that enable or afford movement. Therefore it is vital to coordinate and monitor transport service and its provision as poor transport results in inaccessibility that can exacerbate social exclusion (Hine et al., 2003). Relation of transport and social exclusion pinpoints lack of accessibility as an important factor contributing towards exclusion. Improvement to public transport accessibility will only address the transport inequalities experienced by individuals and groups whereas it is also equally important to assess the direct and indirect role of transport in the process of exclusion (Witter, 2007).

4. Measurement of Social Exclusion

To measures social exclusion, it is necessary to understand and monitor the process of social exclusion and identify the factors that can cause entry or exit from situations of exclusion rather then counting numbers of excluded and describing the characteristics of socially excluded (Walker

1995). Being a complex concept, social exclusion, therefore requires careful measurement especially when analysing policy and decisions regarding the allocation of infrastructure, monies or services. Measurements of social exclusion typically include attributes such as employment, public assistance, education, health and available services at some level of geographic aggregation such as census or political or administrative units (Miller, 2005, SEU, 2003). Social exclusion can be measured through accessibility audit which include Geographical Information System (GIS) based mapping of socio-demographic, transportation information and deprivation data or by consultation and liaison with local communities, service providers and professional. This also involves utilization of skills and knowledge of the community transport sector and other community networks (Titheridge, 2004). All the approaches and methodologies used to measure social exclusion try to capture the multidimensional aspect of the exclusion but are not focused on the salient dimension which exacerbates social exclusion (Silver et al, 2002).

In Northern Ireland, Northern Ireland Statistical Research Agency (NISRA) have published Noble index of deprivation. These indexes highlight the level of deprivation in different wards of Belfast (NISRA, 2001). Other studies such as index of Multiple Deprivation (IMD) 2004, 2007 in England developed by University of Oxford for department of environment transport and the regions (DETR) highlights areas of deprivations. Pennycook et al., (2001) in their study for Friends of Earth in Bradford district matched data sets such as car ownership, bus availability, traffic volumes and deprivation in GIS to pinpoint areas with multiple problems in access to services and affirmed that negative traffic impacts are concentrated in more deprived areas. They also stressed on the use of cost, frequency of the service to be used to as measure of social exclusion. Spatial analysis of census data and findings from focus groups i.e., older women, sole parents and young unemployed people is used by Hurni, (2005) to investigate the distribution of transport disadvantage locations across Sydney metropolitan areas to measure accessibility.

4.1. Underpinning Idea of Social Exclusion and Transport - Accessibility

The fundamental concept behind social exclusion and transportation is that groups within society become excluded due to inaccessibility from vital facilities and services due to inadequate access to transport (SEU, 2003; Hine et al, 2003). Inadequate access limits the groups and individuals to participate fully in society. Access and social exclusion are interconnected through a coherent discourse in which resources such as money car etc are required to reach essential destinations and is core to the individual capacities. Access is also influenced by the nature of time- space organisation in the household, by the nature of the transport system and by the nature of time-space organisation of the facilities and opportunities individuals are seeking to access (SEU, 2003; Cass et al., 2005).

Access refers to the means or opportunity to approach or enter a place, the right or opportunity to use something (Soanes and Stevenson, 2006). Cass et al., (2005) described four dimensions of access i.e. financial, physical, organizational and temporal dimension but considering them separately does not mean that they are separate from each other (Church et al., 2000). In fact these entire dimensions are dependents on each other. Deficiency in any of these dimensions will result in lack of access. Accessibility, derivative of access is defined as measure of the capacity of a location to be reached by, or to reach different locations. Accessibility concept not only include the transport link between the origin and destination, objectives of the trip and the ability of travelling by the target group, but also the potential for interaction which is influenced by the qualities of the land use system i.e. characteristics of the origin and destination. (Rodrigue et. al., 2006; Jong and Ritesma van Eck, 1996; Handy and Niemeier, 1997; Straatemier, 2007).

Accessibility promises to be a useful tool for measuring social exclusion, the performance of transportation system, and assessing and valuing the benefits of proposed changes to network (Levinson et al., 2006). Measuring accessibility requires the knowledge of levels of interactions at destinations and impendence of attraction as these both are important components of accessibility. Impedance can be described as either distance or travel time or cost between the locations i.e. origin and destination. Different measures have been used to measure accessibility (Hilber et al,, 2004; Levinson et al., 2006; Geurs, K.T. and Ritsema van Eck, J.R., 2003; Handy and Niemeier, 1997). These are as follows:

- Infrastructure Based Measures are developed on the performance of the transport system and describe level of service of transport infrastructure

- Activity Based Measures describe the level of access to spatially distributed activities

- Geographical Measures represent accessibility of a location to all other potential locations
    - Potential measures refer to accessibility on the macro level in which activity points are weighted by the necessary travel time i.e. potential to these points

    - Isochrones or contour measures indicate the number of activity points accessible within a certain period.

- Time Space Measures reflect the potential of activities which can be participated by an individual in a defined time space constraint

- Utility based measures consider individual behaviour characteristics in terms of location selection and focus on the benefits i.e., economic benefits which people derive from access to spatially distributed activities

Traditional accessibility measures i.e., infrastructure based accessibility measures, potential measures, isochrones or contour measures and utility measures also classified as placed based accessibility measures require the presence of individuals at certain place. People based accessibility measures i.e., Space time measures are more focused on distribution of individual in time and space as one person can be at different place at the same time (Levinson et al., 2005). Department of Transport classified accessibility measures in quantitative measures i.e., access measures, threshold measures, continuous measures, and origin and destination measures and in qualitative measures i.e., surveys, in-depth interviews and travel diaries.

Straatemier (2007) affirmed that accessibility can be measured at different geographical scales by simple accessibility measure i.e., cumulative opportunity measures which can help planners and policy makers to develop and design integrated transport and land use policies. Practical implementation of various accessibility measures can be estimated through distance or time either by straight-line distance, network models or through field surveys of the actual driving time and of perceived travel time (Handy and Niemeier, 1997). Also accessibility measurement framework includes measures of absolute access, gross access, and closet assignment access, single and multiple activity access, probabilistic choice access and relative access (Church et al., 2003). Jong and Ritsema van Eck (1996) proposed alternative potential measures based on the concept of location profile avoiding problems associated with potential values to measure accessibility. Thevenin (2001) proposed examples of space-time analysis of public transport network of Beasancon city through discrete modelling of service time. Number of jobs and opportunities that can be reached within a certain time period from all residential areas in the city of Växjö, Sweden by comparing car, public transport and bike as mode of transport for accessibility measurement through GIS was proposed by Lyborg (2000). Zone to point measures are used by Makri and Folkesson (1999) to estimate accessibility for various type of opportunities for different roads users through network analysis applying shortest network distance approach in GIS. Reneland (1999) examined the distances i.e., theoretical and air distance from housing areas to certain destinations for accessibility measurement. Potential, activity based accessibility measures incorporating traditional land-use and transport data improved the inter portability of the accessibility results by estimating influence of land-use changes, infrastructure projects, and congestion separately on the development of job based accessibility in a case study of the Netherlands (Geurs and Eck, 2003).

4.2. Limitations of Accessibility Measures

Accessibility analysis involves formulating the idea of accessibility, selecting or developing appropriate accessibility measures or indices, identifying the accessibility measures, assessing accessibility using the selected or developed measures and presenting and interpreting the assessment results (Liu and Zhu, 2004). But different accessibility measures are associated with

limitations also; therefore it is important to consider these limitations before selecting an appropriate accessibility measure. Infrastructure based measures do not consider the variation in the quality of locations. These measures are deficient in considering the behavioural aspect of the travellers i.e. how they prefer one location over the other (Baradaran and Ramjerdi, 2001). Activity based measures are sensitive to travellers with dispersed preferences. Travel time is considered potential among the different zones, which can affect accessibility results. All people in one zone are considered equal in terms of accessibility whereas people may have different accessibility requirements due to disability. The question of access is also related with the question of disability (Cass et al., 2005). Utility based measures demand extensive data and are based on the benefits i.e. economic. It is difficult to model the benefits which have varying significance in view of different travellers in case of absence of a metric unit i.e., money. Space Time measures assume a constant speed in all directions which is not realistic. Variable speed makes the accessibility assessments complex. The activity schedule also does not consider the whole range of activities. Travel times within a transportation network are variable due to congestion so a constant time frame is difficult to achieve. There is no clear statement regarding which method is to be used. Selection of the method depends on the question of what is being measured. Placed based accessibility measures can be used to measure city level accessibility and people based measures can be used to measure individual accessibility (Levinson et al., 2006).

GIS has proved to be a useful tool to measure accessibility. It simplifies city into points of origins and destinations, where potential measurements can be done easily. These simplifications should be performed carefully. It is important to classify the land use to lowest hierarchy unit in GIS modelling to cover the problem of aggregation which affects results. The higher the disaggregation the better will be the results (Berglund, 2001, Lyborg 2000).

Domains developed in different measures of social exclusion (Nobel Index of Deprivation in Northern Ireland, 2001; Index of Multiple Deprivation in UK, 2004, 2007) are deficient as none of these domains have used indicators which are directly related to public transport or car ownership. Geographical access distance to facilities i.e. GP, Health centre, jobs and employment outlets related to access is the only indicator used. Straight line distance or 'as the crow flies' distance is usually used to examine accessibility which is a most common error in GIS. The most appropriate method will be to measure distance along network as people usually travel in cities using roads and streets (Levinson et al., 2006, Hine et al., 2003). Integration of transport network with other data layers is necessary in GIS to avoid straight distance error.

Accessibility measures lacks in terms of subjectivity as they do not highlight the reasons due to which the groups are excluded and how individuals make decisions regarding trade offs which they make in terms of travel choice to activity spaces. These measures are also unable to assess the individual's disabilities which hinder in their accessibility to facilities and services. People also feel excluded due to the facilities such as bus stops and buses if these facilities lack features which help them in their accessibility to network. Accessibility measures are insufficient to count the accessibility hindrance offered by the transport infrastructure. Therefore, analysis of the bus stop and buses especially in terms of their features require qualitative assessment. Social exclusion is a dynamic and multidimensional process in its nature so it is important to consider both objective and subjective measures for its assessment.

5. Methodology

The methodology for the research work is based on the suggestions by Titheridge (2004). According to suggestions social exclusion can be measured through accessibility audit which may include

- Geographical Information System (GIS) based mapping of socio-demographic, transportation information and deprivation data
- Consultation and liaison with local communities, service providers and professional. This process also involves utilization of skills and knowledge of the community transport sector and other community networks.

Considering the subjective and objective nature of exclusion it is most desirable to integrate both the suggestions. The methodology covers both the objective and subjective nature of the social exclusion phenomena. The methodology involves empirical analysis through multi-layered GIS based model considering the demographic data, transportation data, and land use data. Transport deprived areas are identified through empirical analysis. Questionnaire survey is the second part of quantitative assessment. It will help in analyzing the performance of the transport system and highlighting its contribution in social exclusion. Qualitative investigation in the deprived areas will explore experience of the groups and how they perceive impact of the transport network in their lives. An integrated qualitative and quantitative approach is presented below in figure 3.

The methodology is composed of four steps. Data retrieval, the first step includes collection of data from secondary data sources such as census data base, transportation and land use data base and selecting appropriate data indicators for the accessibility audit. The second step of accessibility analysis involves spatial and network analysis of the data in GIS. Geo processing is to be used to overlay the data layers from spatial analysis and network analysis. The resulting layer will be visualized in 2D and 3D maps which will highlight the transport deprived areas. Questionnaire survey is the fourth step which will assess the transport system and the levels of social exclusion offered by it. The last step involves qualitative assessment through In depth interviews. It is necessary to assess the trade offs made by the groups in terms of activity location choice and also for the penalties faced by them in terms of cost and time due to network change.

It is essential to assess both the objective and subjective aspects of the social exclusion. Objective aspects refer to the measurable level of the deprivation whereas the subjective aspects refer to the causes due to which groups or individuals feel excluded within the society. GIS modelling and questionnaire survey i.e. qualitative assessment encompasses the objective aspects of the social exclusion. In depth interview encompasses the subjective aspect of the phenomena.

This paper is produced and circulated privately and its inclusion in the conference does not constitute publication.

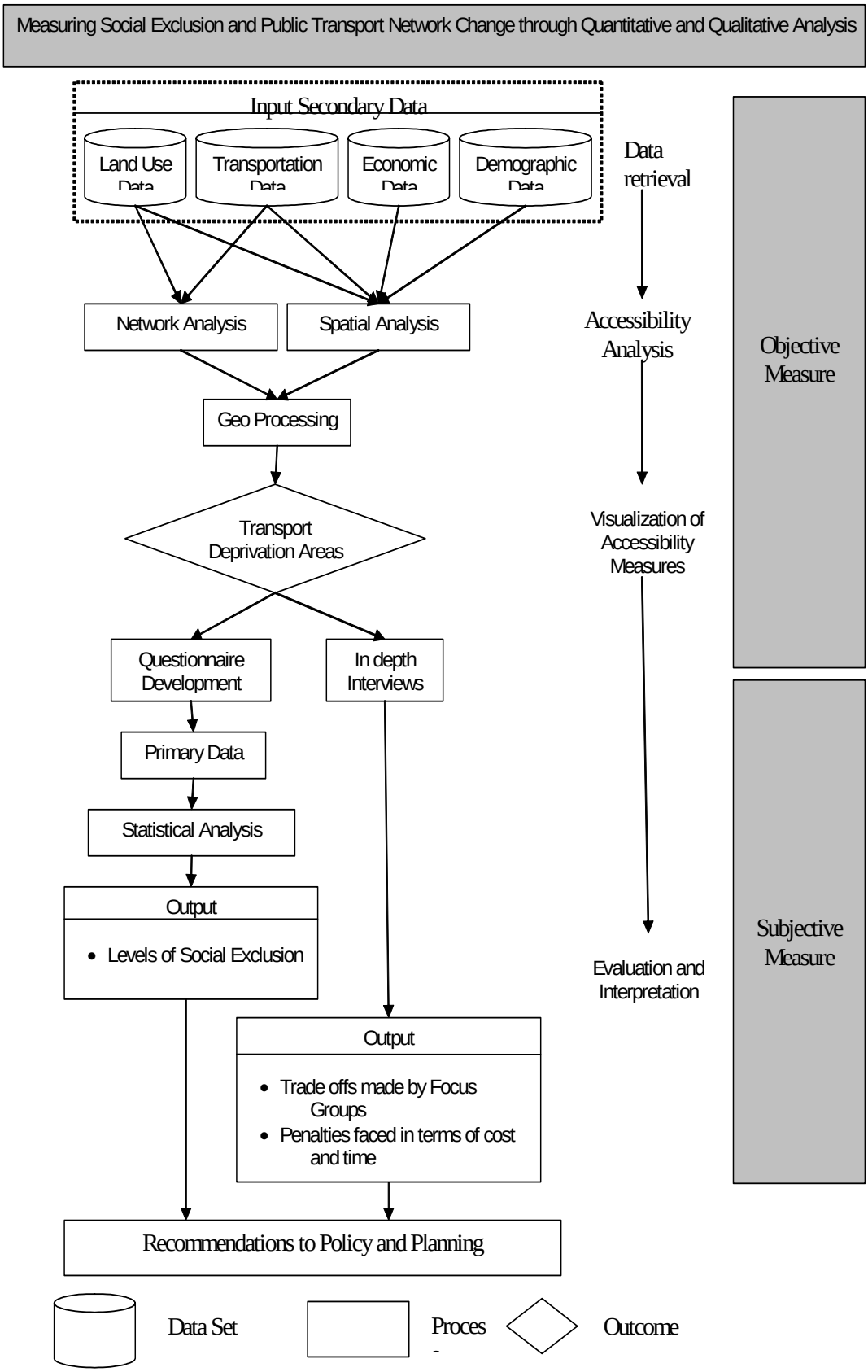

Figure 3:- Integrated Qualitative and Quantitative Approach for Measuring Social Exclusion

6. The case of Belfast City

Belfast is the capital of Northern Ireland and fifteenth largest city in United Kingdom. The population within the urban city limits was 276,459 according to the 2001 census where as the total population in Belfast Metropolitan Area (BMA) was 579,554. The city has an extensive road network and is dependent on car for journey completion. 77% of all journeys in the city are made by car where as only 11% are made by public transport (NISRA, 2001). Pedestrian constitute 6% in the journeys. According to 2001 census 393 cars per thousand of population were available which is high in comparison to other cities in UK (NISRA, 2001). The bus system in Northern Ireland is not de regulated as it is in rest of UK under the 1985 Transport Act. Northern Ireland Transport Holding Company (NITHC) operates bus and rail public transport services in Belfast under the group name Translink through three subsidiaries Metro Service (formal City Bus), Northern Ireland Railways and Ulster Bus. City Bus formed in 1973 operated 60 different routes in Belfast. It was transformed in to Metro service in 2004 and 12 quality bus corridors (QBCs) replaced the routes of City Bus. Better access and connectivity to upgrade the deprived areas was the aim of the transformation. Litman (2004) stated that selection of appropriate indicators is important for analyzing social exclusion as they are important for evaluating conditions and impacts that are difficult to quantify, which is true for many indicators associated with social exclusion. The above stated methodology is used to assess the impacts of transformation on level of exclusion in Belfast city while considering the following important indicators shown below in table 1:-

Data Set	Indicator
Land Use Data	Enumeration District
	Bus Stop Location
Demographic Data	Population Density
Transportation Data	Bus Routes
	Frequency of Bus Service
	Passenger Car Density
	Access Distance to the Bus Stop
	Bus Fare

Table 1: - Indicators used as Input Index Data

In the land use database the lowest spatial unit available for the Belfast city is Enumeration District. These are used for analysis. It will also cater the problem of zoning or aggregation in GIS. The other important indicator considered in land use is bus stop location. The change in transport network makes bus stop an important entity as they serve as access and exit point to the activity spaces and transport network. New Metro QBC have been developed which have replaced the old routes of City Bus with new stops. Considering all the bus stops will help in highlighting all those areas which are either included or excluded from the network. The access distance is important as it is overlaid with the existing road network to highlight all the access roads and activity areas which have gone under deprivation. Access roads link activity areas with public transport through bus stop. Department for Transport (2005) have defined access distance limits which are used as access distance to the stops. These are shown in table 2 below:

Social group	Recommended distance limit without a rest
Normal Individuals	400 m
Wheelchair users	150 m
Visually impaired	150 m
Mobility impaired using stick	50 m
Mobility impaired without walking aid	100 m

Table 2: Recommended Distance Limit without a Rest for Impaired Group – DfT, (2005)

Previous studies (IMD, 2004; Peenycook, 2001; Hurni, 2005) considered access distance of 400 to 800 meter to the activities spaces. The approach is not adequate as this access distance is appropriate for normal human beings whereas individuals with disability can not cover this distance. Elderly and disabled people make a significant part of Belfast population and use bus more in Belfast. Therefore access distance for these people as started by DfT mentioned in the

table above will be used to assess their transport disparities. Demographic data is derived from 2001 census. Population density for every particular social group in every enumeration district is to be considered. It is important as individuals belonging to a social group can be clustered in an enumeration district or they can be scattered in more district. In case of social group clustering in one region, improvement in transport service is the appropriate arrangement to eliminate exclusion but when groups are scattered in regions it is important to consider the reasons of their exclusion (Hine et al., 2003). In the case of Belfast city, segregation due to political conditions has clustered social groups in different zones. Therefore precise demographic statistics are vital for defining excluded areas.

Location of bus stop in an area alone does not guarantee the availability and efficiency of the service. Due to change in the transport network, Belfast has lots of stop which are although connected with network but have low frequency on the route. Frequency of the transport network varies within the whole week i.e., the headway between the buses largely increases on weekends. It is therefore important to consider the frequency on all routes especially on week ends when people may experience temporal exclusion. Frequency of the bus network will also help in estimating the service quality offered by both the network i.e. City Bus and Metro Service. This will highlight the role of transport itself in social exclusion. Belfast city is highly dependent on cars. People use car to complete and perform their activities but cars are not available to all the household members. One or two person has access to car whereas the other members of the family can be deprived in terms of access. Passenger car density will be used as other transport indicator. Transportation network in Belfast have variable fare which is charged as per peak and off peak hours. Bus fare will be used to assess the affordability of the individuals although this will require due consideration will assigning utility values during the analysis in GIS.

Both the network i.e. the old City Bus network and new Metro Network will be assessed through quantitative analysis and areas of deprivation due to change in transport network will be identified. Further qualitative assessment through questionnaire will be carried out to assess the levels of exclusion offered by the transport system. It is important as it will highlight the multi dimensional aspects of exclusion. In depth interviews will be then carried out in focus groups which will help in studying focus group's opinion about the network transformation. How they are penalized in terms of cost and time and what trade off they make in terms of activity choice and travel modes.

7. Conclusion

The configuration of the transport system affects the process of social exclusion as transport system either exaggerates social exclusion or it helps in initiating the process of exclusion. To assess the objective and subjective nature of the social exclusion and its relation with transport, it is important to consider a methodology based on both qualitative and quantitative analysis. Accessibility audit alone without qualitative assessment is not sufficient to address the multidimensional aspects of social exclusion. The above methodology provides planners a tool to tackle the issue of social exclusion. Belfast has historically experienced social inequalities. The methodology will help in addressing the policy issues and providing better connectivity in the city.

8. References

Baradaran, S., Ramjerdi, F. 2001, "Performance of Accessibility Measures in Europe", *Journal of Transportation and Statistics*

Berglund, S. 2001, *GIS in Transport Modelling*, Royal Institute of Technology.

Burchardt T., Le Grand J., & Piachaud P 1999, "Social exclusion in Britain 1991-1995", *Social Policy and Administration,* vol. 33, no. 3, pp. 227-244.

Cass, N. Shove, E., and Urry, J. 2005, "Social Exclusion, Mobility and Access", *Sociological Review,* vol. 53, no. 3, pp. 539-555.

Church, A., Frost, M. & Sullivan, K 2000, "Transport and social exclusion in London", *Transport Policy,* vol. 7, no. 2, pp. 195-205.

Church, R.L. and Marston, J.R 2003, "Measuring Accessibility for People with a Disability", *Geographical Analysis,* vol. 35, no. 1.

Levinson D.M., and Krizek K.J., (ed) 2005, *Access to Destination*, First edn, Elsevier Ltd., Oxford, UK.

Department for Transport 2000a, *Social Inclusion and the Provision and Availability of Public Transport*, The Stationery Office, London, London.

El-Geneidy, A.M., Levinson, D.M., May 2006, *Access to Destinations: Development of Accessibility Measures*, National Technical Information Services, Springfield, Virginia.

Ferrari, P. 1999, "A Model of Urban Transport Management", *Transportation Research Part B,* vol. 33, pp. 43 - 61.

Gaffron, P., Hine, J.P. Mitchell, F 2001, *The Role of Transport in Social Exclusion in Urban Scotland: Literature Review*, Scottish Executive Central Research Unit, Edinburgh.

Geurs, K.T., and Ritsema van Eck, J.R., 2003, "Evaluation of accessibility impacts of land-use scenarios: the implications of job competition, land-use, and infrastructure developments for the Netherlands", *Environment and Planning B: Planning and Design,* vol. 30, pp. 69 - 87.

Handy, S.L. and Niemeier, D.A. 1997, "Measuring accessibility: an exploration of issues and alternatives", *Environment and Planning,* vol. A, no. 29, pp. 1175-1194.

Hilber, R & Arendt, M 2004, "Development of accessibility in Switzerland between 2000 and 2020:first results", *conference on spatial issues and transport*Swiss Transport Research Conference, Monte-Verita, Ascona, Switzerland.

Hine, J. & Mitchell, F. 2003, *Transport Disadvantage and Social exclusion,* Ashgate Publishing Limited, Hampshire, England.

Hurni, A., 2005, "Not welfare on wheels: relationships between transport, accessibility and wellbeing", *Looking Back, Looking Forward*University of New South Whales, Sydney, Australia.

Rodrigue J.P., Comtois, C., Slack, B., 2006, *The Geography of Transport Systems,* 1st edn, Routledge, Oxon.

Julian Hine, Margaret Grieco 2003, "Scatters and clusters in time and space: implications for delivering integrated and inclusive transport", *Transport Policy,* vol. 10, no. 4, pp. 299-306.

Kenyon, S., G. Lyons and J. Rafferty 2002, "Transport and Social Exclusion: Investigating the Possibility of promoting Inclusion through Virtual Mobility", *Journal of Transport Geography,* vol. 10, no. 3, pp. 207-219.

Lyborg, L. 2000, *Towards Accessibility Planning by means of GIS, Master Thesis*, Lund University.

Lyons, G. 2003, "The introduction of social exclusion into the field of travel behaviour", *Transport Policy,* vol. 10, no. 4, pp. 339-342.

Madanipour, A., Cars, G. and Allen, J 1998, *Social Exclusion in European Cities,* Jessica Kingsley Publishers Ltd, England.

Makrí, M. and Folkesson, C. (1999) Accessibility Measures for Analyses of Land Use and Traveling with Geographical Information Systems. Proceedings of 2nd KFB-Research Conference, Lund Institute of Technology, Lund. www.tft.lth.se/kfbkonf/4Makrifolkesson.pdf

Miller, H.J., 2005, May 5-last update, Social Exclusion in Space and Time. Available: http://64.233.183.104/search?q=cache:vaSGMcyFMz8J:www.geog.utah.edu/~hmiller/papers/social_exclusion_space_time.pdf+Social+Exclusion+in+Space+and+Time+Harvey+J.+Miller&hl=en&ct=clnk&cd=1&gl=uk [2008, November 17].

Northern Ireland Statistics and Research Agency (NISRA) 2001, [Homepage of Department of Finance and Personnel], [Online]. Available: http://www.nisra.gov.uk/default.asp.htm [2008, November, 7].

Pennycook, F., Barrington-Craggs, R., Smith, D. & and Bullock, S. 2001, *Environmental Justice; Mapping Transport and Social Exclusion in Bradford*, Friends of the Earth, London.

Policy and Research Unit 2001, *The Development Brief*, Development Department, Belfast, United Kingdom.

Reneland, M. 1999, *The GIS Research Project Accessibility in Swedish Towns 1980 and 1995*, Chalmers University of Technology, Sweden.

Silver, H., Miller M. S., 2002, October-last update, Social Exclusion: The European Approach to Social Disadvantage. Available: http://64.233.183.104/search?q=cache:HEEl7IbNjrYJ:extension.osu.edu/~hcrd/people/staff/Social%2520Exclusion%2520The%2520European%2520approach.pdf+silver+2002+social+exclusion&hl=en&ct=clnk&cd=2&gl=uk [2008, November 17]

Soanes, C., Stevenson, A., 2006, *, The Concise Oxford English Dictionary* [Homepage of Oxford Reference Online, Oxford University Press], [Online]. Available: http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t23.e254 [Ulster University, 2008, June 2]

Social Exculsion Unit (SEU) 2003, *Making the Connections: Final Report on Transport and Social Exclusion*, Social Exclusion Unit, Office of the Deputy Prime Minister, United Kingdom.

Solomon, J. (2000) "Transport and social exclusion," *Proceedings of Seminar of European Transport Conference, Homerton College, Cambridge, 11 –13September,* Association for European Transport, Planning and Transport Research and Computation Education and Research, 141-153.

Straatemier, T. 2007, "How to Plan for Regional Accessibility?", *Transport Policy,* vol. doi: 10.1016/j.tranpol.2007.10.002.

Thevenin T., 2001, "The performance of the public transport system in Time and Space", *6th International Conference on GeoComputation, University of Queensland*University of Queensland, Brisbane, Australia.

Titheridge H., 2004, *Social Exclusion and Transport Policy*, Research Report edn, Centre for Transport Studies, UCL (University College London), London, UK.

Litman T., April 4, 2003, "Social Inclusion As A Transport Planning Issue in Canada", *Transport and Social Exclusion G7 Comparison Seminar*Victoria Transport Policy Institute, London.

Tom de Jong and Jan Ritsema van Eck, 1996 1996, "Location profile-based measures as an improvement on accessibility modelling in GIS", *Computers, Environment and Urban Systems,* vol. 20, no. 3, pp. 181-190.

Walker, R. (1995) 'The dynamics of poverty and social exclusion', in G. Room (ed.) *Beyond the Threshold: The measurement and Analysis of Social Exclusion*, pp 103-128, Bristol: The Policy Press.

Witter, R., 2007, "The Role of Public Transport in the Context of Social Inclusion - the Transantiago case", *7th Swiss Transport Research Conference* Swiss Transport Research Conference, Monte Verita / Ascona.

Zhu, X. & Liu, S., 2004, "Analysis of the impact of the MRT system on accessibility in singapore using an integrated GIS tool", *Journal of Transport Geography,* vol. 12, pp. 89-101.