GIS-based evaluation of public facility provision to achieve improved governance and equitable service delivery

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1   ABSTRACT

The use of a GIS-based methodology – Service Access Planning - for assessing service provision and developing facility plans in South Africa to improve governance and equitable service delivery is described. A case study of library investment for eThekwini municipality is used to illustrate the methodology. The South African constitution requires that every citizen be granted access to basic services. In this context it has become a legislated requirement that local authorities in South Africa prepare Integrated Development Plans and develop performance management systems in order to promote development and deliver services effectively. Reporting requirements flowing from this occur in an environment full of pressures relating to insufficient financial and human resources to deal with the quantum of the development challenge, competing political and administrative priorities, and the need to maintain existing infrastructure and at the same time to extend infrastructure into new areas.

eThekwini (Durban), South Africa is a metropolitan area with a wide spectrum of development contexts, wherein the use of Geographic Information Systems to evaluate access to public facilities and the availability of social services – based on agreed provision standards across this range of contexts – has led to improvements in governance and the targeting of capital investment to areas of greatest need. In tandem with the development of service provision standards, the GIS accessibility analysis enables more effective provision, management and monitoring of publicly provided facilities and services. Importantly, this technology promotes a transparent process which is empirically based and so cannot be unduly influenced by political pressures. It also supports the visualisation of results and ongoing reporting on agreed performance indicators in terms of service delivery goals. Short and long term planning for facility development and services provision thus takes place in a framework of shared understanding that allows for the easy recognition of investment priorities within and across district boundaries and for a range of facilities and services.

2   INTRODUCTION

In the South African municipality of eThekwini the use of GIS accessibility analysis – Service Access Planning - to evaluate access to public facilities and the availability of social services, based on agreed provision standards, has led to improvements in governance and has directed capital investment to the areas of greatest need. In tandem with the development of service provision standards, the GIS accessibility analysis has enabled more effective provision, management and monitoring of publicly provided facilities and services, within a transparent process. The methodology applied ensures that the backlog and provision in facilities is based on population distribution and relative shortages and that the process cannot be unduly influenced by political pressures. It also enables visualisation of relative access levels as well as streamlined reporting on agreed performance indicators in terms of service delivery goals. This paper describes the use of the GIS-based methodology for assessing service provision and developing an integrated facility plan which is defensible. A case study of library investment for eThekwini municipality is used to illustrate this methodology.

2.1   Development Context

Development in the eThekwini municipal area is centred on the port city of Durban on the east coast of South Africa. By 2006, eThekwini housed 3.5 million people within an extensive area of some 242 000 hectares, of which only about 40% could be considered urban with a further 10% being made up of densely populated rural settlements. Almost half of the municipal area is thus comprised of sparsely populated rural and farming areas. These areas are extremely difficult and expensive to serve with public facilities and services. The Council of eThekwini, however, strives to establish quality or total living environments for residents with access to a full range of services within reasonable travel times.

The South African constitution requires that every citizen be granted access to basic services. It is therefore a legal requirement that all citizens have access to a basic range of facilities At the moment equitable access in SA is still not a reality due to the legacy of Apartheid-era policies which favoured the residential areas occupied by Europeans or 'Whites' over those inhabited by Africans ('Blacks') or other race groups in so far as public investment was concerned. These policies left a vast amount of the country's citizens without proper access to basic services. In the process of redressing the past the GIS-based accessibility analysis used in this study allows for the identification, in an unbiased manner of, *who* must get *what* type of service, which necessarily results in *where* it must be located geographically. The results of this analysis can then be used in the eradication of backlogs as well as the planning of new facilities. Thus the GIS analysis plays a vital role in *how* the facilities are provided in the broader social and political arena.

3   ESTABLISHING THE WHOM, WHAT, WHERE AND HOW

It is not possible to rely only on the market to successfully regulate the distribution and access of social facilities in an equitable manner and thus the welfare approach is the more appropriate one to follow in the provision of social services, from a developing country perspective. Smith, in Amer 2007, presents the key concept of the welfare approach as being "who gets what, where and how". A key question in respect to facility location is for *whom* the facility is planned, that is the population to be served. Thus the demand targeting and demand estimation in the provision of social facilities and services are crucial. Issues of cultural, economic and social variation in facility use and demand become important considerations. The *what* refers to the service provided and the *where* to the concept of spatial variation, whilst the *how* refers to the broader social and political functioning. These elements are essential components of the accessibility analysis and the defining of provision standards.

3.1   What is accessibility analysis?

The maximum distance people are willing to travel and the capacity of facilities to serve those who reach such a facility using the available transport resources are the key variables to consider in an accessibility analysis. The ability to reach a service is generally governed by a willingness or ability on behalf of the potential user to pay for the trip in terms of time and/or money. In reality, this mainly translates into a maximum distance people are prepared or able to travel, after which the cost of travel exceeds the usefulness of the service to be received and the trip is foregone. The introduction of the concept of range or distance to the provision of social facilities immediately introduces a spatial dimension.

The other concept that requires consideration is the minimum market (population or income) needed to bring about the selling or provision of a particular service. In the provision of free public services, the minimal value (threshold) will not be measured in respect of income or profit but will relate more to the efficiency of providing the service to at least a minimum (viable) number of clients. Thus, setting the distance and threshold standards are pivotal to the outcomes of the analyses. The threshold standard may be a single number (such as 30 000 people per hall) or may be more specific with regard to persons per m^2 of park space or patients per nurse-hour.

3.2   The role of standards in accessibility analysis

Appropriate standards/provision guidelines facilitate service provision and the backlog determination processes and make them more easily quantifiable as well as transparent to decision makers. In this way, a much more equitable provision of services and facilities to diverse communities is likely to occur. The incorporation of comparable and benchmarked standards and guidelines within governance and delivery mechanisms is essential to enable auditable and defensible measurement of progress with respect to service delivery.

Furthermore, space and facility provision standards are extremely useful for longer term planning as they support the allocation and reservation of land for various uses including open space and facilities within a planning area, as well as being a firm guide when communicating with private developers and other tiers of government regarding local planning needs. Most importantly, if there is general agreement on facility standards and guidelines, community meetings and other planning processes are less likely to be conflict-

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ridden and become more productive, resulting in informed decision-making which is compatible with development outcomes in the wider context.

4 APPLYING ACCESSIBILITY ANALYSIS

4.1 Primary characteristics of the accessibility modelling

Certain steps and procedures must be followed in the accessibility modelling to undertake an audit of facility provision and to plan for future developments. The following sections give some insight into the datasets required to do a proper accessibility analysis and the procedures followed in applying the accessibility analysis.

GIS models vary significantly in their manner of computing "access". The model used in this case incorporates the use of transport networks. The advantage of using a road network is that it takes into consideration the topography of the area in question, i.e. a road can only cross a river, cliff or rail line where there is a bridge and where road alignment takes into consideration existing development. Different types of roads also have different speeds/ impedances affecting the movement of traffic. GIS-based software that use only straight line distance cannot take the aforementioned factors fully into account.

The population data, i.e. total population as well as other socio-economic variables (such as age and income which are cardinal when evaluating people's access to transport), is used in the model. A detailed grid (in our case a hexagons grid) is created and used to assign the population data to each polygon.

Social facility data is required and specifically the geographical coordinates of facilities together with attribute data reflecting facility type, use and capacity. The data may be used as point data or assigned to the hexagon layer depending on the level of accuracy required and /or processes to be run.

The Flowmap[1] software which was used in this project simultaneously interrogates the threshold/ supply of a range of facilities in relation to the demand present in an entire study area in order to evaluate access to the facilities using a selected mode of transport on a specified road network. Evaluation and auditing of the supply and demand of facilities is performed within a fine grained spatial context thereby ensuring that results can be used at a detailed level to inform decisions around providing services and facilities in a spatially equitable manner to a specific target group. This is most useful in balancing and planning facility capacity within an area. The model contains further useful capability to assess changes in threshold values, travel cost or time and mode of travel.

4.2 Auditing well served and poorly served areas

Catchment area analysis and proximity counting, which together comprise the catchment-based approach developed for facility auditing, is used initially. Tools for *optimisation* for future investment, re-location, or testing rationalisation options of facilities are then applied as required. The catchment-based approach is specifically designed to assist planners of nodal- or central place-type services and facilities to audit service *accessibility and availability* from the perspective of existing and potential customers, and then to explore and plan ways to achieve a better match between supply and demand, and also achieve the best trade-off between improved service availability, accessibility and thresholds. The catchment area allocation method is essentially aimed at demarcating and distinguishing *well-served areas* from *poorly served areas*. The allocation process is based on the assumption that people will travel to the closest facility and is highly suitable for strategic distribution of local social facilities even if not all persons use the closest facility to home. The assumption is particularly relevant in this context given that high levels of poverty and unemployment result in limited travel resources for the majority of public facility users.

Following the demarcation and mapping of served areas, the poorly served areas are analysed to establish locations for new or expanded facilities or services. The density of the unserved demand is mapped and

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[1] www.flowmap.geog.uu.nl

analysed using proximity counting. This enables a visual identification of centroids of unserved geographic areas. This procedure does not prioritise locations but when, maps are made using carefully chosen intervals, they are suitable for a 'first cut' to identify the total area of shortfall and for identifying all sites where there is sufficient demand to support a selected facility within the travel distance requirements. In some instances, this is sufficient to inform planning; however in an environment of constrained resources the process is used, together with the available capital budget, to identify an appropriate number of facilities that can be developed in the medium term. The optimisation routine is then used to select the most optimal sites to impact on the greatest number of people within the limit.

4.3 Determining prioritised and optimal locations for interventions

The optimisation routine selects the most optimal sites up to a limit set by the user. This number is generally determined by the available resources to spend on providing certain facilities. The software seeks out the optimal placing for these possible new facilities, based on the principle that the maximum number of people possible – who are not currently served by an existing facility – will be served by these facilities.

Where sufficient demand for an entirely new facility cannot be achieved (within the set distance or time variables) in the poorly served areas, other options need to be considered to meet the demand. These may include questions of whether:

- existing facilities can be increased in size or operational capacity, i.e. an extension of operating hours;

- longer access travel times should be accepted; or,

- facilities can be relocated or shared with other sectors, or private sector partnerships entered into.

The output of the analysis is produced in the form of spatial outputs (maps), as well as output tables. These can be used to develop statistics of the study area or sub-areas with respect to facility backlogs (numbers). The numerical outputs can then be used in conjunction with the spatial outputs to motivate for changes in service levels and/or facility numbers for that particular sector.

5 THE CASE STUDY: PUBLIC LIBRARIES IN ETHEKWINI

The application of GIS-based accessibility modelling for the audit of current access to libraries and identification of backlogs in eThekwini is discussed as a good practice example. This includes the process followed by the eThekwini Council to report on delivery and spatially prioritise social infrastructure and investment of public facilities based on an agreed set of standards.

5.1 Application of the Service Access Planning Methodology

CSIR's Service Access Planning methodology was applied to test library access and sufficiency of capacity in relation to the population for the entire metropolitan region.

The objectives of the analysis were fourfold:

- to test the current supply of facilities with respect to the set standards and review these with respect to current performance and affordability of new facilities;

- to evaluate and visualise the current supply versus demand coverage, i.e. to understand the quantum and location of backlogs in service delivery;

- to seek new locations for facilities using an optimisation routine; and,

- to test the viability of any facilities being proposed in terms of the eThekwini 2008/9 to 2010/11 draft capital budget.

Operationally library services are provided by both local and provisional government. Discussions were held with the library services staff to establish essential key variables required as input into the model. The variables were chosen to reflect as closely as possible actual conditions and are based on agreed policies and standards.

A catchment analysis was undertaken for libraries along with 13 other facility types. Table 1 outlines the analysis criteria for libraries.

Table 1: Data and analysis criteria for libraries

Facilities analysed	All operational libraries (84 in total)
Demand	Entire city with two sets of population figures: Total population (2006) Total population (2006) plus adjustments for future increase in population based on proposed low-cost housing plan

Supply	Three scenarios were tested:
	
	   a. The 84 current libraries for 2006 population
	   b. The 84 current libraries plus optimal locations for proposed new libraries (8 urban and 3 rural) to serve the 2006 population
	   c. Same as (b) above but to serve the population adjusted to include the impact of the proposed low-cost housing projects

Travel mode and time	Public transport – up to a maximum travel time of 15 minutes

The analysis performed comprised:

1) constrained catchment area analysis – where the total demand was allocated to the nearest facility with capacity (fixed) within 15 minutes travel time;

2) a proximity count of unserved demand at 10 minute concentration; and

3) optimisation for 11 new facilities for two population scenarios, i.e. current population as well as a future population distribution that incorporated the impact of the medium term public (low income) housing development plan.

5.2 Results of the library accessibility modelling

The initial optimisation analysis which sought to locate 8 new facilities to serve the major part of the population backlog resulted in all new facilities being located in urban areas. To meet developmental goals it was decided to seek in addition the 3 best rural locations, but to allow the model a longer travel time (30 minutes) to allocate unserved people to the selected sites. The strategy for library service delivery in rural areas (where settlement density is very low and road infrastructure is limited) is to develop a limited number of regional type libraries at nodal points rather than smaller decentralised facilities which would have a higher total capital and operating cost.

Several sets of results were derived from the analysis namely:

1) accessibility of the current libraries to the current (2006) population;

2) optimal locations for 11 new libraries for the current population and the future 2010 population;

3) accessibility of population to current libraries plus 11 optimally located future libraries for each population scenario; and

4) a proximity count of still unserved demand after the addition of new facilities.

There were minor differences in the geographical locations of proposed libraries for the two population scenarios due to population (and hence demand) shifts. Only the results of the longer term (i.e. 2010 scenario) will be discussed here and shown on the map. The statistics presented in the tables that follow are all for 15 minutes maximum access travel time. However, the location of the 3 proposed *rural* libraries were selected based on the maximum number of people which could be served within 30 minutes of the new locations; since low population densities, budget constraints and operational considerations dictated the development of fewer but larger libraries in such areas.

For the purpose of policy formulation, reporting on accessibility statistics and implementation, the eThekwini municipal area was classified into three settlement types namely Urban, Rural and Dense Rural (Green, Morojele & vd Merwe 2006).

Table 2: Accessibility statistics for 84 current and 11 proposed libraries optimised for the population, adjusted for the low-cost housing plan and reported by settlement type

	15 min public transport access			
	Urban	Dense Rural	Rural	Total
Average travel time	4.4	10.4	16.2	6.2
Population served	2 918 497	252 291	161 182	3 331 970
% population served	100.0	79.6	42.1	92.1
Land area covered (ha)	94 486	16 128	36 914	147 528
% land area covered	94.6	65.5	31.5	61.0

Table 2 shows that the addition of 11 new optimally located facilities (8 urban and 3 rural) will improve the overall accessibility – within a 15 minutes travel time – from a current 70% to 92% of the population served (2010 population). Although the 3 rural locations are not the most optimal in terms of a city-wide perspective (since there are urban locations which can serve more people), each can potentially be reached by 60 000 currently unserved rural persons within a 30-minute travel time. The map of eThekwini (Figure 1) shows the optimal location for the 11 new libraries.

It is noted that the addition of 11 new facilities is not enough to eradicate the entire backlog. There remains a future modelled backlog in library capacity – that of people living further than 15 minutes from a library. The total remaining backlog of 286 000 persons (approximately 5 libraries) is nevertheless a major improvement on the current situation where the backlog is modelled to be over 1 million people. The demand that remains (after the additional 11 new libraries) is too widely distributed to be served by a facility of significant size (i.e. having capacities to serve more than 40 000 persons) and thus no additional facilities are proposed for implementation in the medium term. Other strategies, such as mobile libraries or outreach programmes, may have to be implemented to serve this dispersed demand. Alternately it may be acceptable for rural people to travel more than 30 minutes to a library and for the municipality to perhaps effect public transport improvements. Some expansion of existing library capacity in selected areas may also be considered where user pressure is evident.
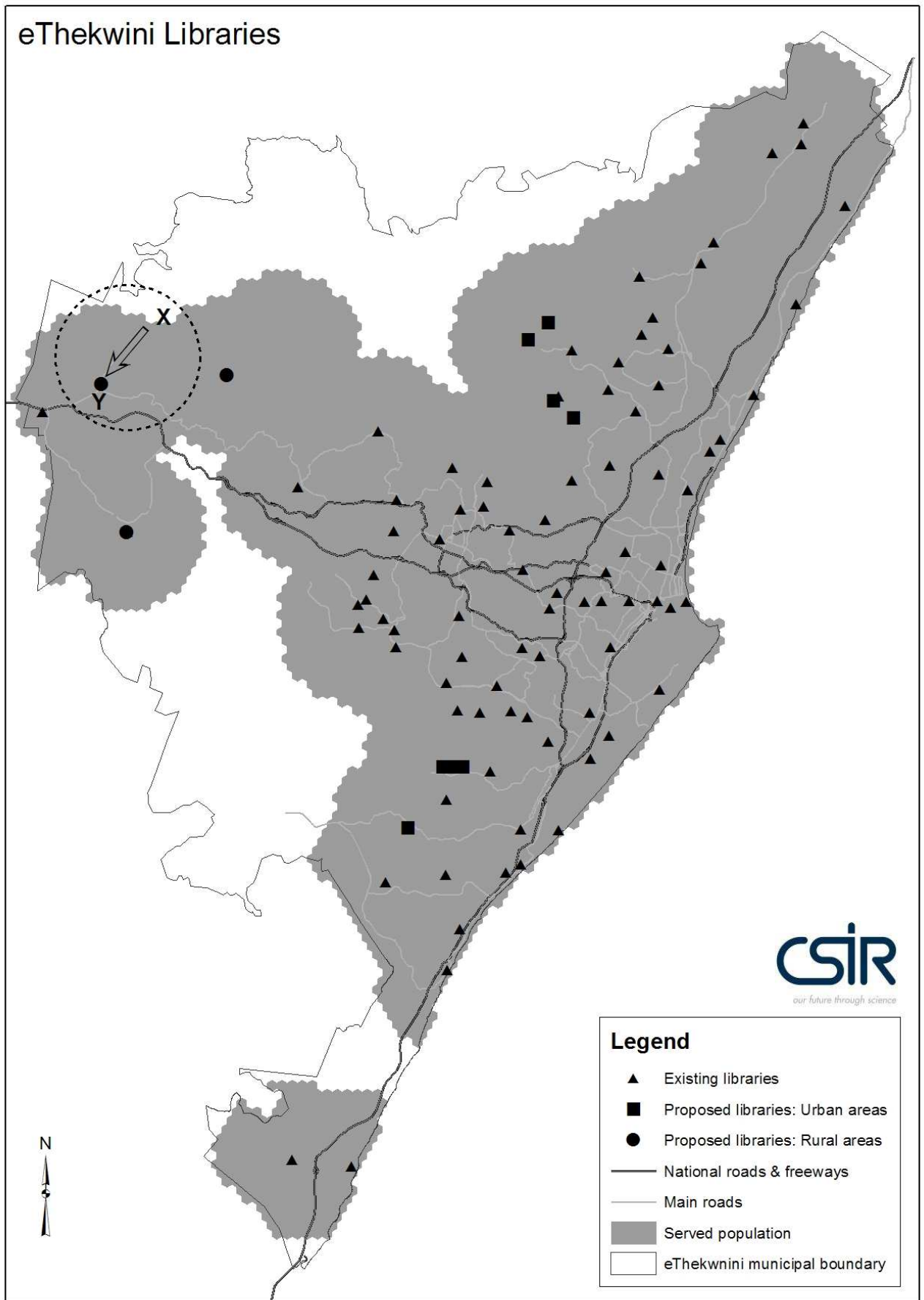
Figure 1: Recommendations with regard to proposed locations for 11 libraries for backlog eradication

6 EVALUATION OF THE SERVICE ACCESS PLANNING APPLICATION

6.1 Usefulness of the results from the eThekwini accessibility modelling

The results of the libraries modelling, as well as that for the modelling of the other facilities, have been used in a number of important areas including:

- **Evaluating requests for new facilities**
  The identified needs act as an empirical base to evaluate requests that originate from municipal departments, the community, and councillors. Indeed, the modelling outputs have influenced facility investment locations in eThekwini. A major impact of the study was the use of its outputs to convince the municipal Rural Area-based Management unit to change the planned location of a new library. The initial site – located in a low density rural area and for which planning was already at the architectural drawing stage – was scrapped in favour of the more accessible location (identified by the accessibility modelling results) in a rural development node. When situated in the new node (marked by an X on Figure 1) 60 000 people can reach the facility within 30 minutes travel, as opposed to the previous site (marked with a Y on the map) which would only have been accessible to a maximum of 20 000 people.

- **Capital budget strategic planning**
  The municipality is embarking on an evaluation of how best to spend its capital budget in order to achieve the outcome of a Quality Living Environment for all residents. Understanding which services are well provided for in comparison to those that have poor coverage allows one to make strategic choices about where to allocate additional funds. Since there is now a Social Facility Plan in place it means that facility provision will have a 'voice' in these budget discussions.

- **Inter-City Budget Forum discussions**
  The Access Model analysis is being used as a means of motivating at the national level for additional grant funding to deal with service backlogs. Having a scientific model adds credibility to one's motivations and puts the municipality 'ahead of the game' in relation to the other South African metropolitan cities.

- **Community participation in determining priorities**
  The outputs of the modelling are used to populate the Ward and Sub-regional Profiles which are then discussed with ward committees to confirm community priorities. In this way priorities voiced by the community, over time, become more strategic since they are informed by good information.

- **Evaluation of new development applications**
  eThekwini is now setting in place a formal system for evaluating all new development applications to ensure that large developments set aside space and/or provide a monetary contribution to off-set the public facility needs of all new large residential development applications.

6.2 Specific successes with regard to the eThekwini Accessibility study

Recommendations derived from the modelling results were largely welcomed by eThekwini and incorporated in the medium and long term planning of the respective service sectors investigated. Some positive aspects of the study, to date, which have not been discussed above include:

- The required data gathering for the modelling resulted in the creation of a central database of facilities which can also be used for other purposes.

- The Municipality can corroborate the results of the modelling with a qualitative assessment of needs obtained from the communities themselves.

- Contribution to the Quality Living Environments strategy through giving support to a well located social infrastructure in the urban fabric and thereby improving service coverage in the most cost effective manner.

- Limiting the construction of 'white elephants' or under-utilised facilities. This is especially relevant given budgetary pressure and competing priorities.

- Added relevance in the planning for integrated service delivery.

- Help in informing the budgetary process for both facility provision and the evaluation of housing projects.

6.3 Costs and benefits of using the models

Notwithstanding the major contribution of the approach and the use of its associated tools, there are some constraints to its widespread use if the facility databases do not exist or are not maintained and updated. All detailed empirical planning approaches, such as Service Access Planning, are reliant on good data.

The use of these types of models is most cost-effective if the activity can be sustained over a reasonable period of time (say 3 to 5 years), and if there is in-house capacity building and technology transfer. Ultimately, much of the potential benefits depend on the capability of staff to interpret the maps and assimilate the report findings to influence facility investment decisions. The process followed in local government to implement the results and ensure that these results impact on capital budget choices are critical steps in ensuring that development needs are addressed in pragmatic, efficient and sustainable ways.

7 CONCLUSIONS

The case study proves how the Service Access Planning methodology and accessibility modelling tools can significantly contribute to achieving a more accessible, and equitable strategic level facility location plan, primarily because of the following:

- The approach and tools provide a defensible empirical base for the determination of facility needs amongst different wards and planning regions.

- The approach enhances the prospect of the integration of sectors in the form of multi-purpose centres or priority investment hubs since a common analysis base is used.

- The approach enables backlogs to be spatially determined in relation to population need. Although theoretical in nature, the model has very successfully identified areas with facility backlogs which have been corroborated by officials. The outputs support the planning of facilities where they are needed and where people live irrespective of ward boundaries and political processes.

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