DECISION SUPPORT SYSTEM FOR THE PLANNING AND DEVELOPMENT OF INTEGRATED FACILITY NODES

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INTRODUCTION

The need for co-location and integrated planning

The provision of anything but a very basic level of service to all areas is not financially possible. This can be attributed to various reasons which include budgetary constraints and the high costs associated with servicing areas that are outside the existing bulk service corridors and which have relatively low local demand densities in relation to the demand thresholds required for the viability of higher-quality services. Thus multi-purpose centres, or ‘one-stop’ shops, are widely regarded as an important means of offering a broad range of services to communities and can be a key delivery mechanism for addressing service provision in areas of need (Green & Morojele 2001). By aligning such centres along a public transport system, it can also be expected that not only will access to basic services be improved but so will the viability of the public transport system.

Aims and objectives

The *e*Thekwini Municipality (formerly Durban Unicity) commissioned a study to identify a multi-facility system that can be developed around public transport nodes. The purpose of this project was to map areas with insufficient access to community social services and to investigate facility investment options that would not only address the needs in poorly served areas, but also support the development of multi-purpose centres around public transport nodes.

By implication, the study is therefore also aimed at identifying ways of promoting an urban structure and a social service delivery system that would enhance the use and viability of the public transport system. This implied overall goal is both in accordance with the Spatial Development Framework for the *e*Thekwini Municipality and the National Land Transport Transition Act (2000). Of relevance to land transport and integrated planning is Section 18(b) of the Act, which states that a municipality should:

> *‘direct employment opportunities and activities, mixed land-uses and high density residential development into high utilisation public transport corridors, interconnected through development nodes within the corridors’.*

The objectives of this study were to:

- map the current level of access for the identified publicly-provided facilities;
- identify the backlogs in public facility provision for these facilities;
- identify suitable location(s) for different facility types for public investment; and
- develop an integrated investment plan for a range of municipal facilities that can be developed as multi-purpose / multi-facility centres at transport interchanges.

ISBN: 0-620-28855-8

Decision support systems

Decision support systems (DSS) are aimed at addressing semi-structured, strategic decision-making problems, and therefore facilitate explorative search and the use of multiple problem-processing methods (Naudé 2001). Thus decision support tools are a means to an end.

THE TOOLS AND PROCEDURES USED

Working in collaboration with Utrecht University in The Netherlands, CSIR Transportek has developed an accessibility modelling spatial DSS referred to as AccessMap. Among the suite of tools available is *catchment area analysis* and *proximity counting*, which together comprise the catchment-based approach that was followed in this study. The advantages of the system include:

- using an actual road network to simulate travel and different transport modes;
- an allocation process that considers the demand for a service in an area as well as the capacities of existing facilities; and
- the link to a GIS to enable visual interpretation and mapping.

Figure 1 provides a summary overview of the objectives of catchment-based analysis and planning, and the key aims of each stage (i.e. the 'analysis' stage and the (explorative) planning stage. It also shows a combined five-step procedure developed by CSIR Transportek for facility auditing and planning.

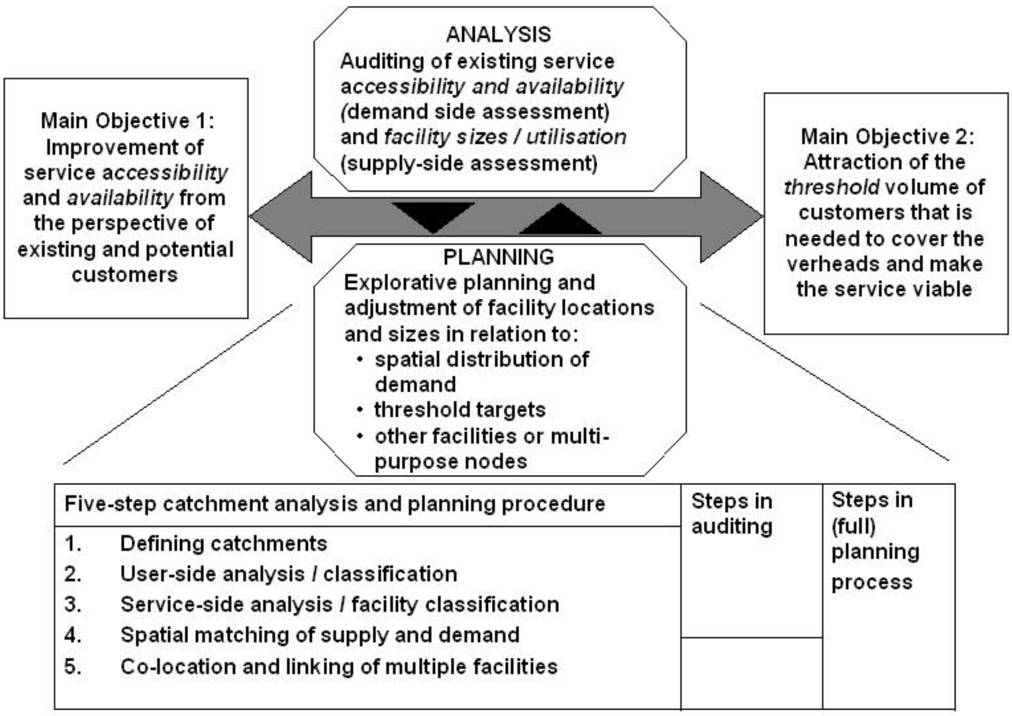

Figure 1: Overview of catchment-based analysis and planning
(Source: Naudé AH, Green CA and Morojele NI 2001)

The catchment-based approach is specifically designed to assist planners of nodal- or central place-type services and facilities with the following:

- auditing of service *accessibility* and *availability* from the perspective of existing and potential customers; and
- explorative search and planning of ways to achieve a better match between supply and demand, and achieve the best trade-off between improved service availability, accessibility and thresholds.

Catchment area analysis

The catchment area allocation method is essentially aimed at demarcating and distinguishing *well-served areas* from *poorly served areas*. This process can be used to develop *access sufficiency* indicators, which provide a combined index of the *accessibility* and *availability* of services to the people in a defined local area. In view of the underlying allocation process, these indicators are however very sensitive to assumptions about maximum access ranges. It is therefore important that these are chosen with care to make the results as realistic as possible.

The results of a catchment area analysis process include:

- demarcated catchment areas for each facility;
- classification of facilities with respect to accessibility, capacity utilisation, and whether or not the minimum threshold target is satisfied (e.g. a threshold target of at least 400 pupils per school); and,
- classification of areas based on existence or sufficiency of access to facilities, and calculation of *coverage indicators* (e.g. indicators of the percentage of the area that has access to an uncongested facility within the specified access range).

Once this process is complete, the areas that do not have sufficient access to facilities can be analysed using the proximity counting approach.

Proximity counting

Proximity counting is an accessibility analysis technique used to highlight locations within a study area that are the most accessible and therefore are potentially suitable for locating services. Such areas can be identified in two ways, either:

- through analysing the total demand in an area, irrespective of current facility provision; or
- analysing only the demand that is poorly served under existing facility provision and access standards.

This latter process, also known as a proximity count of unallocated demand (after a catchment area analysis), can be used to assess potentially viable locations for facilities, where facilities exist, or to identify where capacities could be considered to be increased. This procedure, however, does not take into account a declining demand with increased distance and is therefore suited for facilities with short travel distance requirements.

Basic procedure for a single facility type

This section provides a summary overview of the five-step analysis and planning procedure as set out in Figure 1, focusing on a single facility type such as primary schools, clinics, etc. These are:

Step 1: Defining catchments

The basic purpose of defining catchments is to distinguish between accessible and inaccessible customers – in other words, between those falling within the primary, well served catchment area, and those falling outside. Locations are excluded from any facility catchment *either* because of inaccessibility, *or* because of lack of supply centre capacity.

Step 2: User / demand side analysis and classification

The basic purpose of this step is to improve on, and overcome, the averaging problems associated with simple access and availability indicators (such as density of facilities, or number of facilities per 1 000 people). By applying catchment area analysis techniques, it is possible to locate and map pockets of unserved or poorly served demand, and calculate the numbers involved. Seen from a *planning perspective,* this information is also directly relevant to issues such as the location and right-sizing of facilities.

Service-demanding areas can be distinguished on the basis of their *accessibility* and *access sufficiency*, the relevant classifications being:

- *well-served areas* – where users are within an acceptable access range and facility capacity; and,
- *poorly-served areas* – where facilities could be out of reach or overburdened, and part of the demand cannot be satisfied because of poor access and / or capacity constraints.

The distinction between well-served and poorly-served areas can be used to develop *coverage indicators* for the whole of a municipality, district or facility service area (such as a police precinct). This would typically be expressed in percentage terms, indicating what proportion of the relevant users has sufficient access to the service in question, given certain specified accessibility and / or availability standards.

Step 3: Supply-side analysis and classification

Seen from an *auditing* perspective, the purpose of this step is essentially to supplement the types of information usually generated by facility audits (e.g. facility capacity, condition, suitability, etc.). If existing facility utilisation data is available, it then becomes possible to undertake various comparisons, such as to compare the actual utilisation of a facility with the predicted demand that has been allocated in terms of the catchment analysis technique; or to compare current capacity and utilisation levels with the minimum threshold for the facility in question. Seen from a *planning* perspective, the analysis should highlight if the existing facility sizes, and the spatial distribution thereof, are satisfying the relevant threshold and service level targets.

Figure 2 provides a conceptual framework for analysing some facility sizes and related supply-side issues. A typical example in many urban contexts, are facilities which regardless of being above the minimum viable threshold for their operation, are overburdened as a result of the size of demand they have to serve (condition D in Figure 2). The facilities are *potentially upgradable* without exceeding operating efficiency, or that a second facility could be built within a reasonable distance. In the rural context, many facilities may be operating above their capacity or coping level, but below the minimum threshold that is needed to cover the overheads and other costs for upgrading the service to the minimum specification. Such facilities (see condition B in Figure 2) may be classed as *overburdened but below a viable threshold size.* A second possibility, indicated by condition A in Figure 2, could be that facilities are *under-utilised and undersized*. A third possibility is that a facility may already be *right-sized* (C), and have the necessary infrastructure and equipment.

As in the case of the user-side analysis, it is possible to derive ratio-type indicators for a district or other type of service area (i.e. percentage above or below specified target). It may also be useful to produce a tabular profile with cross-classifications in terms of different criteria (e.g. below / over capacity *and* below / over relevant threshold targets).

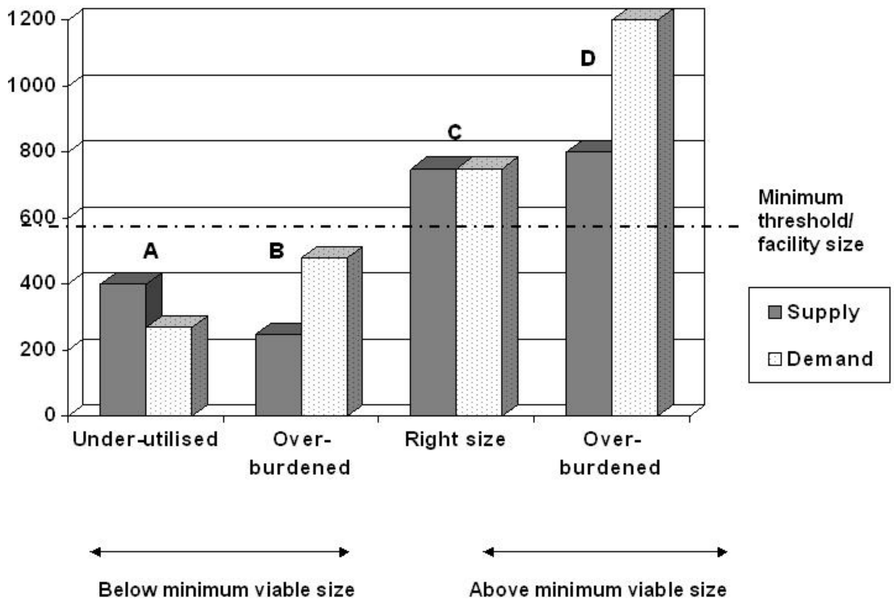

Figure 2: Framework for analysing facility sizes

Step 4: Matching of supply and demand
The main purpose of this step is to explore ways of adjusting facility locations and sizes in relation to: a) the spatial distribution of demand, b) relevant service level / threshold targets and c) the need to consider other facilities, multi-purpose nodes or co-ordination agreements that may have been made as part of a spatial or integrated development planning (IDP) process. However, since the emphasis is still on a single facility type (at a given level in the service hierarchy) the purpose is not to explore any of the co-ordination and integration issues in any depth. This is rather the purpose of the next step.

The usual combination of proximity counting and catchment area analysis procedures can be used together with the '*facility size framework'* (i.e. Figure 2) to explore different right-sizing and location options. During this process it may also be useful to explore variations in the spatial distribution of demand, both from a long-term population migration perspective, and with reference to daily, weekly or monthly movement patterns. It is also possible to explicitly consider periodic markets and associated periodic activities (which are usually supported by mobile facilities) by developing 'dynamic reach maps' to indicate accessible locations.

Step 5: Co-location and linking of multiple facilities
The use of catchment area analysis methods to locate and plan for multi-facility centres, essentially involves five steps:

- successive catchment area analyses and reach counts to identify the areas of highest need for each individual facility type;
- creation of an integrated 'need map' through the overlaying of the need maps of individual facility types;
- review of the existing central place system, established nodes, existing locations of major facilities (e.g. hospitals), etc.;
- use of the integrated needs map and the results of the central place analysis to identify possible locations for multi-purpose centres or facility clusters; and,
- iterative testing and review of the potential locations, using catchment area analysis and related techniques.

THE *e*THEKWINI MUNICIPALITY CASE STUDY

Facilities analysed

The following public facilities representing the supply or destination data, were analysed:
Transport nodes
Clinics
Community halls
Fire Stations
Libraries
Billing points
Police services (including SAPS and Metro Police).

Policy or process-determined settings of key variables

All the data and key variables used are summarised in Table 1. Besides data inputs which need to reflect actual conditions, a number of variables have to be set by the analyst, but these should ideally be based on agreed policies and standards, or the results of a facilitated process involving key stakeholders. The key variables that would normally need to be set in this way include:

- maximum access ranges, where a distinction may need to be made between 'local' and 'wide' access ranges, depending on the level of facility in a possible service hierarchy (e.g. whether one is referring to clinics or hospitals);
- the relevant mode of movement or travel, which in many cases may be walking;
- feasible travel speeds (which will be specific to the area being analysed);
- minimum facility sizes or threshold targets;
- the planned capacities of new or upgraded facilities; and
- an estimation of the demand for a facility.

The steps as outlined in the previous section were carried out for each facility type, with the exception of Step 3, which was not carried out in full because the classification of facilities was not a crucial aspect of this study, although where relevant, the predicted (modelled) demand at each facility was indicated.

Integrated plan

An integrated plan was then developed based on the individual assessments of the current accessibility status of the facilities investigated. As indicated in Figure 3, the integrated plan recommended the following:

- **priority investment hubs***,* where coordinated investment in new social facilities would address the pent-up need for two or more types of facilities, *and* contribute significantly to multi-purpose development and clustering around public transport nodes;
- **focus areas for the development of one or two specific types of social facilities**, where there may be a lesser, or uncertain, potential for significant cluster development or nodal strengthening (i.e. compared with the priority investment hubs) but where there are still significant pockets of poorly-served social needs; and
- **facilities or facility clusters that could be rationalised**, where there is possibly surplus capacity possibly exists, or where capacity could be utilised for other or extended functions.

Table 1: Key variables used for the accessibility modelling of the various facility types				
Facility type	**Demand**	**Maximum access range**	**Mode of travel**	**Minimum facility size / threshold**
Transport nodes	Weighted households based on annual income according to the following equation: [Below R30k x 1] + [institutional pop/4.4] [R30k to R72k x 0.5] + [(above R72k + unspecified) x 0.25]	15 minutes	Public transport	N/A
Clinics	Persons in households earning R3 500 / month and assuming 8 clinic visits per year per person	15 minutes	Public transport	Estimated using the number of nurses seeing 40 patients a day and a clinic operating 250 days a year nursesx40x250
Community halls	Persons in households earning R3 500 / month	15 minutes	Public transport	30 000
Fire Stations	N/A	23 minutes response time	Emergency fire trucks	N/A
Libraries	Total population	6 km	N/A	Varied according to 3 sizes of 20 000, 40 000 and 60 000
Billing points	Total population	30 minutes	Public transport	N/A
Police services	Total population	15 minute response time	Emergency vehicles	60 000

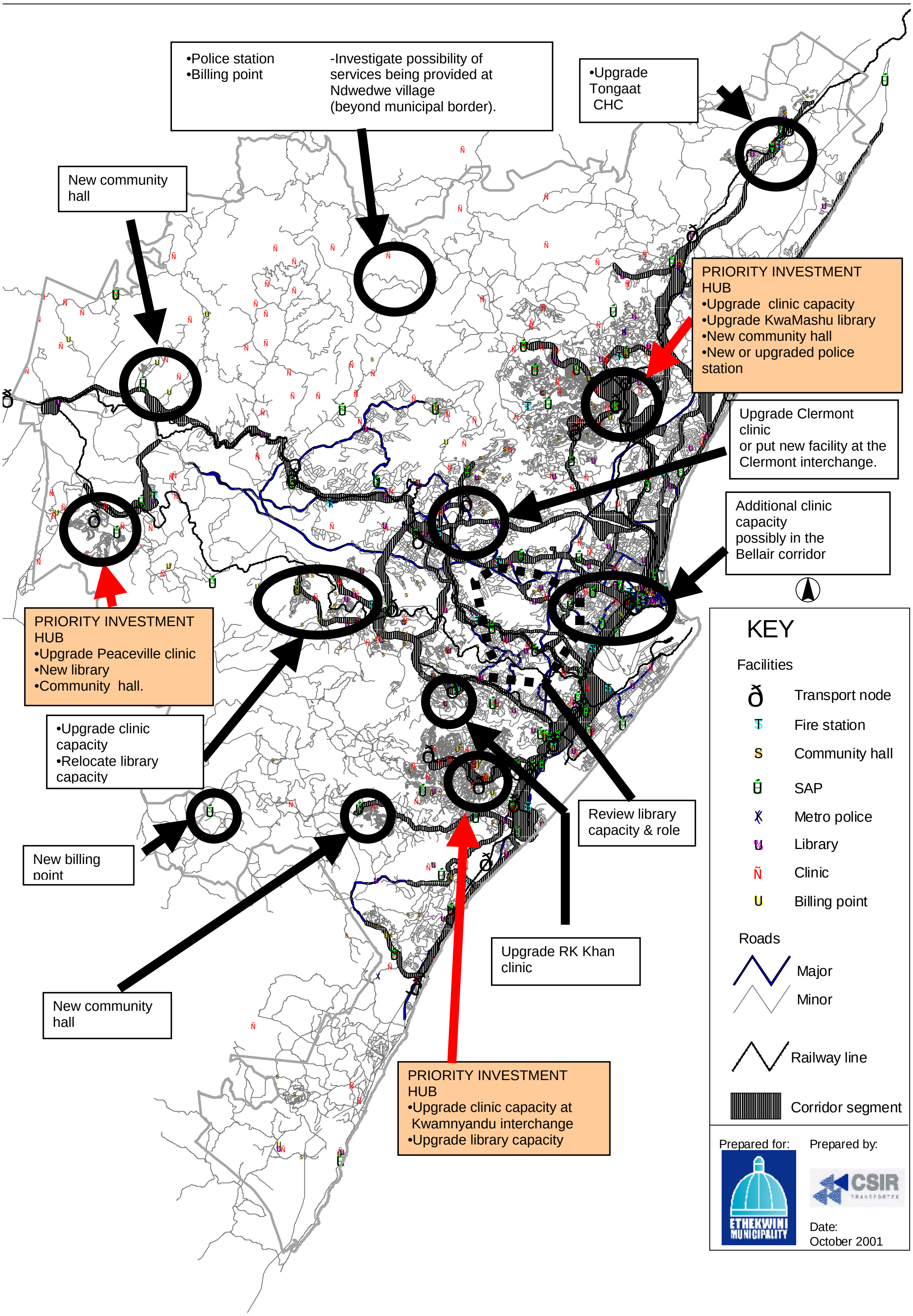

Figure 3: Integrated plan: *e*Thekwini Municipality case study

CONCLUSIONS

Besides the obvious need for at least some degree of integrated planning, there is an important caveat that has to be stated and acknowledged by all parties at the outset. This is, that adjustments to the locational configuration of services will *not necessarily* always be the best way to improve service accessibility (Gore, 1993). In this regard, Gore (1993) refers to Moseley (1979), who suggests that all of the following policy options should always be kept in mind:

- to facilitate the mobility of the person;
- to make the service itself mobile;
- to induce the person to live nearer to the service; and
- to provide the service in a location nearer to the person.

In many cases adjustment of capacities is the most feasible option and must also be considered.

In terms of the normal, geographically dispersed, sector-specific form of service delivery, the provision of anything but a very basic level of service to all areas, even on the periphery of a city, is typically not financially justified. This is usually because of stretched public sector budgets, the high costs of servicing areas that are outside the existing bulk service grids or corridors, and relatively low local demand densities in relation to the demand thresholds for viable facilities. The problem can, in many cases, be addressed through an integrated approach to service provision. Both in outlying areas and within well-served areas the concept of an integrated service provision can enhance accessibility and reduce travel costs for those dependant on public transport (Naudé AH, Green CA and Morojele NI 2001).

Multi-purpose nodes

The apparent solution is to establish multi-facility systems, located at centrally located nodes, hubs or high-demand areas, linked to smaller, lower order-nodes and periodically-operated facilities serving the peripheral or low-demand areas.

Complexities

The complexities include the differing distribution configurations required by different sectors, their current levels of service and coverage, overlapping catchment areas, competition between service nodes, and widely different levels of household or personal mobility. The minimum thresholds of different facilities are also likely to vary. Moreover, the same facility may have a combination of high- and low-threshold services (e.g. a school which needs to offer science classes requiring a lab and other ‘high-threshold’ facilities) and classes in subjects such as history or languages – where the critical mass is much lower.

Success and problems with regard to the *e*Thekwini case study

The concept of multi-purpose nodes is in general acknowledged as an important delivery mechanism for providing services in areas of need by the *e*Thekwini Municipality. Thus the recommendations of the study have been welcomed and will be considered in the medium and long term planning of the respective service sectors investigated. Positive aspects of the study, to date, are:

- Some sectors are already taking steps to implement the study recommendations. For example, the Health Department has undertaken to review clinic capacities in areas (such as KwaMashu, Clermont, and Umlazi) which the model highlighted for upgrading. Similarly, the Revenue Department is in the process of consolidating its oversupply of municipal billing points in some areas such as in Umlazi.

- The data gathering exercise has also enabled the creation of a central database of facilities, which has created a better understanding of the spatial distribution and capacities of facilities, especially in the areas that have been incorporated into the current municipal boundary.
- The Municipality can corroborate the results of the modelling with a qualitative assessment of needs that has been obtained from the communities.

Problems, costs and benefits of using the models

Most of the problems experienced with the application of the models were related to data collection and verification. This was mainly caused by incompatible and incomplete datasets, which is a legacy of the previously uncoordinated management of spatial data. Another complication was the incorporation of new areas into the newly demarcated Municipal boundary.

Since a large proportion of costs is usually incurred during the data collection and set-up phase, the use of models such as described in this paper is only cost- effective if the activity can be sustained over a reasonable period of time (3 to 5 years), and if there is at least a certain degree of in-house capacity building and technology transfer. Luckily, in this case, the eThekwini administration has, indeed, committed itself to a technology transfer and skills development programme which is currently underway. Ultimately, however, much of the potential benefits will depend on the capability to use these tools to influence facility investment decisions, and achieve real cost savings such as:

- sharing of infrastructure and other overhead costs (which is the main advantage of multi-purpose facilities);
- reduction of the number of sub-threshold, under-utilised facilities; and
- reduction in service access times and costs.

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