Towards Spatial Justice in Urban Health Services Planning

A spatial-analytic GIS-based approach using Dar es Salaam, Tanzania as a case study

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Naar ruimtelijke rechtvaardigheid in het plannen van stedelijke gezondheidszorgvoorzieningen
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(met een samenvatting in het Nederlands)

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to my father

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1 Setting the stage

1.0 The urban health crisis in sub-Saharan Africa

Introduction

This study is an attempt to develop a planning approach that contributes to equitable and efficient provision of urban health services in sub-Saharan cities. The perspective taken is spatial, that is, health service provision is operationalized as a problem of (in-) equality between public demand for health care and the provision of medical services within urban space. Emphasis is on the identification of spatially defined social inequalities arising from the spatial distribution of, and access to, health facilities within rapidly expanding urban areas.

The processes that underlie the concentration of population in urban areas together with the economic developments that have occurred in the region over the past decades form the broader context of the study. The need for improvement of urban health and the provision of equitable and efficient urban health care is currently recognized by global institutions such as, for example, the World Health Organization and the World Bank. Urban health has emerged as and since remained an important theme on the international agenda since the 1990s (Harpham and Tanner, 1995).

The transformation from a rural into an urban society is undoubtedly one of the most striking spatial processes of the twentieth century. Sometime in the beginning of this century, the majority of the world population will be living in cities and towns. To make sense of the transition from a rural into a predominantly urban society, and the effects thereof on urban health, an understanding is needed of the worldwide economic change that has occurred in recent history. Economic development has also affected the availability of public resources for the provision of health services. A short exploration of these important issues is presented below to briefly illustrate the broader problem setting of the study.

The urban transition

In Western Europe and North America, the rise of urbanization during the late eighteenth and early nineteenth century was closely associated with the advent of industrial capitalism, economic progress and societal change. The emergence of the labour-intensive factory system enabled large-scale production, improvements in agricultural production methods, and better transport and communications (Sjoberg, 1960). Because of these fundamental changes in the economic structure, cities could benefit from economies of scale and became the focal point of the production,

distribution and exchange processes that characterize industrial capitalism (Johnston *et al.*, 1994). The scale of urban employment opportunities expanded, while at the same time, technical developments in agriculture (mechanization) allowed for a declining rural population. Cities became the catalysts of an expanding and diversifying (urban) economy that was capable of attracting and absorbing the rural labour surplus.

Three additional points need to be made here. The first is that urbanization in Western Europe and North America was a relatively gradual process that took place during a period of around one and a half century (Potter and Lloyd-Evans, 1998). The second is that urbanization occurred in parallel with the emergence of a large middle class and economic wealth. Thirdly, the cycle of urbanization (Davis, 1965) proceeded more or less synchronous with the demographic transition (Notestein, 1945). Notestein's three-stage model describes the evolution of fertility and mortality levels over time. During the *high stationary* stage, both birth and death rates are high and the population grows only slowly. During the *expansion* stage living and health conditions improve and death rates fall, but birth rates remain high and the population grows rapidly. In the *low stationary* stage economic and social gains combine to reduce poverty and lower the birth rate so that birth and death rates are in equilibrium again, but now at a much lower level. The essence here is that the expansion stage of the demographic transition coincided with the period of most rapid economic expansion, increased demand for employment and accelerated urbanization. The rate of urbanization was low - yet to commence - during the high stationary stage while urbanization had largely run its course - the urban/industrial society was established - on entry into the low stationary stage. In short, western urbanization occurred in a situation where gradual demographic processes matched changes in economic structure.

The urbanization process that is currently affecting sub-Saharan Africa is fundamentally different in a number of ways. Urbanization has commenced later and is predominantly a phenomenon of the colonial and post-independence period. Furthermore, the processes of urbanization - the proportion of the total population living in urban surroundings - and urban growth are occurring much more rapidly and at a far larger scale in the developing world. Another important difference is that the majority of less developed countries are not following the cycle of urbanization as associated with the early stages of industrialization. In stead, economic expansion remains limited and the urban economy generates insufficient stable employment opportunities to absorb the large amounts of poor and unskilled rural migrants, and develop a middle class market. In *demographic* terms, however, sub-Saharan Africa is in its expansion stage. To date, there are no clear signs of transition to the stationary stage.

Numerous authors explain this situation of underdevelopment as the 'uneven' outcome of economic integration into the worldwide capitalist mode of production and use the term 'dependent urbanization' (Frank, 1967; Harvey, 1973; Castells, 1977).

For most countries in sub-Saharan Africa, the period 1975-95 has meant little growth in per capita GNP, especially since the early 1980s. Urban growth, therefore, is not caused primarily by widespread economic opportunity in the cities, but more by a changing rural production structure (a rise in landless people), rural poverty and the hope for self-improvement in the city (Hartshorn, 1992). In most cases new urban residents do not find employment in manufacturing or service industries but rather they are absorbed into the informal sector, which is characterized, by low wages and income uncertainty (Potter and Lloyd-Evans, 1998). The disparity between the number of urban dwellers relative to the size of the industrial employment base is frequently referred to as 'over-urbanisation' (Davis and Hertz, 1954; Sovani, 1964).

The magnitude of urban development is such that responsible organizations cannot manage a controlled spatial development of cities. Weak local governments, private sector and international agencies are unable to assure that sufficient (serviced) land is available, provide affordable housing, safe water, sanitation, electricity, drains, garbage collection, roads, schools, health centres and other forms of infrastructure and service provision (Devas and Rakodi, 1993). The visible result of unplanned urban development occurs in the form of slums or squatter settlements and illegal subdivision of land. In general, such settlements are characterized by substandard housing, overcrowding, and limited access to basic infrastructure and social services. Much the informal housing occurs at the outskirts of cities, which adds considerably to the horizontal expansion of urban areas. The gap between the growth of the urban population in relation to the overall productive level of the urban economy results in high levels of un (-der) employment and deprivation for large parts of the urban population (Gilbert and Gugler, 1992). The growth of urban poverty - aggravated by deteriorating economic conditions and the effects of structural adjustment - has been one of the most notable trends in sub-Saharan Africa during the 1980s and the early 1990s (United Nations Centre for Human Settlements, 1996).

Service provision under stress

The provision of adequate basic health services in urban contexts is becoming harder because of the outcome of three developments. The *first* is the rapid growth of cities and their populations. The *second* is the urbanization of poverty. The health burden imposed on people living under circumstances of poverty and unhealthy living conditions should not be underestimated. In the underprivileged sections of the urban population, infant and child mortality rates may be three or four times higher than the city average and there is a comparable intra-urban differential in all others aspects of health (Tabibzadeh and Rossi-Espagnet, 1989). To quote just another example, the disease burden per person from digestive infections in 1990 was around 200 times higher in sub-Saharan Africa than in the West (United Nations Centre for Human Settlements, 1996). The combined effect of population growth with high morbidity and mortality rates causes a massive increase in the demand for urban health care. The

third factor is not related to the demand for health care but rather to the available financial resources for the provision of medical services. Upon independence, most sub-Saharan countries have attempted to provide universal health services to the population through primary health care provisions (Berman, 1998). In the last two decades, however, the ability of governments to provide public resources for health programs has generally diminished. This is caused by the international call for privatization of the public sector, economic stagnation and structural adjustment (Potter and Lloyd-Evans, 1998).

What emerges is a situation where the carrying capacity of existing public health systems declines in the face of a growing need for essential health care. The poignant situation exists that WHO is promoting the concept of basic health services for all, while others such as the IMF and the World Bank are enforcing a reduction in public spending (George and Sabelli, 1994). The question of who provides for basic health needs, especially for the urban poor, becomes an increasingly urgent one.

Health care as a problem of socio-economic and spatial inequality

One of the imperatives of the primary health care approach, which is widely adopted in sub-Saharan Africa, is a concern for social justice. In health terms this means population coverage irrespective of social position. 'One of the main problems with urban health care is not simply that it lacks quality and comprehensiveness but that, because of maldistribution of facilities, it is often not easily accessible to those in need' (World Health Organization, 1993, p. 49). Equal access - in a broad sense - to basic health needs is, therefore, a pressing issue in the urban context. In this situation of social and spatial inequality, a socially just distribution of scarce public health resources assumes more importance.

1.1 Research objectives

From the many problems that the urban poor in developing countries face, health care is chosen as the study theme of this research. Although health is acknowledged as a fundamental human right, the provision of health care remains a major issue of social and economic concern in sub-Saharan Africa.

The overarching goal of this research is to develop a spatial planning approach that contributes to equitable and efficient urban health care provision. Health care provision is looked upon as a problem of spatial disparity between the need for health care and the provision of medical services. In doing so, it draws upon existing viewpoints and methods of the spatial sciences and on the added value of GIS technology.

To achieve this overall goal, a number of interrelated themes are further investigated in the course of the study. These more specific objectives can be formulated as follows:

- to operationalize urban health care as a problem of (in-) equality in urban space,
- to explore the processes of Tanzanian economic development and urbanization of Dar es Salaam and to illustrate their impact on urban health and urban health care,
- to examine the dynamics of the Tanzanian health care delivery system over time,
- to analyze observed socio-spatial patterns of user-provider interaction on the basis of empirical data on health care utilization in Dar es Salaam,
- to develop a GIS-based planning approach that can identify spatial inequality and inefficiency and suggest spatially just intervention priorities.

It is hoped that the development of such a methodology and associated planning support tools will bring local health planners and decision makers in a better position to identify spatial inequality and re-direct the allocation of scarce public health resources to those most in need in the future. In the case of Dar es Salaam, it is hoped that the outcomes of the study will contribute to improvement of the quality of life of the citizens of the city.

1.2 Structure of dissertation

In Chapter 2 urban health care is operationalized as a problem of (in-) equality in urban space (also see Figure 1.1). It forms the theoretical, methodological and contextual foundation for the entire study and culminates in the formulation of the conceptual model and research design. The theoretical framework develops a spatial perspective that can be used to describe and evaluate the functioning of urban health care in geographic space. The methodological framework is about methods and techniques. It identifies the accessibility concept as the most appropriate mechanism and tool to evaluate the spatial performance urban health care systems in terms of equity, efficiency and welfare maximization. The contextual framework explores the empirical literature on accessibility analysis for (health) service planning to see how and in how far GIS is being applied in strategic planning in the health sector in Sub-Saharan Africa.

Chapter 3 introduces the various data sources that are used for the Dar es Salaam case study. Firstly, it provides an overview of the different data sources - mainly sequential aerial photography - that were used to generate a historic overview of the urban

development process of the city and of its current spatial structure. Secondly, it gives a detailed account of the inventory that was carried out to capture the spatial arrangement of the diverse health care facilities and of the sampling strategy that was developed to obtain information on actual spatial health seeking behaviour across different socio-economic strata (see Chapter 5). In the absence of an up to date map at a useful scale, both the inventory and the sampling strategy relied to a considerable extent on the use of aerial photography. Taken together, these data form the empirical foundation of the study. The final section of this chapter comments on some of the problems associated with the lack of up to date and reliable data.

Chapter 4 presents an overview of the broader societal and economic context in which health care provision and utilization in Dar es Salaam occurs. To achieve its purpose, the discussion is organized into two levels: national and local. At the *national* level, the discussion provides an insight in the functioning of the Tanzanian economic and political system over time, and clarifies how these have impacted on the development and structure of the Tanzanian health sector. The *local* level overview zooms in on the case study area and consists of three parts. The *first* part analyses the urbanization process of Dar es Salaam and its changing land use structure over time. The *second* part discusses the characteristics of the road infrastructure and the main modes of transportation used by the city residents to overcome the friction of distance. The *third* part analyses the functional and spatial dynamics in health care provision that have occurred in Dar es Salaam over time.

In Chapter 5 we leave the global level and focus on the analysis of observed socio-spatial patterns of health seeking behaviour in the context of medical pluralism using sample data collected in 1995 and 2000. The discussion in this chapter is organized into five main sections. The *first* section describes the weighting and data integration procedures that were performed to transform the original survey data into representative data. The *second* section describes how the different socio-demographic population strata are identified and what their main characteristics are. The *third* section analyses the non-spatial dimension of health seeking behaviour across identified population strata. The *fourth* section analyses spatial behaviour in terms of mode(s) of transportation, travel distance and time, and the degree of observed spatial rationality. The *fifth* section provides a brief and mainly qualitative overview of the changes in health seeking behaviour that have occurred between 1995 and 2000.

The different research threads all come together in Chapter 6 which presents a 'what if' type of planning approach designed to evaluate and improve the spatial performance of the Dar es Salaam governmental health care system. In doing so it illustrates how more sophisticated GIS-based analytical techniques can be usefully applied in support of strategic spatial planning of urban health services delivery.

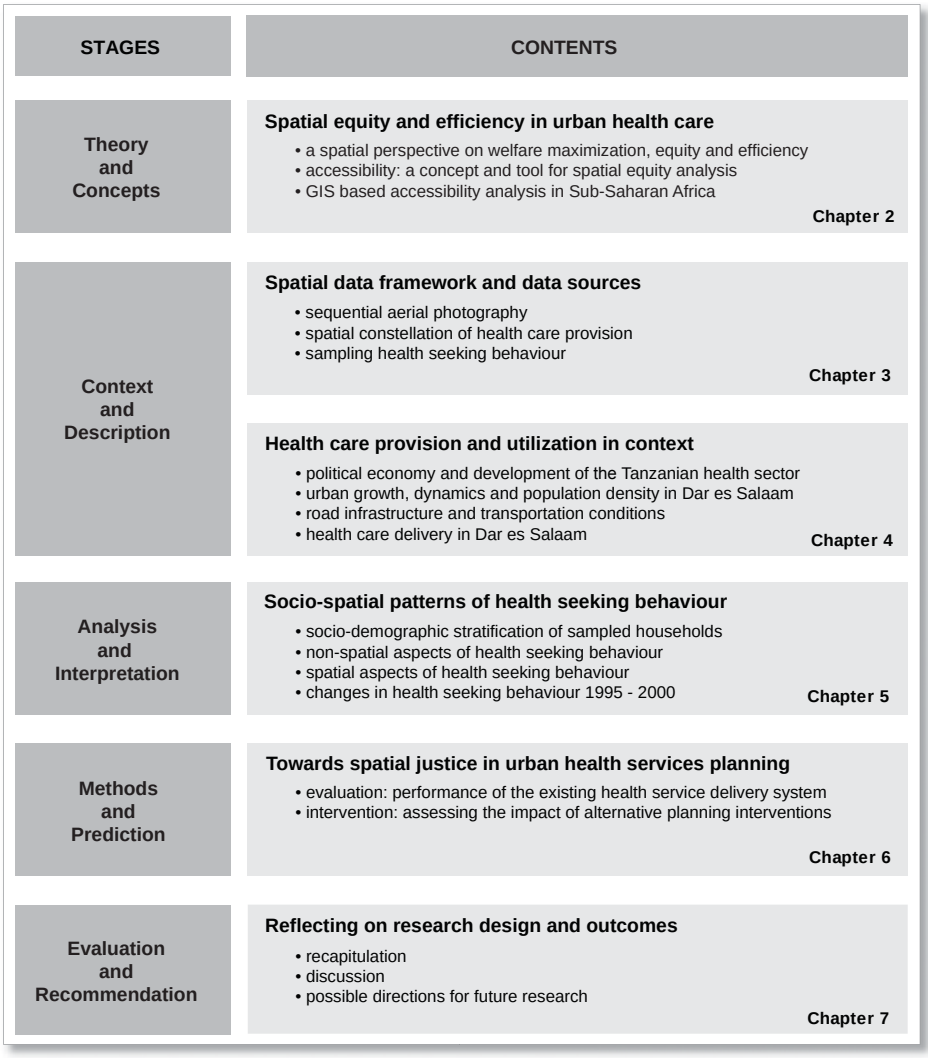


Figure 1.1: Structure of dissertation

Chapter 6 consists of two main parts: an *evaluation* and an i*ntervention* framework. The *evaluation* framework is developed to appraise the performance of the existing Dar es Salaam governmental health delivery system on the basis of generic quantitative accessibility indicators.

The *intervention* framework explores how existing health needs can better be served by proposing alternative spatial arrangements of provision using scarce health resources. It consists of a set of 'what if' type of planning instruments that can support health planners to *(i)* detect spatial deficiencies of a given delivery system, *(ii)* propose

priority spatial planning interventions and *(iii)* estimate the expected impact of potential interventions on spatial performance.

Chapter 7 briefly recapitulates the overall research approach developed, reflects on the strengths and weaknesses of the analytical tools presented, explores the prospects of embedding such planning instruments into strategic planning of urban health service delivery systems in sub-Saharan Africa and, proposes possible directions of future research.

2 Spatial equity and efficiency in urban health care

2.0 Introduction

This chapter lays the foundation for the remainder of the study and clarifies the relationship between the proposed study and previous work conducted on the topic. It consists of a number of building blocks, which together form the theoretical, the methodological and the contextual framework of the study. The discussion commences with a short background overview of the emergence of urban health care as a central theme in national health systems in sub-Saharan Africa and identifies the main objectives and guiding principles of public health care provision.

The first building block, describes the theoretical framework of the study. We take the guiding principles of health care as our point of departure and place them in a spatial context through a discussion of two important bodies of spatial theory: neoclassical location theory, and spatial welfare theory as formulated by (Smith, 1977). The importance of describing the neoclassical approach is that it provides us with fundamental spatial analytic constructs, which can be used to create a simplified model of the working of health care systems in geographical space. Spatial welfare theory builds upon the neoclassical approach and yet represents a more realistic framework: it enables us to move our simplified model of the spatial organization of health care closer to the complexity of reality.

The second building block describes the methodological framework. The discussion centres on the translation of previously identified theoretical constructs into appropriate methods and techniques. It consists of an exploration of the concept of accessibility, its most common operationalizations and the identification of the most appropriate type of accessibility measure for this study.

The third building block is the contextual framework which is an account of *(i)* the empirical literature on accessibility for health services and *(ii)* the applicability of analytical GIS approaches for health care planning in sub-Saharan contexts. Together, these building blocks culminate in the formulation of the conceptual framework and a step-by-step description of the remainder of the study.

2.1 Urban health care and its guiding principles

Health is a universal human right and a major focus of social and political concern worldwide. Health also is a somewhat elusive concept that can be defined in various ways. One definition comes from the World Health Organization (1978) who regards

health as 'a state of complete physical, mental and social well-being'. Such an ideal state may be desirable but is of limited practical use as it implies that most of humanity would be unhealthy at all times. More productively, we might think of health as being physically and mentally 'fit' and capable of functioning effectively for the good of the wider society. Seen from this perspective, health is viewed upon as a prerequisite for social advancement and economic progress: the healthier people are, the more likely they are able to contribute to social and economic development. Economic growth, in turn, can enable responsible authorities to provide better health care and thus improve the health status of a population. This does not mean that economic growth automatically results in improved health status or that a high Gross National Product is required before health can be improved. Much will depend on the level of available health resources and the distribution mechanism that is in place.

During the 1970s, increasing recognition was given to the fact that poverty, inadequate living conditions and malnutrition were at the root of poor health. These insights culminated in the Alma Ata declaration where WHO and UNICEF launched the worldwide 'Health-for-All' strategy. The Health-for-All strategy aims to reach and maintain the highest attainable level of health for all people. It consists of a range of services intended to promote good health, prevent illness and treat people that have become ill. It is a practical approach to making essential health care universally accessible to people in an acceptable and affordable way. At the very least, all people should have such a level of health that allows them to work productively and participate in social life (World Health Organization and Unicef, 1978). Five basic principles underlie the strategy: adoption of a multi-sectoral approach, a focus on prevention, involvement of local communities in decision-making, use of appropriate health technologies, and an equitable distribution of services. In the past decades, primary health care has become adopted throughout the developing world.

In most sub-Saharan countries, post-independence governments adopted the primary health care approach and took on a dominant role in the provision of health care with the objective to provide universal access to health services at no or little cost to the user (Berman, 1998). Initial emphasis was on extending health service coverage in rural areas. Towards the beginning of 1990s, it was increasingly recognized that rapid expansion of urban areas was irreversible and resulted in profound inequalities in health status and access to health care amongst city populations. Since then, *urban* primary health care has become and remained a major concern of public health authorities worldwide (Tabibzadeh and Rossi-Espagnet, 1989; Atkinson, 1993; Atkinson and Merkle, 1994).

Since the mid 1990's national health systems in African countries are being restructured in an effort to cope with increased demand for health care in an environment of public budget constraints. The outcome of these changes is a shift away from pure state provision of health care towards a situation with greater reliance

on market forces. Throughout sub-Saharan Africa, this takes the form of the emergence of market driven private health care provision and the introduction of cost-recovery measures in the more centrally planned public health care sector. These adjustments should be seen in the broader context of a resurge of global belief in 'free market' processes and a re-thinking of government roles in social policy (Creese *et al.*, 1998). Under these new conditions, inequalities in health status and in accessibility to health care are increasing (Lerer, 1998 56). Turshen (1999) describes this in terms of a declining role of the World Health Organization and a growing hegemony of the World Bank. This issue is taken up in further detail in Chapter 4.

The above-described developments illustrate that a new situation has emerged whereby public and private health care systems operate side by side, but each is driven by different principles. The essential distinction is that private health care provision is market-led and based upon the expectation that the health care user pays at the point of use or buys into private health insurance - generally tied to employment - that meets the costs of treatment. Public health care provision, by contrast, makes provision available on the basis of need rather than ability or willingness to pay. Curtis and Taket (1996) refer to the latter ideology as collectivist, which means that public health services are not paid for by the individual user, but are funded via some form of general taxation or compulsory insurance. It will be clear that the primary health care approach is essentially collectivist and driven by welfare objectives, such as the improvement of the quality of life and achieving maximum health benefits to the greatest number of people.

When making decisions about the provision of public health services the following guiding principles apply. The *first* is to provide services in an equitable way. Notions of fairness and social justice are invariably stated as being at the core of public health care interventions. Normally, this viewpoint entails that priority should be given to the more vulnerable population groups. The *second* objective is to provide services that are effective. Treatments should offer real benefit; resources should not be wasted on providing services that offer little health gain. The *third* objective is to provide services that are efficient. By this we mean how to provide services that maximize health benefit to society while minimizing the cost of provision (Carr-Hill, 1994). As a general rule there will be tension between the efficiency and equity objectives: providers wish to manage resources efficiently whereas the wish of users will be to have resources provided equitably. Health care provision is thus inevitably tied up with issues of resource allocation, distribution and priority setting: decisions have to be made about the nature and range of services to provide and how they are distributed amongst the members of society. Obviously, these are questions of an economic and political nature.

At the same time these are questions of a geographical nature since health care services will have to be provided at particular points in geographical space. Because of this

there will always be a degree of geographical variation between the provision and use of health services. The real question that needs to be addressed is therefore whether such geographical variation is acceptable or represents inequity. This subject is further explored in the sections that follow.

2.2 Theoretical framework: a spatial perspective on welfare maximization, equity and efficiency

In this paragraph we translate the guiding principles of urban health care into a spatial context, clarify the need for a locational decision making process (spatial policy) for distributing public health resources, and provide an ethical framework that enables us to evaluate the performance of alternative spatial distributions of health resources in terms of their contribution to health needs satisfaction.

We do so in a step-by step manner. We begin with a brief overview of neoclassical economics and its spatial extension. Taken together, this body of theoretical thought enables us to establish a simplified model for the spatial organization of health care provision. We then continue with a discussion of spatial welfare theory, which brings our model closer to reality by identifying the main shortcomings of neoclassical thought and presenting alternative solutions. Although most of the discussion is 'generic' the link to the 'production', 'consumption' and distribution of health care is apparent throughout the discussion.

Neoclassical economic theory: a basic regulatory mechanism

An appropriate point of departure for our analysis is neoclassical economics, which presents a view of how economic activity functions in capitalist society. It considers the economic processes of production, consumption and distribution of goods and services. Production concerns the creation of all the goods and services needed by society, consumption concerns their utilization by the members of society. What is produced and in what quantity depends, in theory, on what consumers are prepared to buy which, in turn, depends on the price asked by the producer and on what the consumer can afford. In neo-classical economic theory, markets automatically adjust to changes in demand and supply and tend towards a state of equilibrium at a price that brings supply and demand into balance by virtue of the intrinsic price mechanism (Dicken and Lloyd, 1990).

The concept of utility - that which individuals try to maximize - is central to the theory of consumer behaviour. Consumers maximize utility on the basis of individual tastes and preferences for goods and services and allocate their expenditure accordingly among alternative goods or services, subject to their budget constraint - represented by

income - and the prevailing set of prices. The theory of consumer behaviour is based upon the assumption of consumer sovereignty, which means that the individual consumer has perfect knowledge of the market and acts economically rational. The analysis of individual consumer behaviour can subsequently be extended to represent the collective consumption of an entire society. This is achieved by aggregating individual utility functions into a social welfare function expressing community preferences for goods and services.

The neo-classical analysis of production is analogous to that of consumer behaviour: to maximize profit, the individual producer operates at the highest level of efficiency in its use of resources and produces at the lowest cost. Producers and consumers are both guided by the desire to optimize: to get the best possible outcome for their efforts. Producers seek maximization of profits, consumers aim to minimize their expenditure in meeting their consumption needs.

When production and consumption are brought together, the price mechanism ensures that resources are distributed among alternative goods and services in such a way that no reallocation is possible without diminishing the total value of production and the overall utility or welfare derived from it (Walker, 1981). The 'invisible hand' of the market guides economic activity towards optimal resource allocation and maximization of social welfare (Goodall, 1987).

Such an ideal economic or social state is termed Pareto optimal: it is impossible to make any individual better off without at the same time making someone else worse off. Proponents of neoclassical economics consider Pareto optimality as a situation in which a society achieves optimal allocative efficiency as well as distributive equity. We will return to this issue later but first we explore how neo-classical analysis can be extended to incorporate geographical space.

Neoclassical location theory: a simplified spatial model

In this section we reconsider the processes of production, consumption and distribution but now from an explicitly geographical perspective. In doing so we adhere to the assumptions and mechanisms embedded in neoclassical economic thought. At the same time, we need to introduce some additional assumptions. These assumptions allow us to develop a simplified spatial model of the real world, which enables us to focus explicitly on the role of geographic distance in the spatial organization of health care provision.

It is assumed that consumers all live equidistant from one another on an isotropic plane in which transportation costs are uniform and exactly proportional to distance in all directions. Consumers exhibit uniform utility maximizing behaviour, which means that they have identical incomes, demands and tastes.

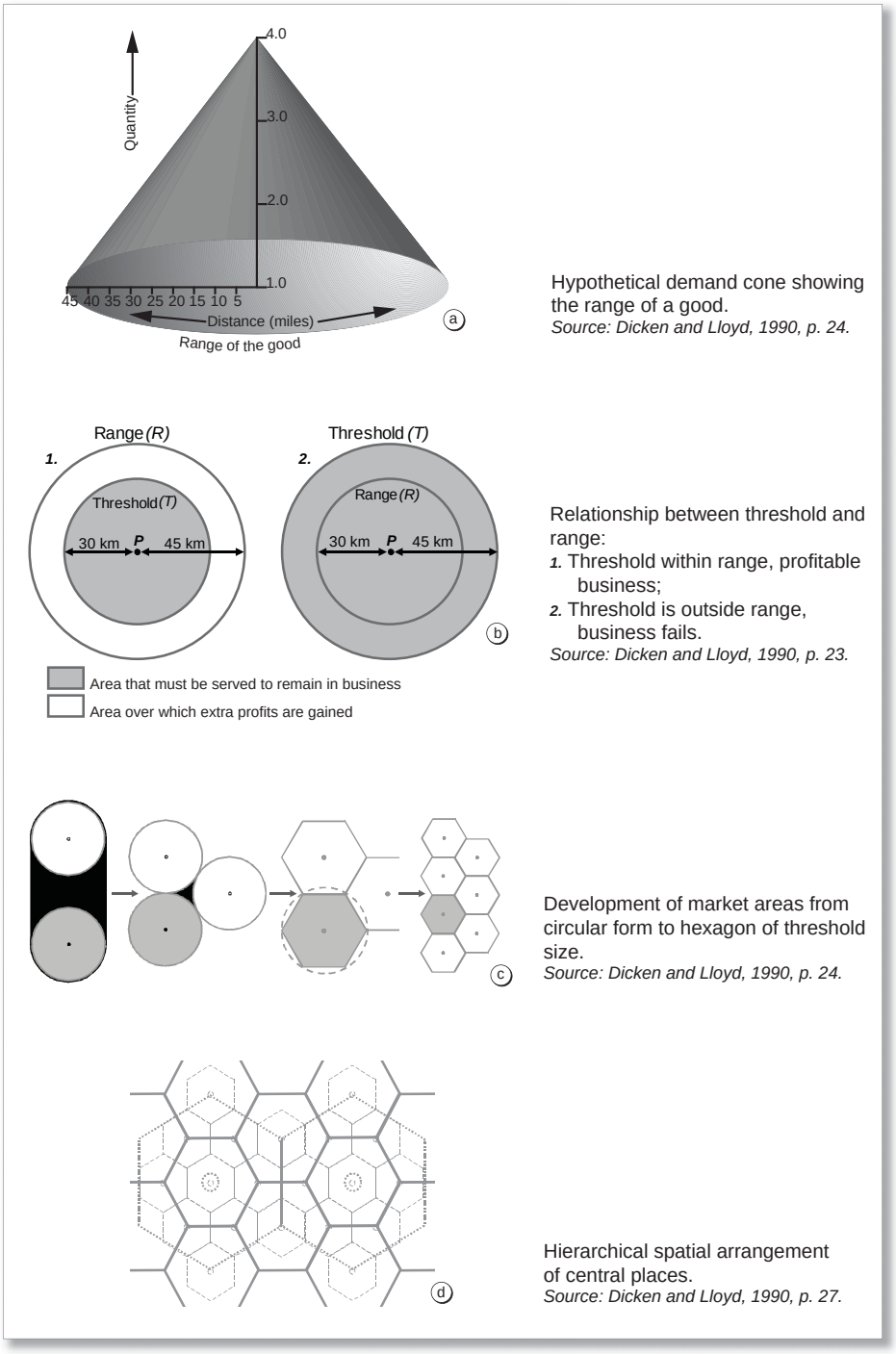


Figure 2.1: Main concepts of neoclassical location theory.

Producers and consumers both act economically as well as spatially rational. As we recall from the theory of consumer behaviour, the rate of consumption of a utility maximizing individual depends on the price or exchange value of a good or service.

In a world in which geographical space matters, this price will be made up of two elements. The first element is the market price of the good or service at the point of sale. The second element is the cost of travelling to and from that point. This means that, with a fixed budget of time, money or effort, the amount of a particular good or service or the frequency with which it will be consumed, will decrease with increasing distance from the production facility up to a point where demand for that good or service will become zero (see Figure 2.1*a*).

Adoption of this spatial perspective implies that the production of goods and services will depend on two economic mechanisms: the threshold value and the range of a good. The threshold value is defined as the minimum level of consumer demand needed for the profitable production of a particular good or service. The range of a good or service describes the effective size of this demand, which is defined by the maximum distance consumers are willing to travel to obtain a particular good or service. If the threshold exceeds the range, profitable provision of a good is not possible and the good or service will not be provided. Range and threshold value both have a spatial form as illustrated in Figure 2.1*b*.

The analysis of individual producer behaviour in geographical space can subsequently be extended to represent the collective spatial arrangement of production within a defined territory. This is explained as follows. Additional producers of the same good or service will enter the market until total consumer demand is satisfied. In doing so subsequent producers will have to take into account the existing location and market area of already established producers to avoid unnecessary competition. As more and more producers enter the market, the spatial arrangement of production will exhibit a progression from initial non-overlapping circular market areas towards hexagonal market areas. This progression is illustrated in Figure 1.1*c*. Given that there is free entry into the market and a desire to optimize, the geographical extent of individual hexagonal market areas will tend to approach the threshold size. The result is a compact, uniform lattice of production centres, each serving hexagonal market areas of identical size, equivalent to the threshold size for that good.

So far, the discussion has limited itself to the production of one good or service only. In reality, however, we will see that a diversity or 'bundles' of goods and services will be produced. Each will have a specific range and a specific threshold value. Inexpensive, regularly demanded (lower order) services will have a small spatial range and threshold value while expensive, irregular (higher order) services will have a larger spatial range and threshold value. Put together, these postulates and assumptions lead to the formation of a regular interlocking hierarchy of hexagonal lattices, each

describing the non-overlapping market area of a different service outlet. Higher order outlets are located at the centre of large hexagons; lower order outlets will locate at the centre of small hexagons (see Figure 2.1*d*).

The outcome of a perfect market in a space economy would, in theory, generate a 'spatial Pareto' situation. No alteration of what is produced and consumed *where* could make anyone anywhere better off without at the same time making someone else some*where* else worse off (Smith, 1977, p. 146). In our simplified model of the space economy, spatial Pareto optimality is seen as a situation in which a society achieves optimal spatial efficiency as well as equitable spatial distribution.

Christaller (1966) used the above-described assumptions and economic mechanisms to formulate his central place theory, which seeks to explain an apparent order in the spatial arrangement of urban settlements in terms of their sizes and their intermittent spacing. Settlements are seen as central places providing goods and services to the surrounding populations. Central place theory is concerned primarily with the locations of (retail) service activities and is described as being complementary to Weber's theory of industrial location and von Thünen's theory of agricultural location (Davies, 1967). Berry and Garrison (1958) extended the range of central place applications to the spatial organization of a hierarchy of retail services within urban areas. The analogy to the intra-urban provision of health care provision is then easily made.

What now is the relevance of neo-classical location theory for spatial health care planning? First of all, we have obtained a first insight in the way - at least in theory - in which a society may maximize human welfare in an economic as well as in a spatial sense. Furthermore, the discussion has provided us with two analytical constructs of fundamental importance: threshold value and range. On the basis of these two mechanisms, the characteristics of service supply in relation to the spatial expression of consumer demand can be described. Important also is that we are not only concerned with the location of individual service supply points, but also how they function in relation to one another in geographic space. Finally, the notion of hierarchy in service supply has been introduced. Each of the above mentioned issues are essential considerations in the structure of any health care system. Apart from the hierarchical nature of health care systems, concepts such as market area, efficiency of provision and equality of access are fundamentally important considerations.

At the same time, the normative nature of the neoclassical approach and its strict assumptions make that the model does not reflect reality sufficiently well. In the next paragraph, we move away from this rather rigid approach and re-examine some of the restrictive assumptions in an attempt to bring our model closer to reality. We do so through a discussion of spatial welfare theory as formulated by (Smith, 1977; Smith, 1994).

Spatial welfare theory: a more realistic spatial model for urban health care

The spatial welfare approach defines the state of society by the quantities of goods (and bads) produced and their distribution among consumers territorially disaggregated. Spatial welfare theory objects to the narrow perspective of neo-classical thought and demonstrates that an unregulated free market system does not culminate in welfare maximization but results in unacceptable social, economic and spatial inequality. It provides arguments why governments need to intervene in imperfect markets to assist in welfare maximization and provides an ethical framework within which rational policy judgments can be made (Smith, 1994, pp. 389-394). Analogous to health care, the welfare approach focuses on quality-of-life issues, emphasizes questions of social justice, and highlights distributional issues with a spatial dimension.

The keywords of the welfare approach are 'who gets what where and how' (Smith, 1977). The *who* refers to the population of the area under study, subdivided into groups on the basis of relevant characteristics. The *what* refers to the goods and bads enjoyed. The emphasis on *where* provides the spatial perspective and concerns the identification and understanding of place-to-place variations in welfare, which includes differential access to health services. The *how* refers to broader societal processes, such as the functioning of the economic and political system, that influence human welfare (Smith, 1977; Chisholm, 1995; Knox, 1995).

Spatial welfare theory identifies a number of shortcomings of the neo-classical perspective. The fundamental objection to neo-classical thought is its reliance on unrestricted individual consumer preferences as the origin of collective consumption patterns: the individual is seen as the primary atom and his/her preferences as the ultimate data for the welfare of society. The counter position of spatial welfare theory is that consumer preferences and the budget constraint are not autonomous but strongly influenced by the society and economy in which the individual lives. Income reflects the position in the economic, social and political structure. Poor people may not be able to express demand effectively in the marketplace, thus limiting opportunity for satisfaction (in severe cases, basic needs may not be fulfilled at maximum utility). In such situations, consumption patterns do not reflect free choice but rather display repressed preferences or constrained choice. Likewise, consumer preferences are not autonomous but subject to external influences. People are not freely deciding atomistic individuals but members of societal groups, which also influences their preferences. As a result, different groups within society are bound to have different - possibly conflicting - preferences. In most cases this will mean that the preferences of the richer will be implemented because they have the political power. The implication is that the aggregation of individual utility functions into a social welfare function is unrealistic as it erroneously assumes community consensus on how welfare maximization should be achieved. In other words, neoclassical theory correctly identifies tastes, prices and the

income constraint as the immediate determinants of consumption but fails to investigate the origins of personal preferences and of the budget constraint. Focus is on welfare maximization only, there is no concern for the way in which goods and bads are distributed among the members of society (this issue is further discussed in the next section).

Another obvious shortcoming of neoclassical thought is the assumption that individuals act as 'homo economicus'. In reality consumers and producers are not perfectly informed and rational beings capable of optimization. They will not fully maximize utility/profit as they have sub-optimal knowledge of the market and imperfect ability to process this knowledge. Instead of optimizing, they exhibit satisficing behaviour, that is, they make decisions that allow them to reach a threshold level of satisfaction. Upon achieving the threshold, they feel little incentive to strive for maximum satisfaction.

Spatial welfare theory incorporates geographical space as an element of utility or welfare but in a way that differs from neoclassical location theory. The very theoretical constructs of the isotropic plane and uniform consumer behaviour are abandoned in favour of the realistic conception that alternative locations in geographic space offer alternative combinations of goods and bads and that consumers will exhibit different spatial behaviour as a result of differences in preferences and incomes. The individual will nevertheless tend to locate himself at that place whose characteristics posses a higher level of utility than other places known to him. The concept of place utility - the spatial equivalent of economic utility - is used to describe consumption in space. Place utility refers to the net composite of (dis-) utilities, which an individual derives at some point in geographic space. In their spatial behaviour, individuals are not only constrained by imperfect knowledge but also by economic constraints - embodied by the budget constraint - that impact on them. In other words, as people arrange themselves in geographic space, they may not necessarily reveal real preferences and may have unfulfilled needs.

It is important to note that the place utility of a particular location is not only a function of the intrinsic values of the location itself, but also of its relative spatial position with respect to other places. For many sources of needs or want satisfaction, the individual depends on movement to sources of supply. Spatial accessibility with respect to, for example, health care services is, therefore, an element of real income, which impacts on human well-being.

The outcome of the process of consumption in space is a situation characterized by place-to-place variations in quality-of-life standards or human well-being: there is spatial variation of levels of need satisfaction. Depending on the magnitude of the differences in budget constraint among people, place utility can be a major force behind the emergence and persistence of socio-spatial inequality within urban areas.

This is simply because the poor have less freedom in realizing their space preferences than the more well-to-do.

The next question that needs to be addressed is how production is incorporated in spatial welfare theory. Spatial welfare theory incorporates geographical space as a specific consideration for the achievement of efficiency in production. The fact that production is driven by profit implies that the location decision is directly linked to the production costs and the level of expected effective demand that can be satisfied at a particular location. In an optimal space-economy, the spatial arrangement of production would be such that the correct services are produced (in correct quantity at correct price) at the correct locations.

In the real world, however, the spatial arrangement of production will not reach such an optimal state for at least four reasons. *First*, the process of production - like that of consumption - is not fully informed or perfectly rational. *Second*, producers are not free to locate anywhere but are restricted to settle at available locations only. *Third*, imperfect spatial mobility of production factors prevents easy adjustment to spatial changes that occur in the market (Johnston *et al.*, 1998). The *fourth* reason is the existence of spatial externalities. Put simply, an external effect is an unpriced effect. It may be a benefit received by those who do not pay for it (a positive externality) or a loss incurred by someone who is not compensated (a negative externality). A classic example of a negative externality is the air pollution resulting from a localized industrial plant. A positive externality could be proximity to valued services such as schools, parks or health clinics. The examples usefully illustrate that the externality concept has a strong geographical dimension. Activities take place at a specific location in geographic space and the side effects of these activities - whether positive or negative - emanate from these locations and affect the surrounding areas. In most cases, these effects will tend to diminish with increasing distance from the source of the externality (Pinch, 1985).

The main conclusion to be drawn from the discussion presented above is that spatial welfare theory demonstrates that an unregulated economic/spatial system is unlikely to achieve maximum social/spatial welfare unless there is some form of government intervention into the market system, so that either prices are adjusted to reflect full social costs or outputs are controlled to a socially optimal level (Walker, 1981). It is equally important to realize that until now, the discussion has only considered the production and consumption of *private* goods and services; that is goods and services produced according to market exchange principles. In the following section, we further elaborate spatial welfare theory but there the production and consumption of collectively provided *public* services in geographic space is at the centre of the discussion.

Public services, collective consumption and the necessity of spatial policy

Those goods or services that - while valued by individuals - may not be produced if their supply is left to market forces are termed public goods. Three basic characteristics define a pure public good or service (Walker, 1981). The *first* characteristic is that of joint supply: if a good or service can be supplied to one person, it can also be supplied to all other persons at identical quality at no extra cost. The *second* characteristic is non-excludability: once the good or service is supplied to one person, it is impossible to withhold it from others so that those who do not wish to pay for it cannot be prevented form enjoying its benefits. The *third* characteristic is non-rejectability, which means that once a good or service is supplied it must be equally consumed by all (Pinch, 1985). The crucial point here is that the combined characteristics of pure public goods imply that their supply leads to market failure. This can be clarified by distinguishing between the *use value* of goods and services - the extent to which they can satisfy human needs - and their *exchange value* - the prices they can command in the market. The specific characteristic of a pure public good or service is that it has a recognized use value, but because of its characteristics this does not translate into an exchange value. A rational individual wishing to maximize utility will not pay for a public good or service if it can be obtained free. The absence of an exchange value thus prevents a pure public good or service from being produced under market conditions.

In reality, public good or services are actually not consumed and benefited from jointly and equally by all. Because of this they are more appropriately termed impure public goods or services. In the context of public service provision in urban areas, geographical space contributes to impurity by means of variations in access across space. This is explained as follows. Within a defined territory, public services - theoretically equally available to all - have to be located at particular points in space. Even if these services are provided free of charge at the point of supply, individuals will have to bear the cost of travelling to the facility. This means that with a fixed budget of time, money or effort, the amount of a public good or service or the frequency with which it will be consumed will decrease with increasing distance from the facility up to a point where demand for that good or service will become zero (Dicken and Lloyd, 1990).

In this way variation in access across space, generates inequality and undermines both the joint supply and the non-excludability criteria of a public good. In case a service is delivered to the consumer - for example an ambulance service - the costs for supplying the service will increase with distance. The quality of the service - e.g. response time - to the consumer will also vary with distance. In this case, geographic space generates inequality with respect to the joint supply criterion of a pure public good.

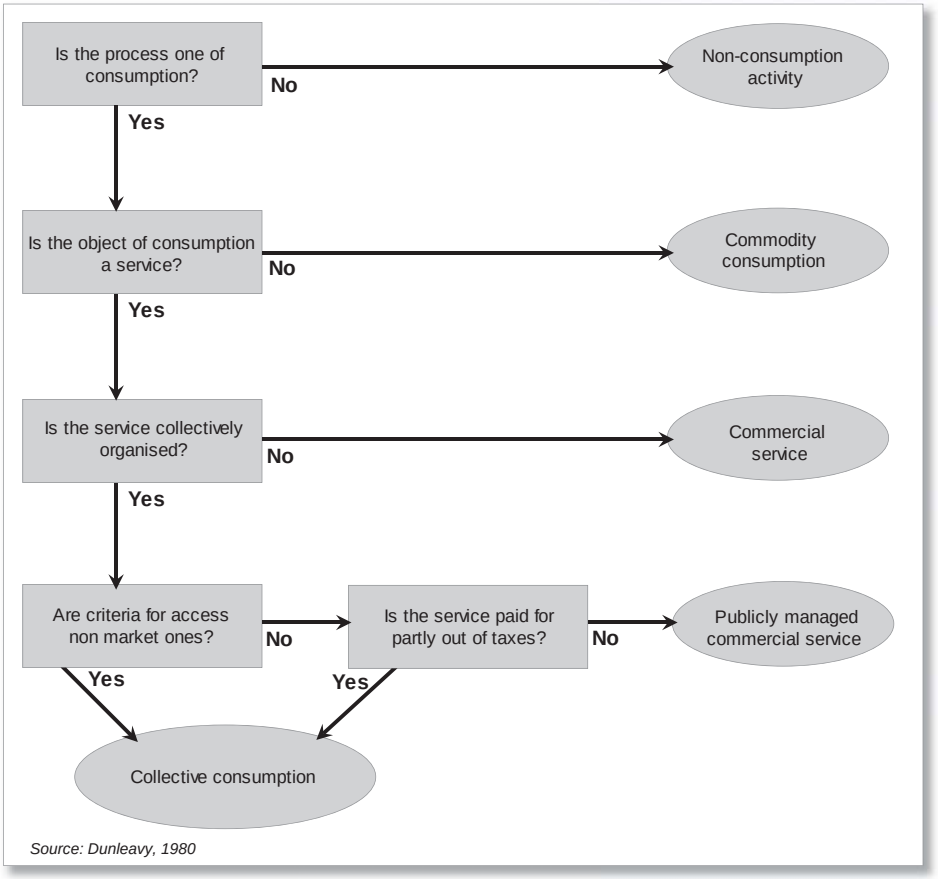


Figure 2.2: Collective consumption defined.

It is important to note that the pure theory is based upon the characteristics of the goods and services themselves and not whether they are produced within the private or the public sector of the economy. In fact, there are few *technical* reasons why services such as education and health care should be allocated by the public sector in preference to the private sector. The decision to allocate many services through the public sector is, not because of their technical characteristics, but because of social objectives translated into political action. A common reason for public provision is dissatisfaction with the inequalities in the distribution of services as allocated through private markets. Governments intervene in producing public services to assist in welfare maximization (Smith, 1995). The provision of public services is usually organized and managed by a state-operated system and financed, at least in part, through taxation. Their overall level of output is related to the general process of public resource allocation in society, which constrains what can be spent on them. Public goods, thus, differ from private goods as they are part of the process of collective consumption (see Figure 2.2).

Apart from a concern with the level of resource allocation, governments will have to devise criteria for the distribution of public resources among the members of society. As mentioned before, the objective of public resource allocation is often to achieve what is considered a fair or socially just distribution. Because of this, collectively provided services are normally consumed by users according to non-market criteria such as social need rather than ability to pay. At the same time, society wishes to obtain the best return for their investment in public resources, so that issues of efficiency and effectiveness are also important.

Since the recipients will be dispersed within a defined territory, there is also a need for a locational decision making process. This transposes the welfare objective to achieving, as much as possible, a spatially just distribution of public resources in a spatially efficient manner. Invariably, this involves making judgments between alternative spatial arrangements of provision in a defined territory. To evaluate existing situations and suggest improvements, however, we need criteria for distinguishing better from worse. This is the subject of the following section.

Evaluating the performance of alternative spatial welfare distributions

A useful starting point for the evaluation of (spatial) distributions is the principle of equality. Equality - like health - is a universal human right and refers to impartiality. A distinction can be made between arithmetic and proportional equality. Arithmetic equality refers to perfect equality of treatment where exactly the same quantity of benefits goes to all irrespective of circumstances. Proportional equality, however, is output oriented: to achieve equality in results may require inequality in resource allocation. It refers to situations where there is equality of treatment in the same circumstances but different circumstances justify differential treatment in the distribution of benefits (Smith, 1994). Proportionality, thus, requires the identification of relevant differences that justify differential allocation of resources.

Efficiency is about comparing costs (resources spent) and benefits (well being produced) of alternative resource allocations in such a way that the welfare gains to society are maximized. It refers to the way of obtaining the highest output from a finite level of resources (Carr-Hill, 1994).

Equity is a more elusive concept and not automatically interchangeable with equality. Equality is about equal shares (inputs or outcomes) while equity refers to fairness and it may be judged fair by society to be unequal. We also need to distinguish between two elements of equity: horizontal and vertical equity. Horizontal equity is concerned with equal treatment for equal need. Vertical equity, however, has a moral and ethical dimension as it refers to the effort to develop a rationale to allocate resources among people who are in unlike circumstances (Truelove, 1993). It will be clear that for vertical equity to exist, the distribution of resources must be seen by society to be fair.

What is regarded as fair and socially just, thus, depends to a large extend on social and political judgments which reflect the prevailing ethical ideology, rather than something with absolute moral authority.

The most influential ideological positions that have a bearing on the distribution of resources are libertarianism and egalitarianism (Smith, 1977). The libertarian perspective relies on the 'economic' justice of free-market competition. Differences in ability result in the more productive people and localities receiving greater benefits. The invisible hand of the market performs social justice in distribution by means of the Pareto criterion. The fact that social well-being will vary across space is accepted as socially just. The argument in favour of Pareto optimality is that it involves minimal ethical content.

Attractive as this may seem, the libertarian line of thought can be criticized on two counts. *First*, the (space) economy will not function in a perfect manner in reality for reasons elaborated before. The *second* and fundamental shortcoming of the Pareto criterion is that it is 'a-historic'. While correctly identifying tastes, prices and the income constraints as the immediate determinants of consumption (in space), the model says nothing about how these conditions originate and how the distribution of goods and bads among members of society is. If the distribution of benefits is unequal to start with, this could become more unequal. In a situation where the rich become richer and the poor no poorer, this would still be considered as a welfare improvement by the Pareto criterion. The application of the Pareto criterion in a non-growth economy, for example, would prevent redistribution in the direction of the poor, no matter how unequal the initial distribution is. This characteristic makes the Pareto criterion a deficient tool for judging alternative (spatial) distributions.

The egalitarian perspective, by contrast, emphasizes the primacy of equality in distribution while efficiency is seen as a secondary goal (Coates, 1977). The main advantage of an egalitarian point of view is that it enables to judge an existing situation in terms of the degree of inequality observed. Furthermore, alternative spatial arrangements can be judged by their tendency towards reducing inequality: the more equal the alternative arrangement the better. In short, the dictum 'the more equal the more just' (Smith, 1994) provides more convincing grounds for evaluation and action than the Pareto criterion.

A well-established concept for evaluating spatial (in-) equality from an egalitarian perspective is 'territorial justice'. Davies (1968) describes territorial justice as follows. If the objective of collectively provided public services is 'to each according to his need' then the most appropriate distribution between areas must be 'to each according to the needs of the population of that area'. Territorial justice is rooted in the principle of proportional equality - provision proportionate to need - and is about securing a geographical match between resource allocation and resource needs. Since the

approach is concerned with relative variations in resource provisions between areas, it can also be usefully applied in contexts where there is an overall shortfall in resource allocation. The concept of need thus is a relative one which should be seen in the context of existing conditions in society in relation to some socially accepted norm.

The empirical identification of variations in need in a territorial distribution requires the development of social indicators. Territorial social indicators refer to measures of social well-being in a defined territory, which may refer to a broad concept or a specific condition such as, for example, health status. To avoid the problems of the ecological fallacy, the level of territorial disaggregation should be at a sufficiently fine resolution. With territorial social indicators spatial variations in well-being can be properly assessed and spatial policies developed to counter identified disparities. Over the past decades, the social indicator approach has become widely accepted as a desirable monitoring and policy development tool (Johnston *et al.*, 1998).

With the concept of territorial justice and the social indicator approach a suitable theoretical framework has been established for describing and evaluating the performance of alternative spatial distributions of collectively provided public services in terms of welfare maximization.

Linking spatial welfare theory to urban health care

Through the discussion on spatial welfare theory a general theoretical framework is formulated. The analogy to health care provision is clear but so far has only been implicit. The subject of this section is to explicitly link spatial welfare theory to urban health care by briefly returning to the question 'who' gets 'what' 'where' and 'how' as illustrated in Figure 2.3. Some comments are also made on health seeking behaviour of patients.

The broader context of urban health care provision

In an ideal society health care systems would be capable of meeting all the health needs of a population. Experience, however, shows that this has proven to be unrealistic and contemporary health planners recognize that the need for care will almost inevitably exceed supply. In the Western world, the expressed need for and cost of health care has continued to grow despite limited population growth, rising living standards and improvements in diet, hygiene and preventative measures. In part, this is driven by changing health needs of an aging population, technological innovations and increasing personnel costs but it is also related to rising expectations in terms of the type and volume of services required. Despite the affluence of Western society, cost containment policies have been put in place since the 1970s in recognition of the fact that the expressed need for health care may actually be insatiable. Even in affluent societies, health care systems will, therefore, satisfy relative rather than absolute health needs.

Although the same essential issues play a role in the debate on health care provision in sub-Saharan Africa, it is important to stress that the context of this discussion is a totally different one. The demand for health care is also growing but the underlying causes are quite unlike those of the Western world. In sub-Saharan Africa, rapid population growth, the urbanization of poverty, malnutrition and unhealthy living conditions are the main causes of morbidity and mortality in the city. Furthermore, the severe budget constraint of the large contingent of urban poor restricts them from expressing sufficient effective demand for essential (private) health care of adequate quality. At the same time, adverse economic conditions restrict national governments to allocate adequate amounts of public resources to health care. Current levels of government expenditure on health care in sub-Saharan Africa are generally far too low to satisfy even modest health needs (Creese *et al.*, 1998).

Key issues in the ongoing world-wide socio-political and ethical debate concern the degree to which health care should be financed through collective means or should be left to market forces. Over the last decade, the welfarist orientation has lost grounds to more libertarian interpretations which promote increased privatization of health care: efficiency considerations currently outweigh equity issues. In most countries in sub-Saharan Africa the outcome of this process is the emergence of pluralist health care, that is, side by side functioning of market driven private health care provision together with collectively provided public health care. The strength of spatial welfare theory is that it provides a unifying framework that can be used to describe the spatial arrangement of private as well as public health provision. Since the interrelations between economic development, urbanization and health care provision in sub-Saharan Africa are all essential issues, they are separately discussed in more detail in Chapter 4.

Demand, supply and spatial distribution of health care in urban areas

Urban areas exhibit variations in the spatial distribution of health needs. Such variations occur as a result of permutations in population densities, socio-economic, demographic and living conditions which all impact on the health status of people. The existence of spatial variations in levels of well being - of which health needs are part - within urban areas closely matches spatial welfare theory as was previously illustrated through the examination of the concept of place utility. Also, cities are not static but evolve over time. If we consider the process of rapid urbanization that is ongoing in sub-Saharan Africa, it will be clear that the spatial distribution of health needs is dynamic. Changes occur not only because of urban expansion and densification processes, but also because of evolving health needs as part of the epidemiological transition.

The fact that health needs will vary across space and time implies that the spatial structure of health care provision has to adapt to - if possible even anticipate - these changes. This makes that the spatial arrangement of health care provision in rapidly

changing urban settings is an issue that requires ongoing attention of health planners. As illustrated in Figure 2.3, the spatial organization of private health care provision is governed by the profit principle - satisfying effective demand in an efficient manner. Public health care provision, by contrast, aims to maximize health needs satisfaction in an equitable manner. Spatial welfare theory demonstrates that this does not only require a process of mobilizing collective resources for health care but also a form of spatial planning for distributing these resources to a spatially dispersed population. The discussion on spatial welfare theory has indicated that territorial justice is a suitable concept for distributing public health resources in geographic space.

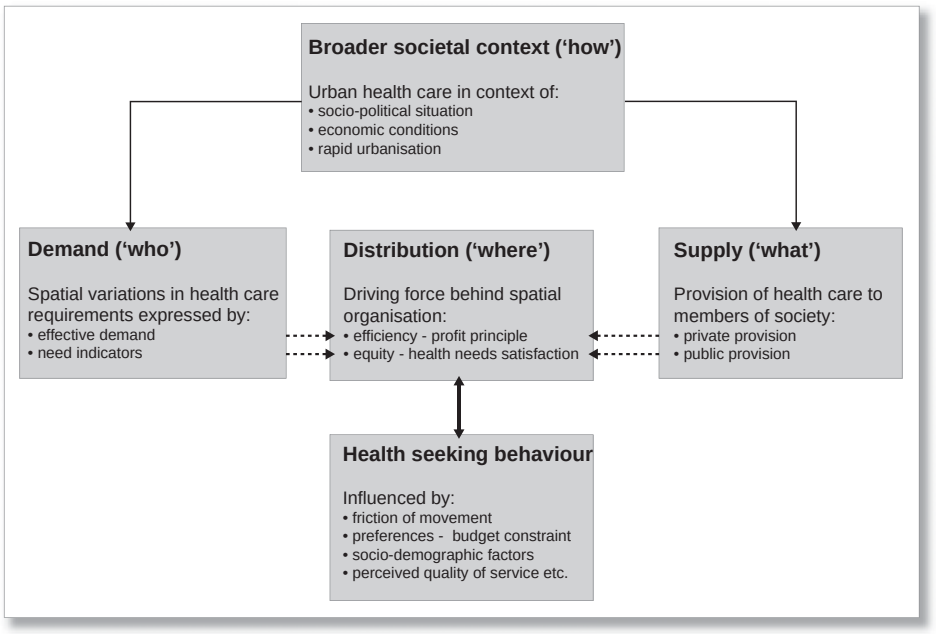


Figure 2.3: A working model of spatial welfare theory in urban health care.

The adoption of the 'health needs' objective as the basic regulatory mechanism for the spatial allocation of public health services is, however, not without problems. This is because health needs are hard to define and measure. In addition to medical criteria, health needs must be understood in the context of the individual and the social, technical, political and economic environment that exists at a particular time. Value judgments will play a role regardless of the definition adopted, and planning outcomes may be affected by the way in which health need is operationalized. As described previously, a way forward is to establish practical indicators of health needs based on empirical evidence. The establishment of spatially disaggregated health indicators in sub-Saharan cities is, however, generally problematic given the paucity of reliable, up to date and disaggregated data (also see Chapter 3).

Health seeking behaviour: access and utilization

An important contribution of spatial welfare is its dismissal of the neoclassical assumptions of equal friction of distance in all directions and of absolute rationality in human (spatial) behaviour. Obviously, the friction of distance is not equal in all directions but largely determined by existing road patterns and restricted by physical barriers to travel. Furthermore, it is not a function of physical distance alone but influenced by the available modes of transportation, travel time, costs, congestion level, and so forth.

Health care utilization - the outcome of the process through which individuals decide which particular medical facility to use - will not occur under conditions of perfect information and will not necessarily be economically and spatially rational (Golledge and Stimson, 1997). Commonly recognized co-determinants of health seeking behaviour include socio-economic status, demographic characteristics, health care costs, type and severity of illness, perceived quality of care and, friction of distance (Joseph and Phillips, 1984; Phillips, 1990).

As illustrated in Figure 2.3 health seeking behaviour can be viewed upon in two ways. Firstly, as the *outcome* of a given spatial arrangement of health care provision. Second, it can be used as the *input* for the planning of health care interventions aimed at increasing health needs satisfaction. Regularities in revealed health seeking behaviour can be identified and subsequently used to identify under-serviced areas and set priorities for health care interventions. Proper health care planning thus requires understanding of the factors that govern actual health seeking behaviour. The strength of such an approach is that it roots health-seeking behaviour in the social and spatial context in which decisions are made. It also implies a move from a normative towards a descriptive planning framework that incorporates actual patterns of spatial behaviour. The analysis of the factors governing health seeking behaviour is the subject of Chapter 5.

The argumentation presented above has shown the strength of spatial welfare theory as a theoretical framework for describing the functioning of urban health care (whether private or public) in geographic space. In the next section we move away from theoretic abstraction and orient the discussion to the methodological framework of this study.

2.3 Methodological framework: accessibility analysis

This section identifies appropriate methods and techniques of spatial analysis that can be used in a GIS environment for the representation and modelling of a spatially equitable and efficient health care system. To appreciate what contemporary GIS-

based spatial analysis has to offer, this section commences with a brief overview of how this subject area has developed over time. Attention then turns towards an exploration of the concept of accessibility, its most common operationalizations and the identification of the most promising type(s) of measure for this study.

Spatial analysis and human geography

The origins of spatial analysis lie in quantitative geography, which developed into an important school of thought in the 1950s and 1960s (Johnston, 1979). The spatial analytical approach was a reaction to the regional paradigm in human geography with its emphasis on the unique and the particular (regional differentiation and regional synthesis). The spatial analytical approach, by contrast, emphasized the importance of developing generalized laws, models and theories of spatial organization within a logical positivist framework. (Berry and Marble, 1968) have described the primary goal of the approach as building accurate generalizations with predictive power by precise quantitative description of spatial distributions, spatial structure and organization, and spatial relationships.

The introduction of quantitative techniques in human geography was an important outcome of the spatial analytical approach. Relevant theories, statistical techniques and mathematical methods were incorporated from other systematic sciences and extended, modified and applied in geographical research (Johnston, 1979, p. 54). Two main fields of study characterize spatial analysis: statistical spatial data analysis and spatial modelling. Much of the spatial modelling work of that time were mathematical interpretations of neo-classical economics, central place theory or classical mechanics. Research efforts emphasized the development of spatial theory and quantitative techniques; the significance of the research problem itself was often secondary (Goodall, 1987).

Up to the early 1970s there was great interest in and widespread use of spatial analytical methods by human geographers. After that, the popularity of model-based approaches declined and during the 1980s spatial analysis became largely forgotten (Rushton, 1993; Maguire, 1995). The disillusion with the spatial analytical approach was caused by two important factors. The first was the recognition that many of the models did not properly represent human behaviour (a lack of credibility) and that their outcomes were not easy to interpret or practical to use (a lack of acceptability). The result was a real paucity of applied models in use by planners in either the public sector or the private sector (Clarke, 1997). The second factor was the changing perspective of planners and decision-makers. There was concern that the mechanical approach of quantitative geography failed to respond to broader issues of equity, pollution as well as the increase in uncertainty posed by global crises of energy and economy (Harris and Batty, 2001). Increased academic interest in understanding how individuals behave and structure their spatial organization, as well as the resurgence of

interest in public policy issues made that behavioural and radical geography came to the forefront in mainstream geography. Starting from the mid-1990s, however, a reappraisal of spatial analytical techniques can be observed, largely as a result of the widespread proliferation of GIS.

GIS and spatial analysis

Whereas spatial analysis has traditionally been the domain of quantitative geography, GIS has emerged from rather different origins. Rooted in computer science and computer graphics, the early GIS systems were primarily developed as tools for the storage, retrieval and display of geographical data. Capabilities for spatial analysis were very limited. Since then, GIS systems have matured considerably and modular multi-purpose packages with broad functionality have come to dominate the market. What remains, is that the vast majority of GIS applications is oriented towards database automation and relatively simple mapping and query operations. Most GISs have been established with the objective to increase the efficiency and effectiveness of the organization.

Starting from the mid-1990s a substantial number of publications illustrate a growing (academic) interest in the possibilities of using spatial models in GIS for planning purposes. A number of developments are responsible for the reappraisal of spatial analysis: technological progress, a maturing community of GIS users and academic advancement in the field of spatial analysis itself (Fotheringham and Rogerson, 1994; Maguire, 1995; Birkin *et al.*, 1996; Longley and Batty, 1996).

Technological progress stimulates spatial analysis in at least three ways. To begin with, the availability and affordability of powerful desktop computers has substantially removed the processing bottleneck that formerly restricted spatial analysis. Furthermore, GIS software provides spatial analysts with a support environment with excellent tools for spatial data management and visualization. Last but not least, - in the Western World - there is generally a much greater availability of digital data that can be utilized as inputs into spatial models. New techniques of data capture -such as remote sensing and Global Positioning Systems- have come within reach of most GIS users and digital (spatial) databases are increasingly seen as a tradable commodity and strategic resource.

A second development concerns the changing requirements of a maturing GIS community. The initial focus on database creation and routine information management is slowly evolving and more and more users also want to utilize GIS for the analysis of their data. Although the demand for such functionality is still restricted to more experienced users and to application areas such as business and service planning, overall demand will further rise in future. This development illustrates the evolution of GIS from a transaction-processing tool towards a decision-support tool,

capable of sophisticated analysis and modelling operations. It also reflects the desire of organizations to gain competitive benefits from the use of GIS (Openshaw and Clarke, 1996).

A third development responsible for the reappraisal of spatial analysis comes from academic advancement in the field of spatial analysis itself. Ongoing re-specification and reformulation of models has resulted in a new generation of analytical models with a much higher degree of credibility and acceptability. There has been a trend away from crudely specified, large-scale models towards data-rich models specifically designed for tightly defined application areas. The deterministic neo-classical foundation - a common characteristic of 'older' models - has been supplanted by probabilistic techniques capable of a more appropriate representation of human spatial behaviour. Not only have existing methods improved, but also a whole range of new methods (e.g. micro simulation, neural networks, and cellular automata) has developed alongside.

The combined impact of these developments is that many basic and some advanced spatial analysis capabilities have become incorporated in commercial GIS software in recent years. Despite this extension, many professional spatial analysts consider the current level of analytical functionality in commercial GIS as deficient and not reflecting the advances made in the last ten years (Openshaw and Clarke, 1996; Hendriks and Ottens, 1997; Fotherinham, 2000). Most of the academic modelling tools continue to be developed as separate modules (mostly research prototypes), which can be coupled to the GIS through a data transfer mechanism of varying sophistication. It is worthwhile noting that the coupling approach has strong similarities with the system architecture of Spatial Decision Support Systems.

What about the future of spatial analysis in GIS? It is very probable that further enrichment of analytical functionality in GIS can be expected as a result of the progression of above described developments. It should be equally clear, however, that spatial analysis is outside the mainstream of GIS applications and will remain so for the foreseeable future (Longley and Batty, 1996). The success of analytical GIS will, therefore, very much depend on its ability to provide real support to decision-making by offering acceptable and robust methods of problem solving to the planning community (Clarke, 1997).

The challenge for spatial analysts is, thus, to further enhance their analytical methods, to support their practical application in planning contexts, and to educate end-users about the benefits and pitfalls of using them. In the next section, focus is on the accessibility concept which is an important field of study within spatial analysis.

Accessibility: a concept and tool for spatial equity analysis

Spatial planning of health care facilities at the intra-urban level concerns the identification of suitable locations for a given number of health facilities in a defined territory, in such a way that the health needs of a spatially dispersed population are served in an optimal way. Basic to this type of location planning is the concept of accessibility. Stated in general terms, accessibility relates to the ability of people to overcome the friction of distance to avail themselves of services at fixed points in space. As argued before (see section 2.2), access to sources of need satisfaction has an important bearing on human well-being: accessibility can be viewed upon as a scarce resource, which is dependent on distribution and redistribution through the planning process (Smith, 1974). Accessibility is used as a mechanism through which we can approximate the degree of health needs satisfaction - and/or predict the expected number of patients - for a potential location.

Although accessibility is a familiar planning objective and a frequently used term in the geographic literature, it is a slippery notion, which has been defined, and operationalized in a variety of ways. We therefore first need a clear insight in the accessibility concept, only then we can investigate how accessibility can best be given operational form in the context of this study.

A very useful framework that introduces the notion of accessibility in the context of service provision is provided by Moseley (1979). Moseley systematizes accessibility as consisting of three components: *(i)* people, *(ii)* the activities or opportunities that they require, and *(iii)* the transport or communication link between the two. The strength of this framework is that it makes explicit that accessibility varies according to the characteristics of people, of the activity or opportunity, and of the transportation infrastructure. Accessibility is the outcome of the combined characteristics of the three components mentioned above. Moseley's framework explicitly positions accessibility as a concept consisting of a socio-economic as well as a spatial dimension between which important relationships exist.

A comparable but more elaborate framework for understanding accessibility is described by Geurs and Ritsema van Eck (2001). They present accessibility as the outcome of four interrelated components: a spatial component, a transport component, a temporal component and an individual component (see Figure 2.4).

The spatial component of accessibility describes two elements: *(i)* the spatial distribution of opportunities (and their characteristics) and *(ii)* the spatial distribution of demand for opportunities (and their characteristics). In general terms, it refers to consumption in space (place utility) and production in space (space utility) as previously described in section 2.2. In terms of health care, it reflects the spatial arrangement of health care provision in relation to the spatial variation of health needs

of people. In the case of private health care the attuning mechanism is effective demand; in the case of public health care it is some indicator of health needs.

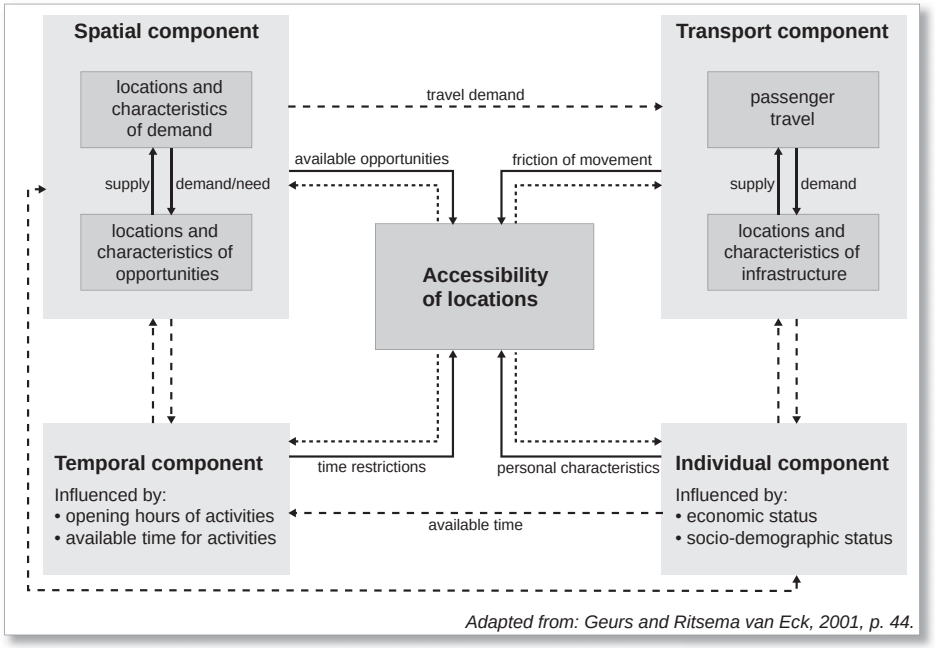


Figure 2.4 : Components of accessibility and their relationships.

The spatial arrangement of opportunities is normally represented by point locations; attractiveness is mostly measured in terms of variations in size and functional make up. Another important consideration concerns the representation of the spatial variation in demand or need. This requires some form of spatial disaggregation: the breaking down of a bounded region into smaller zones, thus grouping people by proximity. For analysis at the intra-urban scale, the definition of spatial units for which demand or need is estimated, can be based upon the boundaries of administrative units (e.g. census tracts, wards). An important motive for using such units is the link to descriptive data (e.g. census data) that can be used to approximate demand or need. A disadvantage is that these units may be arbitrary in size and shape and internally heterogeneous (problem of the ecological fallacy).

In the more recent literature, a trend can be observed towards using smaller geographic units, the use of postcode areas in particular. Another approach is to subdivide a study area into a regular tessellation of some kind (squares, hexagons). The advantage of such an approach is the near elimination of the ecological fallacy (Spiekerman and Wegener, 2000). A disadvantage is the weaker link to secondary data sources. In most cases, the spatial component is measured for a resident who begins a trip to an

opportunity from the place of residence but alternative approaches are described that incorporate multi-stop trips and trip chaining (Arentze *et al.*, 1994).

The transport component consists of three elements *(i)* the location and characteristics of the transport infrastructure, *(ii)* the demand for travel and *(iii)* observed infrastructure use (mobility). Transport itself is not the desired product but a means to an end. The purpose of the transport component is to describe how people overcome the friction of distance that separates the point of demand from the point of supply (Pacione, 1989). Friction of distance is normally described in terms of travel mode, time, costs or effort. It can be estimated by Euclidian distance, some modification of it such as, for example, the Manhattan metric or actual distance/time calculation along a street network (Hanson and Schwab, 1986). The latter is generally considered to give the best approximation (Geertman and Ritsema van Eck, 1995). Generally, travels patterns show some form of distance decay, that is, the interaction between two locations declines with increasing disutility (travel distance, time, cost and effort). The perception of friction of distance is not given but varies with transport mode, purpose of trip, characteristics of the household and characteristics of the attractiveness of the destination.

The temporal component of accessibility describes the *(i)* availability of activities at different moments in time and *(ii)* the times at which individuals are able to participate in activities. An example of the first is that accessibility to health care depends on the opening hours and days of medical facilities. An example of the second occurs if the opening hours of a medical facility coincide with the working hours of an individual. This component shows that accessibility is not merely about making connections in physical space but also needs to take available time into account. The incorporation of the temporal component of accessibility finds its origins in the space-time studies from (Hägerstrand, 1970).

The individual component of accessibility refers to the characteristics of individuals that impact on accessibility. Approaches that incorporate individual characteristics and preferences do exist - and will be touched upon in the following - but their practical application is relatively scarce. By far the most common approach is that the individual component of accessibility is incorporated into accessibility measures by disaggregation of the population under study using economic and socio-demographic characteristics.

Obviously, the four components of accessibility are interrelated: the spatial component is an important factor determining travel patterns; it may also introduce time restrictions and influence people's opportunities. In turn, the individual component influences travel demand, the available time for activities and the demand/need for opportunities. Furthermore, accessibility also influences the contributing components through feedback relationships: accessibility is a location factor for people and

activities and influences travel demand, people's opportunities and the time needed to participate in activities (Geurs and Ritsema van Eck, 2001).

Accessibility measures: an overview and evaluation of approaches

The subject of this section is to give operational form to the concept of accessibility. It shortly describes and evaluates the following measures *(i)* container measures, *(ii)* simple distance measures, *(iii)* cumulative opportunity measures, *(iv)* composite measures, *(v)* time-space approaches and *(vi)* utility-based approaches.

Container measures

The simplest and crudest measure of accessibility - mainly used in the political science literature - is the container approach: access is determined on the basis of a simple count of facilities or services by some administrative area. There is no consideration for the structure of the transportation network, the frictional effect of distance or properties of the supply side (Talen and Anselin, 1998). Although this approach has some merit at higher levels of spatial aggregation - when resources are allocated by the political process to individual administrative units - it is not appropriate for analysis at more detailed geographic scales such as that of intra-urban health care provision. It also does not reflect any of the previously identified components of accessibility.

Simple distance measures

The simplest distance measures operationalize accessibility as the straight line distance between two locations in geographic space. This type of measure is often used in situations where standards exist in terms of maximum travel time or distance to an opportunity (e.g. every person must be able to reach a health facility within 30 minutes travel time). Accessibility is measured from a demand location to a single (the closest) opportunity. This type of approach is based upon the notions of neo-classical location theory. It is very commonly used and mostly operationalized on the basis of standard GIS functionality. In their simplest form, this is done through the generation of service areas around opportunities using functions such as buffers or Thiessen polygons, often in combination with overlay and query procedures (Doherty *et al.*, 1996). An advantage of simple distance measures is that the data requirements are modest and that results can be interpreted easily. This type of approaches also has clear disadvantages. *First*, demand is assigned to the nearest - mostly Euclidian distance - opportunity in a deterministic manner. In other words, the transport, the individual and the temporal components of accessibility are neglected. A *second* problem with this type of approach is that - although it has some merit for evaluating existing situations - it is not very suited for forecasting and scenario-building.

Cumulative opportunity measures

Cumulative opportunity measures indicate the number of opportunities - or number of potential customers - that can be reached within a given travel time or distance

(Breheny, 1978). All potential opportunities within a given cut-off distance/time are weighted equally. Accessibility increases if more opportunities can be reached within a given travel time or distance. This increase can be the result of either a change in the ease of reaching destinations (a change in the transport component) or a change in the number of available opportunities (a change in the spatial component). They incorporate both the spatial and the transport component of accessibility but do not evaluate their combined effect (as is the case in composite measures). The individual component can be approached through socio-economic disaggregation of the population under study.

A well-known research tool from which cumulative opportunity measures are derived is the 'location profile'. A location profile is a graph that for a single location depicts the cumulative number of opportunities for a growing distance range. De Jong and Ritsema van Eck (1997) describe two basic accessibility indicators that are derived from the location profile and used in a GIS environment. The proximity count is the number of opportunities within a given (a fixed maximum acceptable) distance range from a particular starting location. The threshold distance is the shortest distance to a given (a fixed minimum) number of opportunities. On the basis of these measures, a tessellated accessibility surface can be constructed that shows the general pattern of accessibility, or expected number of customers, for a new activity for each location in a bounded region.

The main advantage of cumulative opportunity measures is that their results are straightforward and easy to interpret by non-specialists. Other important advantages are that the data requirements are relatively undemanding and that alternative scenarios can easily be generated. An obvious disadvantage is the lack of differentiation between opportunities that are near to the demand origin and those just within the specified cut-off distance. *Second*, all opportunities are equally desirable despite potential differences in their characteristics. *Third*, the choice of a cut-off travel distance or time (the range) is a somewhat subjective matter. Frequency distributions of travel times or distances from a travel survey can, however, provide relevant information for the determination of an appropriate cut-off value. Another weak point of the proximity count as a measure for potential market size, is that it is based upon deterministic behavioural assumptions: it is assumed that all customers will always visit the nearest opportunity (Ritsema van Eck and de Jong, 1999).

Composite measures

Composite measures of accessibility have a long and rich history and were originally introduced to human geography by the 'social physics' school of thought. At the basis of this type of accessibility measures lies the gravity model, which utilizes the principles of Newtonian physics to explain social phenomena. Briefly, the gravity model stipulates that two places will interact with each other in proportion to the product of their size and inversely according to some function of the distance between them

(Abler *et al.*, 1972, p. 221). The accessibility measure is termed composite as it captures two parameters (the spatial and the transport component) into a single index: *(i)* scale impacts which are operationalized in terms of the utility of the destination location; and *(ii)* distance impacts operationalized in terms of separation units of some kind. The accessibility of a particular location is seen as a function of its relative proximity to alternative destinations of varying utility in a given spatial system.

Because of the probabilistic nature of composite measures they assume non-deterministic fuzzy market areas. Composite measures are mostly used to explain why some localized activities attract more users than do others and to explain the way in which an activity impacts on the surrounding area in terms of customer flows (Haynes and Fotheringham, 1984, p. 11). Generally speaking, the more accessible a location is, the higher the intensity of possible spatial interaction with surrounding locations becomes. Composite accessibility measures describe aggregate human behaviour, not individual behaviour.

Well-known analytical tools for estimating interaction potential are the potential model and the spatial interaction model. Whereas the potential model considers places one at a time with respect to interaction potential with all other locations in the system, spatial interaction models describe the pair wise interaction flows themselves among all locations in the system. When interaction potential is computed for a large number of locations in a bounded region, a map of a potential surface can be constructed.

The main advantage of composite approaches is that they offer a probabilistic view on human spatial behaviour and that their data requirements are modest. Furthermore, some argue that the measure corresponds with a concept that most non-specialists would accept: it denotes a range of choice offered by the land use and transport components in the form of a sum of potential destinations (Geurs and Ritsema van Eck, 2001). Compared to measures of cumulative opportunity, however, the calculated accessibility indicator is harder to interpret. Calculated values have no meaning by themselves and can only be compared to other sites, in the sense that a higher value indicates a more accessible location (Geertman and Ritsema van Eck, 1995; de Jong and Ritsema van Eck, 1997).

The most important disadvantage of gravity-based measures is that they have only limited theoretical justification other than the analogy to a law of physics. Despite numerous efforts (e.g. Wilson, 1970), a link to a theory of human spatial behaviour was never sufficiently established. A second disadvantage is how to reconcile the individual component of accessibility with a model that describes aggregate outcomes. In practice this problem is reduced by breaking down the population under study into socio-economic and demographic strata, allowing each subgroup to have its own characteristics of consumer behaviour. A third disadvantage is that of self-potential: in their basic form composite measures are extremely sensitive to short distances.

Finally, composite measures require the estimation of a distance decay function to describe the friction of distance. For plausible results, the calibration should be estimated using recent empirical data of spatial travel behaviour in the study area. The distance decay function should reflect the characteristics of the opportunity and of demand. Calibration is compounded by two theoretical issues *(i)* the fact that stated/revealed behaviour is not necessarily the same as preferred behaviour, and *(ii)* the extent to which human behaviour itself may change if the spatial arrangement of opportunities changes (Horton and Reynolds, 1971; Breheny, 1978; Rushton, 1993; Golledge and Stimson, 1997). The implication is that travel surveys should pay due attention to the identification of reasons behind stated/observed behaviour (also see Chapter 3).

Time-space approaches

Time-space approaches operationalize accessibility in a rather different manner than those described previously. Time-space approaches were developed, in part, as a reaction to the shortcomings of gravity-based measures and are related to the work of Hägerstrand (1970). At the heart of time geography is the notion that all of the actions and events that sequentially make up an individual's existence have both temporal and spatial attributes. The time-space approach attempts to define a bounded region of time and space at the individual level and to identify the main factors that constrain the individuals' freedom to occupy certain space and time locations. Movement of the individual in the spatial-temporal environment is restricted by three categories of constraints. *Authority constraints* refer to the limitations of access in place and time as enforced on individuals by, for example, authorities. *Capability constraints* refer to limitations of movement because of *(i)* physiological necessities and *(ii)* available transportation means. *Coupling constraints* refer to the 'where, when and for how long' the individual must join other individuals in order to finish a task (Johnston *et al.*, 1998).

By identifying these constraints it would become possible to deduce reasons why a particular individual follows one space-time path rather than another. Concern is with the space-time constraints of individuals and not primarily with the decision process that guides space-time behaviour. The significance of the motivations that underlie spatial behaviour is recognised but these are viewed upon as being elusive and therefore difficult to handle[1] (Golledge and Stimson, 1997).

The opportunities that can be reached given time and space constraints can be seen as a measure of accessibility. Accessibility can be improved either by expanding the action

[1] Geurs and Ritsema van Eck (2001) report on more recent research efforts that relate time-space approaches to the decision-making process by means of the random utility concept.

space of the individual or by placing more opportunities within its bounds. The main difference with cumulative opportunity and composite measures is their explicit link to the individual and the temporal components of accessibility. Time-space accessibility measures are able to reveal differences in individual accessibility, where composite and cumulative opportunity measures are aggregate measures that assign the same level of accessibility to all persons or members of a socio-economic group, that share the same origin location (Geurs and Ritsema van Eck, 2001).

The advantage of a time-space approach is that it accounts for each of the components of the accessibility concept (see figure 2.4). The fact that it is a disaggregate approach also is its main disadvantage as it has rather demanding data requirements to be implemented. Because of the large data requirements, applications are often restricted to smaller study areas and/or subsets of the population.

Utility-based accessibility approaches

Utility-based accessibility approaches assign particular importance to conceptualizing the decision process to explain and model individual spatial choice behaviour. This type of approaches is mostly operationalized using discrete choice models. These models are generally rooted in random utility theory (Thurstone, 1927), in which the probability of an individual making a particular choice depends on the utility of that choice relative to the utility of all choices. The expected choice behaviour is captured using a utility function that reflects the attractiveness of the destination, the travel impedance, the socio-economic characteristics of the individual, and their tastes and preferences (Borgers and Timmermans, 1993). Discrete choice models sometimes take a form similar to that of gravity-based measures, but given their solid theoretical foundation, they have an advantage over gravity-based measures (Borgers and Witlox, 1997; Handy and Niemeier, 1997).

The main advantage of utility-based approaches is their solid theoretical foundation in economic theory and that they encompass all components of accessibility. The disaggregate approach, again is also an important disadvantage as data collection is a very demanding task. For every individual one needs to record what his/her perception is of all the available alternatives and how they are weighted. The conceptualization of the decision making process requires considerable interaction with respondents. Because of the large data requirements, utility-based applications are often restricted to subsets of the population and smaller study areas. Another disadvantage is that the outcomes of a utility-based measure are not easily interpreted by non-specialists (Geurs and Ritsema van Eck, 2001).

Identification of suitable measures for urban health care planning

The question that remains is which of these measures is the most appropriate for urban health care planning in sub-Saharan Africa. This question is answered by looking at factors such as *(i)* theoretical and methodological soundness, *(ii)* ease of

interpretation, *(iii)* data needs, and *(iv)* usability for urban health care planning in the sub-Saharan context.

We begin with excluding container and simple distance approaches for two reasons. *First*, their theoretical soundness is too limited (they neglect the transport, the individual and the temporal components of accessibility). *Second*, these measures are not suited for forecasting and scenario-building which is an essential consideration for location planning in the urban health sector.

Despite their theoretical elegance, time-space and utility-based measures do not appear to be the most appropriate for this type of study for two reasons. The first reason is practical and refers to the difficulty in obtaining data. The conceptualization of the decision making - in the case of utility measures - process requires considerable interaction with respondents. In practice it will be close to impossible to collect such data in the field. The second reason is conceptual. Since this study sets out to establish a socio-economic typology of patients and model their expected spatial choice behaviour - a more aggregate approach -, it should not rely on a theoretical framework that focuses on individual level explanation.

Gravity-based operationalizations of accessibility feature prominently in the empirical literature. Despite their theoretical limitations, composite approaches are successfully applied to describe more aggregate spatial behaviour and have undemanding data requirements. An important advantage is their probabilistic view on human spatial behaviour. Composite measures should therefore not be excluded and are considered to be a useful option for this study.

Cumulative opportunity measures are also suitable for a number of reasons. *First*, their more aggregate nature matches the proposed level of analysis for this study. *Second*, the interpretation of the performance measure of accessibility is straight forward which is an important advantage over gravity-based methods. *Third*, the data requirements of comparative approaches are comparable to gravity approaches. *Fourth*, cumulative opportunity measures can be usefully applied in situations in which norms exist with respect to maximum travel distance or minimum threshold (this is often the case in health care). *Fifth*, advanced comparative measures have recently been developed that take spatial competition effects into account (Ritsema van Eck and de Jong, 1999). Accessibility surfaces can be constructed for situations where a new facility is planned as part of a chain of facilities and the objective is not to maximize the market area of the individual facility alone but rather that of the chain as a whole. This clearly is a crucially important consideration in planning for new public health care facilities. To summarize the above, it appears that the most sound way to represent and model a spatially equitable and efficient urban health care system in the sub-Saharan context, is to use a 'what if' type of GIS-based approach on the basis of a composite or a cumulative opportunity measure of accessibility.

2.4 Contextual framework: GIS based accessibility analysis in sub-Saharan Africa

The former paragraphs have established that there is a need for systematic location planning in the public health sector, and that accessibility analysis provides a useful conceptual and methodological toolkit to support such planning efforts. In this section, focus is on *(i)* the empirical literature on accessibility analysis for (health) services, and *(ii)* the applicability of 'what if' accessibility analysis in a GIS environment in Sub-Saharan Africa.

Accessibility analysis in (health) service planning: the empirical literature

The empirical literature on location planning for services has a long history and is overwhelmingly vast and varied. It covers a host of application areas which range from health care (Wellings, 1983; Oppong and Hodgson, 1994; Bullen *et al.*, 1996; Martin *et al.*, 2002), education (Pacione, 1989; Densham and Rushton, 1996), day-care centres (Truelove, 1993) and emergency services (Ritsema van Eck, 1993; Peters and Brent Hall, 1999) to retailing outlets (de Jong and Krygsman, 1999), parks (Erkip, 1997; Nicholls, 1999), libraries and public playgrounds (Talen and Anselin, 1998).

Common to all is that the concept of accessibility - and some operational form of it - is a central element in the analysis. Despite this similarity, the range of methodological approaches and application contexts is very diverse. A structured overview of a selection of academic publications in this field is presented in Table 2.1. The overview is certainly non-exhaustive and skewed towards health service applications but a number of qualitative conclusions can, nevertheless, be inferred from it.

Accessibility analysis becomes GIS based

Table 2.1, clearly shows that the period up to 1990 can be considered as the pre-GIS era. This is followed by a period of transition from 1990 - 1995 in which GIS makes its entry in the empirical field of accessibility analysis. After 1995, accessibility analysis is predominantly conducted in a GIS environment, regardless of the field of application. Obviously, the emergence of GIS as a tool in empirical service planning closely correlates with the general uptake of GIS technology, and with the earlier discussed rediscovery of spatial analysis.

Table 2.1 also shows how GIS impacts on the way in which accessibility analysis is operationalized. In the pre-GIS era, spatial disaggregation is predominantly based upon some form of administrative zone; the friction of distance is generally calculated in terms of Euclidian distance. With the uptake of GIS, spatial disaggregation is increasingly tessellation based (although zones remain used); and network calculations become the dominant way of representing the friction of distance.

Author	Year	Approach	Measure	Spatial disaggregation	Socio-economic disaggregation	Friction of movement	Utility of opportunity	Focus	Country	GIS	Service
Truelove	1993	'What is'	Cumulative	Census tract, Enumeration area	Income, age	Euclidian	Yes	Urban	Canada	No	Day care center
Densham and Rushton	1996	Location allocation	Distance	Education district	Population, children	Euclidean + correction	No	Regional	United States	Yes	Education
Pacione	1989	'What if'	Composite	Postcode zone	Population, age	Euclidian	No	Urban	Great Britain	No	Education
Breheny	1978	'What is'	Cumulative	Census zone	Population, children	Travel cost	Yes	Urban	Great Britain	No	Education
Fortney	1996	Location allocation	Distance	Census tract	Population, children	Euclidian	Yes	Urban	United States	No	Education
Brent Hall et al.	1995	'What is'	Composite	District	Population, fertile females	Network	No	Regional	Costa Rica	Yes	Health service
Secondini et al.	1996	'What if'	Composite	Census tract	Population, size	Euclidean	Yes	Regional	Italy	Yes	Health service
de Jong et al	1991	'What if'	Cumulative	Tessellation	Population, size	Network	Yes	Urban	Canada	Yes	Health service
de Jong and Amer	2002	'What if'	Cumulative	Tessellation	No	Network	No	Urban	Tanzania	Yes	Health service
Martin et al.	2002	'What is'	Cumulative	Tessellation	Population, size	Network	No	Regional	United Kingdom	Yes	Health service
Marks et al.	1992	'What is'	Distance	Zipcode zone	Population, elderly	Euclidian	Yes	Regional	United States	Yes	Health service
Walsh et al.	1995	'What is'	Distance	Zipcode zone	Population, size	Network	Yes	Regional	United States	Yes	Health service
Bullen	1996	'What is'	Distance	Parish boundary Urban ward	Population, size	Euclidian	No	Regional	Great Britain	Yes	Health service
Doherty et al	1996	'What is'	Distance	No	Population, size	Euclidean + correction	Yes	Urban	South Africa	Yes	Health service
Hyndman et al	1997	'What is'	Distance	Census district	Population, age cohort	Network	Yes	Regional	Australia	Yes	Health service
Peters and Brent Hall	1999	'What is'	Distance	Tessellation	Emergency caller Population, size	Network	No	Regional	Canada	Yes	Health service
Perry and Gesler	2000	'What is'	Distance	Village (Point)	Population, size	Euclidian + Travel time	No	Regional	Bolivia	Yes	Health service
Hyndman et al.	2001	'What is'	Distance	Census district	Population, disadvantaged	Euclidian	Yes	Urban	Australia	Yes	Health service
Mallick and Routray	2001	'What is'	Distance	Village (Point)	No	Euclidean	Yes	Regional	India	Yes	Health service
Lovett et al.	2002	'What is'	Distance	Parish/Ward	Population, size	Network	No	Regional	United Kingdom	Yes	Health service
Parker and Campbell	1998	'What is'	Distances	Postcode zone	Patient number	Euclidian Network	No	Regional	Great Britain	Yes	Health service
Khan	1992	'What is'	Composite	SMSA	Population, size	Euclidean	No	Regional	United States	No	Health service
Wellings	1983	'What if'	Cumulative	Tessellation	Population, size	Euclidian	Yes	Regional	Lesotho	No	Health service
Massam et al.	1986	Location allocation	Distance	Village (Point)	Population, size	Euclidian	Yes	Regional	Zambia	No	Health service
Annis	1981	'What is'	Distance	Village (Point)	Population, size	Euclidean + correction	Yes	Regional	Guatemala	No	Health service
Knox	1982	'What is'	Distance Cumulative Composite	Census tract	Population, size	Network	No	Urban	United States	No	Health service
Ayeni et al.	1987	Location allocation	Distance	Village (Point)	Population, size	Euclidian	No	Regional	Nigeria	No	Health service
Hodgson	1988	Location allocation	Distance	County	Population, size	Euclidian	Yes	Regional	India	No	Health service
Mulvihill	1979	Location allocation	Distance	Home location of individual (Point)	Population, poor	Euclidean	Yes	Urban	Guatemala	No	Health service
Oppong and Hodgson	1994	Location allocation	Distance	Village (Point)	Population, size	Euclidian	Yes	Regional	Ghana	No	Health service
Geertman	1995	'What if'	Composite	Tessellation	Population, size	Network	-	Regional	Netherlands	Yes	Housing
de Jong and Ritsema van Eck	1997	'What if'	Cumulative	Tessellation	Population, size	Network	Yes	Regional	Netherlands	Yes	Jobs
Talen and Anselin	1998	'What is'	Container Composite	Census tract	Population, size	Network	No	Urban	United States	No	Playground
White et al	1997	'What is'	Distance	Enumeration district	Population, size	Euclidian	No	Regional	United Kingdom	Yes	Post office
Nicholls	1999	'What is'	Distance	Census unit	-	Euclidian Network	Yes	Urban	United States	Yes	Public park
Erkip	1997	Container	Container	Districts	Population, low income	Travel time	Yes	Urban	Turkey	No	Public parks

Author	Year	Approach	Measure	Spatial disaggregation	Socio-economic disaggregation	Friction of movement	Utility of opportunity	Focus	Country	GIS	Service
de Jong and Ritsema van Eck	1997	'What if'	Cumulative	Tessellation	Population, size	Network	Yes	Urban	Netherlands	Yes	Retail service
de Jong and Krygsman	1999	'What if'	Cumulative	Tessellation	Population, size	Network	Yes	Urban	South Africa	Yes	Retail service
Ritsema van Eck and de Jong	1999	'What if'	Cumulative, Composite	Tessellation	Population, density	Network	No	Urban	Netherlands	Yes	Retail service
Makin et al.	1997	'What if'	Time space	Home location of individual (Point)	Individual	Network	Yes	Simulated	Simulated	Yes	Retail service
Huff	1963	'What is'	Composite	Statistical unit	Population, size	Travel time	Yes	Urban	United Kingdom	No	Retail service
Hanson and Schwab	1986	'What is'	Cumulative	Home location of individual (Point)	No	Euclidian	No	Urban	Sweden	No	Retail service
Handy and Niemeier	1997	'What is'	Time space Composite	Neighborhood	No	Network	Yes	Urban	United States	No	Retail service

Table 2.1: Overview and characteristics of the empirical literature on accessibility analysis for (health) services.

In the most recent literature, separate network calculations are made to accommodate for both public and private modes of transport (e.g. Martin *et al.* 2002; de Jong and Amer, 2002). The individual component of accessibility was and remains mostly incorporated by disaggregation of the population under study using economic and socio-demographic characteristics. The utility of opportunities is incorporated in nearly all studies.

GIS based accessibility analysis for health services

When looking at the type of accessibility measure used in health service analysis, a number of observations can be made. *First*, most GIS operationalizations in the health sector are based upon Euclidian distance measures. The analysis is focused on the existing situation; there is little attempt to develop scenario's that can be used by decision makers to evaluate the effects of alternative planning interventions. Cumulative opportunity and composite measures have such 'what if' capability but they appear much less frequently; time space approaches have not been encountered in the empirical health sector literature (probably this is related to the difficulty in obtaining proper data).

The emphasis on 'simple' distance measures can be interpreted as an indication of the relative immaturity of the average GIS user in the health field (likely this is combined with a limited conception of the accessibility concept itself). The more 'advanced' measures of accessibility are used by specialized academics - geographers and GIS practitioners - with a traceable history in the field of spatial analysis and GIS. The latter category of applications is not focused on the analysis of existing situations but more oriented towards 'what if' scenario development (Higgs and Gould, 2001). These types of applications normally make use of a specialized modelling tool, which is coupled with the GIS.

Second, most publications are studies of potential accessibility; the use of GIS in studies that incorporate actual health care utilization are relatively rare (Gatrell and Senior, 1999).

Third, if we take a geographic perspective, it is clear that most GIS applications in the health field come from the developed world. Their focus is predominantly at the regional/rural scale (although intra-urban applications do exist). If we look at the developing world, it is very apparent that applications with an intra-urban focus - apart from publications by Doherty *et al.* (1996) and de Jong and Amer (2002) - are very scarce. The conclusion that can be drawn from this is that there remains considerable scope for further research in GIS based accessibility analysis in the *urban* health sector in the developing world. The applicability of such a type of analysis in Sub-Saharan Africa is shortly commented upon in the following pages.

Optimal versus acceptable spatial solutions

Before doing so, however, a few words need to be said about approaches that use optimization techniques and those approaches that focus on providing 'acceptable' solutions to planners and decision makers. A very large literature exists on the use of optimization methods in location planning that comes under the location-allocation umbrella (Bach, 1980; Beaumont, 1980; Leonardi, 1981; Ghosh and Rushton, 1987). Location-allocation models jointly optimize the location of centres and the allocation of consumers to those centres. This type of optimization problems requires the specification of an objective function (e.g. the maximization of consumer benefits) and a set of constraints such as minimum levels of supply. The approach demands finding a spatial solution that maximizes the objective function while, at the same time, not infringing the constraints. Hodgart (1978) and Hanssen *et al.* (1987) provide good general reviews of this family of models.

For an overview of location-allocation approaches for health service planning in the developing world - mostly dating back to the 1970s and 1980s - see Rahman and Smith (2000) and Rushton (1984). From Table 2.1, it can be seen that location-allocation approaches were quite popular in health planning in the developing world during the pre-GIS era. Nearly all of these location-allocation applications are concerned with the provision of regional/rural services. This is a clear reflection of the rural orientation of development thinking of that period. GIS-based location-allocation approaches are surprisingly scarce, despite the fact that it has become part of standard GIS functionality. Given that the literature on location-allocation approaches is still 'alive', it appears that proponents of optimization approaches hardly cross-fertilize with academic GIS practitioners.

The principal arguments advanced by proponents of optimization methods is, that the possible range of solutions in geographic space is such that only computer-based search procedures can evaluate all possibilities and suggest optimal policy interventions

(Hodgart, 1978; Oppong and Hodgson, 1994). A number of arguments can, nevertheless, be formulated that provide counter evidence to this viewpoint. Firstly, one can argue that in a decision support environment one should not look for one unique optimum solution: for a decision maker it is more useful to work with a set of acceptable locations as a basis for evaluating several 'what if' scenarios. Secondly, accessibility is rarely the only factor that determines the location decision, restrictions such as, for example, the availability of sites will inevitably exist in reality. Thirdly, by providing planners with 'what if' tools, the congruity between the problem as seen by the decision maker and the modelling tool improves. It allows decision makers to generate their own solutions to problems and examine in more detail the consequences of their decisions (Densham and Rushton, 1996; Jankowski and Ewart, 1996; Miller, 1996). From the above, it is concluded that for this research the need is for a 'what if' scenario type of approach rather than using a restrictive global optimization solution.

Applicability of GIS based accessibility analysis in sub-Saharan Africa

The former paragraph established that GIS-based accessibility analysis offers a useful toolkit that can be used to support location planning in the urban health sector. Furthermore, there is abundant literature pointing to the value of GIS for health care planning within research and practical applications (Gatrell and Loytonen, 1998; Gatrell and Senior, 1999; Albert *et al.*, 2000; Maheswaran and Craglia, 2004). At the same time, there is little evidence, certainly in the published literature, that GIS is being used in strategic decision-making. Practical applications - especially in urban health care - in sub-Saharan Africa are currently virtually non-existent.

This raises the question in how far contemporary accessibility analysis is applicable in African (urban) health planning practice of today. Obviously, this question needs further evaluation upon completion of the study but a few preliminary comments can be made at this stage.

To begin with, the discussion on the applicability of spatial analysis in Developing Countries is not new. Rushton's (1984) review indicates that after a promising start in the 1970s, the application of spatial analytical techniques (mostly rural location-allocation applications) in developing countries generally became rejected in the 1980s by planners and the major development agencies such as the World Bank, Unesco, the United Nations and USAID. In stead, many institutions embraced the 'urban functions in rural development methodology' to bring urban service functions to rural populations (Rondinelli, 1984). This approach emphasizes provision of services as an integrated package based on an analysis of settlement hierarchy. It is qualitative and stresses the use of easily available data and of analytical methods that do not require sophisticated technical skills or computing facilities (Tewari, 1992).

Spatial analysis was dismissed on the grounds of being too sophisticated for local circumstances given the problems of *(i)* availability of computing resources, *(ii)* the lack of trained personnel, *(iii)* limitations of the methods to capture the complexity of the planning problem, *(iv)* comprehensibility to decision makers, and *(v)* data availability (Rushton, 1984, p. 161). If we contrast these arguments with the previously described forces behind the recent reappraisal of spatial analysis in the Western World (technological progress, a maturing GIS community, increasing availability of digital data, and academic advancement in spatial analysis) a few observations can be made.

Computing resources no longer form a significant barrier for spatial analysis
Hardware and software barriers to adoption of spatial analysis have much reduced since the 1970s. With the advent of affordable desktop computers, hardware is no longer a serious bottleneck. Adequate computing facilities have rapidly become available in academic institutes and in public institutions in many African countries. Software also is much less a problem. There is considerable evidence of the adoption of GIS in these institutions in recent years, which means that standard GIS functions for spatial analysis are now generally available. More advanced spatial modelling tools, however, are much less widespread as that they are still mostly research prototypes which have to be coupled to GIS. Birkin *et al.* (1996) come to the conclusion that it is only by linking such spatial modelling routines that GIS can play a more proactive role in the health care planning process. In short, the current hard- and software environment is much more conducive for spatial analysis than some decades ago although advanced modelling tools are not generally available in sub-Saharan Africa.

Scarcity of trained personnel remains
An important difference with the Western World is that the adoption of IT and GIS in sub-Saharan Africa is more recent and many (G) IT projects are still in their initial stages. Given this situation, experienced local GIS practitioners with expertise in the use of spatial analytical techniques will still be scarce. Foley (2002) reports that health authorities have made limited use of GIS because of a lack of IT expertise amongst staff, a limited appreciation of spatial aspects of planning, limited resources and the complexity of the planning process itself. Although Foley describes the situation in the United Kingdom there is every reason to believe that, in this respect, the situation in sub-Saharan Africa is even less favourable. The implication is that close collaboration is needed between GIS academics with expertise in spatial analysis and health professionals to advance strategic applications of health based GIS work in this part of the world. Apart from collaboration, training can remedy this situation. This requires that spatial analysis become incorporated in GIS education aimed at professionals involved in location planning of urban services.

Limitations of analytical methods have substantially reduced
As discussed previously, a common problem with spatial techniques developed during the era of quantitative geography was that the models did not represent human

behaviour sufficiently well. Since then, however, a new generation of analytical models has been developed with a much higher degree of credibility. There has been a trend towards data-rich models designed for specific application areas. The deterministic neo-classical foundation has been supplanted by probabilistic techniques capable of a more appropriate representation of human spatial behaviour.

Comprehensibility to decision-makers has improved
Another important shortcoming of the early quantitative approaches was that decision makers did not generally accept them as a useful tool to work with. In many cases this was caused by a mismatch between the formulation of the problem by the analyst and the problem as seen by the decision maker. Decision makers desired an analysis system to help them generate alternative 'what if' scenarios, analysts tended to formulate the location problem as an optimization problem. As illustrated during the discussion on accessibility measures, current approaches show much more recognition for the desires of decision-makers. The emphasis on optimization has been replaced with 'what if' approaches that aim at identification of good though possibly sub optimal solutions. Finally, with the excellent visualization capabilities of GIS, the interpretability of the access measures has also improved.

Data availability remains an important bottleneck
The availability of secondary data that can be utilized as inputs into spatial models remains extremely scarce in sub-Saharan Africa (although some improvement can be expected with the advent of high resolution imagery such as IKONOS). Often quoted data problems for analytical planning applications in the developing world pertain to the lack of disaggregated data, differences in classification of data, variations in frequency of updating, data inconsistency in time and aerial unit and the general lack of socio-economic data at a useful spatial resolution (Yeh, 1991). Given the dynamic nature of urban areas, the shortage of resources for routine data collection and the initial stages of G(IT) adoption, the availability of up to date and reliable data is a major problem - also see Chapter 3 -, which is not likely to change in the short term.

In conclusion, the applicability of spatial-analytic GI techniques in sub-Saharan Africa is in a better position than it was a few decades ago. Data availability remains a considerable bottleneck. The scarcity of trained personnel remains but can be remedied through collaborative approaches between health professionals and experienced GIS practitioners. On the positive side, the computing environment has much improved and current analytical tools are more robust and more geared to the needs of the decision maker.

Ultimately, however, the success of GIS-based accessibility analysis in sub-Saharan Africa will depend on its ability to provide real support to decision-making by offering acceptable and robust methods of problem solving to the health planning community.

2.5 Conceptual model and research design

In this final paragraph the different threads of the previous discussion are brought together in the general conceptual model and research design of this study.

General conceptual model

Figure 2.5 illustrates how the theoretical, methodological and contextual framework link into the general conceptual model. The figure shows the imperatives of public health care which were the starting point of the analysis of this chapter.

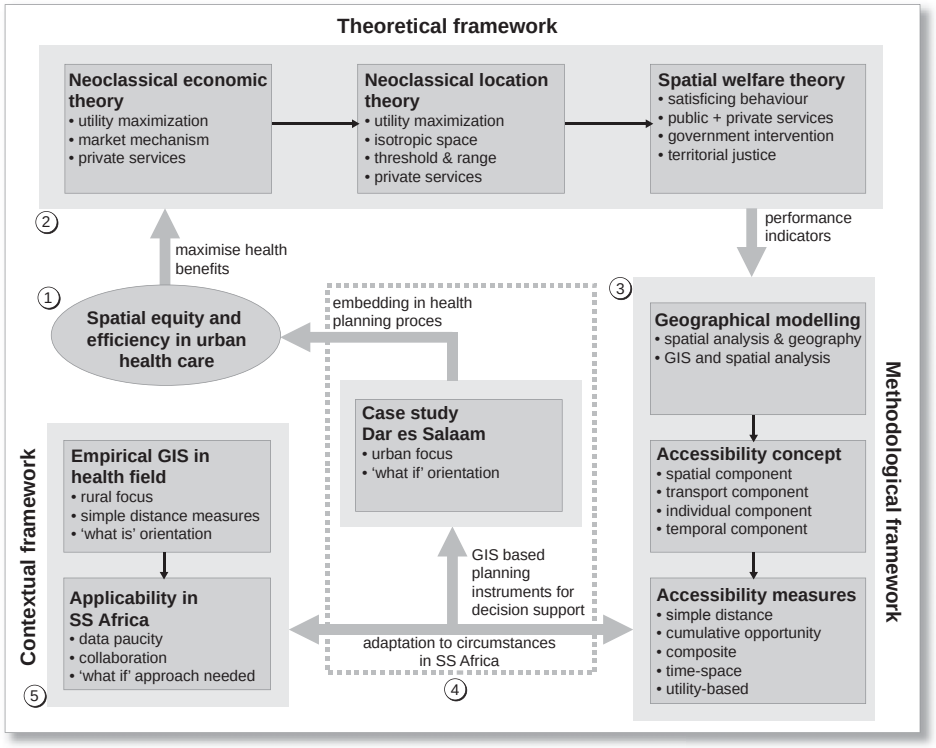


Figure 2.5: General conceptual model.

The link to economics is logical as it is the main discipline concerned with welfare maximization. The economic construct of utility maximization is transposed into geographical space through the discussion on neoclassical location theory. The added value of spatial welfare theory is not only that it provides a broader and less rigid framework than neoclassical location theory, but also that it incorporates the functioning of public services. Territorial justice is the guiding principle of distributing public services in geographic space; its evaluation requires the establishment of spatial performance indicators. Spatial performance indicators, in turn, can be described using the accessibility concept and operationalized with accessibility measures of varying

complexity. The function of the contextual framework is to contrast methodological advancement with real world applications. The first outcome is that most health care applications are in early stages of development. They normally have a rural orientation, are based upon straightforward distance measures. Focus is on the analysis of existing situations rather than on scenario development. The second outcome is that there is a (need for but) near complete absence of 'what if' type of urban health care applications that can support decision-makers in sub-Saharan Africa. This study aims to partly fill that gap.

This is done by structuring the remainder of the research around an empirical case study of the city of Dar es Salaam in Tanzania. The assumption is that Dar es Salaam is a more or less typical example of a large city in the sub-Saharan region. This means that the overarching aim of the study - to develop a GIS based planning approach that contributes to equitable and efficient provision of urban health services in sub-Saharan cities - remains intact.

Research design

Following from the general conceptual model, a number of research stages can be defined for the case study (see Figure 2.6). To begin with, a description of the broader context of urban health care provision in Dar es Salaam is needed. This is done by a closer analysis of the elements 'urban' and 'health care'. The 'urban' element consists of a description of the development process over time and current spatial structure of Dar es Salaam. The 'health care' element is addressed by providing an overview of the dynamics of the health system in Tanzania and Dar es Salaam over time. Taken together, this covers the 'how' element of spatial welfare theory. The second stage relates to the various data sources needed to implement the Dar es Salaam case study and to the setup of the conceptual data model.

As illustrated in Figure 2.6, secondary data needed to be compiled and complemented with primary data, which were collected during field surveys in 1995 and in 2000. Both secondary and primary data feed into the conceptual data model, which is set up to match the previously identified components of accessibility. This setup covers the 'who' gets 'what' and 'where' of spatial welfare theory and enables proper operationalization of accessibility measures during the analysis stage.

The third stage is the conceptual model for the analysis, which consists of three phases. The first phase is the analysis of socio-spatial health seeking behaviour (revealed as well as stated). Its aim is to obtain insight in the main user groups of (public) health care and isolate the main factors that determine health seeking behaviour across different socio-economic strata. Identified behavioural regularities will be used as input in subsequent stages of the analysis. The second phase is to evaluate existing accessibility levels to governmental health care in Dar es Salaam.

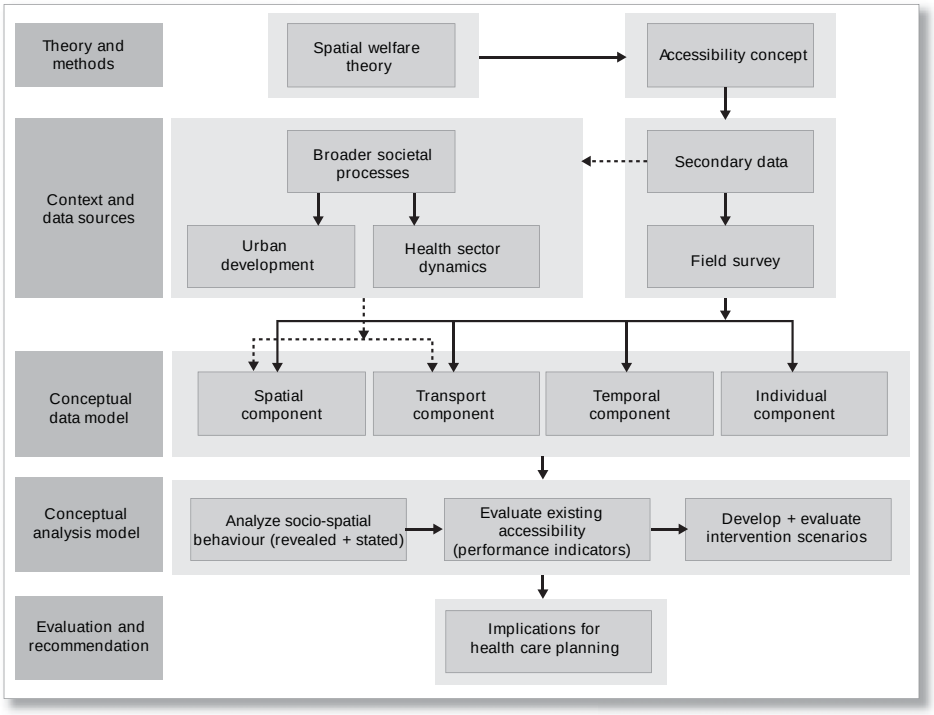


Figure 2.6: Research design of case study.

The third phase is to develop alternative scenarios of the 'what if' type that improve overall accessibility levels.

The fourth and final stage of the research is to reflect on the outcomes of the case study work, and comment on the applicability of GIS-based analytical techniques for strategic urban health care planning in sub-Saharan Africa.

3 Spatial data framework and data sources

3.0 Introduction

The purpose of this chapter is twofold. The first objective is to present a generic conceptual data model that can be used for the analysis of spatial equity and efficiency in urban health care. The conceptual data model directly follows from the theoretical and methodological framework presented in Chapter 2. The second objective is specific to this particular research as it illustrates how the empirical foundation for the Dar es Salaam case study is established. It introduces the various data sources and the way in which they are assembled to populate the conceptual data model with data representing the Dar es Salaam situation.

The structure of the chapter matches these objectives. The first paragraph describes the suggested generic spatial data model and gives a short preview of the data collected for the case study. The second paragraph provides a detailed account of the secondary data sources and pre-processing activities. The third describes how primary data were obtained. The fourth and final paragraph shortly comments on data quality issues and problems associated with data paucity.

3.1 A generic spatial data framework

The generic conceptual data model reflects the previously identified accessibility concept - Moseley (1979); Geurs and Ritsema van Eck (2001) - and matches its components, which together determine the accessibility of locations (see Figure 3.1, Part A). Obviously, this data model can be used for the evaluation of different types of facility location problems (schools, parks, health centres etc.) in different geographic study areas. Depending on the facility type and study area, the components of the data model are populated with application and location specific data. Invariably, the aim will be to establish a complete and temporally consistent database that properly represents reality at given moments in time.

The main role of Figure 1.1 (Part A), however, is to illustrate that by incorporating the temporal dimension into the data model, a flexible data framework unfolds that does not only allow for the analysis of past or present situations but is also very suited for 'what if' types of analysis that involve predicting future situations. The proposed setup makes it possible to, for example, develop different scenarios for urban expansion and densification processes based on criteria such as migration and demographic trends, environmental/physical constraints and urban development plans. In a similar manner,

the impacts of real, proposed or simulated changes in the transport component (e.g. new road infrastructure or public transport routes, changes in travel behaviour) can be evaluated. On the basis of such simulations - whereby some of the elements of the situation for which we are planning are varied while others are kept constant -, decision makers can develop alternative intervention strategies and evaluate their expected impacts.

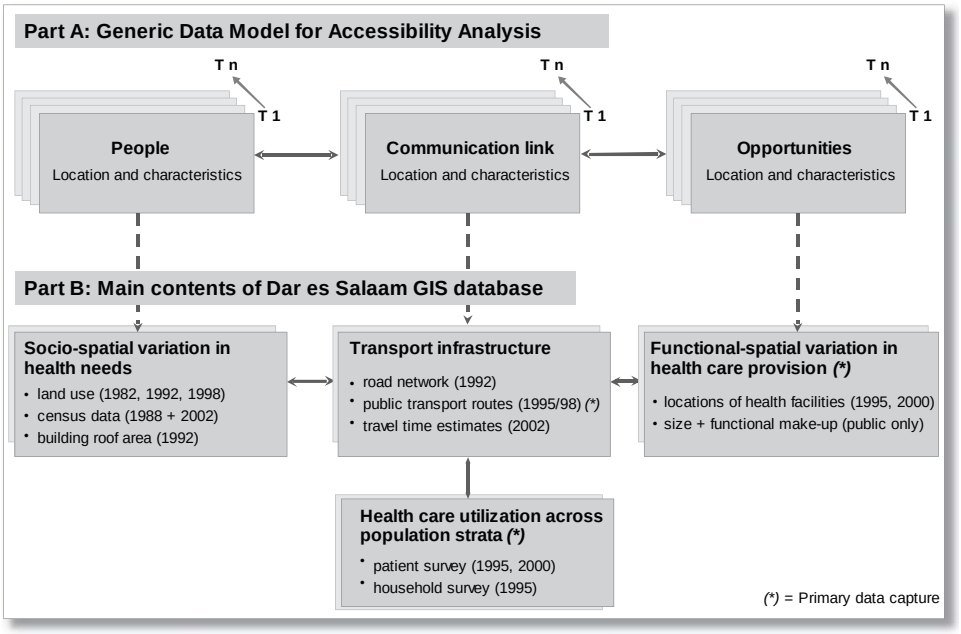


Figure 3.1: Generic conceptual data model and main contents of the Dar es Salaam GIS database.

Incorporation of the temporal element in the evaluation of accessibility of locations is important for at least three reasons. *First*, (health) planning is future-oriented. The general objective is to provide for a future spatial structure of activities, which is in some way better than the one that would exist without planning. Future states are generally strongly conditioned by the present and past states. *Second*, the process of rapid urbanization that occurs all over sub-Saharan Africa requires that decision makers not only have to have insight in the existing extent and structure of the city but also of its expected future state within a given time span. *Third*, planning is also concerned with the monitoring of effects, that is, to see in how far expected developments have come true and in how far past interventions have been effective or in how far they need modification. The proposed set-up can accommodate these requirements and, therefore, offers a suitable spatial data framework for accessibility analysis.

Although the conceptual data model is generic, the physical structure and exact data contents will obviously vary from situation to situation depending on the availability and characteristics of data sources that can be obtained to represent the research problem in its local situation. Figure 3.1 (Part B), illustrates how the generic data model is operationalized for the Dar es Salaam case study and also gives a preview of its main contents. The main data sources are just mentioned here; in the following paragraphs they are all described in detail. The socio-spatial variation in health needs (people) is approximated using various data sources such as land use snapshots for three moments in time. Two other data sources (census data and building roof area) are used to estimate population densities for smaller spatial units. The location and characteristics of the communication link are described by means of the road network, the public transport routes and travel time estimations for different transportation modes. The functional and spatial variation in health care provision (opportunities) is described by capturing the locations of health care facilities and - wherever possible - their size and functional make up. The outcome of the interplay between the three components of accessibility in the Dar es Salaam context, is recorded through a household and a patient survey that together provide the necessary empirical support to describe, analyze and model socio-spatial patterns of health care utilization.

In general, - and the Dar es Salaam case study is no exception - the effort put into database development is very considerable and takes up a large proportion of available resources. Usually, data will have to be compiled from multiple sources with varying quality and scales and integrated to form a consistent data set.

The first step in setting up the database is to identify what secondary data already exists. Some of these data may still be in analogue format and require a conversion process; others may have been digitised and (at best) stored in current GIS. Obviously, the use of readily available secondary data sets helps to reduce database development time. The second step is to identify which of the required data are not readily available, as these will have to be acquired through some kind of primary data collection process. In the next sections, an overview is presented of the available secondary data sources and of the primary data collection efforts that were undertaken to establish the GIS database representing the Dar es Salaam situation.

3.2 Secondary data sources and the generation of basic spatial data

This paragraph provides an overview of the secondary - mostly spatial - data sources and the pre-processing procedures that were carried out to establish part of the GIS database. The GIS database is later used to *(i)* describe and analyze the urban development process of Dar es Salaam over time and *(ii)* to perform the accessibility

analyses. As will become clear, much of the description that follows in this section originates from previous research carried out by ITC alumni. It must also be noted that a very considerable part of the pre-processing work - including integrity checking and harmonization efforts - have been done by (Sliuzas, 2004) in the framework of his PhD research. The structure and textual contents of a considerable portion of this section is, therefore directly accredited to his work.

The data required for this research are derived form a variety of sources comprising topographic maps, vertical and oblique aerial photography, multi-spectral satellite data, a city map and extracts from a large-scale digital topographic data set (see Figure 3.2). Apart from considerable scale differences, the above mentioned spatial data sources have varying geographical coverage. Figure 3.2 also shows how the spatial extent of the main data sources varies. In several cases it has been necessary to combine data derived from large-scale sources with that derived from small-scale sources.

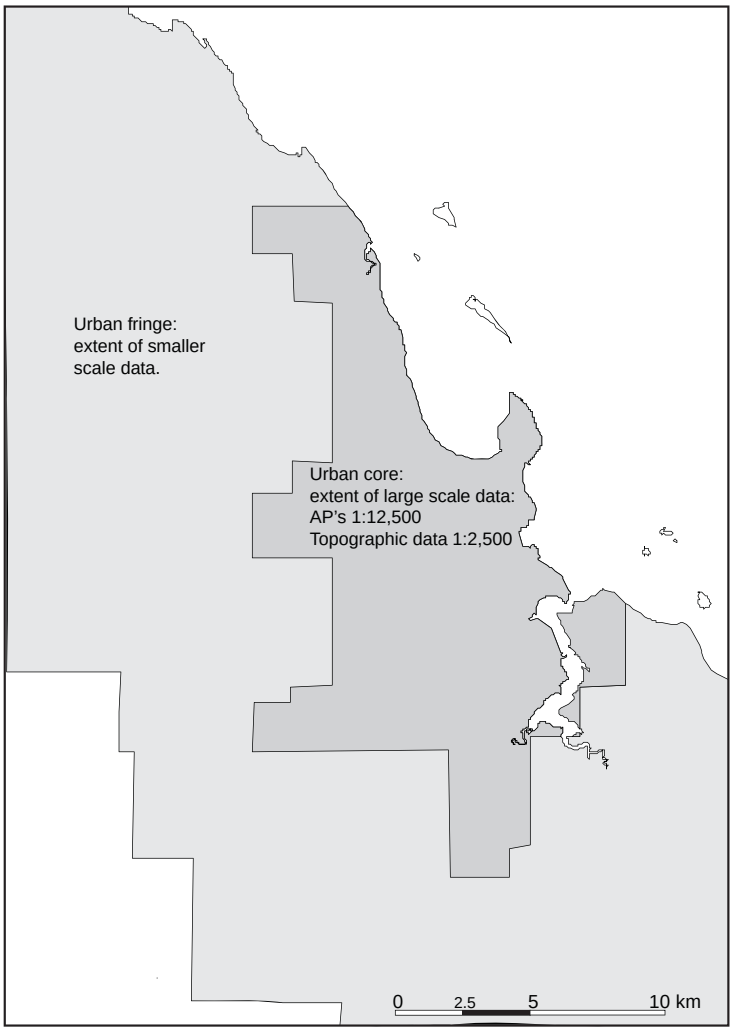
Creating multiple land use data sets

This research makes use of three separate snapshots of land use for 1982, 1992 and 1998 that have a similar geographical coverage. The function of the land use snapshots is twofold. First, they are used to describe and explain the urban development process of the city over time.

The production of multiple land use data sets over a period of time is common practice in urban planning, but in the Dar es Salaam context, one that is not unproblematic. In this research the production of these land use snapshots involves the use of three different sensors (i.e. vertical aerial photographs, Small Format Aerial Photography and SPOT), several different scales of aerial photography and the interpretation work of a number of persons over a considerable period of time.

The land use data for 1982 and 1992 has been created via interpretation of several sets of aerial photographs with scales varying from 1:12,500 - 1:63,000. The two data sets are the result of land use interpretations covering the extent of the large-scale data set using aerial photographs at scale 1:12,500 and a later interpretation of small-scale photographs of the remaining - more peripheral outer part of the - study area. Kyessi (1990) created the initial interpretation of 1982 from 1:12,500 scale photographs. His land use classification was later slightly modified/simplified by Hakuyu (1995), who also generated the initial land use data of 1992. Hashim (1999) subsequently expanded the 1992 data using small-scale photographs to cover the urban fringe area, while Sliuzas (2004) completed the fringe area for 1982.

Given the smaller scale of photography used in the fringe areas it was necessary to reduce the complexity of the land use classification to accommodate for the lack of detail on the photography.



Data source

Topographic map sheets
1970, scale 1:50,000

SPOT satellite images PAN (10 m) and XS (20m), 1998, May

Small format aerial photographs (SFAP), colour
1998, 35 mm, high oblique, 500-800m altitude

Dar es Salaam City Map and Guide
1995, scale 1:20,000 (based on 1992 aerial photographs), J/V-ABN, Norway & Surveys and Mapping Division, Tanzania

Vertical Aerial Photos, Panchromatic
1982, scale 1:12,500
1982, scale 1:63,000
1992, scale 1:12,500
1992, scale 1:54,000

Digital topographic data
- selected layers from the database - buildings, public buildings, contour lines, roads, rivers
1:2500 (derived from 1992 aerial photographs)

Figure 3.2: Overview of secondary spatial data sources.

The original 2-digit classification system was therefore reduced to 8 main classes and delineation was carried out based upon a Minimum Mapping Area (MMA) of 1 hectare. The classification used for 1982 and 1992 is shown in Table 3.1.

Land use class	Aerial photos 1982 & 1992	SPOT 1998
Residential		
Planned residential	■	■
Informal settlement	■	■
Other urban		■
Industrial	■	
Commercial	■	
Institutional	■	
Recreation	■	
Non-urban		
Vacant and agriculture	■	■
Ocean & estuaries	■	■

Table 3.1: Main land use categories

Although a similar classification system and rules are applied in this work, the data was found to contain several inconsistencies. These have been introduced as a result of data migration from one GIS environment to another and small variations in georeferencing, interpretation, classification, delineation and digitizing. Such variations can be expected both between interpreters and for a single interpreter over time. To improve the temporal consistency of the data, a comparison of the 1982 and 1992 data sets was undertaken to identify potential classification conflicts by looking for unlikely change situations (i.e. areas changing from an urban land use to vacant). Wherever unlikely changes were identified, the original photographs were re-examined and the validity of the change was established. Having removed major inconsistencies from the 1982 and 1992 data, the latter was displayed over a fused SPOT XS/PAN image of May 1998 and a more generalized delineation of urban land in 1998 was carried out by visual interpretation and on-screen digitizing by Hashim (1999).

Given the lower spatial resolution of the SPOT images the land use classification required further simplification, concentrating efforts on mapping the geographic extent of planned and informal residential areas. Additional information for delineation was obtained by referring where possible to SFAP images of November 1998 that were available for several parts of the city. The latter proved to be particularly useful in areas of very low-density settlement where it was sometimes difficult to distinguish between built-up areas and bare sand due to their rather similar spectral signatures and the inadequate spatial resolution of the imagery. Sliuzas (2004) concludes that this working method results in sufficiently consistent land use data for citywide studies.

Creation of other basic spatial data sets

In addition to the land use snapshots, several other spatial data sets were created to enable the description and analysis presented in subsequent chapters. Table 3.2 provides an overview of all spatial data sets that were generated. It shows that many of these data are captured by digitizing features from a variety of data sources. Some of the more important data sets are further elaborated below.

Road centrelines were originally digitized by Sliuzas (2004) using the 1:50,000 topographic maps. This road data set was further expanded and detailed - for the urban core area - using the 1:20,000 City Map and checked on topological consistency by de Jong and Amer (2002). Together with a group of urban planners of the City of Dar es Salaam, the complete public transport network - all roads and official bus stops used by public transport - and all operational bus routes were identified and georeferenced by Amer and Thorborg (1996). The public transport network was updated by Berhie (1998) who also recorded bus travel speeds in the field for a number of bus routes. In 2002, a group of ITC students coming from Dar es Salaam estimated travel times for a considerable number of public transport routes (a number of new bus routes were also added). Using these recorded data and estimations, de Jong and Amer (2002) were able to derive realistic travel time approximations for public transport. Possible changes in the public transport network since the research of Berhie could not be incorporated in the data set.

Another important data set for this research is that of building centroids. This point data set is derived from the 1:2,500 digital topographic data with a related attribute table that contains data on the type of building and its roof area in m^2. The conversion of the essentially CAD type vector data into a workable GIS format was done by Visser (1999). The importance of this data set is that it can be utilized as an indicator of density, for example, the number of houses - or total roof area - per hectare or some other spatial unit of choice.

By using the roof area of buildings in combination with a small sample-based population survey, Dangol (1998) was able to approximate the roof area per person for unplanned settlements; a proxy with which population estimates can be generated. The combined use of the building centroids with the findings of Dangol is the first of two methods used to approximate spatial variations of population density (or: health needs) within Dar es Salaam. The second approach is based upon more recent population data - the 2002 census -, which is, however, captured at ward level. Since this is a too coarse spatial unit for the purpose of this research, a spatial disaggregation procedure is developed to generate population data at an acceptable spatial resolution (see Appendix B).

Data set	Data Source	Created by	Description	Component of accessibility
Land use 1982	1: 12,500 AP's 1: 63,000 AP's	Kyessi, 1990 Sliuzas, 2001	Land use classes, for categorisation see Table 3.2. Harmonisation and integrity checking by Sliuzas.	
Land use 1992	1: 12,500 AP's 1: 54,000 AP's	Hakuyu, 1995 Hashim, 1999	Land use classes, for categorisation see Table 3.2. Harmonisation and integrity checking by Sliuzas.	
Land use 1998	SPOT 1998 SFAP, 1998	Hashim, 1999	Land use classes, for categorisation see Table 3.2. Harmonisation and integrity checking by Sliuzas.	Location and characteristics of people
Building	1:2,500 Topo data	Visser, 1999	Building centroids 1992 - private/public buildings + roof area	
Ward boundary	Dar es Salaam City Council 1988 2002	 Hakuyu, 1995 Amer, 2003	Boundaries of wards. Notes: (i) ward boundaries of 1988 And 2002 are not identical, (ii) census data at ward level used to derive spatially disaggregated population estimates	
Road	1:50,000 Topo maps 1:20.000 City map	Sliuzas, 2001 Amer, 2002	Centrelines – categorised: primary and secondary roads	
Bus route	Dar es Salaam City Council + Local Planners	Amer, 1995 Berhie, 1998 Amer & de Jong, 2002	Location of bus-routes Recording travel time for number of bus routes Estimation of travel time	Location and characteristics of communication link
Bus stop	Local Planners	Amer, 1995	Location of bus-stops	
River	1:50,000 Topo maps	Sliuzas, 2001	Categorised: main rivers and streams	
Landform	1: 12,500 AP's 1: 54,000 AP's	Kyessi, 1990 Hashim, 1999	Categorised: river valley/floodplain, swamp, salt pan, quarry, coastal plain, hills, ocean/estuaries	Factors influencing future urban development
DEM	1:2,500 Topo data 1:50,000 Topo maps	Sliuzas, 1999	20x20 meter pixel size DEM covering entire study area	
Coastline	1:50,000 Topo maps	Sliuzas, 2001	Coastline	
Edge	1: 12,500 AP's	Sliuzas, 2001	Boundary of study area (excluding coastline)	Study area boundary + administrative units
Municipal boundary	Dar es Salaam City Council	Sliuzas, 2001	Boundaries of municipalities	

Table 3.2: Overview of generated spatial data sets.

With the creation of the data sets described in Table 3.2, a considerable part of the Dar es Salaam GIS database is established. Apart from the capability to describe the urban development process of the city, a number of data sets is also suited for the analysis of spatial equity and efficiency in urban health care. The combination of land use data with the building data and the 2002 census data can be used to describe the spatial variation of health needs. Likewise, the communication link is described by means of the road network and the public transportation system. The GIS database is, however, still incomplete. No secondary data exist on *(i)* the locations and characteristics of health care providers (opportunities), *(ii)* travel behaviour and *(iii)* demographic and socio-economic characteristics of health care users. These missing data are collected through a primary data collection process; the way in which this was done is described in the next section.

3.3 Primary data collection procedures and sampling strategy

This paragraph describes the design and implementation of primary data collection activities undertaken to obtain empirical data on health seeking behaviour across different population strata. Primary data collection, more precisely, is oriented towards obtaining data on *(i)* health seeking behaviour of (primarily) governmental health care clients, and *(ii)* spatial choice behaviour in the context of pluriform health care provision. The decision to emphasize the functioning of governmental health care is because this is the sector for which interventions can actively be planned for by health officials. The relatively recently emerged situation whereby private and governmental health care operate side by side, provides the rationale to explicitly consider spatial choice behaviour in the context of pluriform health care provision.

Primary data are collected by means of a field survey, which was first carried out in 1995. To enable the identification of changes in health seeking behaviour over time, a second field survey was undertaken in 2000. Because of limited resources the scope and geographic coverage of the 2000 effort was less elaborate: data collection was restricted to health seeking behaviour of (mainly) governmental health care clients in the southern and poorest part of Dar es Salaam (mostly Temeke municipality). The measurement instruments and sampling design of the 2000 field survey, however, were near identical to that of 1995. In both cases, the field survey was commissioned by and executed in close collaboration with the Dar es Salaam Urban Health Project. The collected socio-economic, demographic and travel behaviour data - which address parts of the spatial, transport and individual components of the accessibility concept as previously illustrated in Figure 2.4 - are used as empirical support for explanation and prediction in subsequent chapters.

Field survey activities are sub-divided into three distinct phases. First, a design phase with emphasis on the creation of an efficient sampling strategy and accurate measurement instruments. Second, a preparation phase in which data collection teams were formed, instructed and the survey design tested. Third, an implementation phase in which actual data collection took place. Each of the phases is described in more detail in the following.

Design phase: development of sampling strategy and measurement instruments

The design phase of the survey aims to devise an accurate measurement instrument and an efficient sampling scheme which is economical and practical to operate and which - as much as possible - yields unbiased estimators given the limitations of available fieldwork resources. The degree to which this is actually achieved, determines in how far the explanations and predictions presented in the next chapters can be generalized to be of scientific value.

Design appropriate sampling strategy
Together with the design of the measurement instrument, an efficient sampling strategy needs to be devised to ensure that explanations and predictions based on fieldwork data can later be generalized. Typically, empirically supported generalizations are based upon partial information because it is impossible, impractical, or extremely expensive to collect data from all the potential units of analysis covered by the research problem. It is also unnecessary, since precise inferences on all the units (a set) can be based upon a relatively small number of units (a subset) provided that the subset accurately represents the relevant attributes of the whole set (Frankfort-Nachmias and Nachmias, 1997). In other words, the chief aim of a sample is to act as a reliable substitute for the whole statistical population from which the sample is being drawn. In the context of this study, the inhabitants of the city of Dar es Salaam represent the statistical population. The sampling approach should - as much as possible - result in representative information on health seeking behaviour of the Dar es Salaam residents.

Sampling theory stipulates that after identification of the statistical population, a sampling frame is established which - ideally - lists all the individual members of the statistical population from which a sample is to be drawn. In the Dar es Salaam situation, such a list is (obviously) inexistent and, within the scope of this study, impossible to compile. The way forward, then, is to create a substitute sampling frame. The substitute sampling frame developed for the fieldwork rests on a cluster sampling approach, which is generally acknowledged as a cost-effective sample design. Cluster sampling involves first selecting larger groupings and then selecting the individual sampling units from within the clusters. Clusters are normally selected by a random sampling procedure, thereby restricting the sample to a limited number of geographical locations (sub samples from the populations of selected clusters are later combined).

Depending on the research problem, researchers can include all the individual sampling units in a selected cluster, or make a second stage selection using an appropriate sampling procedure (Frankfort-Nachmias and Nachmias, 1997). By using a cluster sampling approach the overarching sampling frame becomes the list of clusters although the study itself remains focused on individuals.

To match the previously specified data collection objectives, two cluster types are used in this study for primary data collection. The *first* cluster type is the health facility - the trip destination - where a sample of outpatients is interviewed in the waiting room prior to treatment. The motivation for choosing the health facility as a cluster to record health-seeking behaviour is threefold. First, patient samples give a good insight in *(i)* the main user groups that are serviced and *(ii)* the areas from which facilities attract their clients. Second, actual behaviour is recorded; there is no problem of a recall period: respondents can easily motivate why they attend the selected clinic and which mode of transport was used. Third, sampling at the health facility is efficient - provided that sufficient patients attend the facility - a relatively large sample can be obtained in a short time with limited staff resources. An ethical drawback is that interviewing individuals at the moment they require health care can sometimes be strenuous for respondents.

The *second* cluster type is a spatially demarcated residential area. In this case, interviews are conducted at the trip origin: door-to-door household interviews are conducted in selected spatially bounded residential areas. The main motivation for this type of cluster-based household sampling is that it provides a neutral insight in spatial choice behaviour in the context of pluriform health care provision. A drawback is that respondents have to recall if health care was obtained within a specified recall period and, if so, which facilities were visited, how they travelled and what motivated their choice. The household survey, by definition, records past behaviour, which cannot be verified. An important practical drawback is that prior research on health seeking behaviour in Dar es Salaam (Zambrano, 1995) indicated that conducting door-to-door household interviews is much more time consuming and requires more logistical support than interviewing patients at health facilities.

It is important to note that the consequence of using two different cluster types is that, in essence, the fieldwork consists of two separate surveys, which are conducted, in parallel. At the same time, they share a common foundation as the same measurement instrument - which is further described in the next section - is used in both cases. The implications - opportunities and limitations - of this dual approach are touched upon in the last paragraph of this chapter. Figure 3.3 illustrates the overall design of the two-stage cluster sampling strategy for the patient and the household survey. The design is partly idealized *(i)* to illustrate the guiding principles for obtaining a truly probabilistic sample and *(ii)* to act as an outline to discuss the concessions that needed to be made to enable primary data capture in the Dar es Salaam context.

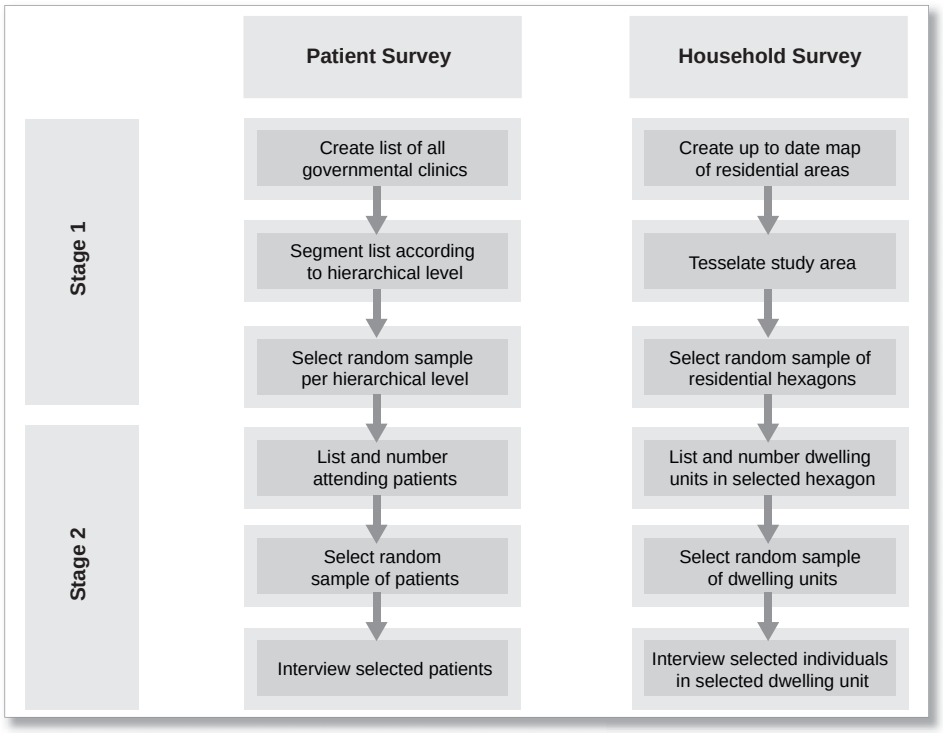


Figure 3.3: Overall design of the two-stage cluster sampling approach for the patient and the household survey.

The procedure to obtain *patient sample* data is as follows. Stage 1 of the sampling approach is unproblematic and requires no more than compiling a list of all governmental health care facilities in the Dar es Salaam area. The list is then segmented into three sub-lists reflecting the hierarchical level (dispensary, health centre and hospital) of health care facilities. In deciding on the amount of health care facilities in the sample - which is further discussed in the next section -, focus should be on the primary level of dispensaries as this is the most probable form of future planning intervention.

Higher order facilities (health centres and hospitals) should, nevertheless, be present in the sample as they also provide dispensary level health services. A simple random sample of facilities at each hierarchical level is drawn to complete Stage 1 of the sampling approach.

Stage 2 is concerned with obtaining data from selected patients. Strictly speaking, the sampling approach requires probability sampling which means that each patient should have an equal probability of being included in the sample (the sample size per facility would vary according to the number of attending patients). In theory this could be achieved by counting and numbering the patients that attend a given health facility

within a specified time interval, draw a random sample and then interview selected patients (since patients can not be asked to wait the interview would probably have to be conducted at a later stage at their homes). Although theoretically possible, such an approach in the Dar es Salaam context would be highly unpractical and inefficient. To compile a listing of the sampling population per health facility would be time consuming, but feasible. The main problem, however, is that it is impossible to identify where selected patients exactly live - the trip origin - because an up to date map does not exist and a system of home addresses is largely absent in Dar es Salaam. Since it is impossible to trace back selected patients to their homes, there is no practical alternative than to interview patients at the health facility prior to, or directly following, treatment. Given the absence of reliable information on attendance rates, the practical solution is to obtain a fixed-size patient sample from each health facility. The limitations involved in drawing inferences from the sample obtained in this manner are shortly evaluated in the last paragraph of this chapter.

Having touched upon the problem of localizing where individuals live, a few lines need to be devoted to describe how spatial behaviour - the origin and destination of each trip - is captured during the field survey (see Figure 3.4). The designed spatial framework builds upon the research of Zambrano (1995), which demonstrates that surveyors with professional air photo interpretation skills and a good knowledge of the study area can obtain accurate approximations of trip origins based on indications from respondents. Using, the - at the time of the survey - most recent vertical aerial photography of 1992, an uncontrolled photo-mosaic with a regularly spaced set of control points is constructed at a scale of 1:12.500. The photo-mosaic covers the built up area of Dar es Salaam and its surroundings to an extent of approximately 20 by 30 kilometres. The *destination* of each trip is represented by the location of the attended health facility, which is georeferenced on the photo-mosaic using a uniquely coded small sticker. To capture the approximate *origin* of each trip a hexagonal tessellation is created; printed on transparent film and superimposed on the photo-mosaic using its control points. The tessellation virtually subdivides the study area into smaller uniform geographic units. Since each hexagon has a legible unique code, the combined use of the photo-mosaic with the superimposed hexagonal tessellation, enables adequate capture and easy encoding of both the origin and the destination of each trip (Amer and Thorborg, 1996).

The tessellation is dimensioned in such a way that each hexagon has an edge to edge diameter of 250 meter which means that it covers an area of nearly 5.5 hectares. With this level of spatial disaggregation, the size of the individual hexagon is large enough to accurately approximate trip origins during the patient survey. At the same time, the spatial resolution remains sufficiently detailed to *(i)* describe the spatial variation of demand/need for health care (see Chapter 2) and *(ii)* be used in the sampling strategy for the household survey. The latter is further elaborated below.

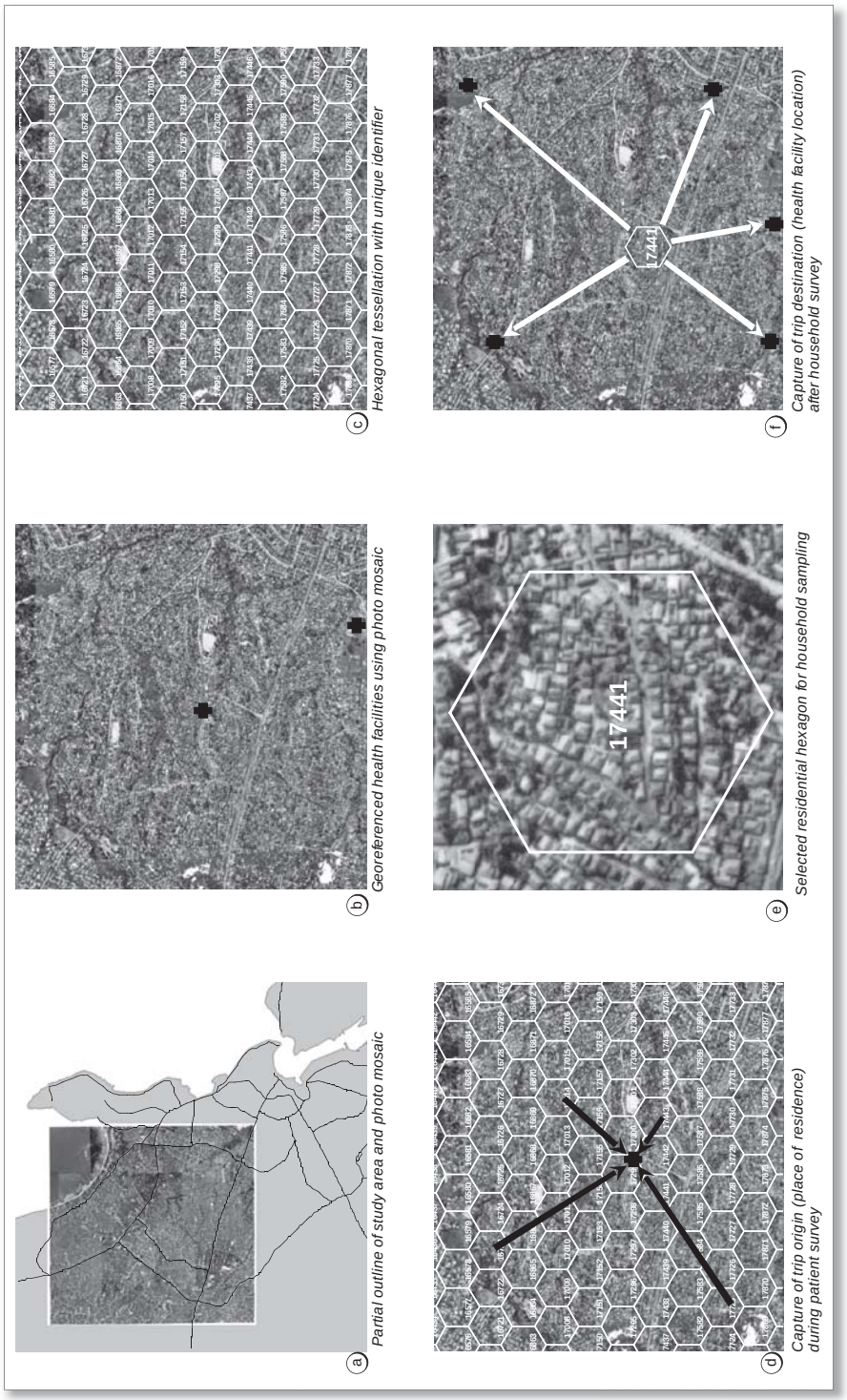


Figure 3.4: Spatial data framework designed to capture the spatial dimension of health seeking behaviour.

The procedure to obtain *household sample data* - if all data would have been present and in digital format at the time of the survey - would have been as follows. First, capture land use data via interpretation of the most recent aerial photography to create, as much as possible, an up-to-date land use map of the study area. Then, subdivide the entire study area into uniformly shaped spatial clusters by superimposing the above-described tessellation on the land use data layer. A simple aggregation procedure assigns the dominant land use to each hexagon, after which a selection of all residential hexagons is made. To complete Stage 1 of the sampling approach, a simple random sample of residential hexagons is drawn. In Stage 2 of the cluster sample, a list of all dwelling units is first generated for each selected hexagon after which a random sample of dwelling units is selected (the sample size per selected residential hexagon varies with the number of dwelling units). Finally, interview selected individuals in each of the selected dwelling units.

From the start, it was clear that the reality of the household survey was going to be more problematic than the formal approach described above. A number of concessions - mainly due to data paucity - were foreseen.

First, the sampling frame is not complete because of the temporal mismatch between the air photos and the field survey: areas of residential expansion that have emerged between 1992 and 1995 are missing from the sampling frame. Since alternative data sources were not available this shortcoming could not be resolved. *Second*, the interpretation of the 1992 air photos was not completed until 1995 (Hakuyu, 1995), which meant that the land use data were not available in a usable form at the start of the fieldwork. The identification of residential hexagons could, therefore, only be done visually using the analogue photo-mosaic in combination with the superimposed tessellation. Given the large extent of the study area, it meant that it was not feasible to manually compile a numbered listing of all residential hexagons - later work shows that it concerns around 5.000 hexagons - from which the sample could be drawn. The way forward, nevertheless, was to try to obtain a sample, which is as unbiased as possible. The following two guidelines were devised to help selecting residential hexagons. The first is that the sample should primarily represent a mix of poor to middle class (also: planned and informal) residential areas. High income residential areas are excluded since the health seeking behaviour of the well-to-do is outside the scope of this research. The second guideline is to obtain a set of sampled hexagons, which is geographically distributed over the built up area of the city. Using these guidelines, the actual selection of residential hexagons would be done 'blind folded' during the implementation phase of the fieldwork.

Stage 2 of the household survey would also need a concession. A decision was made not to compile a numbered listing of dwelling units per selected residential hexagon for two reasons. First, to do so would be very time consuming, but theoretically feasible, using the analogue photo-mosaic in combination with field verification to ensure that

new constructions are included. Second, and more importantly, it was feared that field surveyors - who are not necessarily skilled in air photo interpretation - would have considerable difficulty in orienting themselves in the field using aerial photography because of the very haphazard physical development pattern that characterizes many residential areas. As a result, the procedure to locate the selected residential units would become (highly) error prone. Problems of this nature have also been observed by Sliuzas (personal communication, 2003) when conducting his fieldwork in Dar es Salaam. To avoid these potential problems, the practical alternative is to obtain fixed-size household samples from selected residential hexagons on the proviso that no more than one questionnaire is obtained per dwelling unit. The limitations and dangers involved in drawing inferences from the sample obtained in this manner are commented upon in the last paragraph of this chapter.

Questionnaire design

Together with the design of the sampling strategy and the establishment of the spatial framework that captures trip origins and trip destinations, a measurement instrument needs to be developed that records the non-spatial characteristics of health seeking behaviour. The chosen measurement instrument to capture primary data for the Dar es Salaam case is to conduct face-to-face personal interviews using a pre-designed questionnaire. The overall design of the patient and the household questionnaires is the same. As illustrated in Figure 3.5, the questionnaire is designed to record the demographic and socio-economic characteristics and the health seeking behaviour of respondents. The main building blocks of the questionnaire are briefly described below.

After recording some administrative data, a series of (mostly) factual questions elicits objective information from the respondents with respect to their demographic and socio-economic conditions. Typically, such background questions include items such as gender, age, marital status, household composition, education, occupation and income. To enable a more reliable insight in the socio-economic differentiation - or relative level of deprivation or prosperity - of respondents in the Dar es Salaam context, the questionnaire also includes a set of proxy questions that record characteristics of housing conditions, the availability of basic infrastructure, and the ownership of transportation means and consumer goods. The main reason for including this type of questions is to obtain background information that can later be used to classify respondents into demographic and socio-economic strata. Such classifications, in turn, help in explaining socio-spatial patterns of health seeking behaviour. Another essential objective of the questionnaire is to accurately record *observed* health seeking behaviour (patients) as well as *past* health seeking behaviour (patients and households) within a predefined recall period of three months.

Observed behaviour is recorded by means of a short series of open-ended questions that document the motivations (costs of treatment, availability of drugs, distance,

perceived quality etc.) for choosing a particular health facility and the mode of transport (walk, public transport, car etc.) that is used. All respondents (patients and households) are guided through another series of - similarly phrased - questions, which explicitly focus on past health seeking behaviour in relation to the perceived severity of the health problem. This is done by recording, which facilities respondents (or members of their household) attended - or would have attended - in case of a mild, moderate or severe health problem. For each of these situations, the motivation and mode of transport is recorded. The questionnaire also records which of the mentioned health facilities is the one the respondent usually attends.

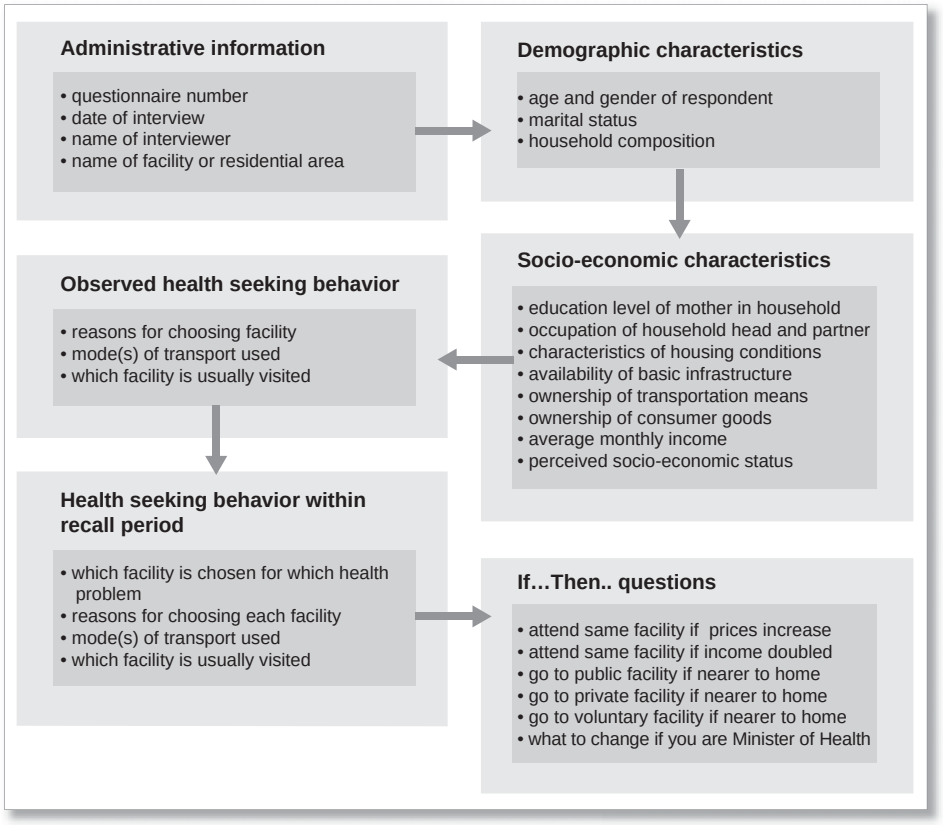


Figure 3.5: Building blocks of survey questionnaire designed to capture socio-spatial patterns of health seeking behaviour.

So far, attention is devoted to health seeking behaviour within existing socio-economic conditions and a given spatial configuration of health care provision. The final set of questions aims to identify in how far respondents expect to change their health seeking behaviour if financial conditions or spatial circumstances change. This is done by asking if respondents would *(i)* attend the same facility if prices for treatment increased and *(ii)* attend the same facility if their income doubled. The response to changes in

the spatial configuration of provision is identified by asking respondents if they would consider going to a public, a private or a voluntary health facility in case this would be established at half the distance of their home in comparison with the currently visited facility. The questionnaire concludes with an open-ended question, which encourages respondents to freely express their views on the current health system by asking them what they would first change if they became the Minister of Health. A sample questionnaire is attached in Appendix A.

Obviously, the content of the questions is not the only important aspect that needs to be considered when designing a questionnaire. Questions must be worded so that the respondent understands them; embarrassing and leading questions - phrased in such a manner that it seems to the respondent that the researcher expects a certain answer - must be avoided. Also, the sequence of questions and the format of the response categories need premeditation. Instructions for the interviewer - what to do when the respondent provides a certain answer, when to probe for a more detailed answer - are incorporated in the questionnaire.

To further encourage the cooperation of respondents, each interview is preceded by a short introductory statement where the interviewer *(i)* introduces him/herself, *(ii)* states the purpose of the study, *(iii)* explains why it is important for the respondent to answer the questionnaire, and *(iv)* assures the respondent that the information provided will be held strictly confidential.

This section concludes with the note that contents and design of the questionnaire build upon prior ITC research on health seeking behaviour in Dar es Salaam as documented by Zambrano (1995) and Assefa (1995).

Preparation phase: establish competent data collection teams and test survey design

Focus of the previous section was on developing a sampling strategy and measurement instruments that - as much as possible - minimize the introduction of sampling bias and measurement error. During the preparation phase, focus is on *(i)* further refinement of the sampling strategy and questionnaire, *(ii)* avoiding *non*-sampling errors and *(iii)* obtaining a reliable estimate of the total expected sample size with available field survey resources.

For the 1995 field survey a period of nearly three months was available with a monetary budget that allowed fieldwork support for two months from about 10 local persons. The preparation phase required 1 week for refinement of the questionnaire, 2 weeks for the formation and training of the data collection teams and for conducting the pilot surveys. The final 2 weeks were reserved for 'clean-up' and 'cross-checking' activities. This meant that around 6 weeks - 30 working days - were available for actual

data collection. Below, a more detailed description of the training and testing phase of the field survey is presented.

Refinement of sampling strategy and questionnaire
First, the contents of the draft questionnaire was further refined in close collaboration with local key informants from the Dar es Salaam Urban Health Project and the Tanzanian Ministry of Health. The questionnaire was then translated into Kiswahili and checked on proper translation.

Local key informants agreed to the proposed sampling units but commented on the proposed sampling strategy for health facilities. There was agreement on the emphasis on governmental dispensaries and on the exclusion of profit-oriented private health care providers but the local informants suggested to include at least one not-for-profit (voluntary) health facility in the sample. The motivation for this was to see in how far the motivation for attending voluntary facilities differs from that of patients attending government facilities. Naturally, inferences made from such a limited sample can only be indicative.

Establishing and training data collection teams
An important objective of the preparation phase is to incorporate measures that minimize non-sampling error. In survey research, non-response - simply defined as observations that are not carried out - can be an important source of non-sampling error (Frankfort-Nachmias and Nachmias, 1997). Non-response can take a variety of forms. Respondents may not be at home when the interviewer calls, they may decline to cooperate or only provide answers to parts of the questionnaire, or be un-interviewable because of a language barrier or illness. Non-response can also be caused by interviewers if they only partially fill out, misplace or lose questionnaires. To a considerable degree, the proportion of non-response depends on the skills of the interviewers. A crucially important element is, thus, to establish a properly trained and motivated team of field workers.

For the 1995 fieldwork, three teams were formed: a patient team, a household team and a georeferencing team. The team responsible for patient interviews at health facilities consists of five female surveyors with prior interviewing experience. The reason for composing a female team is that earlier research (Zambrano, 1995) indicates that a large proportion of patients is female and more easily respond to female surveyors (male patients are also responsive to female surveyors). Patient interviews are to be conducted in the morning when most patients gather at the health facility. The household survey team is of mixed gender and consisted of four recommended individuals with prior interview experience in other sample surveys conducted by the Dar es Salaam Urban Health project. Household interviews are to be conducted in the late afternoon when residents have returned home from work. Each of the two teams had a supervisor responsible for internal coordination and quality control. Both teams

are trained to ensure that all interviewers properly administer and fill out the questionnaires.

The third team consists of two urban planners with excellent knowledge of the city and professional skills in air photo interpretation. The main responsibility of this team is to ensure accurate georeferencing. Georeferencing using the photo-mosaic with the superimposed tessellation - as previously illustrated in Figure 3.4 - takes two forms. In the case of questionnaires conducted at the health facility, the origin of the trip needs to be captured which is achieved as follows. Each respondent describes in detail in which area of the city (s) he lives. On the basis of this information, the georeferencing team approximates the place of origin on the photo-mosaic and records the corresponding hexagon code on the patient questionnaire. In the case of household surveys, it is the destination of a trip that needs to be captured. This is done in a different manner. After finishing all questionnaires in a particular residential sampling area, a list is compiled of the health facilities - with a description of where they are located - which have been attended by the respondents. Using this list, the health facilities are later localized in the field and georeferenced on the photo-mosaic. Since accurate georeferencing is a crucially important element on which an important part of the research rests, the members of the air photo team were selected and trained with great care and worked in close collaboration with the author.

Pilot survey and sample size estimation

After training the teams a pilot survey was carried out - one for each sampling unit - to test how the designed data collection method worked out in practice. The pilot survey showed that the overall sampling approach, including the method to capture the spatial dimension of user-provider interaction proved to be working very well. On the basis of the pilot survey minor final modifications to the questionnaire and working approach were made.

Another important outcome of the pilot survey is that the total sample size for the main survey could be estimated. Formally, researchers need to determine the required level of accuracy of the estimates - or acceptable standard error - to determine the necessary sample size. In practice - and this research is no exception - the attainable sample size is not determined by statistical considerations alone, but governed by the available resources and time.

The starting point of the sample survey was that the household and the patients sample should roughly be of equal size. The household pilot indicated that a surveyor could conduct around 10 questionnaires per day. This means that - with a team of four surveyors and around 30 sampling days available - the total anticipated household sample size would, at most, be around 1200. The sample size per residential area was fixed at 40 questionnaires, which means that the aim was to obtain samples from 30 residential areas (each bounded by one hexagon). The decision to base the sampling

approach on a fixed size sample was previously motivated. The choice for the sample size itself is a trade off between, on the one hand, the desire to obtain a good geographic spread of household sampling areas and, on the other hand, the wish to obtain a proper insight in the characteristics of health seeking behaviour per residential sampling unit. In part, this choice - one area per working day - was also informed by logistical (travel) considerations.

The patient pilot indicated that around 16 questionnaires could be obtained per person per day, which means that - with a team of 5 surveyors - around 80 questionnaires can be obtained per day per health facility if attendance rates are sufficient. On the basis of these figures the aim was to take a patients sample at (around) 15 health care facilities to attain a total sample of 1200 patients. With the completion of the pilot survey and the estimation of the total expected sample size, the field survey entered its implementation phase, which is described in the next section.

Implementation phase: actual data collection

Proper training, motivation and supervision of the data collection teams made that the implementation phase of the field survey proceeded very smoothly. The day-to-day working approach is illustrated in Figure 3.6. The figure shows that patient and household sampling are iterative processes, which are executed in parallel.

Selected health facility/residential area
Using the previously described sampling strategy and sample size estimation, Stage 1 of the patient survey was to draw a sample of 12 - out of 36 - governmental dispensaries, and 1- out of 7 - higher order facilities using an official listing of all governmental health providers in the Dar es Salaam region. Before drawing the sample, all governmental health facilities were georeferenced on the photo-mosaic. In most cases this was done through field verification. For governmental health care provision it was possible to obtain some information on the functional make-up and staffing of individual facilities (later used as proxy for the capacity of facilities). Non-governmental facilities were generally unwilling to release such information; official records containing such information do not exist.

Given the absence of a reliable official listing of not-for-profit health facilities, two truly voluntary facilities with a not-for-profit orientation were selected for patient interviews in a non-random - but hopefully unbiased - manner during the implementation phase. Since the identification of residential hexagons could only be done visually using the analogue photo-mosaic in combination with the superimposed tessellation, a truly random sample of residential hexagons could not be drawn. In stead, 30 residential sampling areas were gradually identified using the previously specified guidelines (geographic dispersion and lower income settlements).

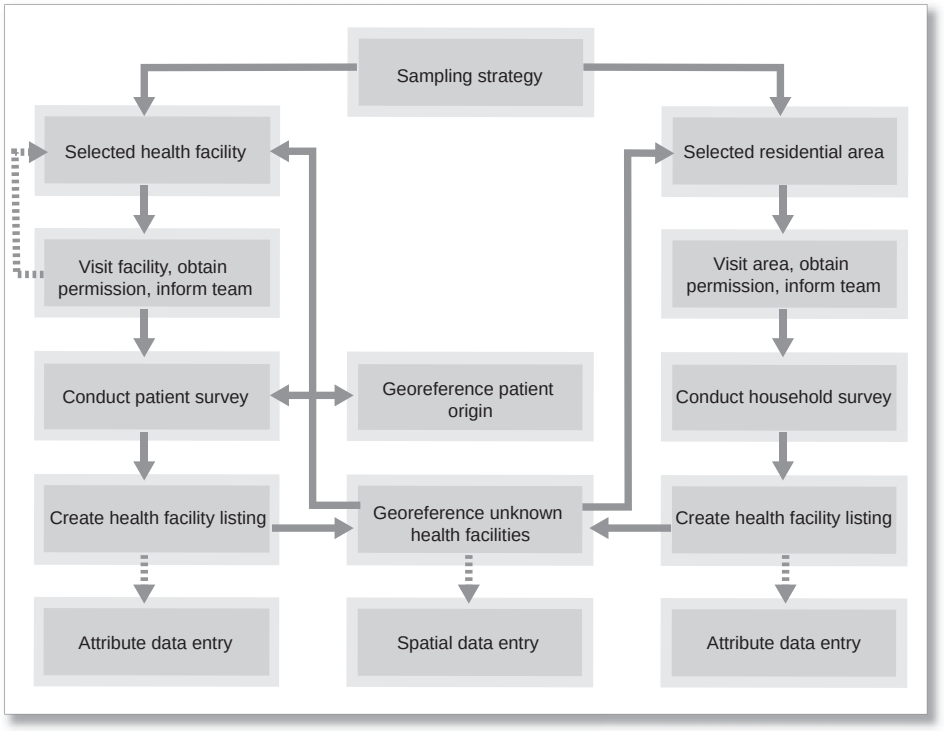


Figure 3.6: Day-to-day working approach during field survey implementation.

Visit health facility/residential area

The next step is to visit a selected health facility, explain the purpose of the survey to - and obtain permission from - the responsible medical officer. Invariably, the medical officers responded positive and granted their permission to conduct the interview at their facility. The fact that the covering letter - which endorsed the survey - was signed by the Chief Medical Officer of Dar es Salaam helped. Another reason for such visits is to assess if attendance rates are sufficient to obtain the required sample size within a time span of two sampling days. For reasons of efficiency, dispensaries with extremely low attendance rates would have to be excluded from the sample and substituted with another. Fortunately, this situation did not occur.

The procedure for the household survey is very similar. Prior to the survey, each residential area is visited to explain the purpose of the survey and obtain permission from the community leader (again using a covering letter). Also, the spatial demarcation of the sampling area is shown to the coordinator of the household data collection team. The endorsement of the community leaders - who are paid a token fee for their collaboration - proved to be extremely useful as they inform the members of their constituency. Their endorsement guaranteed the safety of the interviewers and made that virtually all respondents agreed to the interview.

Conduct patient/household survey

In all cases, the patient survey is conducted together with the georeferencing team to instantaneously capture the spatial origin of each patient. In case insufficient patients were found at a clinic, the teams return the next day until the required sample size is obtained. The household team works independently of the georeferencing team since the location of the health facilities attended by the respondents of the household survey, is captured *a posteriori*. The coordinators of the data collection teams perform quality control during the survey (check if questionnaires are fully filled out etc.). During the patient survey ITC staff is always present to ensure quality control.

Create health facility listing

Upon completion of each sampling day, a list of all the health facilities that are attended by the respondents - patients as well as households - is derived from the questionnaires. The georeferencing team then sets out to georeference the unknown health facilities through field verification. Towards the end of the fieldwork period, an attempt was made to georeference *all* clinics in Dar es Salaam - not just those attended by respondents - by means of a time-consuming street-by-street 'sweep' of the entire city. The procedure to locate, code and georeference the attended health facilities proved to be a difficult and time consuming task as it, altogether, involved the identification of over 350 different clinics which are dispersed all over the Dar es Salaam region.

Apart from locating the facilities, three types of problems were encountered. First, some respondents mention the name of the medical attendant that provided treatment or the settlement name rather than the facility name. Second, there are facilities that are part of a chain and share the same name but are located in different localities. Third, in a few instances, health facilities changed their name, moved to another location or had closed down. Although many of these problems were solved during the fieldwork period itself, a one-week mission was undertaken in May 1996 to clarify remaining problem cases. Finally, the name of each health facility as recorded on the questionnaire is matched with the corresponding facility code as indicated on the photo-mosaic.

Data entry and verification

For entry of descriptive questionnaire data a series of data entry screens was designed using a simple data base management system. The data entry screens included data integrity checks and pre-coded response categories to avoid data entry mistakes. Furthermore, data entry was done twice by two different individuals. By comparing the files, differences were detected and the necessary corrections made. The conversion of the spatial data into the GIS environment consisted of a simple digitizing process. Most of the data entry and verification was done upon completion of the implementation phase of the field survey.

The 2000 field survey: similarities and differences

In the year 2000, a second round of primary data capture was undertaken. The objective of this second field survey was the same as that of 1995: to obtain empirical data on health seeking behaviour across different population strata in Dar es Salaam. Apart from obtaining up to date information, the second fieldwork makes it possible to assess in how far health-seeking behaviour has changed over time. The overall sampling approach is very similar to that of 1995 but limited - time and monetary - resources made that the geographic coverage and scope of the 2000 effort was less elaborate. Since the 2000 effort could not cover the entire city, it was decided to restrict the geographic area to the southern and poorest part of the city (mostly Temeke municipality). Also, the scope of the sampling strategy had to be reduced: in 2000 only a patient survey - using the same 2-stage cluster sampling design - was conducted. This choice is made because a patient survey requires less complex logistics and - with a given amount of resources - results in a larger sample size than a household survey.

The patient sampling approach was slightly modified to partially compensate for the loss of the household survey. Like the 1995 patient survey, emphasis remains on governmental health care (mainly dispensaries but including a higher order facility) while including the voluntary sector. The only real difference is that in 2000, patient samples were also obtained from profit-oriented private facilities. Inclusion of all types of health care provision in the sample provides an insight in the health seeking behaviour of governmental, voluntary as well as private health care clients.

The measurement instruments used during the 1995 and the 2000 field surveys are the same. Spatial behaviour of patients was again captured using the 1992 photo-mosaic together with the superimposed hexagonal tessellation. To enable optimal comparison, the content and structure of the questionnaire was not changed apart from adding a few questions that inquire if respondents perceive changes in the health care system over the past years (e.g. costs, availability of medication, perceived quality of treatment, opening hours, and friendliness of medical staff).

For the 2000 field survey, only three weeks were available, with resources that allowed fieldwork support of about 7 local persons. A preparation phase of one week was needed to assemble and train the patient interview team (5 individuals), and to conduct the pilot. The georeferencing team consisted of the same two individuals that had participated in 1995. The remaining two weeks were used for actual data collection. Given the available time, the ambitious aim was to collect data from 8 health facilities. To properly reflect the field survey objectives it was decided to select 4 governmental, 2 private and 2 voluntary facilities. The sample size was again fixed at around 80 questionnaires per facility aiming for total expected sample size of around 640 questionnaires.

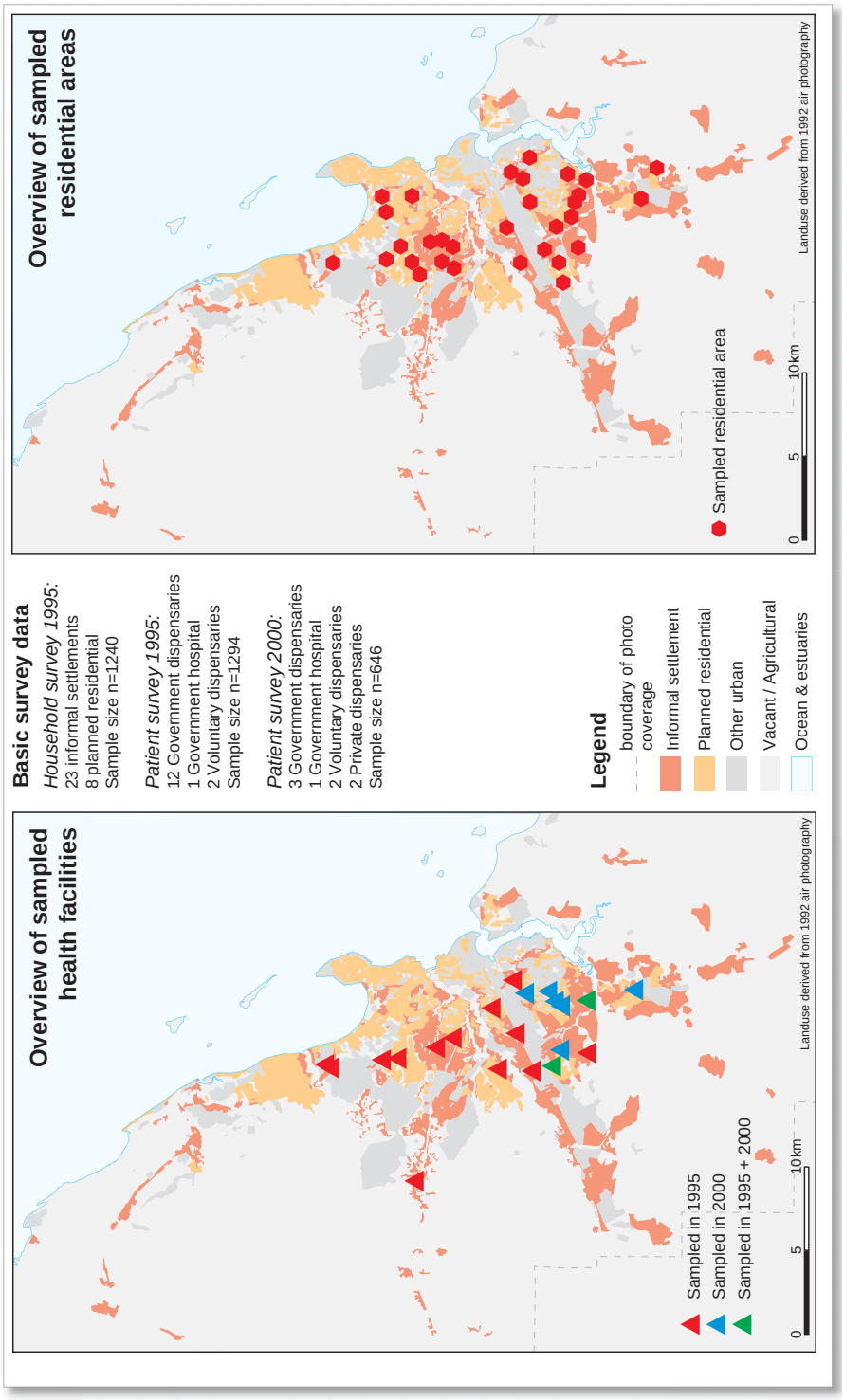


Figure 3.7: Spatial distribution of sampled health facilities and residential areas and total sample sizes obtained.

A few words need to be said about the method for selecting the health facilities - stage 1 of the sampling strategy - to be included for patient sampling. Like in 1995, the health facility sample could not be randomly drawn because a reliable listing of voluntary and private health care providers did not exist. Two of the four governmental facilities were selected because they were also part of the sample in 1995; the remaining two were randomly selected (together 1 higher order facility and 3 dispensaries). The 1995 procedures that applied during the preparation and the day-to-day working approach during the implementation phase were also adhered to in 2000. Figure 3.7 gives an overview of the spatial distribution of sampled residential areas (planned and informal), type and hierarchical level of health facilities, and the total sample sizes obtained during the 1995 and the 2000 field surveys.

3.4 Comments on the quality of the Dar es Salaam GIS database

The preceding paragraphs have described the way in which the Dar es Salaam GIS database was established and elaborated its contents as summarized in Figure 3.1. On a number of occasions, limitations of secondary data sources and forced concessions in primary data collection procedures were noted. These limitations and concessions should be viewed in the light of overall severe dearth of disaggregate data describing the Dar es Salaam situation.

In general, the extent to which shortcomings of any database will affect decision making depends on the purpose for which it is used. In other words, quality is a relative notion which refers to 'fitness for use'. The purpose of this section is to provide arguments that the established database - despite its limitations - is of adequate quality for this research and will provide reliable information to officials involved in urban health care planning. We do so by shortly commenting on the quality - in terms of error, accuracy, logical consistency, being up to date, and completeness - of the main contents of the Dar es Salaam GIS database.

Socio-spatial variations in health needs

The socio-spatial variation in health needs is approximated using the land use snapshots - which identify planned and informal residential areas - in combination with two other data sources - census data and building roof area - that are used to generate a basic proxy for population/health needs (see Appendix B for details on the procedure developed). As mentioned before, an important characteristic of these secondary data sets is that they are derived from sources with differences in scale and varying spatial extent. In the case of the land use data they are the result of interpretation work of a number of persons over an extended time period. On the positive side, gross errors in the datasets will be largely absent because they have been

carefully compiled either by ITC staff or by M.Sc. students under their direct supervision. Furthermore, logical inconsistencies within and between the data sets - as well as apparent remaining errors - have been identified and removed during the phase of harmonization and integrity checks. What remains are unavoidable measurement and classification errors of limited magnitude which will not significantly impact on the reliability of the outcomes of the analysis. The main reason for this is that the basic spatial unit used to represent socio-spatial variation of health needs is the hexagonal tessellation. Since the size of the individual hexagon is over 5 times larger than the MMA of the land use data, the remaining measurement and classification errors will be smoothed out. Obviously, it would have been better if more complete, more detailed and more up to date data could have been used for the estimation of health needs but such data do not exist at the moment.

Locations and characteristics in transport infrastructure

The location and characteristics of the communication link are represented by the road network, the public transport routes and travel time estimations for different transportation modes. The available data used to describe the communication link are generally unproblematic and of adequate quality for this research for a number of reasons. First, the road network is sufficiently complete and accurate since the large majority of the road data has been captured from larger scale data which describes the road network to a very detailed level. Second, its topological consistency is correct as this has been established and checked in the framework of prior research by de Jong and Amer (2002). Third, the captured road network - although representing the 1992 situation - remains quite a reasonable reflection of the current situation, no major changes have occurred in the main structure of the road network in the last years. A similar argument applies to the public transport routes: although changes have undoubtedly occurred in terms of, for example, the number of buses on the road, the public transport routes themselves have not changed much. The described approach for deriving travel time estimations results in realistic travel times during non-peak hours (see Appendix C for details).

Functional-spatial variation of health care provision

The functional and spatial variation in health care provision (opportunities) is represented by the point locations of health care facilities and - wherever possible - data on their size and functional make up. Given that nearly all the locations of health care facilities were captured directly in the field, positional error is small. Furthermore, secondary data sources have been obtained that describe the size and functional make up of governmental health care facilities (1995 and 2000). Together, these data are sufficiently complete for the (temporal) analysis of the functioning of the governmental health sector. Finally, the spatial distribution of the large majority of non-governmental health facilities was captured for entire Dar es Salaam in 1995. Temporal changes in the non governmental sector can to some extent be identified for the southern part of the city (because of the limited geographic scope of the 2000 field

survey). The lack of data on the size and functional make up of the private sector is a given fact but one that is less problematic than one might expect because - as field observation shows - the large majority of the private facilities are small scale dispensaries providing basic services only.

Health care utilization across population strata

The outcome of the interplay between the three components of accessibility is captured through sample based household and patient surveys with the aim to obtain representative data on health seeking behaviour. The data collection strategy was governed by three guiding principles: *(i)* avoid sampling bias, *(ii)* minimize measurement error and *(iii)* avoid non-sampling error. In retrospection, only limited measurement error is expected since the questionnaires were carefully designed and the spatial data framework - designed to capture trip origins and destinations - functioned very well in practice. Also, non-sampling error is limited because of proper training and motivation of the data collection teams and the support of the community leaders and responsible medical officers which virtually eliminated non-response. There are no reservations on the quality of the data obtained in this regard.

Some unavoidable concessions had to be made in the sampling strategy in the sense that it was not at all times possible to draw a fully random sample (selection of residential hexagons, fixed size household and patient samples). The point to make here is that this does not automatically imply that (unacceptable) bias is actually introduced into the samples obtained. In fact, the amount of bias introduced is expected to be limited because of two reasons. First, the selection of residential areas was done in an unsystematic and indiscriminate manner resulting in an eventual selection of areas that are geographically dispersed all over the city. Furthermore, 23 out of the 31 sampled residential areas (± 75%) are unplanned. This matches figures of Robertshaw *et al.* (2000) stating that around 75% of the Dar es Salaam population lives in unplanned areas. Second, the use of fixed size residential and patient samples is not problematic because the objective of the analysis is to understand health care utilization - across population strata - of respondents; the data is not used to compare between residential areas or individual health facilities.

General statements on the functioning of the governmental health care sector as a whole can, nevertheless, be made since the sample (1995) includes 30% of the existing dispensaries. Because the patient sample size obtained from non-governmental health care facilities (private and voluntary) is limited, inferences made from it can only be indicative. The role of the non-governmental sector can, however, be analyzed using the data of the 1995 household survey.

3.5 Concluding remarks

The sheer length of this chapter seems to mirror the collective effort involved in establishing the Dar es Salaam GIS database. Although its contents are not ideal, the preceding pages have illustrated that the current data compilation is of sufficient quality for the purpose of this research. Obviously, it would have been better if more complete, more detailed and more up to date data could have been used but such data does not exist at the moment. What has been compiled simply is the best that is currently available for Dar es Salaam. If and when new data become available they can be incorporated into the database. The overall research *approach*, however, will remain unaffected.

4 Health care provision and utilization in context

4.0 Introduction

The purpose of this chapter is to present an overview of the broader societal and economic context in which health care provision and utilization in Dar es Salaam occurs. To achieve its purpose, the discussion is organized into two levels: national and local. At the *national* level, it provides an insight in the functioning of the Tanzanian economic and political system over time (section 4.1 and 4.2), and clarifies how these have impacted on the development and structure of the Tanzanian health sector (section 4.3). The discussion presented in these first sections is non-spatial, has a policy orientation and directly connects back to the *how* component in the 'who gets what where and how' of spatial welfare theory as previously elaborated in Chapter 2.

At the *local* level the discussion zooms in on the case study area and becomes strongly spatial in its orientation. The structure is such that it directly links back to the accessibility concept (people, link, opportunities) which is discussed in detail in Chapter 2. Section 4.4 analyzes the city's urbanization process and its changing spatial structure over time to illustrate how the spatial distribution of health needs *(people)* has evolved. Health needs are approximated via a spatially disaggregate proxy of population size. Section 4.5 provides an overview of the characteristics of the road infrastructure and of the main modes of transportation *(link)* to explain how the residents of Dar es Salaam overcome the friction of distance. Finally, section 4.6 provides an overview of the functional and spatial dynamics in health care provision *(opportunities)* that have occurred in Dar es Salaam during the 1990s.

This chapter also has forward linkages. Firstly, the outcome of the interplay between abovementioned components of accessibility, *i.e.* observed health seeking behaviour, is further analyzed in Chapter 5 using the survey data collected in 1995 and in 2000. Observed regularities in health seeking behaviour, in turn, are subsequently modelled in Chapter 6 to identify areas un-serviced by (public) health care facilities and prioritize planning interventions.

4.1 Tanzania at a glance

At independence in 1961, Tanzania was one of the poorest countries in the world, mainly depending on subsistence agriculture. Some forty years later, Tanzania is the fifth poorest country globally for income per capita (280 US dollars in 2002).

Indicator	Tanzania							Sub-Saharan Africa
	1960	1970	1980	1990	1995	2000	2001-2*	2001-2
Population (millions)	10,2	13,6	18,5	25,4	29,6	33,7	35.2	688
Population growth (annual %)	2.8	3.0	3.2	3.1	2.8	2.2	2.1	2.3
Urban population (% of total)	5	7	15	22	27	32	34	32
GNI (Atlas method, US$ billion)	-	-	-	4.8	4.9	8.9	9.6	311
GNI per capita (Atlas method, US$)	-	-	-	190.0	160.0	270.0	280	450
GDP (annual % growth)	-	-	-	7.0	3.6	5.2	6.3	-
GDP per capita (annual % growth)	-	3	-0.2	3.1	0.6	2.6	4.1	-
Inflation	-	3.5	30.2	35.8	28.4	5.9	4.6	-
Aid per capita (current US$)	1	4	37	46	30	30	36	21
Aid (% of GNI)	-	-	-	29	17	11	13	5
External debt (% of GNI)	-	-	-	159	145	-	72	-
Health expenditure, (public, % of GDP)	-	-	-	1.6	2.9	2.8		2.5
Age dependency ratio	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.9
Fertility rate (total, births per woman)	6.8	6.8	6.7	6.3	5.8	5.3	5.0	5.1
Life expectancy at birth (years)	41	46	50	50	49	44	43	46
Infant mortality (per 1,000 live births)	142	129	106	102	103	104	107	105
Illiteracy (% of population age 15+)	-	64	51	37	31	25	24	38
School enrollment, primary (% gross))	-	33	93	70	67	63	-	86
School enrollment, secondary (% gross)	-	-	-	5	5	6	-	27

Source: World Bank, World Development Indicators, 2003 CD-ROM

** Most recent estimate used 2001-02*

Table 4.1: Tanzania at a glance

On the Human Development Index - which combines life expectancy, literacy rate and income - Tanzania ranked 160th out of 175 countries in 2001, down from 126th in 1990. Measured in domestic prices, real income per head is only about 30 percent higher than at independence. Poverty remains widespread and deep, with half of the Tanzanians living below the poverty line. Poverty is concentrated in the rural areas although urban poverty has also grown along with rapid urbanization and stagnating urban economies (The World Bank, 2001).

Tanzania in 2002 - for an overview of indicators see Table 4.1- has a total population of about 35 million people with an estimated annual growth rate of about 2.4 percent. The population of Tanzania remains predominantly rural, accounting for 66 percent of the total. The share of the urban population, however, has been rising rapidly, from 6 percent in 1967, to 34 percent in 2002. Tanzania's urbanization rate is among the highest in the world. As a result, considerable pressure is placed on the capacity of urban services and on the growth of employment opportunities in urban centres. Like most African countries, Tanzania - with a marginally declining fertility rate of 5.5 children per woman - has not yet embarked on a demographic transition to lower population growth. The very high dependency ratio - combined with rapid population increase - is a major hindrance to economic growth and poverty reduction. The infant mortality rate is high - and rising - at 107 per 1,000 live births. Twenty four percent of Tanzania's population aged 15 years and above is illiterate. The primary school gross enrolment ratio is officially estimated at 63 percent; considerably lower than in 1990 and showing further decline over the last decade.

Secondary school enrolment is at 6 percent, far lower than the 27 percent average for Sub-Saharan Africa. The HIV/AIDS pandemic - 10 percent of the adult population is estimated to be infected in 1999 - poses a major threat for eroding the limited gains made in economic and human development (UNDP, 2000). It mainly strikes adults in their prime productive years and has eroded life expectancy from the peak of 52 years in 1988 to 43 years in 2002, anticipating further decline.

The structure of the economy - as elsewhere in sub-Saharan Africa - has not changed significantly since independence. Agriculture accounts for about 50 percent of GDP, provides 85 percent of exports, and is the source of employment for the majority of Tanzanians. The country's non-diversified economy remains vulnerable to weather conditions and fluctuations in world market prices. Industry is dominated by the manufacturing sector, which currently accounts for about 8 percent of GDP and concentrates on agricultural processing and the manufacture of light consumer goods. Minerals (*i.e.* gold) and tourism are envisaged to offer a big push toward economic growth in the coming years (IDA and IMF, 2000).

To date, however, Tanzania has not been able to exploit its potential. The lack of persistent high rate economic growth - even though it has been one of the largest

recipients of aid in sub-Saharan Africa in absolute terms - is one of the main factors behind the lack of progress made since independence. In the next section, we further explore why this has been the case.

4.2 The political economy of post-independence Tanzania

The pre-Arusha period 1961 - 1967

At independence Tanzania inherited an economy with all the features of a colonial economy: foreign-dominated, absence of an industrial base, weak transport infrastructure, poor delivery of basic social services, mass poverty and a slow growing economy. The new government - headed by President Nyerere - initially followed a cautious development strategy aiming to eradicate poverty, disease and ignorance (illiteracy) in two decades. The strategy to achieve this was to modernize agriculture, to increase exports of primary agricultural products, to attract foreign funds for industrial and infrastructural investment, to accelerate the training of Africans to take over posts in the state and private industry, to improve and expand provision of basic infrastructure and social services, and to weld a colonial territory into a nation (van Arkadie, 1992). During the 1961-67 period per capita income growth was at an average of nearly 2 percent per year, the highest rate of any period in independent Tanzania (see Figure 4.1).

After 1965, nonetheless, it became apparent that the achievements of the pursued development strategy did not match expectations. The ambition to transform traditional smallholder subsistence agriculture with low productivity into a more modern agricultural sector producing both food and export crops did not generate the desired results. Efforts to attract foreign investors proved difficult and import substituting industrial growth was also below expectation. The collapse of the market for sisal - then the major export crop - illustrated the vulnerability of the economy and restricted government investment in agriculture and industry. Finally, the government was concerned to see that the benefits of independence accumulated in the hands of a small elite of Asians and politically powerful Africans. Confronted with these problems, the government felt that a new strategy was needed to speed up development (Heijnen, 1976; Bigsten and Danielsson, 1999).

The Arusha period 1968 - 1978

The Arusha Declaration in 1967 marked a turning point in Tanzanian political and economic history. The government abandoned the cautious policies pursued up to that point and launched a radical development strategy aiming at self-reliance and African socialism. The Arusha declaration emphasized human development and economic

growth with equity. It voiced a clear political commitment to raising the living standards of all, and the targeting of government programs to meet basic needs. Rural development would be the backbone of economic progress, complemented with expansion of import substituting industrialization. The strategy was based on pervasive state control over the economy and on the prospect of a viable public sector as the principal engine of social development and economic growth. Banking and the industrial sector were nationalized, international trade and private retail trade confined to state enterprises.

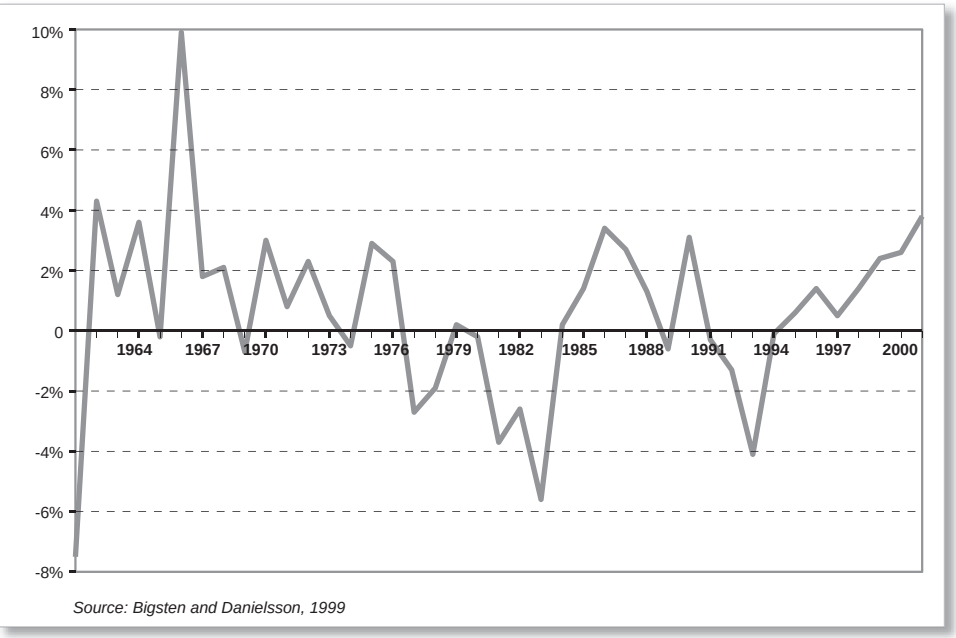


Figure 4.1: Per capita income growth between 1961 and 2001.

To increase agricultural exports and modernize peasant production, the government pursued a program of rural development called *ujamaa*. This involved the creation of cooperative farm villages where, it was argued, agricultural production as well as the provision of basic infrastructure and social services could be undertaken more efficiently. Initially, the government called for the voluntary concentration of the dispersed rural population into villages but after 1973 it imposed this policy. By the mid 1970s most of the rural population - nearly 10 million peasants - had been forced to give up their land and resettle into cooperative farm villages.

State spending on agriculture reached historic levels during this period with hundreds of millions of dollars invested in large-scale agricultural modernization projects and in setting up agricultural parastatals. The Tanzanian government could secure the required investment funds with relative ease because of two reasons. First, western

bilateral donors and the World Bank were quite willing to provide extensive aid to Tanzania because of the 'human face' of its development strategy. Second, foreign loans and credits were cheap as a result of the 1973 oil price increase ('petrodollar recycling').

Despite massive investments, the approach of cooperative agriculture was not at all an economic success. Towards the end of the decade, forced villagization, poor investment choices, political interference, a heavy bureaucratic system and increasing corruption, reduced the effectiveness of investments to very low levels. Ultimately, the *ujamaa* experiment led to a decline in agricultural exports, major food shortages and a tremendous increase in domestic debt. In 1974 the government began to implement its Basic Industries Strategy of import substituting industrialization, aiming to serve the East African market. Just as in the agricultural sector, the industrial investment program was state-led; investments were supported by donors or externally financed. Again, the rapid increase in industrial investment outstretched the capacity of the weak African technological and managerial cadres to properly plan for, run and maintain the investments and - apart from further increasing domestic debts - generated little corresponding increase in industrial output. Despite all problems, overall per capita income growth during the 1968-78 period was still positive at about 0.7 percent per year (see Figure 4.1). With rapidly mounting foreign debts, little productive growth and the break-up of the East African Community in 1977 it was clear that the Tanzanian economy suffered from internal structural weaknesses and was heading for an economic crisis (Bigsten *et al.*, 2001).

The crisis period 1979 - 1985

After the collapse of the commodity boom of 1975-78, the Uganda war in 1978-79, the second oil crisis in 1979 and the global recession that followed - external factors beyond control of the national government -, the Tanzanian economy faced very severe problems. Sharply rising interest rates multiplied Tanzania's debt obligations, while declining terms of trade reduced foreign exchange earnings. In response, Tanzania turned to the IMF, but an agreement was not reached and for about two years a deadlock situation prevailed. The position of the IMF was that aid was conditional to policy changes (currency devaluation, reduction of subsidies, reduction of budget deficit, import liberalization). The government position, on the other hand, was that Tanzania was a structurally weak economy and that the remedies proposed would not help to revive the economy.

Following the breakdown of negotiations with the IMF, donors became increasingly critical of the country's development strategy. There was growing evidence that in spite of the Arusha declaration neither socialism nor self-reliance had been achieved and that effectiveness of aid had been low. With a cut-off of aid from the IMF and the World Bank, and the scaling down of bilateral donor support, aid flows declined

sharply and Tanzania was faced with a foreign exchange and economic crisis of unprecedented proportions. By 1982 the country was in a desperate situation with widespread shortages and sharply deteriorating living conditions. Industrial output collapsed due to lack of imports of fuel, raw materials, intermediate goods and spares, and agricultural production declined. The shortage of foreign exchange made that most basic consumer goods disappeared from the shops by 1981, a situation that persisted for three or four years. A parallel market emerged where consumers often paid much higher prices for basic commodities. Many Tanzanians withdrew into subsistence activities or found other ways to deal with shortages. During the crisis period per capita income fell by 1.5 percent per annum (see Figure 4.1) according to official estimates, but a more significant income decline is likely because of high black market prices.

Without assistance from the international financial institutions, Tanzania implemented its own adjustment program in 1983, which emphasized increasing agricultural production, particularly for export, in an attempt to alleviate both food and foreign exchange shortages. It devaluated the currency, reduced subsidies, raised real produces prices for food and export crops and allowed limited private trade. These changes did alleviate somewhat the shortage of consumer goods and increased agricultural production but the measures were not sufficient to counter the crisis. Ultimately, pressure from the IMF/World Bank and bilateral donors, the failure of independent national efforts to revive the economy, and the resignation of President Nyerere in 1985, combined to persuade the government to reopen negotiations with the IMF.

Initial reforms 1986 - 1992

In 1986, Tanzania reached agreement with the IMF and the World Bank, thus embarking on structural adjustment. Structural adjustment programmes, in general, have a dual aim of *(i)* balancing national incomes and expenditures and *(ii)* substituting state-based economic interventions by market mechanisms, very much reflecting libertarian ideology (Briggs and Mwamfupe, 2000). Adjustment packages typically include both short- and long-term measures. *Stabilization programmes* aim to produce a short-term effect, their focus is to correct the balance of payment by reducing budget deficits. This is mainly achieved by currency devaluations, import reduction, the removal of state subsidies and the reduction of public expenditure. S*tructural adjustment programmes* are designed to promote change in the longer term, they mainly focus on economic liberalization. They aim to achieve this by trade liberalization; the promotion of private (foreign) investment; the strengthening of export sectors with a comparative advantage (i.e. primary commodities); the privatization of government industries; and market deregulation. By adopting such measures, IMF and the World Bank argue that the conditions are set in place to facilitate higher levels of sustainable economic growth, which in time will alleviate poverty. At the same time, there is general agreement that macroeconomic reforms, in the short term, cause lower or even

negative GDP growth and negatively impact on the living standards of the majority of the people (Loewenson, 1993; Asthana, 1994; Peabody, 1996).

The IMF and World Bank supported the Tanzanian government in launching the Economic Recovery Programme (ERP) for the 1986-89 period. This restored donor confidence and there was a second aid boom, which peaked, in the early 1990s. The main targets of ERP were to *(i)* increase output of food and export crops, *(ii)* increase capacity utilization in industry from 25 to 65 percent, *(iii)* restore macro-economic balance, *(iv)* reduce inflation from 30 to 15 percent, *(v)* increase foreign exchange earning from exports from $400 to $630 million and *(vi)* rehabilitate and maintain social services. Although per capita income growth was at around 1.2% per annum during this period, the initial reform by no means reached its stated targets (Gibbon and Raikes, 1995). In 1989, the reforms entered a second phase under the Enhanced Structural Adjustment Programme (ESAP) for the period 1989-92.

The new reforms aimed to continue earlier efforts, but widened to include institutional reforms and privatization in the banking system, agricultural marketing, the parastatal sector, and the civil service. Although the ESAP was launched in 1989, little progress was made for a number of years although per capita income growth was positive at around 1.2 percent per annum (see Figure 4.1).

Three reasons can be given for the slow pace of reform during this period. *First*, there still was considerable political opposition to reforms from within the government and simple bureaucratic 'foot-dragging' delayed their realization. *Second*, there was inadequate institutional capacity for timely implementation of as complex an issue as economic reform. *Third*, economic reforms - such as downscaling the civil sector and privatizing/closing down parastatal enterprises - are sensitive issues which goes against vested interests and has far reaching effects on many people who may lose their job or privileges (Gibbon and Raikes, 1995; Bigsten and Danielsson, 1999; Bigsten *et al.*, 2001; The World Bank, 2001).

Off track 1993 - 1995

During the second term of President Mwinyi, political commitment to adjustment further diminished and reforms veered off track. Government revenue fell, large tax exemptions were granted to politically favoured persons, and there was a general feeling that corruption, tax evasion and mismanagement had become widespread. In late 1994 the IMF, and even the Nordic donors, suspended their aid programme. Per capita income growth was negative at an average of 1.2 percent between 1993-95 (see Figure 4.1).

Back on track 1996 - 2003

Reforms got back on track following the first multi-party elections in late 1995. The new government under President Mkapa put high priority on implementing economic reform, fighting corruption and mending relations with donors (Hoebink, 1997). Since then, considerable progress is made towards stabilizing the economy and reducing budget deficits. Achievements in structural reform have included streamlining the civil sector - overall government employment has been reduced from 355,00 to 270,000 since 1993 -, privatization of about two thirds of the parastatal enterprises, and a far-reaching restructuring of the financial system (IMF, 2003).

Inflation dropped from over 30 percent in the early 1990s to 4.6 percent in 2001, the lowest in 15 years. Per capita income growth rates have been at around 2 percent per annum for the period between 1995 and 2000, and climbed to 3.8 percent in 2001, the highest level in 25 years. Overall average growth rates have also been more stable than in the past, despite the negative effect of the slowdown of the world economy on commodity prices and tourism (The World Bank, 2001). Export volumes of principal agricultural commodities have also experienced upward trends (Naschold and Fozzard, 2002). At the beginning of the new century, the status of the adjustment program is relatively satisfactory and in 2001 Tanzania is included in the IMF/World Bank *HIPC initiative* that provides debt relief to the world's poorest and most heavily indebted countries. Freed-up resources resulting from debt relief should be used for poverty reduction activities (Gupta *et al.*, 2002). Education, health and water are priority sectors within the Tanzanian poverty reduction strategy.

In looking forward, the IMF and IDA (2001) estimate that the Tanzanian economy will grow at an average annual growth rate of close to 6 percent during the period 2001 - 2020. This projection is based upon the assumption that further improvement in infrastructure and transportation, and normal weather conditions, will allow for agricultural growth of 5.5 percent a year. Investments in privatized parastatal enterprises and in new gold mines are expected to lead to average annual growth rates of 6.5 percent in manufacturing and 8.5 percent in the mining sector. Economic growth will also be supported by a continuation of economic liberalization and public sector reform. Despite relatively positive recent macroeconomic developments, the pace at which Tanzania is currently travelling is still too low to have a sizeable impact on poverty reduction. The Tanzania Vision 2025, nevertheless, expresses hope in ridding the country from poverty, disease and ignorance by achieving sustained growth - at an average of 8 percent - thereby halving abject poverty by 2010 and eliminating it by 2025. Furthermore, Tanzanian aims to develop a modern export-led economy and leap into the category of middle-income country. Achieving this ambitious target is undoubtedly a daunting task, judging from Tanzania's past record. (Danielsson, 2001) agrees that Tanzania needs such growth rates to visibly impact on poverty in the medium term, but doubts whether such growth rates are realistic given the constraints

that face the Tanzanian economy. How the political economy of the country has impacted on the provision of health care is further examined in the next section.

4.3 Development and structure of the Tanzanian health sector

Pre-independence

Up to the second half of the 19th century Western medicine was totally unknown in Tanzania - then Tanganyika - and people depended on traditional medical practitioners. Western biomedical health care arrived in the pre-colonial era with missionary organizations that opened dispensaries at their mission stations; intended to serve the missionaries themselves but also offering healing to the African population as a way to spread faith. The Germans, during their administration of the country from 1890 - 1916, established the first governmental medical institutions and opened hospitals in several of the main administrative centres of the country. Their primary aim was to treat the colonial government officials, merchants, the military troops, settler farmers and their plantation workers. The British government, which later administered Tanzania for the League of Nations, basically continued the German policy of providing mainly urban hospital-based health care but broadened its scope by establishing rural dispensaries - catering for the underprivileged African population - as well. Many of the rural facilities were, nonetheless, run by missions (Clyde, 1962; Titmuss *et al.*, 1965; Nsekela and Nhonoli, 1976; Mandara, 1991; Munishi, 1995).

Expansion of state provision following independence

At independence, the nationalist government inherited a greatly underdeveloped health system with nation-wide around 1,000 small-scale dispensaries and 100 hospitals with 11,000 beds of which over 40 percent were in voluntary institutions (Gish, 1975). Recognizing the fundamental inadequacies of the colonial system and the vast needs of the population and economy, the government took the responsibility for financing and managing health service provision. Shortly after independence Tanzania began its first five-year plan for economic and social development (1964-69). The main health policy objective was to ensure equitable distribution of health services to all members of society by developing a countrywide network of rural health services in combination with referral hospitals in the larger urban centres. In this manner, the government attempted to shift emphasis from limited hospital-based care for the better off urban populations, to extensive basic services for the rural subsistence level majority.

The outcome of the plan was quite unsatisfactory and by no means a breakthrough towards solving Tanzania's pressing health problems. Only 13 percent of the planned (300) dispensaries were completed and 24 percent of the (84) rural health centres, but

80 percent of the urban-based hospital beds were realized. The different completion rates reflected the ability of the central government to implement the construction of hospital beds and the weakness of the understaffed and under funded local authorities in establishing rural facilities. Overall, the lack of trained manpower to staff rural facilities and the scarcity of funds - heavy priority was placed upon the educational sector - caused the slow pace of progress made in the development of health services. The first plan, in short, proved to be unrealistic for a country whose political, social and economic structure was just beginning to be formulated (Gish, 1975; Beck, 1981).

The Arusha declaration of 1967 gave a strong impulse to the health sector. The egalitarian objectives remained but the strategy changed which reflected in the health policy in a number of ways. *First*, the government took complete responsibility for establishing a public health care system to meet the population's health service needs. For-profit private health care was forbidden. Authorized organizations - armed forces, parastatals - were still allowed to operate and establish health care units as long as they were run as a public service with modest fees. Religious entities were discouraged. *Second*, health services were directed toward the rural areas where the majority of the population lives, and toward basic health needs; very much the same as later defined under the primary health care approach (see Chapter 2). At the base of the referral pyramid - in or close to the *ujamaa* villages - were rural dispensaries and health centres. Referral hospitals in larger cities were at the top of the pyramid. *Third*, health services would be provided using uniform population-based standards for construction and staffing of facilities (a dispensary should serve 10,000, a health centre 50,000 people). *Fourth*, it was determined that the country would invest in being self-sufficient in all types of (para-) medical personnel. *Fifth*, government health services were made available at no charge to all patients. *Sixth*, health care provision would be financed on the basis of tax revenue and donor support (Beck, 1981; The World Bank, 1999). Apart from the desire to improve social welfare, the promise of free health - and other social - services for all, was used by the new government to strengthen the political base and establish a modern nation-state in areas inhabited by religiously and ethnically mixed societies (Munishi, 1995).

During the 1970s, the health sector - like much of the public sector - grew dramatically and the expansion of health service infrastructure and service provision during this period was impressive (although the quality of health care provided was relatively limited). Most of the growth was indeed seen in the rural health system. The number of government operated rural health centres more than tripled between 1969 and 1978, and the number of dispensaries nearly doubled. Many of the dispensaries and health centres were built on a self-help basis by villagers who after construction called upon the government to provide the personnel, equipment and drugs (Munishi, 1995). This expansion resulted in about 90 percent of the population living within 10 kilometres of a health facility, and nearly three quarters within 5 kilometres of health services by 1978. The growth of hospitals was limited to keep the bed-to-population ratio

constant. Most of the institutions for training health personnel were opened during this period and large numbers of rural medical aides, medical officers, and nurses were trained and deployed in rural areas (Nsekela and Nhonoli, 1976; The World Bank, 1999).

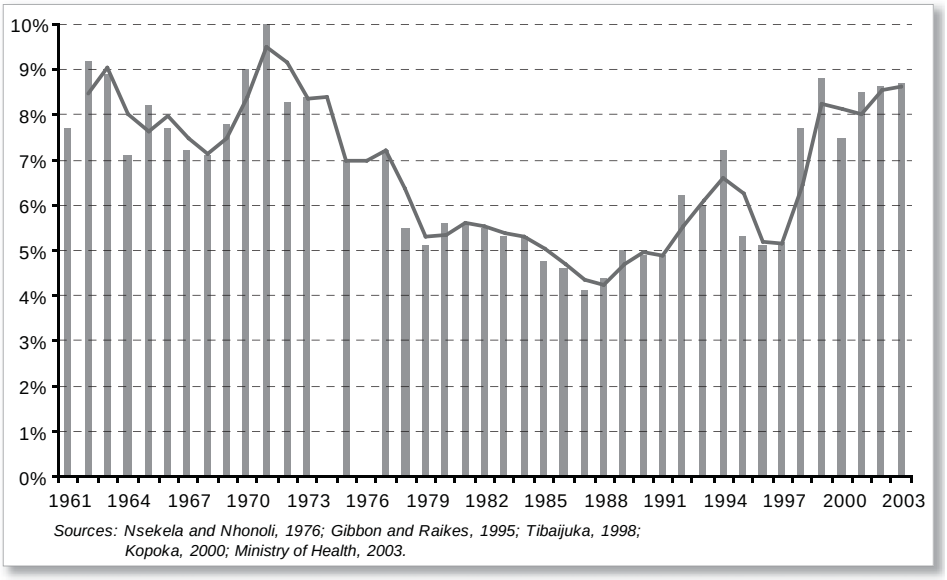


Figure 4.2: Health care expenditure as percentage of total government expenditure. Trend line shows 2-year moving average.

Health care expenditure during this period was substantive (see Figure 4.2) and extensively supported by donors. Most of the donor support was provided for the establishment of health facilities; assistance to the running of services through recurrent financing was limited. The expansion of the health sector strongly reflected in improved health indicators: life expectancy, for example, improved from 41 to 50 years and infant mortality rates declined from 142 to 106 between 1960 and 1980 (see Table 4.1).

Economic crisis, structural adjustment and the demise of public health care

The impressive investments and accomplishments were not sustained through the 1980s. The severe economic crisis that hit the country in the late 1970s placed severe strains on the government's capacity to mobilize public resources to maintain and manage health services at a satisfactory level. The expansion of the health care system came to a near standstill and the government experienced severe difficulties in financing and managing existing health services. Over time, the economic crisis led to the erosion of the health service network, which tended to reverse the health gains

made during the 1970s (Tibaijuka and Cormack, 1998). Health care expenditure - as percentage of total government expenditure - declined from around 7 percent in 1977-78 to 5.6 percent in 1980-81 to just over 4 percent in 1987 (Tibaijuka, 1998). Per capita spending on health during this period declined by around 25 percent (Gibbon and Raikes, 1995; Lugalla, 1995). Health was, thus, allocated a smaller share in a shrinking budget.

The problems that emerged during the 1980s can be summarized as follows. On the demand side, the population grew by about 3 percent annually so that population growth alone placed continuous pressure on the government to deliver sufficient health services. At the same time, the economic crisis created severe supply side problems. The recurrent costs - largely a government responsibility - became enormous following the huge capital investments in health infrastructure and training of health personnel in the 1970s. Concurrently, government revenues sharply declined as a result of the end of the commodity boom and the economic crisis that followed. This problem was further compounded by the increase in the costs of imported pharmaceuticals, medical supplies and equipment. Declining aid flows further aggravated the situation.

Without altering the fundamental definition of the government's role and near monopoly position in the health sector, policy makers attempted to stretch shrinking resources over expanding needs (World Bank, 1999, p. 47). The impact of drastically declining resources in the public health budget in the face of rising demand had harsh repercussions on the functioning of the public health system. Severe under funding resulted in *(i)* poor maintenance of health facilities, *(ii)* chronic shortages of drugs and essential medical supplies, *(iii)* severe shortages of health equipment, *(iv)* a dramatic decline of real wages - to 20 percent of the 1970 level with three quarters of the civil servant salaries below the poverty line - causing dissatisfaction, unethical and self interested behaviour of health workers, *(v)* declining transport facilities to serve the referral system, *(vi)* lack of coordination and decreased attention to supervision of lower level facilities and *(vii)* overcrowding and long waiting times particularly in urban health facilities. In short, the crisis caused quality standards of care at government health facilities to plummet (Kavishe, 1990; Tibaijuka, 1998; Kopoka, 2000; Mackintosh and Tibandebage, 2002).

At the same time, the economic crisis and structural adjustment negatively affected the living standards of many Tanzanians. Rising unemployment (retrenchment), the fall in real wages, and increased cost of basic commodities (removal of food subsidies, higher prices of imported goods) eroded household's incomes. An increasing proportion of the poor lost the purchasing power to meet minimum food needs, which reflected in a rise in malnutrition. Malnutrition, in turn, predisposes to infection and ill health (Loewenson, 1993; Asthana, 1994; Lugalla, 1995). The urban poor have been the hardest hit and constitute the most vulnerable group (Rakodi, 1993).

By the end of the decade and continuing well into the 1990s, the system that had aimed at rapid improvement in human welfare had not met its ambitious targets. The stresses placed on the economy and the health delivery system during the 1980s and early 1990s can be observed in overall health outcomes. Overall, progress towards improved health outcomes (see Table 4.1) has been disappointingly low as evidenced by a stagnating life expectancy and infant mortality rate, while the AIDS epidemic added critical new challenges. Tibaijuka (1998) signals rising morbidity rates, resurgence of controllable diseases (e.g. cholera) and stagnation - perhaps even increase - in mortality rates.

Health sector reform and the emergence of pluriform health care provision

In the early 1990s, it is recognized that the lack of progress in improving the health status of the Tanzanian population and the meagre performance of the health care system requires new thinking about the role of the government in the health sector. In response, the government of Tanzania embarked on a health sector reform which is a process of change in policy and institutional arrangements designed to improve the functioning and performance of the health sector and ultimately the health status of the population, with a focus on those most at risk (The Ministry of Health, 1999). The essence of the health sector reform is to shift roles and responsibilities within the health sector, change the way the sector is financed and managed, and lead to a more efficient and effective health care system. Its overall purpose is to improve access, utilization, quality, and financing of health services through increased efficiency and effectiveness in use and allocation in resources, to maximize impacts on health outcomes (Berman, 1998; The World Bank, 2001). The first official evaluation of the health sector was done in 1993, implementation of health reforms started gradually and is currently planned to continue until 2011. Obviously, the health sector reform is informed by structural adjustment and its libertarian ideology.

Although the health sector reform comprises a broad policy framework, covering a wide range of aspects, the most fundamental changes can be summarized as follows. *First*, the constraints on private sector participation in providing health services are eased by re-legalization of for-profit private medical practice. Voluntary providers are again encouraged to participate in health care provision. The lifting of the ban on private health has resulted in a rapid increase in pharmaceutical stores and private clinics mainly in the larger urban centres. The development of private medical practice in Dar es Salaam is further described later on in this chapter. *Second*, to ensure more sustainable financing of the government health sector, alternative ways of raising health funds are introduced or investigated. The most prominent is the gradual introduction of user fees in all government health facilities to create revolving funds that are then used to improve the quality of care and raise the availability of drugs. Secondary objectives are to discourage unnecessary use and bypassing of lower-level facilities.

Other financing methods under investigation are the establishment of a national health insurance system for employees and community financing schemes. *Third*, government health spending should be oriented towards cost effective public health interventions (*e.g.* immunization, maternal and child health programmes, control of communicable diseases) and essential clinical services. This type of services helps to resolve the major health problems, have the greatest social payoffs and mostly benefit the poor. High-level medical services are de-emphasized, as their contribution to public health is rather limited and favour those with higher incomes, usually in urban areas. The relative budgetary allocations to the health sector as a whole should be increased. *Fourth*, to increase the responsiveness of the health system to local conditions and community needs, the responsibility for managing and delivering basic health services is decentralized from the central to the local (district) level. With the devolution of power, the responsibility of the Ministry of Health becomes policy formulation, health legislation, regulation and control of government and private providers, health research and the control of epidemics. *Fifth*, donors - which together fund around 50 percent of total health care expenditure - are asked to concentrate their activities and support in areas that are of high priority to the government. The objective of this recent financing method is to move away from standalone projects towards a sector-wide approach whereby different donors pool resources which are then channelled through the government system in support of the health sector reform as a whole (The United Republic of Tanzania, 1994; Hiza, 1995; The Ministry of Health, 1999; The World Bank, 2001).

The result of the health sector reform is the emergence of a pluriform health care system with simultaneous provision of decentralized government health services, for-profit private medical practice, and occupational and voluntary not-for-profit health care providers. Health sector reforms are not particular to Tanzania but widespread throughout the developing world. Their implementation has sparked massive academic debate. The central point in the debate concerns the marked shift away from the primary health care approach that emphasized equity towards a more market-based allocation of health care emphasizing efficiency. Advocates of health reforms argue that in times of resource scarcity, priorities in health interventions have to be made. Adversaries tend to emphasize that access to essential health services becomes increasingly dependent on one's ability to pay. User fees are seen as leading towards increased inequity as they provide a stronger disincentive to the poor and vulnerable than to the better off (Loewenson, 1993; Gilson and Mills, 1995; Leighton, 1995; Gilson, 1997; Turshen, 1999; Benson, 2001). In the case of Tanzania, Abel-Smith and Rawal (1992) found that patients are generally willing to pay a user fee provided that services are of adequate quality and drugs are available (patients often paid 'unofficial contributions' anyway for supposedly free services). The health sector reform plan (1999), on the other hand, states that many households cannot afford to pay even limited user charges.

If we examine government health expenditure over time, it can be observed that the share of health in total government expenditure has increased in the 1990s, in particular since 1997[2] (see Figure 4.2). Although a reliable time series of absolute health expenditure for the 1990s could not be identified, Therkildsen (2001) reports a growth of 57 percent in per capita spending on health between 1986 and 1996. More recently, per capita annual government expenditure on health has increased from 4 US dollars in 1997 to 5 US dollars in 2001 (World Health Organization, 2003). This upward trend is consistent with the aim of the government to allocate an increasing share of public resources to the priority sectors - the health sector is one of them - identified in the poverty reduction strategy.

Despite this positive trend, absolute spending remains inadequate. The Commission on Macroeconomics and Health (World Health Organization, 2001) estimates that around 34 US dollar is needed per person per year to cover essential health interventions. The World Bank uses a minimum threshold of 12 US dollars; whereas the Tanzanian estimate is that a per capita expenditure of 9 US dollars is required to reach a minimum standard of health care. Reaching the very modest Tanzanian standard would, nevertheless, require a near doubling of the current health budget (The United Republic of Tanzania, 2000; Naschold and Fozzard, 2002). The inescapable implication is that the delivery of health services will remain to be below acceptable levels at least in the short term. It also points to the continuing need for (massive) donor support to the health sector to close this gap as much as possible.

Nationwide, there is still no evidence of improvement in the quality of health service levels in the 1990s (Therkildsen, 2000), caused by low levels of spending and compounded by inefficient delivery (The World Bank, 2001). The lack of improved health services, widespread poverty and the onset of HIV/AIDS all lead to the conclusion that morbidity has increased from the early 1990s (Naschold and Fozzard, 2002). Life expectancy has dropped from 50 years in 1990 to 49 years in 1995 and shows a steep decline to 43 years in 2002. Infant mortality is on the increase from 102 in 1990 to 107 per thousand newborns in 2002 (see Table 4.1). Access to reproductive health care - measured through the proportion of births attended by skilled health staff - shows significant deterioration from 60 percent in 1989 to around 35 percent in 1999 (The United Republic of Tanzania, 2002; The World Bank, 2003).

In the light of the above, it is tempting to draw the conclusion that the 1990s were, again, a lost decade for improving the health of the Tanzanian people. Yet such a conclusion would probably be too harsh because the health sector reform, increased

[2] The 1995/97 dip possibly reflects the renewed commitment to structural adjustment of the Mkapa administration, which was elected in 1995.

health budgets, and the poverty reduction strategy form a new and more favourable policy environment which has only recently started to address the multitude of problems that exist in the health sector (The United Republic of Tanzania, 2002). The challenge for the first decade of the 21st century, nevertheless, remains to translate the new health service environment into real gains in health status of the Tanzanian population.

4.4 Urban growth, land use dynamics and population density

This is the first of three sections that zoom in on the Dar es Salaam case study. The setup of these three sections is such that each directly links back to one of the components of the accessibility concept (people, link, opportunities) as discussed in Chapter 2. This section[3] analyses the urbanization process of Dar es Salaam, its changing land use structure over time and concludes with an overview of the spatial variations in population density. In doing so, this section reflects back to the *people* component of the accessibility concept. In Chapter 6 the spatially disaggregate population estimate is used again but then as a proxy to describe the demand/need for health care.

Establishment and growth

Dar es Salaam is by far the largest city - in 2002 nearly nine times larger than Arusha, the next largest urban area -, the dominant economic centre, the main port and the former capital of Tanzania. Its transformation from an originally small fishing village into a typical primate city is the outcome of the radical political and economic changes that have occurred over time. Although the history of Dar es Salaam is relatively short, it can be separated into *(i)* the era of Arabic influence, *(ii)* the period of European colonial rule and *(iii)* the post-independence period.

Arabic origins

Dar es Salaam was officially founded as a city in 1862 by Sultan Seyyid Majid of Zanzibar. Prior to 1862 the area was, however, not unoccupied. It was known under the name Mzizima which means 'the healthy town' and inhabited by small family groupings of the Zaramo tribe engaged in fishing and subsistence agriculture (Leslie, 1963). Sultan Majid recognized the potential of the natural deep water harbour and planned to establish a trading centre. He constructed a palace near the waterfront and named it Dar es Salaam, an Arabic phrase meaning 'haven of peace'. After the death of

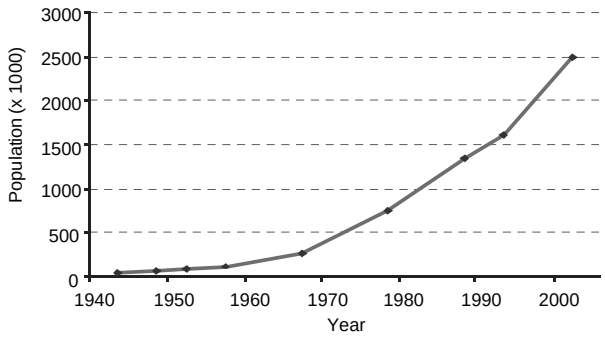
[3] This first two parts of this section are taken from (Sliuzas, 2004)

sultan Majid in 1870 the development of the city stagnated for about a decade and a half (McCullagh, 2000).

European colonial rule

German colonial rule lifted Dar es Salaam from its tentative beginnings and established the foundations of a significant city. Between 1887 and 1916 the city and much of the hinterland was placed under German administrative rule. During this period, communication links (roads, railway) were established which connected the interior of the country with Dar es Salaam. In this way the colonial territory was unlocked and linked to the German economy and development came to focus on Dar es Salaam (Uisso, 1985).

As a result, the population rapidly increased from around 10,000 inhabitants in the early 1890s to around 23,000 persons in 1913 (Kombe, 1995). The pattern of housing and services that emerged was segregated along racial lines: most of the housing of the African residents occurred in the form of spontaneous settlements located on the fringe of planned residential areas designed to accommodate the German administration.



Period	Annual growth (in %)
1943 - 1948	9.0
1949 - 1952	9.4
1953 - 1957	5.4
1958 - 1967	7.8
1968 - 1978	9.8
1979 - 1988	6.0
1989 - 1993	3.3
1995 - 2002	5.0

Source: adapted from Kombe, 1995 and Kombe, 2003.

Figure 4.3: Absolute and relative population growth in Dar es Salaam 1943 - 2002.

The British Government established administrative control over Tanganyika after defeating the local German armed forces in 1916 and maintained this control until the country became independent. Throughout the British period the city's population growth remained substantial (see Figure 4.3). Shelter for the African population continued to be primarily realized via spontaneous settlements and many lived in overcrowded, often temporary, houses of very poor quality (Iliffe, 1970). The colonial administration responded to this uncontrolled growth by producing Dar es Salaam's first master plan in 1949. Low density zones with a good standard of service provision were designed primarily for Europeans, medium density zones were set aside for Asian residents.

High density residential zones with limited infrastructure and few services were reserved exclusively for the African inhabitants. The plan, in short, fell far short of being an effective response to the needs of all of the city's residents. Its direct impact was limited.

Even though poverty has significantly declined in Dar es Salaam in relative terms between 1991 and 2001 - considerably more also than the decline in the rest of the country - it remains an area of utmost concern given that around 450,000 inhabitants of the city still live below the basic needs poverty line (see Table A).

An important challenge for very many residents of Dar es Salaam is to find employment that generates a stable income enabling a reasonable living standard. Formal sector employment opportunities, however, are increasingly insufficient as evidenced by the rising unemployment rate. In part, this is caused by the downsizing of the governmental and parastatal sector as part of structural adjustment. Private sector employment has risen but so far not sufficient to close the gap. Because of limited employment opportunities in the formal sector there has been a considerable increase in informal sector activities (e.g. petty trading, street food vending). Most of the self-employed people have low purchasing power, no savings and suffer from job insecurity.

Indicator	**Year** *(in %)*		**Employment category**	**Year** *(in %)*	
	1991	2000		1991	2000
Poverty (food)	14	8	Agriculture	2	3
			Employee - government	9	4
Poverty (basic needs)	28	18	Employee - parastatal	12	3
			Employee - other	10	16
Unemployment rate	22	26	Self employed (with empl.)	17	6
			Self employed (no empl.)	1	18
Household in 1 room	25	30	Housewife	22	19
			Other	27	31

Source: Household Budget Survey, 2002
Table A: Poverty and (un-) employment in Dar es Salaam in 1991 and 2001.

Another important livelihood problem is housing. Although most houses in Dar es Salaam nowadays have metal roofs and stone walls, they are often of substandard quality. Few homes have bathrooms indoors, most - over 90 percent - have a pit latrine. Particularly in lower-income areas these tend to be poorly constructed/maintained and in the rainy season can be subject to periodic flooding (International Food Policy Research Institute, 2001). The rising share of households occupying a single room shows that overcrowding is also very common

The quality of infrastructure varies between more and less dense areas in the city. Sixty percent of the poor in the central, more densely populated areas have electricity, while only 25 percent have access in the medium density suburban and lower density peri-urban areas.

Water supply is a problem across the city but the nature of the problem varies widely. Eighty five percent of the residents in high-density areas have access to piped water or a public tap, but these are often broken. Half of all suburban dwellers purchase water from a vendor at a relatively high cost. The large majority of peri-urban households - over 70 percent - get water from unprotected wells.

Just over one third of households in high-density areas have their garbage collected. Outside the city center, garbage is usually buried or burned contributing to significant air pollution (International Food Policy Research Institute, 2001).

In summary, Dar es Salaam is a sprawling urban agglomeration where a large number of people is faced with poverty, un (-der) employment, increasing income inequality, substandard housing and limited access to safe water, sanitation, electricity and basic social services.

Box 4.1: Livelihood challenges of the Dar es Salaam population.

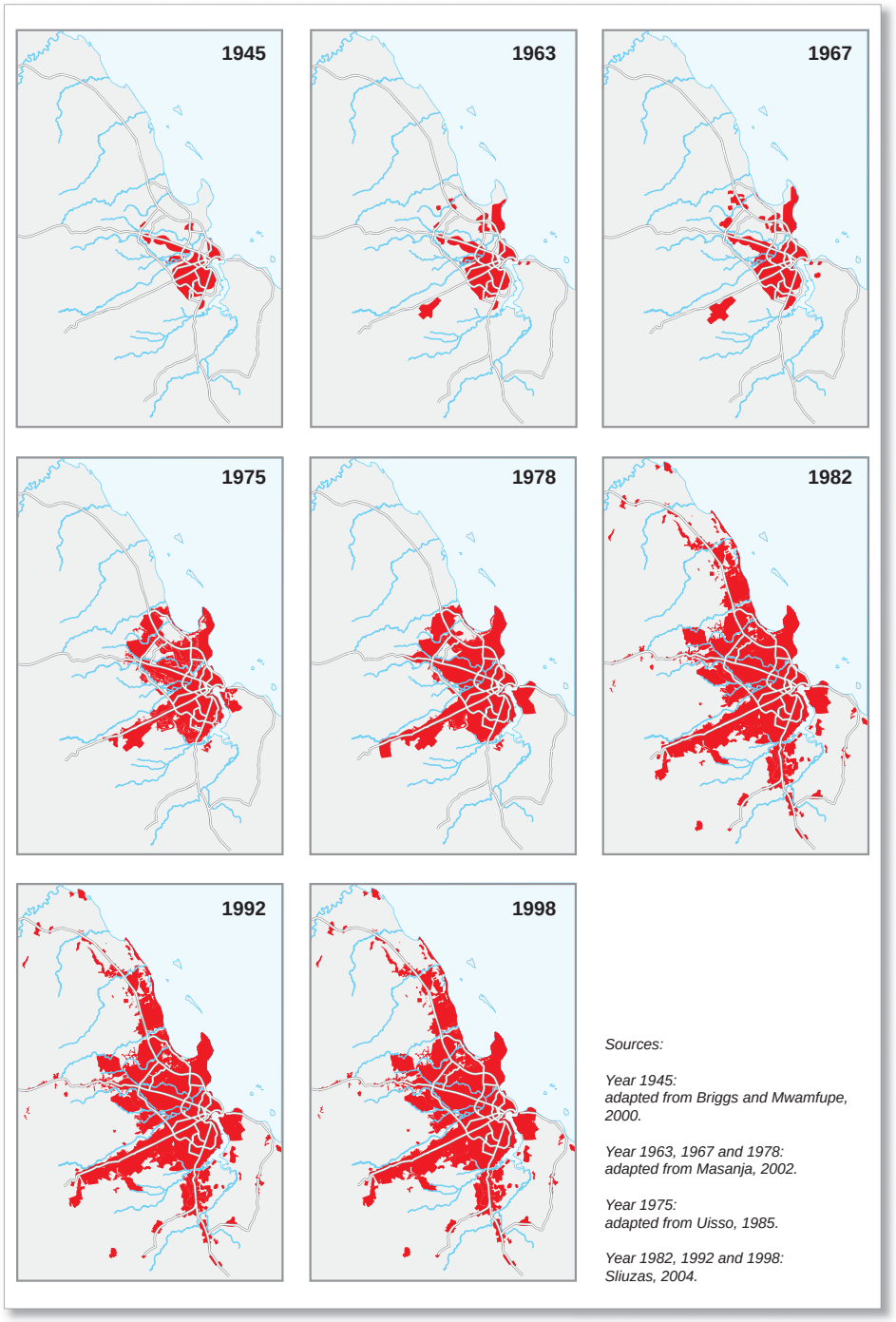


Figure 4.4: Spatial expansion of the built up area of Dar es Salaam 1945 - 1998.

Post-independence

During the post-independence period, Dar es Salaam transformed from a medium sized city with a population of around 170,000 into a large urbanized area with around 2.5 million inhabitants in 2002. High growth rates and an increasingly large absolute population increase (see Figure 4.3) have further exacerbated the problem of providing adequate housing, infrastructure and services to the inhabitants of the city. Although both the central and local government have recognized the importance of managing the city's growth and did respond to the populations' shelter and service requirements their attempts to regulate urban development[4] have been persistently insufficient (Kironde, 2000; Kombe, 2003). As a result, the spatial expansion of the city has occurred largely uncontrolled resulting in urban sprawl and deterioration of the built environment, including lack of basic infrastructure and services. As will be further detailed in the pages that follow, most of the population now lives in informal housing areas that have been constructed on a self-help basis. Peri-urban informal expansion of the city is also expected to continue as this is the only affordable housing option for poor migrants. The ongoing informalization of the urban fabric is the outcome of what has been termed urbanization in poverty: a process characterized by *(i)* rapid population growth, *(ii)* a limited urban economic base, and *(iii)* inadequate institutional capacity to regulate and service urban development (Kombe and Kreibich, 2000). Urbanization in poverty, however, is more than a spatial phenomenon alone. It is also a process with important social and economic dimensions, which have resulted in a situation whereby many of the inhabitants of Dar es Salaam are confronted with a multitude of livelihood challenges (see Box 4.1).

Figure 4.4 depicts the spatial expansion of the built up area between 1945 and 1998. Although it is compiled using data sources of varying detail, it provides an excellent insight in the direction of the spatial development of the city over time. Roughly speaking, the following two factors have been influential in directing the spatial expansion of the city. The *first* is the basic topography of the Dar es Salaam area. It consists of two main landform classes: a relatively flat coastal plain dissected by numerous creeks and a more hilly region to the west and south east of the study area. The coastal plain varies in width from approximately 2 kilometres in the north to more than 10 kilometres in the south. The coastal plain is the area which has developed most rapidly whereas the larger creeks and hills have acted as constraints to development. The *second* factor, facilitating spatial expansion clearly is the presence of major arterial roads (the 1992 situation is depicted on the snapshots). The combined outcome of these facilitating and constraining factors is a finger-like type of urban pattern, which is particularly clear on the 1982, and 1992 snapshots. Land in the interstitial areas was either cultivated or left vacant.

[4] For an in depth review of planning attempts see Sliuzas (2004).

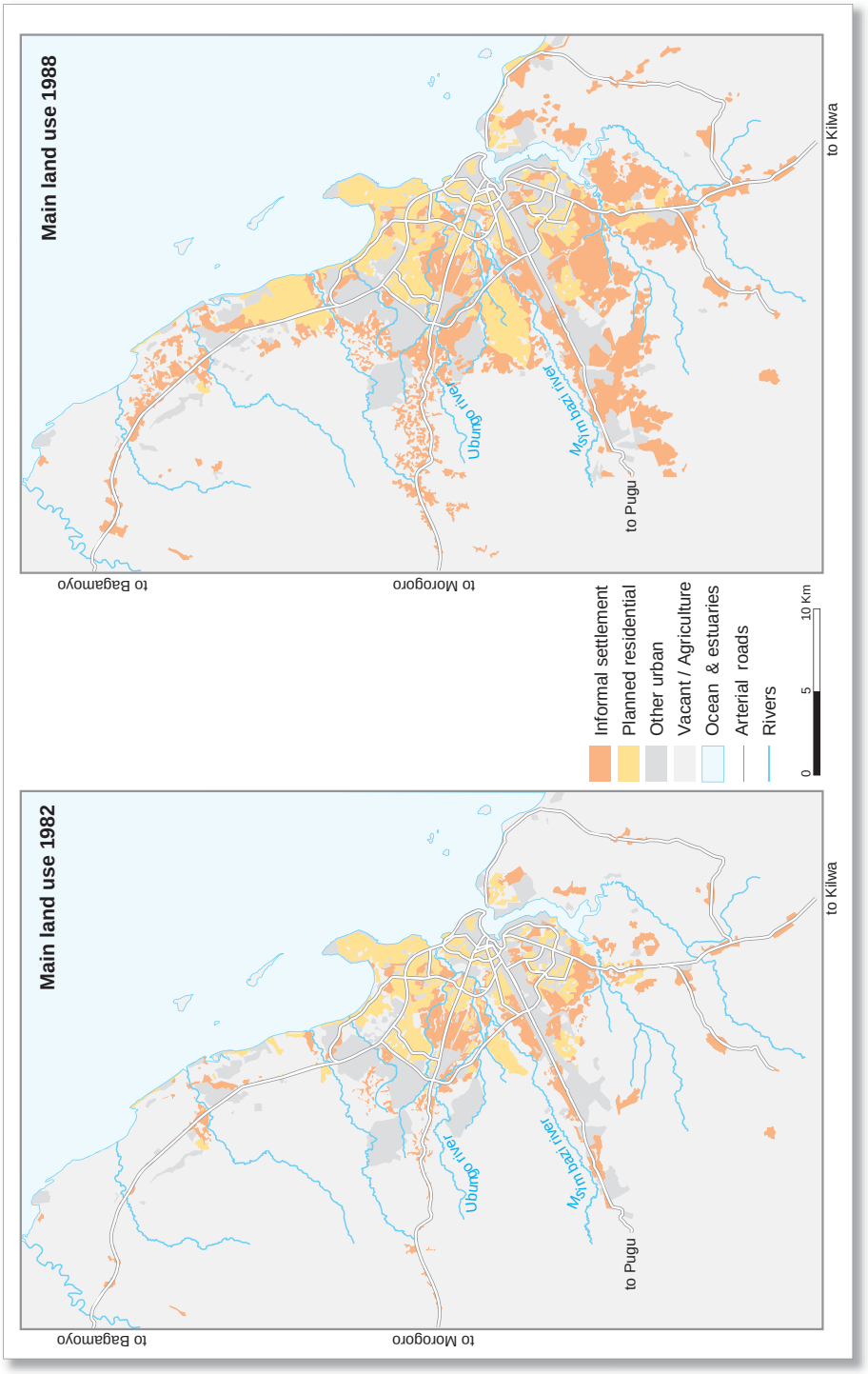


Figure 4.5: Major land uses in Dar es Salaam in 1982 and in 1998.

The pattern that emerges from the 1998 snapshot is, however, somewhat different. Although expansion along the arterial roads continues, there appears to be more infill in the interstitial areas than in the preceding period. Briggs and Mwamfupe (2000) associate this change with increased public transport possibilities and a rise in private car ownership (we return to this issue in section 4.5).

Spatial structure and land use dynamics 1982 - 1998

In this section, some basic statistics and land use maps are generated to depict the internal spatial structure of the city and the main land use changes that have occurred over time.

The GIS based analysis of urban development in Dar es Salaam covers the period 1982 - 1998 using the land use snapshots of 1982, 1992 and 1998 that were previously described in Chapter 3. From Figure 4.5 it can be seen that in 1982 the internal structure of the city is roughly as follows. Industrial activity is mainly located around the harbour area, along the south-western arterial road to Pugu, and in the (far) north of the city. The main institutional area - the University of Dar e Salaam - is situated in the northwest. The more peripheral institutional areas are military areas. Residential areas occupy the more central and southern parts of the city spreading outwards along the main road arteries.

Visual comparison of the 1982 and the 1998 situation shows that there has been very limited non-residential growth but at very a striking expansion of the residential area, predominantly informal settlements. A brief, quantified, analysis of the land use dynamics in the period 1982 - 1992 and 1992 - 1998 is presented below in Table 4.2.

Land use class	Area in hectares			Annual growth rate (%)	
	1982	1992	1998	1982 - 92	1992 - 98
Residential					
Planned residential	4325	5839	6622	3.0	2.1
Informal settlement	5193	8251	13880	4.7	9.1
Other urban					
Industrial	1935	2654	-	3.2	-
Commercial	286	286	-	0.0	-
Institutional	3834	3922	-	0.2	-
Recreation	471	445	-	-0.6	-
Total other urban	7346	8170	8345	1.1	0.4
Total urban	16864	22260	28847	2.8	4.4
Vacant and agriculture	80640	75297	68703	-0.7	-1.5

Table 4.2: Main urban land uses and growth rates 1982, 1992, 1998.

Urban expansion 1982-1992

The overall annual growth rate in this period was about 2.8 percent (see Table 4.2). Three land uses contributed most to urban expansion in the period 1982-1992, namely industry, planned residential areas and informal settlements. In Figure 4.5 it can be seen that some new industrial areas - 13 percent of total growth - were developed in several locations around the city, with the largest developments occurring at Mbagala in the south and in the valleys of the Msimbazi and Ubungo rivers. Much of this is expansion of quarries and sand mining, activities that are very much linked to the extraction of building materials for housing. The expansion of planned residential development - around 28 percent of total growth - was primarily to the north in the Mbezi Beach area and in the west in the Segerea and Tabata area. In both cases development in these areas proceeded slowly as they were only partially serviced with basic infrastructure. Informal residential development in this period was very substantial - comprising 57 percent of all new development - and occurred throughout the city but with significant concentrations to the west and south of the previously built up area. Extensive growth was also evident to the south-west and east of the airport, at Mbagala, in the Mabibo External area and in the hills along Morogoro Road, the main road to the southwest of the city. Informal growth is a direct result of the failure of the public authorities to provide sufficient - affordable and serviced - land to meet the needs of the burgeoning population.

Urban expansion 1992-1998

The annual rate of urban expansion between 1992 and 1998 (4.4 percent) was considerably higher than that of the previous decade. There was also a major qualitative distinction between the two periods with approximately 85 percent of the growth in the latter period being attributable to informal residential development (see Table 4.2). Much of the informal development occurs at the outskirts of the city, which adds considerably to the horizontal spatial expansion of the urban area. In 1992 around 37 percent of the built-up area of Dar es Salaam was informal settlement providing shelter to an estimated 60 percent of the cities population (Mghweno, 1999, pp. 255-256). In 1998 the share of informal settlements has risen to 48 percent and more recent estimates place the percentage of the population in informal housing areas to be as high as 70 - 80 percent (Molon *et al.*, 2001; Kyessi, 2002).

Aside from a fairly substantial further extension of planned development in the Segerea/Tabata area in the west of the city, planned residential development largely took the form of infill developments on relatively small pieces of vacant land, in the Msasani Bay area along the old Bagamoyo Road (see Figure 4.5). In the latter part of the period an increasing amount of house construction also occurred in the Mbezi Beach area, referred to in the previous section, in response to road infrastructure improvements - opening up the area - from the mid 1990's onwards. It was also in this period that the coastal lands to the south of the city were exhibiting increasing

development though here too poor infrastructure and the lack of a high frequency cross-harbour connection has until now prevented more significant growth.

Densification processes and spatially disaggregate population estimates

Urban development is not only characterized by spatial expansion of the built up area but also by densification processes that occur within the urban fabric, particularly in informal housing areas. Several studies have provided clear evidence that construction within existing informal settlements is an ongoing process (Sliuzas, 1988; Kyessi, 1990; Hakuyu, 1995; Dangol, 1998). According to Kombe (2003, p. 3) informal settlements normally go through three growth phases. An *infancy* stage where prospective house seekers convert (peripheral) agricultural land to residential use after which housing densities gradually increase as more newcomers settle in the area. This is followed by a *booming* stage in which more rapid densification occurs. Finally, there is a *saturation* stage when open space is used up and densification mainly occurs as a result of plot densification (subdivision or smaller plots?) and encroachment on limited open public space.

Using the limited data available, it has been possible to establish a spatially disaggregate proxy of population for the entire built up area for 1992 and 1998. The GIS-based procedure that has been developed to generate the population proxy is relatively complex and, therefore, separately described in Appendix B. The interpretation of the results, however, is presented here.

A closer look at Figure 4.6 shows that in 1992 medium[5] and high density residential areas are mostly located in the city core - Manzese and the surrounding area -, along Pugu road near to the main industrial areas - e.g. Vingunguti -, and in the southern part of the city in and around Temeke ward. As a general rule, population density tends to decrease with increasing distance to the city core and the main road arteries. Low density areas mainly occur at the city's periphery. It is also very evident that high population densities occur much more widely in informal than in planned residential areas. Apart from some smaller high density areas - e.g. Kariakoo, Mzimuni, Ilala and Temeke ward - most of the planned areas have a low to medium population density. When comparing the 1992 situation with that of 1998 (see Figure 4.7) a number of observations can be made. It is clear that - apart from expansion - densification processes are occurring all over of the city. Newly developed low density areas emerge mainly at the city periphery - in the south and along main arterial roads - illustrating the infancy stage of urban development.

[5] Low density (0-50 p/ha), Medium density (51-250 p/ha), High density (> 250 p/ha).

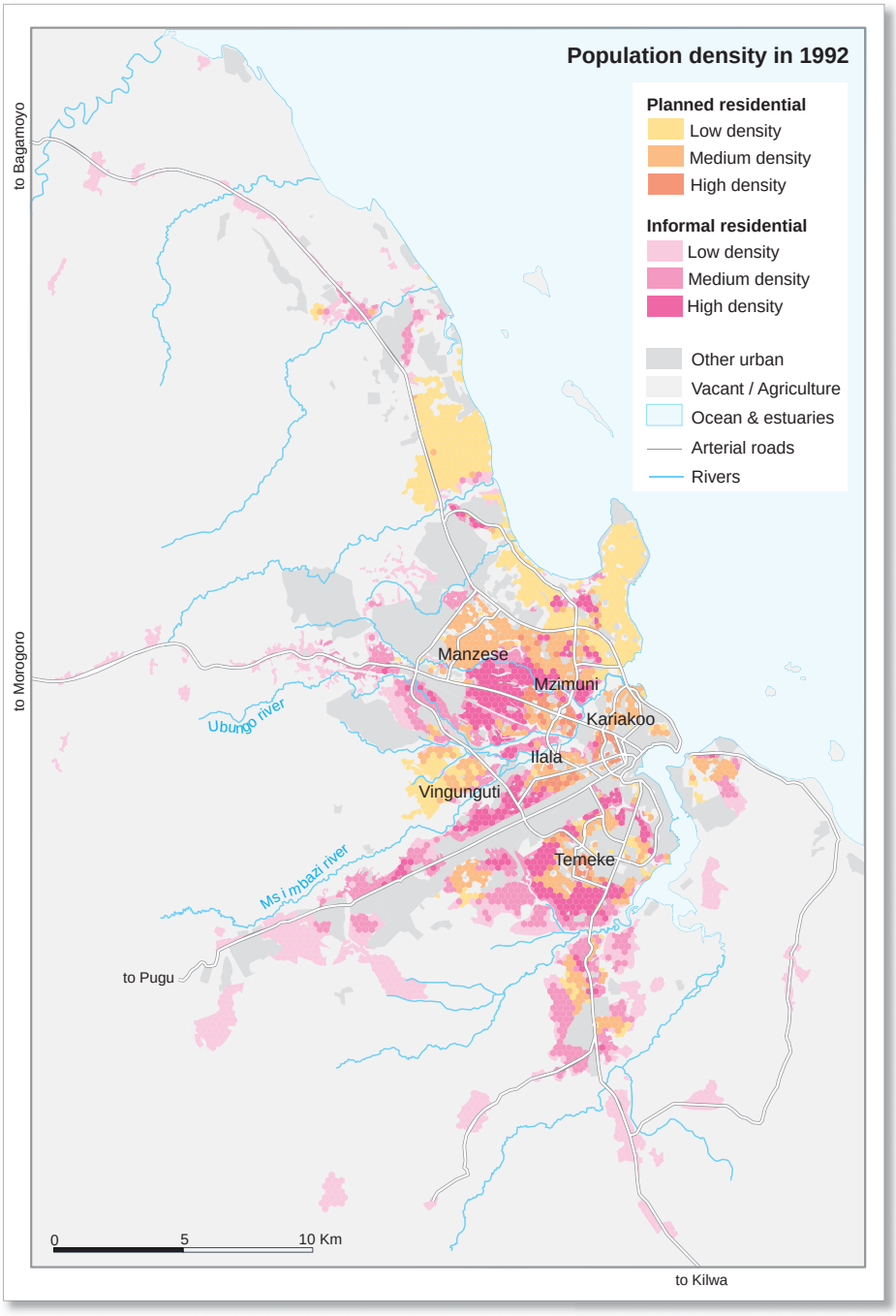


Figure 4.6: Population density classes in planned and informal residential areas in 1992.

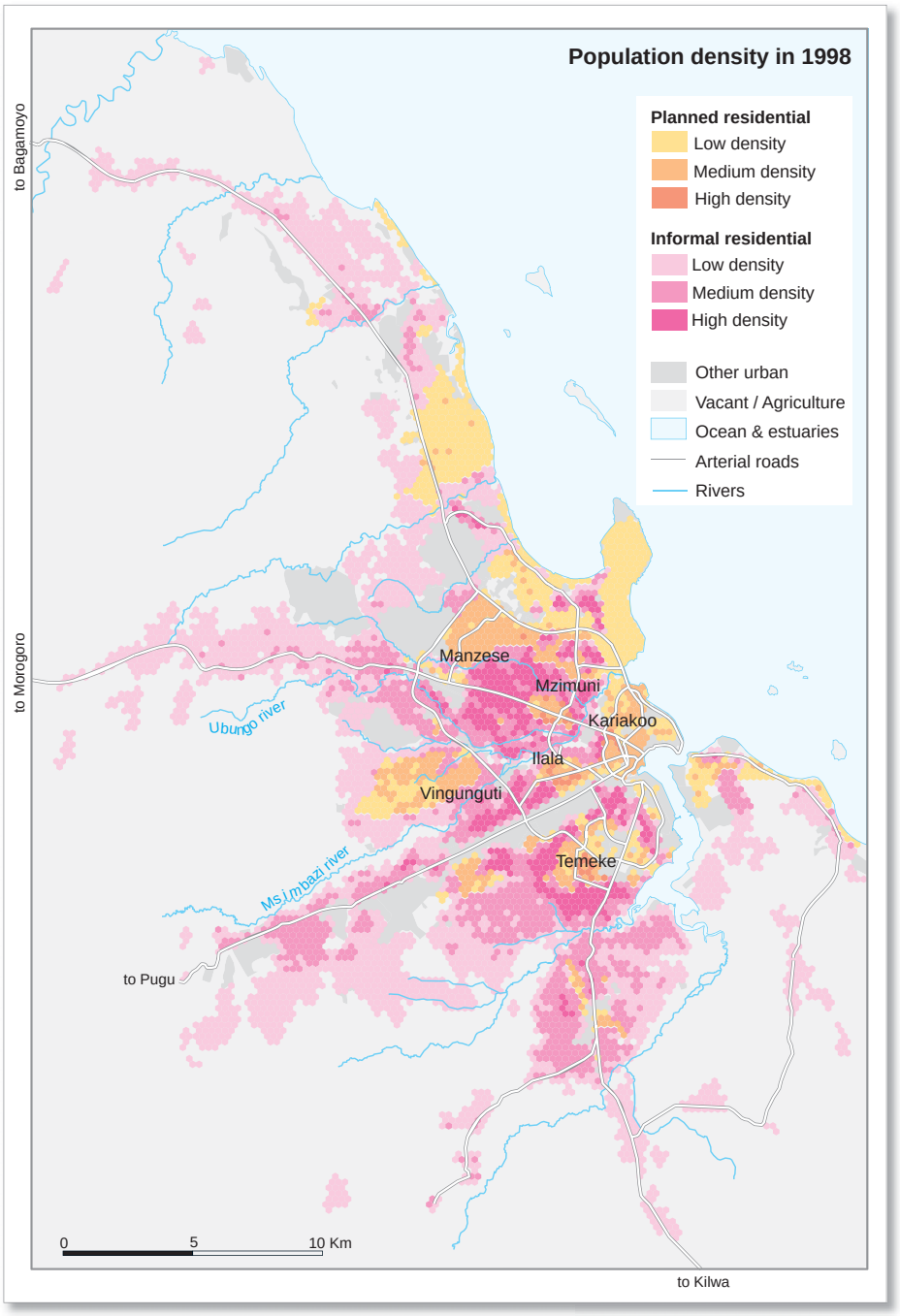


Figure 4.7: Population density classes in planned and informal residential areas in 1998.

It can also be observed that other unplanned areas - such as Makuburi, Ukonga, Segerea, Yombo Vituka and Mbagala - progress from low to medium density. Although this cannot be seen from the map, the actual population estimates show that unplanned areas with medium and even high population densities in 1992 - e.g. Manzese, Vingunguti and parts of Temeke - are further densifying. Overall, the largest changes in population density occur in unplanned areas and to a large extend concentrate in the area south of Pugu road. Planned residential areas, on the other hand, are generally stable in terms of their population, except for newly developing areas such as, for example, Tabata. Interestingly, a number of centrally located wards in the CBD area near the harbour - e.g. Kariakoo - have slightly declining populations in the 1992 - 1998 period.

4.5 Road infrastructure and transportation conditions

The purpose of this short section is to provide an insight in the characteristics of the road infrastructure and the main modes of transportation - the *link* in the accessibility concept - used by the residents of Dar es Salaam to overcome the friction of distance. In doing so, it provides a general insight in the city's transportation situation and in the main changes that have occurred during the last decades. This section also links forward to Chapter 5 in which the mobility patterns of patients seeking health care are analyzed and to Chapter 6 in which these mobility patterns are modelled to identify areas un-serviced by (public) health care facilities.

An urban road network characterized by duality

The road network of Dar es Salaam is characterized by a limited number of arterial roads that go in northern, western and southern directions. Within the city core, a restricted number of circular tarmac roads interconnect the arterial roads. During the 1990s a considerable amount of - foreign financed - widening and resurfacing work has been performed on the main roads to better accommodate the growing traffic flows between areas with concentrations of economic activity and residential areas (Howe and Bryceson, 2000). Although plans for the construction of a new outer ring road exist since 1994 (Kiringoda, 1998) no major extension of arterial roads has occurred during the 1990s. Although the condition of the arterial roads is generally reasonably good, their capacity is inadequate to accommodate the growing traffic volumes especially during peak hours which leads to considerable congestion, particularly in the central parts of the city.

The reasonably good state of the main roads strongly contrasts with the very poor condition of the local access roads within most residential areas. Outside the city centre and off the main roads, streets are typically unpaved and full of potholes so that

cars and other forms of motorized transport have to drive very slowly weaving between the ruts. Travel within residential neighbourhoods becomes particularly difficult during the rainy season, when the increasing number and depth of ruts can bring vehicles to a complete standstill making homes inaccessible except by foot (Habitat, 1995). When this happens the rare motorists leave their car outside the neighbourhood, taxis demand double fares or refuse to enter, and goods have to be transported by cart. Improvement of local feeder roads occurs but is modest because of limited financial resources, technical problems (e.g. unsuitable soil), and social conflict as building or widening roads often requires the demolishing of homes.

Mobility constrained by limited transportation options

Urbanization in poverty impacts on mobility patterns and on the transportation modes used by the residents of Dar es Salaam. Given the generally unfavourable economic situation and the large proportion of lower income residents, it will be no surprise that private car ownership is limited and only affordable for the more affluent. Taxis are unaffordable for the average inhabitant of Dar es Salaam and only used in emergency cases. The use of non motorized means of transport, *i.e.* bicycles, is limited as well because lower income residents can usually not afford to own a bicycle. The use of bicycles is also unattractive because of *(i)* the hot and humid climate, *(ii)* the poor condition of feeder roads and *(iii)* reckless car driving on the narrow and congested arterial roads makes cycling unsafe. In short, to overcome the friction of distance, the very large majority of the residents of Dar es Salaam either walks or depends on public transport. Although private car ownership has increased during the 1990s (Briggs and Mwamfupe, 2000), public transport remains centrally important in satisfying the mobility needs of the Dar es Salaam residents. In the year 2000, walking accounted for 46 percent of all trips, cycling for 3 percent, public transport for 42 percent and motorized private transport accounted for 9 percent (Kaltheier, 2002).

Given the significance of public transport, a brief analysis of the dynamics of the Dar es Salaam public transport system over time is appropriate. Public transport in the city started in 1947 by a British private company which was nationalized in 1970 following the Arusha declaration. In 1974, this company was split into two parts whereby the *Shirika la Usafiri Dar es Salaam* (UDA) was given the exclusive license to operate public buses in Dar es Salaam (Kombe *et al.*, 2003). Fares were kept low - even below the break even point - to make public transport affordable for the poor. From the beginning, the performance of the nationalized public transport company was disappointing as it was poorly managed and starved of investment. Shortages of foreign exchange made it impossible to properly maintain the existing fleet or purchase additional buses. Poor road conditions - even though buses operated on arterial roads only - shortened the operating life of buses. As a result, there was a steady decline in the number of buses operated by UDA (see Table 4.3), from 257 in 1975 to only 12 in 1998.

Year	Operating public buses	Operating private buses[6]
1975	257	-
1980	141	-
1983	141	178
1985	108	294
1990	32	175
1991	25	824
1995	32	1897
1998	12	3301

Source: (Rizzo, 2002).

Table 4.3: Number of licensed public and private buses in service 1975 - 1998.

While public transport supply was in decline, the demand for it was rising as a result of rapid population growth. The outcome was that Dar es Salaam experienced an increasingly severe intra-urban public transportation problem, especially during the 1980s. Buses were hugely overcrowded, timetables were not adhered to - causing long queues and waiting times at bus stops - and total journey time could be enormous (Kombe *et al.*, 2003).

Briggs and Mwamfupe (2000) argue that the chronic public transport problem impacted on the urban shape of the city. People chose to live as close as possible to areas of employment so that walking to work was an option. The alternative was to settle near arterial roads as these at least had the possibility of public transport services to and from employment areas. Interstitial areas were not served by public transport and thus less attractive for settlement.

The first opening of the market to privately run buses came in 1983 when private bus operators - commonly known as *daladalas*[7] - were legally allowed to operate as subcontractors of the UDA on designated routes at fixed fares. Private sector involvement was seen as a temporary means to ease the shortage of public transport supply, there was no ideological change in the public transport policy. Because the fixed fares remained low, profitability was limited and private sector response was modest (see Table 4.3). A more significant step in the deregulation and privatization process of the Dar es Salaam public transport system was taken in 1991 when state control over the number of licenses issued to private operators was abandoned and a more profit-oriented tariff policy was adopted.

[6] Rizzo (2002) estimates that in 1999 the number of unlicensed 'pirate' buses is close to the number of officially registered buses suggesting a total of between 6,000 - 7,000 operational daladalas.

[7] The term *daladala* comes from the name of the 5 Shilling coin used to pay for a trip in 1983. As 5 Shilling was equivalent to 1 US$, *dala* was the Swahilization of dollar (Rizzo, 2002).

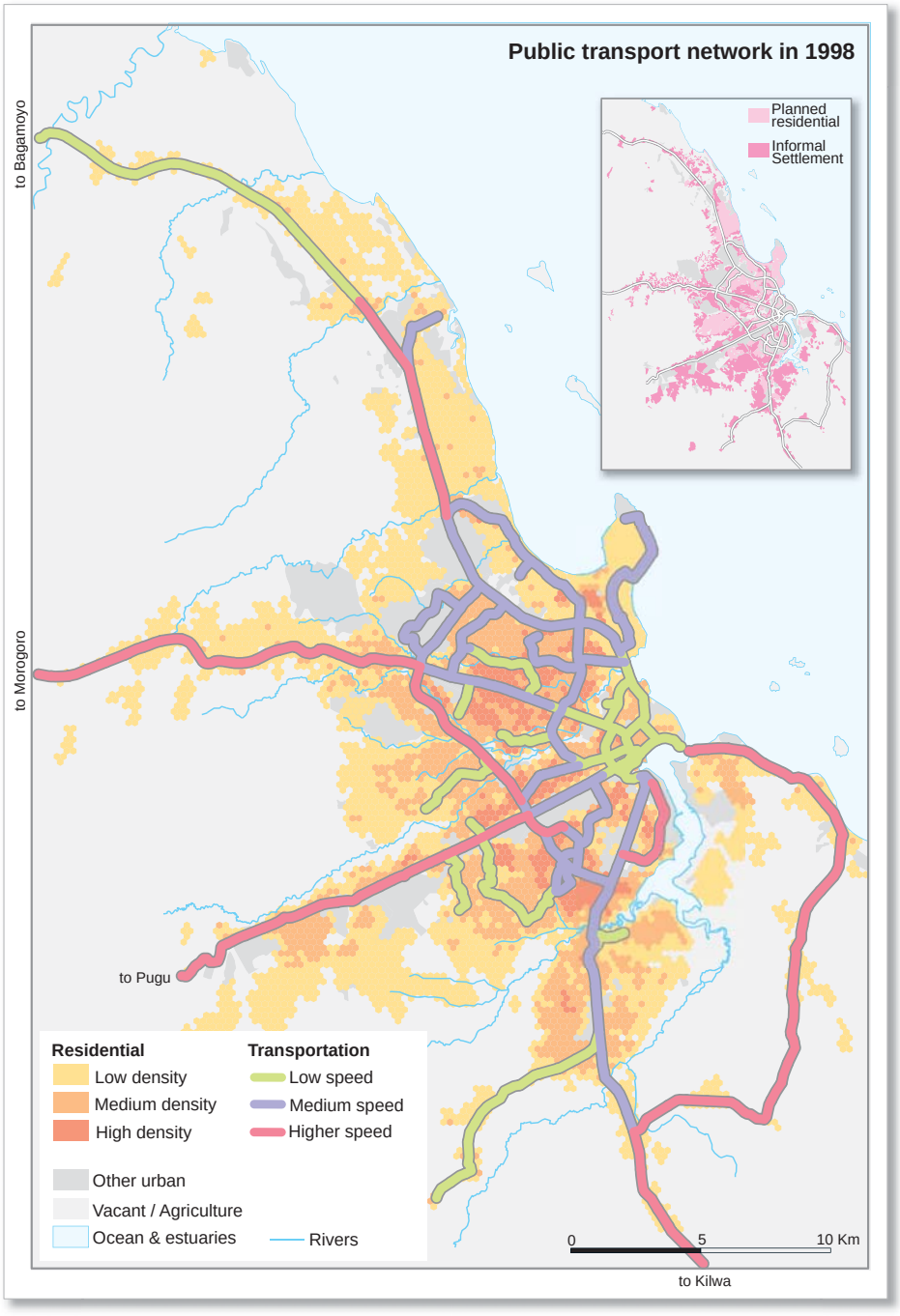


Figure 4.8: Public transportation network, bus speed classes and population density in 1998.

The shift towards a free market regime was completed in 1996/7 with the complete deregulation of the tariff mechanism and bus fares were allowed to be determined solely by market forces. The reaction to these profound policy changes has been a dramatic increase (again see Table 4.3) in the number of registered private buses. By the end of the 1990s, the Dar es Salaam public transport system was almost entirely supplied under a free market regime by a large number of small scale private operators running different types of (mini and micro) buses and converted pick ups (Rizzo, 2002; Olvera *et al.*, 2003).

The positive consequence of the change from state monopoly to privately provided public transport provision is that - after many years of severe transport shortages - private buses have managed to meet a larger part of the demand for public transport. At the same time, intense competition between private bus operators has negative effects. To maximize profit and maintain a competitive edge in a congested market operators drive at excessive speed, overload their vehicles, diverge from allocated routes if these are less profitable than others, disregard formal bus stops, and generally ignore traffic and safety regulations (Kombe *et al.*, 2003). In short, privatization and deregulation has increased the supply of public transport but the quality of the service provided remains inadequate.

If a geographic perspective is taken, deregulation has also made that a larger part of the city has become serviced by public transport. In particular minibuses have started to operate on feeder routes off the main roads along dirt roads into interstitial areas. (Briggs and Mwamfupe, 2000) argue that this tendency has facilitated urban development at locations further away from the arterial roads. They also argue that as these areas become more densely settled, larger buses move in and the smaller buses then get pushed out further into the next urban colonizer zones.

However, a closer look at Figure 4.8 shows that in 1998 the transport system was still insufficiently responding to the spatial expansion of the city. It is very clear that - in the absence of an authority that regulates public transport - daladalas focus on the most profitable routes and thus essentially concentrate on the more densely populated city core and the main roads. For example, in 1998, 53 of the 83 transport routes were radial and served the central business district (Berhie, 1998). Travelling to a destination outside the city centre is therefore complicated because of the need to change daladala routes at least once in the city centre, which increases travels costs and time, particularly during congested peak hours.

Lower density areas away from the arterial roads - mainly informal residential areas - remain largely un-serviced. Finally, figure 4.8 provides an indication of the variation in bus speeds which is low in the congested central parts of the city and on the unpaved routes off the main arterial roads. The highest bus speeds are generally realized on the main roads outside the city centre.

4.6 Health care delivery in Dar es Salaam

The purpose of this section is to provide an insight in the characteristics of the health care delivery system that caters for the medical needs (see Box 4.2) of the residents of Dar es Salaam. It provides an analysis of the functional and spatial dynamics in health care provision - the *opportunities* in the accessibility concept - that have occurred in Dar es Salaam during the 1990s.

Overall, the post-independence history of health care provision in Dar es Salaam very much mirrors the developments that affected that health sector nation wide (see section 4.3). The late 1960s and 1970s was the period of *expansion* with rapid growth of publicly funded health services. This phase was followed by a period of *stagnation* during the 1980s and early 1990s when economic crisis precluded the construction of new facilities and under-funding drastically eroded the quality of health care provided at existing facilities. Towards the end of the 1980s, poor maintenance, chronic shortages of drugs, medical supplies and equipment, and self interested behaviour of health workers brought the Dar es Salaam public health system in a state of near collapse. Stagnating provision in combination with ongoing population growth led to congestion, long waiting times and widespread dissatisfaction among patients (Tibaijuka, 1998; Mackintosh and Tibandebage, 2002)[8]. The third phase is that of *restructuring* in the context of the health sector reform since the mid 1990s with a move towards decentralized decision-making, gradual introduction of cost sharing at public health care facilities and the liberalization of private health care provision.

The following pages provide a closer analysis of, respectively, the developments in the Dar es Salaam governmental and non-governmental health sector since the 1990s. Wherever the available data sources allow, the discussion is placed in the perspective of the 1995 situation (the time of the first field work marking the early stages of structural adjustment and health sector reforms) and the situation in 2000 (the time of the second field work when structural adjustment and health sector reforms were well underway). Before doing so, we shortly discuss the Dar es Salaam Health Project as it was a major player in the city's health sector during that period.

The Dar es Salaam Urban Health Project

At the end of the 1980s, the Ministry of Health of Tanzania and the International Development Agency (IDA) planned the Tanzania Health and Nutrition project which - as a reaction to the deplorable state of the health sector - aimed at reinforcing

[8] Tibaijuka (1998) notes that during this period Dar es Salaam and other urban areas were generally in a worse position than many rural areas in terms of the quantity of health facilities in relation population size. This is seen as an indication that the health policy during the *ujamaa* period was truly rural in its orientation.

government efforts to raise the quality, coverage and effectiveness of basic health services in rural and urban areas across the country. During the preparation phase of this project, the Swiss Development Cooperation (SDC) showed interest in co-financing the Dar es Salaam component on a bilateral basis between Switzerland and Tanzania. Agreement was reached and the Dar es Salaam Urban Health Project (DUHP) started to be implemented from 1990 onwards until the end of 2001, with the Swiss Tropical Institute as the executing agency of the project (Wyss *et al.*, 2000).

Mortality statistics: years of life lost due to premature death
Table B shows that in 1995 the leading causes of premature death are tuberculosis/AIDS, malaria and perinatal/ maternal conditions, followed by diarrhea diseases, injuries and respiratory infection. The most visible trends between 1995 and 2000 are a marked decline of death as a result of diarrhea disease, a rising importance of tuberculosis/AIDS and a noticeable increase in cardiovascular disease.

Although not shown in the table, the mortality statistics clearly indicate that a very large part of the premature mortality burden is on infants, children and women. Infants are particularly vulnerable - nearly one third of the total mortality burden - with the main causes of death being complications arising from birth and the neonatal period, malaria and respiratory infections. The leading causes of death for children - only 4 percent of the mortality burden - are malaria and tuberculosis/AIDS. Males account for 29 percent and females for 35 percent of the mortality burden. Tuberculosis/AIDS is by far the most important cause of adult death.

	Cause of death		**Cause of illness**	
Condition	1995 *(in %)*	2000 *(in %)*	1995 *(in %)*	2000 *(in %)*
Tuberculosis/AIDS	32	37	-	-
Febrile illness/Malaria	15	15	25	50
Perinatal/Maternal cond.	16	14	-	-
Respiratory infection	4	6	17	20
Cardiovascular disease	3	5	-	-
Injuries	5	3	3	2
Diarrhea disease	7	1	9	6
Anemia	-	-	2	3
Urinary tract infection	-	-	-	4
Skin infection	-	-	5	5
Intestinal worms	-	-	4	5
Ear infection	-	-	2	1
Eye infection	-	-	3	1
Other/Uncertain	18	19	30	3
Total (in %)	100	100	100	100

Sources: Wyss and Subiri (1996); Dar es Salaam Medical Office of Health, 2003); Adult Morbidity and Mortality Project, 2004 (- = does not feature separately).

Table B: Dar es Salaam mortality and morbidity statistics 1995 and 2000.

Morbidity statistics: diagnosed causes of illness
Although important, mortality statistics do not represent the entire burden of disease as illnesses can be frequent and even serious without significantly contributing to mortality. Table B shows that malaria - or at least suspected malaria - is by far the largest health problem. Other important health problems are respiratory infections, diarrhea disease, urinary tract infection and anemia. Remarkable is that tuberculosis and HIV/AIDS do not feature at all. Probably this is because the symptoms of tuberculosis and AIDS are typically diagnosed as infections without recognizing HIV/AIDS as the underlying cause of the infection. Morbidity patterns have not significantly changed between 1995 and 2000. The very large difference in diagnosed malaria is not plausible and must be attributed to dissimilar diagnostic and/or recording procedures.

Children bear about one third of the morbidity burden, and adult women use health services by about double the rate (41 percent) of adult men (22 percent). Because of low life expectancy, the proportion of elderly people is very low (Coppens, 2001).

Most of the health burden in Dar es Salaam is caused by communicable and infectious diseases. Many of these are closely associated with poverty and with poor environmental health conditions which - as argued before - are striking features of the city's urbanization process.

Box 4.2: Health status of the Dar es Salaam population.

The aim of the DUHP was to improve the health status of the population of Dar es Salaam especially the urban poor, by improving the effectiveness and efficiency of the city-wide governmental health system based upon primary health care principles (Wyss and Pichette, 1999; Few *et al.*, 2003, p. 47). Since its beginning, the DUHP has gone through three phases with gradually shifting focus areas (for details see Wyss *et al.* 2000). *Phase I* of the project - from 1990 to 1993 - dealt with the most acute shortcomings of the public health delivery system by focusing on regular provision of essential drugs, equipment and medical supplies and on the rehabilitation of dilapidated health facilities. At the same time, it addressed the organizational shortcomings of the institutions responsible for the provision of health services.

Phase II - from 1993 to 1996 - can be viewed upon as a period during which earlier activities were consolidated. At the same time, new initiatives such as, for example, initializing community involvement were launched. Around 1995, rehabilitation of existing health facilities was largely completed (Wyss and Subiri, 1996, p. 4) and DUHP started to consider the construction of new health facilities in under-serviced areas. To identify such areas, DUHP commissioned a research study to ITC culminating in the so-called health coverage plan which analyzed differences in access to governmental health facilities and identified under-serviced areas using a relatively simple GIS-based approach (for details see Amer and Thorborg, 1996)[9].

Phase III of the project - from 1996 to 2001 - was clearly designed to restructure and prepare the Dar es Salaam public health care delivery system to properly function in the new policy context brought about by structural adjustment and the health sector reform. During this phase, the DUHP was able to *(i)* design and implement a comprehensive package of preventive and curative health services tailored to the need of the population of Dar es Salaam, *(ii)* improve the planning capacity of and decentralize decision-making to the three municipal offices of health, *(iii)* integrate national health control programs (e.g. malaria, HIV/AIDS, tuberculosis and leprosy) into the activities of the municipal offices of health, *(iv)* sustain health care financing through the introduction of user charges, and *(v)* improve drug and medical supply management, establish standard treatment guidelines and train prescribers (Wyss *et al.*, 2000).

Governmental health service delivery

With the assistance of the DUHP, governmental health care in Dar es Salaam gradually became more efficiently organized, assured a regular provision of medical supplies and

[9] The empirical data for establishing the health coverage plan also form the basis for this research. The second fieldwork - conducted in 2000 - was also carried out in collaboration with STI and DUHP.

provided a basic but tailor made package of health services to the people of Dar es Salaam.

Number and hierarchical level of facilities
Governmental health service delivery is organized, managed and administrated at municipal level. It continues to be based upon the principles of primary health care and is hierarchically organized. Dispensaries form the bottom of the hierarchy and provide preventive, curative and obstetrical out-patient services for a target population of around 40.000 people. Health centres form the intermediate level and provide basic in-patient care in addition to standard out-patient services for a target population as large as 400.000 to 600.000 people. Hospitals form the apex of the hierarchy and provide standard as well as more sophisticated out-patient and in-patient services for 400.000 to 600.000 people (Pichette, 1996).

Within the study area there are 3 municipal hospitals, 4 health centres and 36 full fledged dispensaries that serve as first contact points for patients seeking medical treatment. In addition, there is one national referral hospital which treats referral cases only. The number of governmental health facilities within the study area has not changed between 1995 and 2000[10]. Most facilities were originally constructed during - some even before - the expansion period of the 1970s; all have been rehabilitated through the DUHP.

Spatial distribution
The spatial distribution of governmental health facilities is shown in Figure 4.9. A closer look at the map reveals the following. *First*, although governmental health facilities are distributed over a very large part of the built up area, it is clear that they are underrepresented in the more recently developed residential areas in the city fringe. In other words, the governmental health care delivery system is not responding to the ongoing spatial expansion of the city. *Second*, it is evident that higher order facilities concentrate in the more densely populated city core - where they can service a larger population - whereas dispensaries are widely spread out over the urban area including areas of low population density. Quite a number of dispensaries is situated at the very periphery of - or even outside - the built up area. These cases concern dispensaries in former villages near to the city; some of which are gradually becoming engulfed by the expanding urban area. *Third*, health facilities are located in planned as well as in unplanned residential areas. *Fourth*, quite a large number of facilities is located near to arterial roads which means that they - in principle - can be accessed by public transport.

[10] A few very small governmental health facilities were excluded from the 1995 survey as they delivered only a limited range of medical services. These facilities had seized to function in 2000. A number of new dispensaries were constructed in rural villages outside the study area between 1995 and 2000.

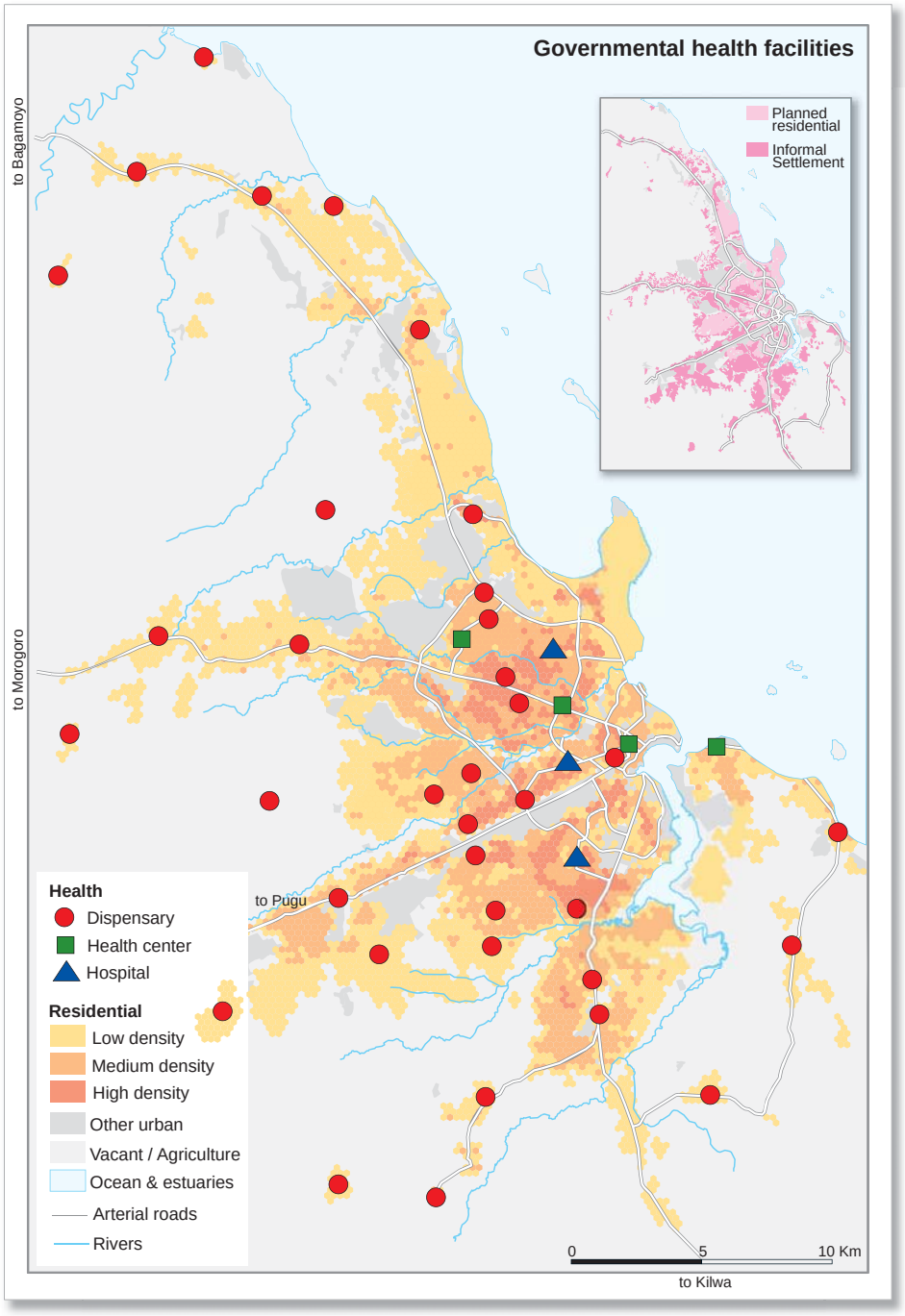


Figure 4.9: Governmental health facilities and population density classes.

Overall, the spatial distribution of governmental health facilities still appears to reflect the uniform population-based planning standards for construction of facilities used during the period that followed the Arusha declaration.

Staff capacity and performance

Table 4.4 provides an aggregate overview of the total staff capacity of the Dar es Salaam governmental health care system and of the number of patients seeking medical treatment. The table shows that health staff is strongly concentrated in higher order facilities. Nearly half of all health workers are employed at one of the three district hospitals, only a third of the staff works at one of the 36 dispensaries. The absolute number of health workers and their relative distribution over the different hierarchical levels of provision has hardly changed between 1996 and 2001.

The strong concentration of health staff in hospitals is quite remarkable if placed in the context of attendance rates as these clearly show that dispensaries and not hospitals play a dominant role within the Dar es Salaam health care delivery system. In 1995 well over 60 percent of all patients was treated at dispensaries whereas hospitals only treated close to 20 percent. In 2001 this discrepancy remains evident but has become less pronounced. A possible explanation for this change is that dispensaries were more attractive to patients in 1995 because they still provided free health services whereas health centres and hospitals were already charging user fees. In 2001, dispensaries had lost this competitive advantage as user fees were then levied at all governmental health facilities. Although dispensaries collectively play a prominent role, it should be noted that there is very significant variation in throughput and staffing between dispensaries[11].

	Staffing		Attendance	
	1996	2001[12]	1995	2001
Health staff (abs.)	1.181	1.124	-	-
Attendance (million)	-	-	2.5	2.8
Hospital (%)	47	45	18	25
Health centre (%)	18	20	18	23
Dispensary (%)	35	35	63	52
Total (%)	100	100	100	100

Sources: Year 1995: Wyss and Subiri (1996). Year 1996 and 2001: The Dar es Salaam City Medical Office of Health (2003).

Table 4.4: Staffing and attendance at governmental health services per hierarchical level in 1995-6 and 2001-2.

[11] Smaller units generally treat less than 100 - or even 50 - patients per day whereas the larger ones have a daily throughput of over 500 patients which rivals that of health centers.

[12] Data are unavailable for six dispensaries in 2001, in these cases the number of health staff is assumed unchanged.

Given the stability of the number of health workers, the absolute increase in the number of patients treated between 1995 and 2001 - from 2.5 to 2.8 million - is quite notable. It illustrates that governmental health care delivery has become more efficient by realizing a 10 - 15 percent increase in throughput with about the same staff resources.

The increase in throughput, however, is less than proportional to population growth. This indirectly indicates that the relative importance of governmental health care appears to have diminished between 1995 and 2001. In 1995 the share of the governmental health sector was estimated at 35 percent (Wyss *et al.*, 1996) to 48 percent (Amer and Thorborg, 1996) of the total. The 2000/1 Household Budget Survey, however, still estimates the share of the governmental health sector in Dar es Salaam at around 50 percent (Household Budget Survey, 2002).

Although the above figures are inconclusive, it remains fair to conclude that governmental health care provision remains very important for a large part of the Dar es Salaam population even though the relative share of the non-governmental sector (see next section) has grown. A reducing relative importance of governmental health care would be conforming to expectations in the light of the health sector reform (introduction of user fees at governmental facilities and increased competition of the private sector).

Finally, the financial resources for the Dar es Salaam governmental health system have increased from 5.5 million US dollar in 1995 to 7.5 million US dollar in 2002 (Wyss and Subiri, 1996; The Dar es Salaam City Medical Office of Health, 2003). Although the increase is sizeable in absolute terms, population growth during this period makes that per capita expenditure on governmental health care in Dar es Salaam is stagnant at a worrying low level of around 3 US dollar[13]. This is below the national per capita expenditure - 5 US dollar in 2001 - and nowhere near the modest Tanzanian estimate that 9 US dollar is required per capita to reach a minimum standard of health care (see section 4.3). The implication is that the package of health services currently delivered by the Dar es Salaam governmental health sector remains grossly insufficient to satisfy the health needs of the Dar es Salaam population.

Non-governmental health service delivery

The former section illustrated how the governmental health sector became more efficient - in terms of patient throughput - with largely unchanged resources (number of facilities, staffing and per capita expenditure). In this section, attention focuses on

[13] Wyss *et al.* (2000) come to a very similar estimate of 3.2 US dollar for 1998.

the dynamics in the non-governmental health sector which - in theory at least - should complement the public health sector in attaining health policy goals. The structure of this section is similar to that of the former but because of inexistent data on staffing and attendance rates, the performance of the non-governmental sector can only be described in a qualitative manner.

The non governmental health sector can be subdivided into three main categories: *(i)* private medical practice, *(ii)* voluntary providers and *(iii)* occupational health services. Private medical practice has a direct profit orientation and is run as a business enterprise. Voluntary providers generally have a charitable orientation, are run by religious entities or NGOs and use donations to enable the delivery of low-cost services to those in need[14]. The type of services offered by voluntary providers is similar to those of the public sector. Occupational health services are linked to formal sector employment whereby larger employers generally provide health services at the place of work for their employees and family members. In other cases, formal sector employers have a corporate arrangement with a private or voluntary provider for the treatment of their employees.

Number and level of facilities

As discussed in section 4.3 the post independence health policy emphasized public sector provision and actively discouraged private sector participation. This changed after 1991 when - in the emerging context of the health sector reform - private medical practice was again legalized after a ban of many years. Figure 4.10 shows that this has led to a very rapid increase in the number of registered private health facilities from around 35 facilities in 1990 to nearly 300 in the year 2000. It also shows a slow but steady downward trend in the number of occupational and voluntary providers since 1993. The decline of occupational health care provision may be associated with the downsizing of the governmental and parastatal employment sector as part of structural adjustment. The decline in the number of voluntary health facilities may signal a decreasing interest of charitable institutions to finance and provide health care in Dar es Salaam ('donor fatigue'). It is also possible that facilities which were previously registered under the auspices of a voluntary organization have (been) re-registered as private facilities.

The hierarchical composition of the non-governmental health sector is very much dominated by dispensaries although a number of (very) large non-governmental hospitals does exist. Over ninety percent of the occupational and voluntary facilities are dispensaries. The vast majority of the newly established private facilities - around

[14] The distinction between voluntary and private provision is not always clear. Prior to liberalization it was not uncommon to establish a 'branch' health facility under the auspices of a voluntary organization but to actually run it as a private for-profit enterprise (Munishi, 1995).

95 percent - are small scale dispensaries, owned by a physician and staffed by one or more medical attendants (The World Bank, 1999). Tibandebage *et al.* (2001) describe that private health care providers make heavy use of medical personnel from the public health sector. Many work on a part-time basis - to supplement their incomes - while others have completely moved out of the public service to start their own private practice or be employed by private health facilities. Nearly all health staff has been trained through and worked for the public sector before moving to the private sector

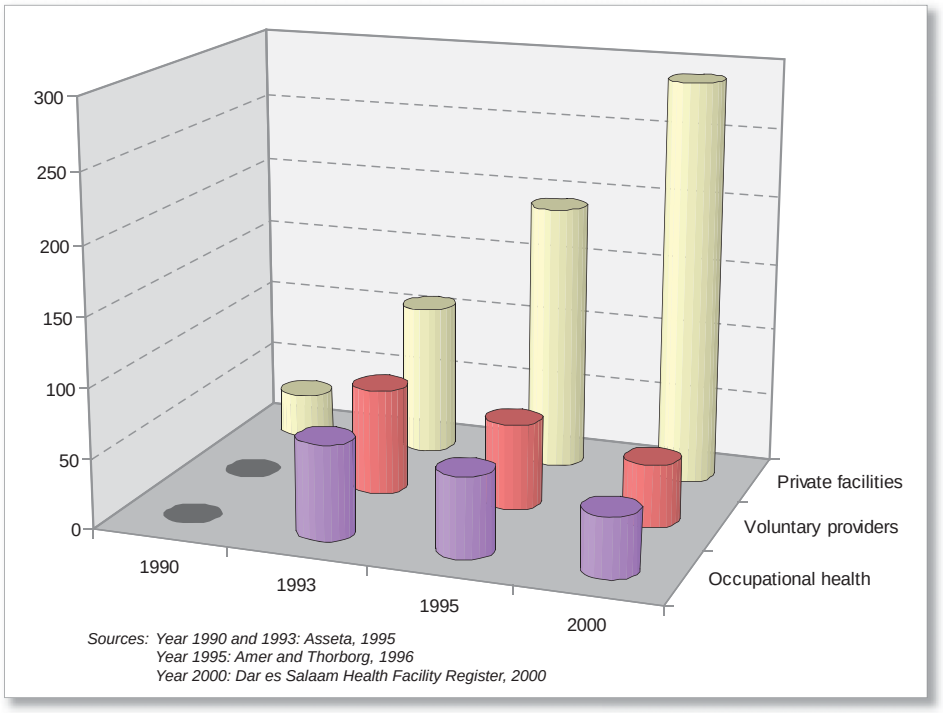


Figure 4.10: Dynamics in non-governmental health service delivery between 1990 and 2000.

Spatial distribution

The spatial distribution of the non-governmental health sector reveals interesting differences between private, voluntary and occupational health provision[15]. The private for-profit health sector has spread throughout most parts of the city and is widely present in planned as well as in informal residential areas (see Figure 4.11). Furthermore, it is evident that the private sector is attracted towards areas of medium and high population density.

[15] The discussion reflects the 1995 situation only; the data required to generate a comparative overview of the non-governmental sector for the year 2000 could only be collected in part due to limitations of fieldwork resources.

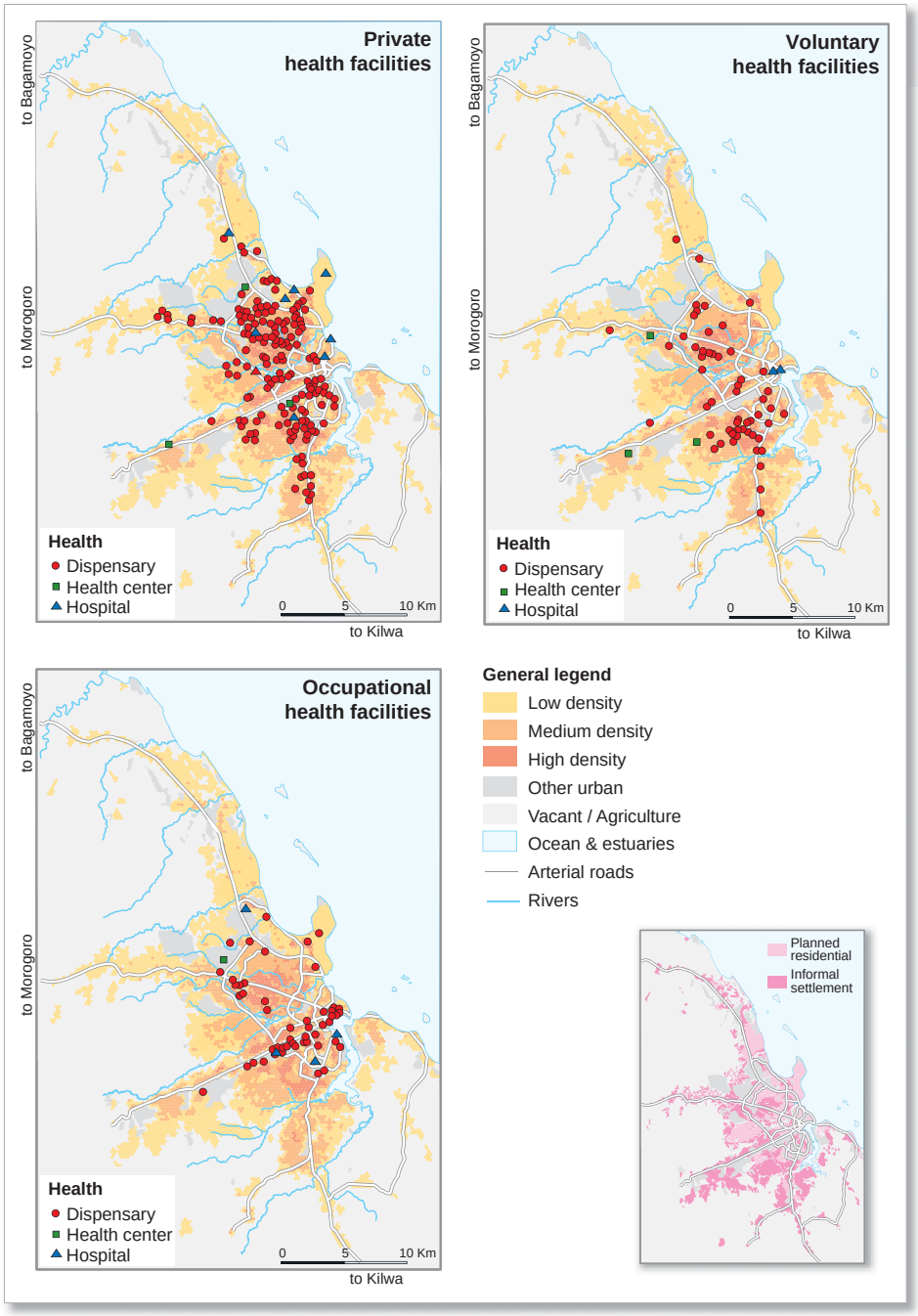


Figure 4.11: Non-governmental health care provision within the study area (1995 situation).

Much fewer private facilities are found in the more peripheral and lower density areas. There is some spatial clustering at easily accessible locations such as markets, public transport terminals, and along - intersections - of arterial roads. It appears that the location choice of private health services is generally guided by spatial variations in effective consumer demand whereby private providers prefer to locate in areas with sufficient potential clients within range to enable a profitable provision of health services (also see section 2.2). Peripheral low density areas are less attractive for the private sector as they will often not have sufficient clients within reach (i.e. the threshold value enabling profitable provision is not attained).

The voluntary health sector has also spread out over large parts of the city but is hardly found in the more recently developed, peripheral areas (see Figure 4.11). The latter is not surprising given their declining number. A closer inspection of the map reveals that voluntary health facilities are particularly well represented in medium and high density unplanned residential areas but have settled much less in planned residential areas with low population density. In other words, it seems that the location choice of many voluntary health services is guided by spatial variations in health needs and often settle in residential areas where they can reach sufficient numbers of lower income clients (also see section 2.2).

The occupational health sector shows a radically different picture (see Figure 4.11). As expected, occupational health facilities are not found in residential but in industrial and institutional areas - including the city centre - which house formal sector employment opportunities. The location choice for occupational health facilities is solely determined by the place of work; the clientele - as stated before - consists of the company's employees and their families.

Non-governmental performance: competition for scarce client resources

The preceding pages showed that the health sector reform has indeed resulted in a reducing relative importance of governmental health care together with a very rapid expansion of private medical practice - especially at dispensary level. The expansion of the private sector following the 1991 liberalization occurred largely uncontrolled because of inadequate institutional capacity to effectively regulate and monitor private sector development. In 1996 the situation was acknowledged to be out of control and all private health facilities were required to re-register following new and more stringent guidelines setup by the Ministry of Health.

Despite the stricter regulatory framework, monitoring and inspection of the private sector remains insufficient because of limited human and financial resources, and no serious action is generally taken against facilities that fail to comply with regulations (Tibandebage *et al.*, 2001). A striking outcome of this situation - lack of enforcement of the legislative framework - is that the quality of medical services provided by the private health sector is very diverse. On the one hand, one can find (very) large private

hospitals with good facilities, modern equipment and well trained staff that provides quality care. On the other hand, the private sector also includes small scale dispensaries with substandard and unsanitary facilities, deficient medical equipment and un (-der) qualified personnel providing poor quality medical care. In short, deregulation and uncontrolled private sector participation has increased the supply of medical services but the technical quality of services delivered by part - but not all - of the private health sector is very low (The World Bank, 1999).

Liberalization of private medical practice has not only brought many new providers to the urban health market but it has also created a fragmented, diffuse and price-competitive market situation in which many private for-profit facilities are struggling to stay in business. Turnover is high with frequent opening and closing of facilities (Macintosh and Tibandebage, 2002). This is hardly surprising if we consider that private sector provision *(i)* occurs in a context of urban poverty and *(ii)* faces the competition of low-cost subsidized governmental and voluntary services[16].

Macintosh and Tibandebage (2002), observe detrimental as well as beneficial strategies within the non-governmental sector to attract patients. *Firstly*, there are facilities that reduce quality (use unqualified staff, over-prescribe drugs or prescribe drugs on the basis of faked diagnosis) in order to remain competitive at low prices. A *second* response to competitive pressure is to move up-market, competing for the limited numbers of higher income and employer supported patients. Since this route requires investing in expensive equipment it is only open to some of the larger voluntary and private providers with access to donations and credit facilities.

Thirdly, - on the positive side - for-profit facilities have started to offer preventive services at no or low cost as a strategy to attract patients who might come to trust the facility and later return for curative (read: profitable) care. *Fourth*, parts of the voluntary sector remains truly charitable and use donations to keep down prices and sustain access and affordability.

Towards effective regulation and management of a pluriform health care system

In the overall context of governmental (weakening role) and non-governmental (uncontrolled expansion and high turnover) health care provision, an important question that emerges is how to best make use of limited resources to improve the

[16] Fieldwork data confirm that turnover is indeed very high: in the southern part of Dar es Salaam only about 50 percent of the private facilities in operation in 1995 still existed in 2000.

quality, affordability and accessibility of the Dar es Salaam health care system as a whole.

The preceding has illustrated that whilst it is possible to draw private providers into health care provision in ways that support the achievement of national health policy goals; their uncontrolled expansion also has negative consequences for the achievement of these goals. National policy makers therefore need to understand the factors that influence the market behaviour of private providers in order to institute policy frameworks which ensure that they contribute, rather than, undermine these goals. Assuring a decent quality health care system that is affordable and accessible to everybody thus requires an appraisal of methods of regulatory intervention, supervision and control of quality of the private sector, as well as an analysis of how the public sector can provide the coverage and types of services not usually supplied by the private sector in an economically viable manner (Wyss and Lorenz, 2002).

Although outside the direct scope of this research, one potential approach for a better and clearer collaboration and complementarity between the public and the private sector would be to focus on contractual approaches. For example, health authorities can request the private sector to provide certain types of health services at predetermined fees in return for some form of government subsidy. Other ways forward could be the assignment of governmental health staff to private facilities or the establishment of accreditation schemes (for more details see Macintosh and Tibandebage, 2002. If such a situation could be achieved, then, it does not matter so much any more whether a health facility is governmental or not.

4.7 Concluding remarks

This chapter provided a two-level overview of the broader societal and economic context in which health care provision and utilization in Dar es Salaam occurs. At the *national* level, the overview identified the main reasons behind the weak performance of the Tanzanian economy over time and explained how IMF/World Bank induced structural adjustment programmes have led to reforms of the Tanzanian health sector and the emergence of a pluriform health care system.

The *local* level overview consists of three parts. It *first* analysed the urbanization process of Dar es Salaam and its changing land use structure over time. It concluded that the ongoing informalization of the urban fabric is the outcome of a general process characterized by *(i)* rapid population growth, *(ii)* a limited urban economic base, and *(iii)* inadequate institutional capacity to regulate and service urban development. The *second* part discussed the characteristics of the road infrastructure and established that the very large majority of the Dar es Salaam population either

walks or depends on public transport. The *third* part analysed the functional and spatial dynamics in health care provision. It illustrated how the Dar es Salaam health sector reforms have lead to the emergence of a pluriform health care delivery system which is characterized by *(i)* rapid and uncontrolled proliferation of for-profit private medical practice, *(ii)* a slow but steady downward trend in occupational and voluntary health care provision and, *(iii)* a non-expanding but more efficiently performing governmental health care delivery system.

5 Socio-spatial patterns of health seeking behaviour under medical pluralism

5.0 Introduction

The purpose of this chapter is twofold. The *first* objective is to provide an insight in the observed socio-spatial patterns of health seeking behaviour in Dar es Salaam in the context of medical pluralism. As previously argued in Chapter 2, proper understanding of health seeking behaviour can serve as a valuable input for the planning of health care interventions aimed at increasing health needs satisfaction. The *second* objective of this chapter, therefore, is to identify regularities in observed health seeking behaviour and derive the main determinants of spatial choice behaviour across population strata.

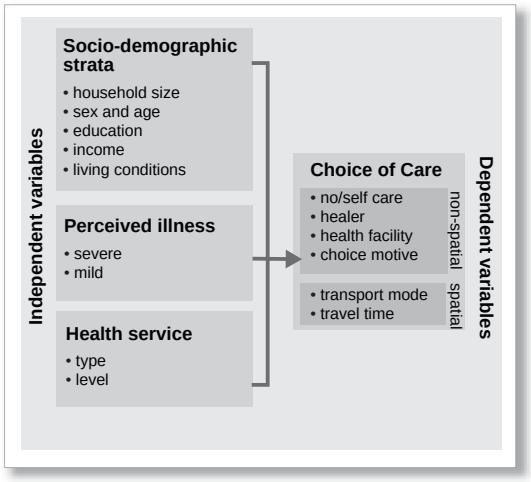


Figure 5.1: Conceptual framework for the analysis of health seeking behaviour.

The conceptual framework underlying the analysis of health seeking behaviour is an adaptation of the model proposed by Kroeger *et al.* (1988). According to this model, health seeking behaviour - the way in which people respond to a perceived health problem - is influenced by three main categories of factors: *(i)* socio-demographic characteristics of the subject, *(ii)* type and severity of the perceived illness and *(iii)* health service characteristics. The independent variables in the model interact and may lead to differences in behaviour under different conditions. The adapted model used in this chapter (see Figure 5.1) slightly differs from the original. *First*, the analysis is not conducted at the individual but at the more aggregate level of socio-demographic strata (the motivation for this is elaborated in section 2.3). *Second*, the friction of distance (mode of transport and travel time) is explicitly incorporated into the model. *Third*, since this is not a clinical study, illness characteristics are looked upon in a simplified

manner and only categorized as those health problems, which are perceived to be severe, and those health problems, which are perceived to be relatively mild. *Fourth*, the characteristics of the health services are looked upon in terms of the *(i)* type of health facility (governmental, private, voluntary or occupational) and *(ii)* the hierarchical level of services provided (dispensary, health centre, hospital). Other potentially important service characteristics such as, for example, treatment costs or technical quality of provided care could not be included, as such data do not exist for individual health facilities.

The statistical and spatial analysis presented in this chapter is based upon the survey data collected in 1995 and in 2000. The data collection procedure and sampling strategy that was developed to obtain the data is described in detail in Chapter 3. The overall societal and spatial context in which health care utilization in Dar es Salaam occurs is elaborated in Chapter 4. Observed regularities in health seeking behaviour are used as inputs in the accessibility models/evaluations, which are described in Chapter 6.

To achieve its objectives, the discussion in this chapter is organized into five main sections. The *first* section describes the weighting and data integration procedures that were performed to transform the original survey data into representative data. The *second* section describes how the different socio-demographic population strata are identified and what their main characteristics are. The *third* section analyses the non-spatial dimension of health seeking behaviour across identified population strata. The *fourth* section analyses spatial behaviour in terms of mode(s) of transportation, travel distance and time, and the degree of observed spatial rationality. The *fifth* section provides a brief and mainly qualitative overview of the (limited) changes in health seeking behaviour between 1995 and 2000.

5.1 Transforming survey data into representative population data

The prime objective of this chapter is to draw conclusions about the health seeking behaviour of the population of Dar es Salaam on the basis of the sample data obtained in 1995 and 2000. Since the samples were obtained in a different manner (households and patients) and at different moments in time (1995 and 2000) it is important to as much as possible ensure that the characteristics of the collected sample data correspond with the characteristics of the population of Dar es Salaam as this determines in how far the explanations in this - and the forecasts in the next - chapter can be generalized. Such an assessment is also important given the earlier recognition (see Chapter 3) that it was not possible to devise a fully random sampling strategy with the available resources.

This means *(i)* that the raw data as obtained from the sample surveys need to be weighted to adjust for potential over/under-representation of particular population segments and *(ii)* that the household and patient sample data need to be integrated in such a way that the combined data properly reflect health seeking behaviour. The stepwise procedure developed to achieve this (see Figure 5.2) is shortly described below. The starting position is that the data collected via the household survey provide an unbiased insight in health seeking behaviour. To begin with, the raw data from the 1995 household survey are weighted using control data that describe household and housing characteristics of the Dar es Salaam population (see Table 5.1).

The control data come from nationally representative household surveys for the year 1991 and 2000 (Household Budget Survey, 2002)[17]. Both include separate representative data for Dar es Salaam[18]. The control data do not contain information on health seeking behaviour.

The outcome of this first weighting process generally results in a (very) good match for the most important household indicators. Table 5.1 illustrates that the weighted household survey statistics and the Dar es Salaam control data closely correspond for the following indicators: household size, prevalence of female headed households, education level, expenditure per adult equivalent, proportion of households below the food and the basic needs poverty lines, the proportion of renters against owner-occupiers, the number of persons per room, and access to electricity. At the same time, it is evident that the weighted survey statistics do not match as well with the control data for the proportion of households living in 1 room (over-representation), for access to piped water (under-representation) and for the proportion of households owning selected consumer goods (mixed results).

Why do these discrepancies remain? *Firstly*, it is quite conceivable that some of the control data and statistics were defined, described and/or interpreted in a dissimilar manner leading to different outcomes. *Secondly*, it must be acknowledged that the sample size of the Dar es Salaam control data set is relatively small which means that some variability can be expected between the control data and the samples collected in the framework of this research. The overall conclusion, nevertheless, is that most of the weighted household survey statistics correspond very well with the control data and thus appear to stand for a sufficiently representative cross-section of the population of Dar es Salaam.

[17] Control data and sample statistics were mostly recorded in a similar manner and generally needed only limited pre-processing to become comparable. Employment survey data, however, could not be made comparable with the Dar es Salaam control data and could not be included in the analysis.
[18] The size of the Dar es Salaam control data sample was 1,124 households in 1991 and 1,225 households in 2000; information on the sampling error is not available.

Key indicator:	Dar es Salaam control data			Raw survey statistics			Weighted survey statistics						
	1991 (%)	1995 (%)	2000 (%)	Househ. 1995 (%)	Patient 1995 (%)	Patient 2000 (%)	Househ. 1995 (%)	Match with control data	Non-user Househ. 1995 (%)	User Househ. 1995 (%)	Weighted health care users 1995 (%)	Weighted health care users 2000 (%)	Weighted & integrated sample data (%)
Usual care provider													
Occupational	-	-	-	13	7	5	14	n/a	n/a	14	**14**	**12**	14
Governmental	-	-	-	46	64	51	44	n/a	n/a	44	**44**	**46**	45
Private	-	-	-	25	16	22	26	n/a	n/a	26	**27**	**24**	25
Voluntary	-	-	-	16	13	22	16	n/a	n/a	16	**15**	**17**	16
Household features													
Average size *(abs.)*	4.8	4.6	4.3	4.8	5.2	5.5	**4.6**	**++**	3.8	4.8	**4.7**	**4.7**	4.5
Female headed	14	18	21	15	6	3	17	**++**	26	15	**15**	**15**	18
Dependants	35	35	35	39	40	34	39	**+/-**	28	42	40	32	35
Education level													
No education	12	11	11	15	17	11	**10**	**++**	15	8	**8**	**9**	10
Primary	68	69	69	71	70	70	**71**	**++**	68	72	**73**	**71**	71
Secondary	17	16	16	9	11	14	**15**	**++**	10	17	**16**	**17**	15
Higher	3	4	4	6	2	5	**4**	**++**	7	3	**3**	**3**	4
Income and Poverty													
Mean expenditure *(abs.T.Sh.)*	15.000	18.500	22.000	18.000	16.000	20.000	18.500	**++**	21.000	18.000	18.000	21.500	19.500
Median expenditure *(abs.T.Sh.)*	12.000	14.000	16.000	14.000	13.500	16.000	14.000	**++**	15.000	14.500	14.500	17.000	15.000
Food poverty	14	11	8	12	12	11	10	**++**	7	11	**10**	8	9
Basic needs poverty	28	23	18	23	23	23	20	**+**	15	21	20	18	18
Housing Conditions													
Rented	69	68	68	55	64	57	**67**	**++**	71	68	**68**	**68**	68
Households in 1 room	25	28	30	40	35	26	46	**--**	53	43	41	35	43
Persons per room	2.5	2.5	2.5	2.5	2.6	2.4	2.5	**++**	2.2	2.5	2.5	2.3	2.4
Access to infrastr.													
Pit latrine	89	86	82	86	86	89	85	**++**	87	84	83	90	86
Piped water	93	90	86	80	83	69	82	**-**	82	82	84	67	80
Electricity	51	55	59	51	41	53	53	**++**	51	53	48	54	50
Consumer goods													
Refrigerator	7	14	20	23	13	25	24	**--**	19	26	21	24	21
Sewing machine	10	12	14	16	17	16	16	**-**	12	17	18	15	16
Television	1	11	20	14	8	25	14	**-**	10	16	12	25	14
Bicycle	10	11	12	27	19	16	25	**--**	19	27	24	14	21

Source Dar es Salaam control data: Household Budget Survey, 2002. Match: ++ = very good, + = good, +/- = reasonable, - = poor, -- = very poor. Statistics in **bold** are variables used for weighting. Note: The basic need poverty line is 8.000 T.Sh. for 1995 and 9.203 T.Sh. for 2000. The food poverty line is 6.000 T.Sh for 1995 and 6.719 T.Sh. for 2000.

Table 5.1: Dar es Salaam control data with raw and weighted statistics of sample surveys.

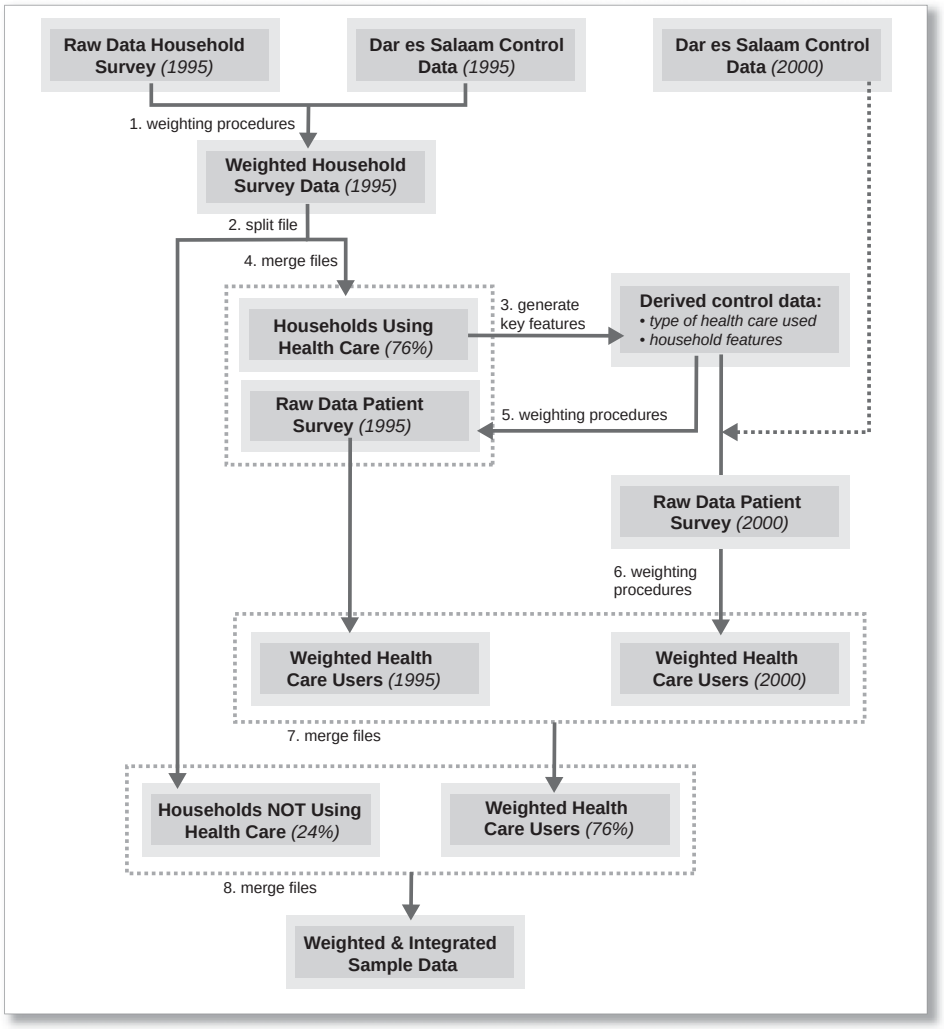


Figure 5.2: Generalised process of survey data weighting and integration.

To obtain core data on health seekers and health seeking behaviour, the weighted household survey data are split into those households that did *not* make use of health care (24%) and those households that *did* make use of health care within a recall period of three months (76%). For the latter category, *(i)* core household and housing characteristics are generated and *(ii)* the relative importance of the different types of health care provision (government, private, voluntary, occupational) is determined. These characteristics are assumed to be representative for health care seekers and are used as 'derived control data' in subsequent weighting efforts. Next, the households using health care are merged with the respondents of the patient survey of 1995 into one combined data set and weighted using the derived control data. The outcome of

these weighting and integration procedures is a data set that stands for a reasonably representative cross-section of health seekers and health seeking behaviour in Dar es Salaam for the year 1995.

In the ideal case, the above-described procedure would be repeated for the data obtained in the year 2000 after which a comparative analysis of health seeking behaviour over time could have been presented. Unfortunately, the resources for the 2000 survey allowed for the implementation of a patient survey only (see Chapter 3). The absence of a household survey means that derived control data cannot be generated for the year 2000, which, in turn, implies that there is no firm basis to weight the raw data of the 2000 patient survey.

A theoretical way forward could be to assume that the independent variables in the health-seeking model (see section 5.0) have not changed significantly between 1995 and 2000. If this would be the case, the raw data of the patient's sample from 2000 could be weighted to represent the 2000 situation using the derived control data of 1995. But, is such an assumption realistic? On the one hand, overall socio-economic and demographic change in Dar es Salaam has been limited although some improvement in expenditure levels and a slight decline in household size can be observed (see Table 5.1). Furthermore, it was established earlier (see Box 4.2) that morbidity patterns have hardly changed between 1995 and 2000. On the other hand, it is undeniable that changes have occurred in the Dar es Salaam health care delivery system between 1995 and 2000 (see section 4.6), which might have induced some change in, for example, consumer preferences for particular types of health care provider. The conclusion therefore is that it would be methodologically incorrect and potentially misleading to present a fully comparative analysis of health seeking behaviour over time with the available data.

A practical way forward that makes use of all available data is to look upon the three surveys as one stratified sample without considering the time dimension. Although also not ideal, this approach is realistic. Given that change between 1995 and 2000 has generally been limited, it is reasonable to expect that the similarities in health seeking behaviour (*i.e.* travel behaviour) will be much more pronounced than potential differences. If the analysis is placed in this perspective, it does make sense to use the derived control data of 1995 to weight the raw data of the 2000 patient survey where needed[19] and merge the outcome with the weighted health care users of 1995.

[19] The derived control data of 1995 were used to correct for the relative importance of provider type and for household size distribution. All other weighting procedures could be based upon the Dar es Salaam control data of 2000 (the dotted line in Figure 5.2).

To re-establish the link with the Dar es Salaam population, the category of households not using health care (24%) is merged with the weighted health users into one combined data set in such a way that the weight of the health users (households using health care + patients 1995 + patients 2000) is 76% of the total. In this manner, a weighted and integrated data set is created which reasonably accurately reflects the Dar es Salaam population *and* provides a good basis for the analysis of health seeking behaviour across population strata.

5.2 Socio-demographic stratification of sampled households

The purpose of this section is to categorize the sampled households into socio-demographic subgroups in an objective and consistent manner. Socio-demographic stratification links back to the '*who*' component of spatial welfare theory as well as to the *people* component of the accessibility concept and is done to assess whether or not different population groups (*e.g.* the urban poor) exhibit different health seeking behaviour. The identified population segments form the basis of subsequent analyses into health seeking behaviour, which is the topic of the sections that follow.

Social stratification on the basis of single variables (e.g. income or education alone) is dismissed as this results in an oversimplification of reality. Scoring approaches - which combine different weighted variables into a score, which is later categorised - are also sub optimal as the assignment of weights is preconceived and inherently subjective. To avoid such shortcomings, use if made of a conceptually more appealing stratification approach, which is multivariate as well as exploratory in nature.

Decomposition of the sampled households into population strata was realized using cluster analysis. Cluster analysis is an exploratory data analysis tool, which classifies a set of observations into mutually exclusive *a priori unknown* groups based on combinations of continuous and/or categorical variables. It does so in such a way that the degree of association is strong between members of the same cluster and weak between members of different clusters. Cluster analysis is thus a tool of discovery, which organises observations - households in this case - into distinct groups where members of the groups share similar combinations of properties.

The Two-Step Cluster Analysis procedure of SPSS™ was used as it *(i)* works with both continuous and categorical data, *(ii)* automatically determines the optimal number of clusters, *(iii)* can be used to analyse larger data sets, and *(iv)* computes the significance level of each variable for identified clusters. Two-Step Cluster Analysis operates on individual cases; it does not consider weighted data.

Key indicator	Weighted & Integrated Sample data	Cluster characteristics			
		1 24% n=557	2 12% n=283	3 41% n=975	4 23% n=555
Household features					
Average size *(abs.)*	**4.5**	5.0	7.4	3.1	4.9
Infants (0-4)	**16**	16	14	17	16
Children (5-15)	**19**	23	29	12	23
Adults (16+)	**65**	61	57	71	61
Female headed	**18**	15	13	24	14
Education level					
No education	**10**	2	17	11	11
Primary	**71**	40	77	82	82
Secondary	**15**	43	6	6	6
Higher	**4**	14	0	1	1
Income and Poverty					
Mean a/e expenditure *(abs.T.Sh.)*	**19.500**	31.000	6.000	18.000	17.000
Median a/e expenditure *(abs.T.Sh.)*	**15.000**	25.000	6.000	15.000	15.000
Food poverty	**9**	0	58	5	0
Basic needs poverty	**18**	2	100	15	0
Housing Conditions					
Rented	**68**	52	36	95	56
Households in 1 room	**43**	5	1	100	0
Persons per room	**2.4**	1.5	2.6	3.1	1.9
Access to infrastructure					
Pit latrine	**86**	54	96	96	94
Piped water	**80**	91	69	78	80
Electricity	**50**	99	34	36	35
Consumer goods					
Refrigerator	**21**	79	9	2	0
Sewing machine	**16**	47	14	4	7
Television	**14**	57	3	1	0
Bicycle	**21**	28	22	13	26

Table 5.2: Weighted statistics per household cluster.

Before performing the actual cluster analysis, a check was made to ensure that the input variables into the cluster model are not too strongly correlated (independent) and have an approximately normal (continuous data) or a multinomial (categorical data) distribution. To control for the general increase of monetary income over time the consumption expenditure indicator was standardised separately for the 1995 and the 2000 respondents. Cluster analysis was then performed using some fifteen independent variables[20] (see Table 5.2) so that each household is assigned membership of a cluster. The outcome of the clustering procedure is that four mutually exclusive population segments are identified which - using the cluster statistics presented in Table 5.2 - are summarized in Figure 5.3.

In demographic terms, the *better off* or more affluent households (Cluster 1) are characterised by an above average household size and dependency rate[21]. This group is

[20] The indicator Female Headed Household did not significantly contribute to the formation of clusters.
[21] The dependency rate equals the combined proportion of infants and children in a household.

also very distinct in terms of education level, income and living conditions. There is a very clear overrepresentation of higher educational attainment, which is associated with far above average levels of consumption expenditure and relatively good living conditions. There are no signs of overcrowding, hardly any single room households and access to basic infrastructure - sanitation and particularly electricity - is much above average. Possession of consumer goods - refrigerator, sewing machine and television - is also common.

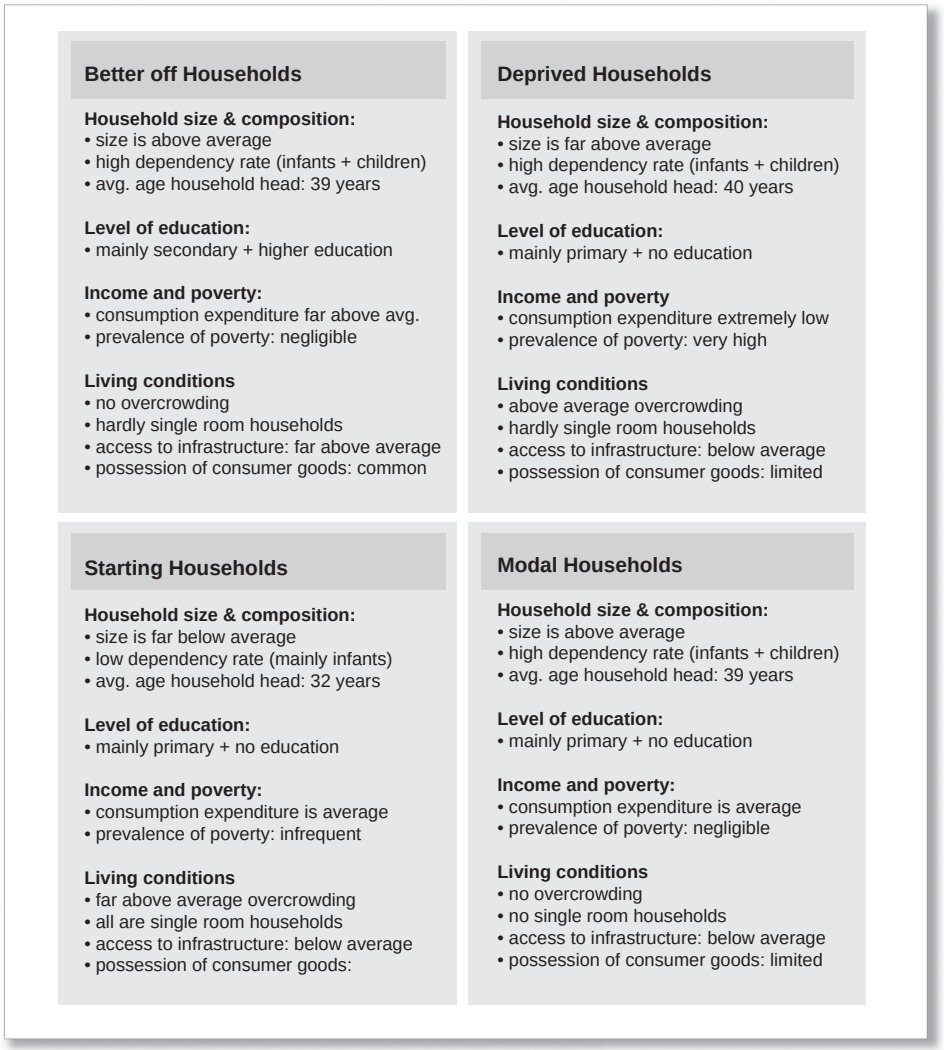


Figure 5.3: Identified socio-demographic strata and their key characteristics.

The (*very) deprived* households (Cluster 2) suffer from multiple deprivations. Household size is far above average and the dependency rate is the highest of all clusters. Education is often absent or basic and the level of consumption expenditure is deplorably low: half of the households in this group suffer from food poverty; all suffer from basic needs poverty. Striking is that people below the basic needs poverty line survive on about half a dollar a day. Those below the food poverty line - the income required to enable a minimum caloric value intake for an adult - have to survive on even less. The severe income deprivation that characterises this group also translates into poor living conditions. Overcrowding is very common and access to basic infrastructure - *i.e.* piped water and electricity - is the lowest of all four clusters. Ownership of consumer goods is limited.

The category of *starting* households (Cluster 3) is the largest and mainly consists of younger and smaller sized households. The dependency rate is considerably below average; if there are dependents they are mainly infants. The education profile of this group is dominated by primary education; higher levels of educational attainment are underrepresented. Consumption expenditure is about average and poverty does not occur in this group. The early demographic stage of the households in this cluster also shows from their living conditions. All households rent a single room and overcrowding is (thus) a common feature. Access to piped water and, particularly, electricity is below average. Ownership of consumer goods is very restricted.

The demographic composition of the *modal* households (Cluster 4) is very similar to that of the better off with an above average household size and dependency rate. Their educational profile (mainly primary education) and level of consumption expenditure (about average), on the other hand, is very similar to that of the starting households. Living conditions are generally reasonable as none live in a single room and there is no overcrowding. Like most inhabitants of Dar es Salaam they nearly all rely on pit latrines for sanitation. Access to piped water is average but access to electricity is (far) below average. Ownership of consumer goods, again, is very restricted.

The main conclusion that can be drawn for the above is that the four main household categories that occur within the sample data have been identified using a multi-variate and explorative clustering approach. The next sections present an analysis of their health seeking behaviour.

5.3 Non-spatial aspects of health seeking behaviour

The analysis presented in the pages that follow is based upon the conceptual model of health seeking behaviour (see Figure 5.1) presented in the beginning of this chapter. An appropriate starting point, thus, is to pose the question what people do when they

perceive a health problem. The survey data show that nearly everyone (93%) would visit a health facility, 6% would rely on self-treatment by buying medication from a pharmacy. Only very few respondents (1%) report that they would go to a traditional healer[22]. As established in section 5.1, more than three quarters of the sampled respondents did actually seek medical treatment at a health care facility within a recall period of three months. On average, health seekers visited a health facility 2.5 times indicating that ill health occurs frequently (also see Box 4.2). Mean attendance rates hardly vary across population strata.

The first part of this section looks into revealed preferences for different types and levels of providers for respectively mild and severe health problems. The second part analyses what motivates patients to choose a particular type and level of health care provider and assesses if these motives vary with socio-economic status and severity of the health problem.

Provider choice in case of a mild health problem

Figure 5.4*a* shows that all population groups make use of occupational, governmental, private and voluntary health care but that they do so in varying degree. The main outcomes are as follows. To begin with, it is apparent that the choice behaviour of deprived, modal and starter households is remarkably similar. For these groups, governmental health care is by far the most important provider: about half of the respondents will go to a governmental facility. Nearly a quarter opts for private health care. Voluntary providers are frequented by about 15-20 percent of the households.

About 10 percent of the households have access to occupational health care (provided or paid for by the employer). The finding that the choice behaviour of the deprived does not diverge from that of modal and starting households is unexpected but probably means that *(i)* the poor are somehow capable of mobilising monetary resources for health care and *(ii)* private and voluntary health care can be obtained at competitive prices in the segmented health care market of Dar es Salaam (see section 4.6).

The choice behaviour of the better off is quite distinct from that of the other groups. These more affluent households make much more use of private and occupational health care and rely much less on governmental facilities. For this group, private health care is the most important option. Governmental and occupational health each holds a share of about 25 percent. Voluntary health care is of limited importance.

[22] Other research (Develay *et al.*, 1996; Wyss *et al.*, 1996) indicates that respondents tend to under-report visits to traditional healers.

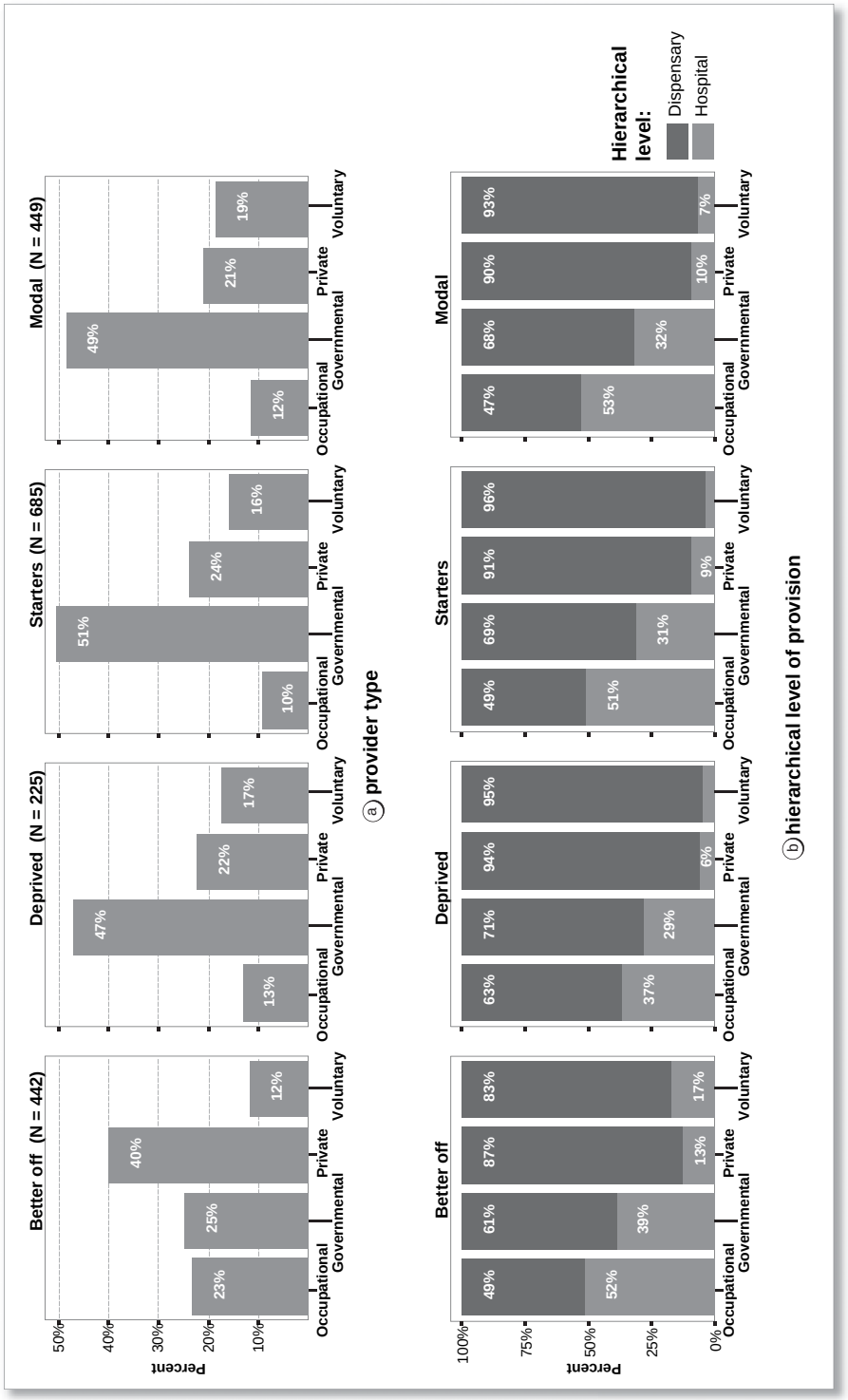


Figure 5.4: Provider type and level of choice for mild health problems per socio-demographic stratum.

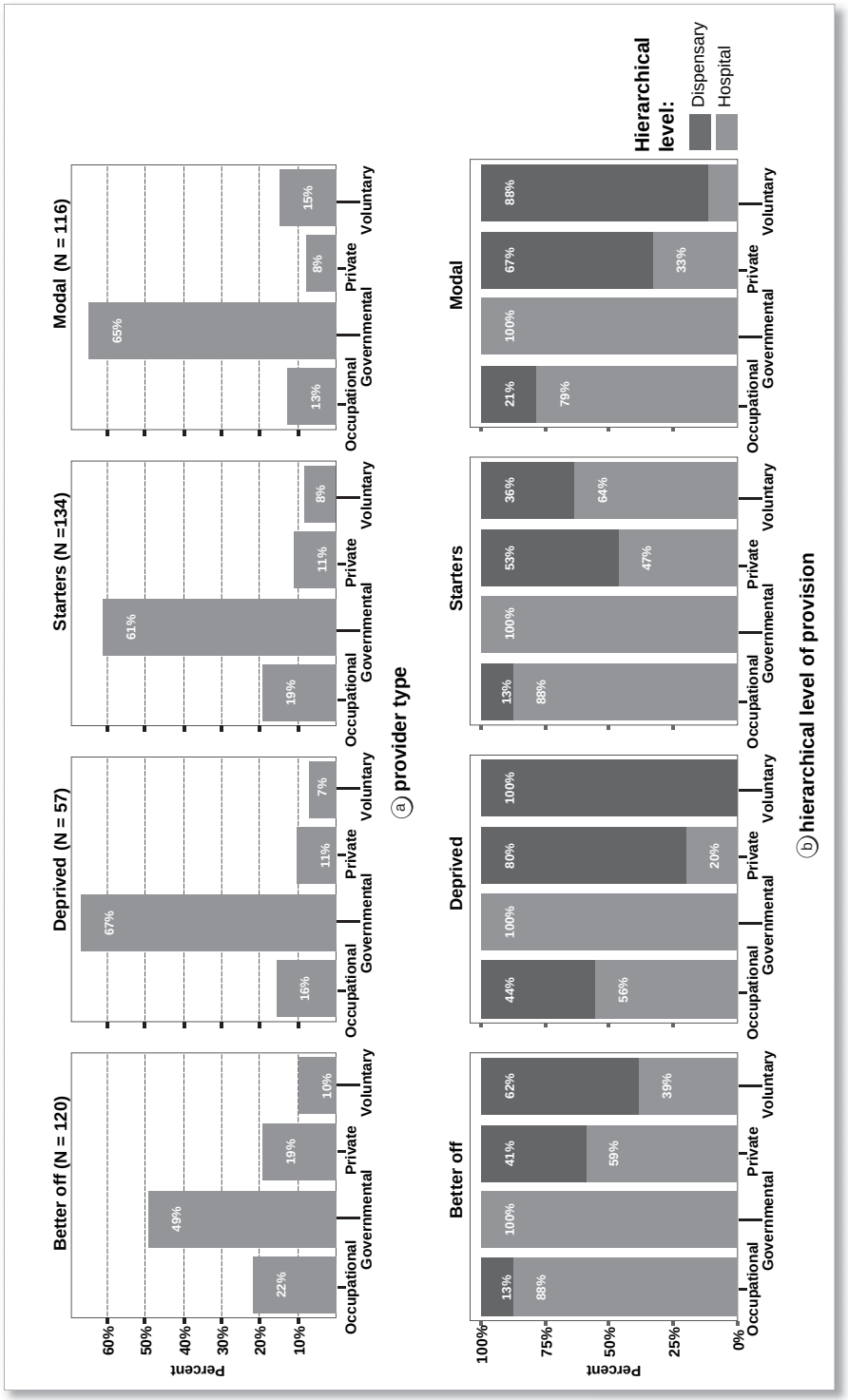


Figure 5.5: Provider type and level of choice for severe health problems per socio-demographic stratum.

The choice behaviour of better off households clearly reflects that they have most access to formal sector employment and that a higher income translates into a higher ability and willingness to pay for private health care.

Overall, as many as 75 percent of all respondents opt for treatment at a *dispensary* in case of a mild health problem, the rest decides upon treatment at a hospital or health centre[23]. The very prominent role of dispensaries is apparent across all population strata and applies to all provider types apart from occupational health care (see Figure 5.4*b*). For the private and voluntary sector the importance of dispensaries is extreme: over 80 and up to 96 percent of the households from all population strata that opt for private or voluntary health care go to a dispensary. This outcome is not very surprising given that the vast majority of private and voluntary facilities are small-scale dispensaries (again see section 4.6).

Better off households make slightly more use of higher order - and generally more expensive - private and voluntary health facilities. Dispensaries also play a key role in the governmental sector: about two thirds of governmental health care users across all population strata choose to go to a dispensary, the rest opts for a higher order facility. Better off households, again, make slightly more use of higher order facilities than the other population groups.

Provider choice in case of a severe health problem

Nearly 25 percent of all health care users report a severe health problem within a recall period of three months. If a comparison is made with the choice behaviour for mild health problems, a number of important differences can be identified (see Figure 5.5*a*). To begin with, deprived, modal and starter households rely even more strongly on governmental health care: about two thirds of the households in these population groups will go to a governmental facility in case of a serious health problem. Private and voluntary health care are clearly much less attractive alternatives. The same tendency can be observed for the better off, but here the 'private-to-government' sector shift is even more pronounced as the share of governmental health care doubles while that of the private sector is halved. Noteworthy, furthermore, is that the share of occupational health care remains about the same across all population strata which signals that households with access to occupational health care appear to opt for it irrespective of the seriousness of the health problem.

Overall, as many as 82 percent of all health care users with a severe health problem choose to go to a *hospital* (see Figure 5.5*b*). For the governmental sector, the

[23] Health centers are excluded from the analysis in this section because only 3 percent of the sampled respondents attended one.

dominance is absolute: all households that opt for governmental health care - by far the most - go to a hospital. Taken together this means that the health services delivered by governmental hospitals are of crucial importance for nearly the entire Dar es Salaam population. It is worth mentioning that deprived and modal households that opt for private or voluntary health care continue to rely heavily on dispensaries. Better off and starter households more frequently choose to go to private and voluntary hospitals[24].

The *main conclusion* that can be drawn from the preceding is that about half of the deprived, modal and starter households - representing the large majority of the Dar es Salaam population - opt for governmental health care in the case of a mild health problem. Only better off households rely mostly on private health care. Universal is that the greater part of respondents go to a dispensary for treatment. For patients suffering from a serious health problem governmental hospitals are by far the most important destination. With some variation this applies to all population strata.

In the next section, we explore what motivates patients to choose a particular type and level of health care provider and asses if these motives[25] vary with socio-economic status and severity of the health problem.

Motives for provider choice in case of a mild health problem

A good starting point for the analysis of user preferences is to state that the reasons for choosing a particular type of health care provider do *not* vary significantly between socio-demographic strata. On the other hand, the reasons for choosing a particular type of health care provider *do* vary significantly (Significance = 0.00, Cramer's V = 0.46) between provider types. The discussion presented below is organised accordingly.

Figure 5.6 provides a good insight in why patients select a particular type and level of health care provider. It does so in two complementary ways. *Firstly*, it provides an insight in the relative importance of the main motivations. *Secondly*, it highlights the motives that distinguish one provider type from the other using standardised residuals[26]. The residuals specify the deviation from the expected average value in the data and compare the importance of choice motives between dispensaries and between hospitals.

[24] Because the absolute number of respondents in these categories becomes rather small these last outcomes should be viewed upon as indicative only.
[25] During the surveys respondents were asked for the main reasons for choosing a particular facility and to prioritize them. Prioritized choice motives have been weighted to reflect their relative importance.
[26] Residuals give the difference between the observed and the expected values in a cross tabulation. Standardized residuals have a mean of 0, a standard deviation of 1 and represent the relative magnitude of the departure from statistical independence.

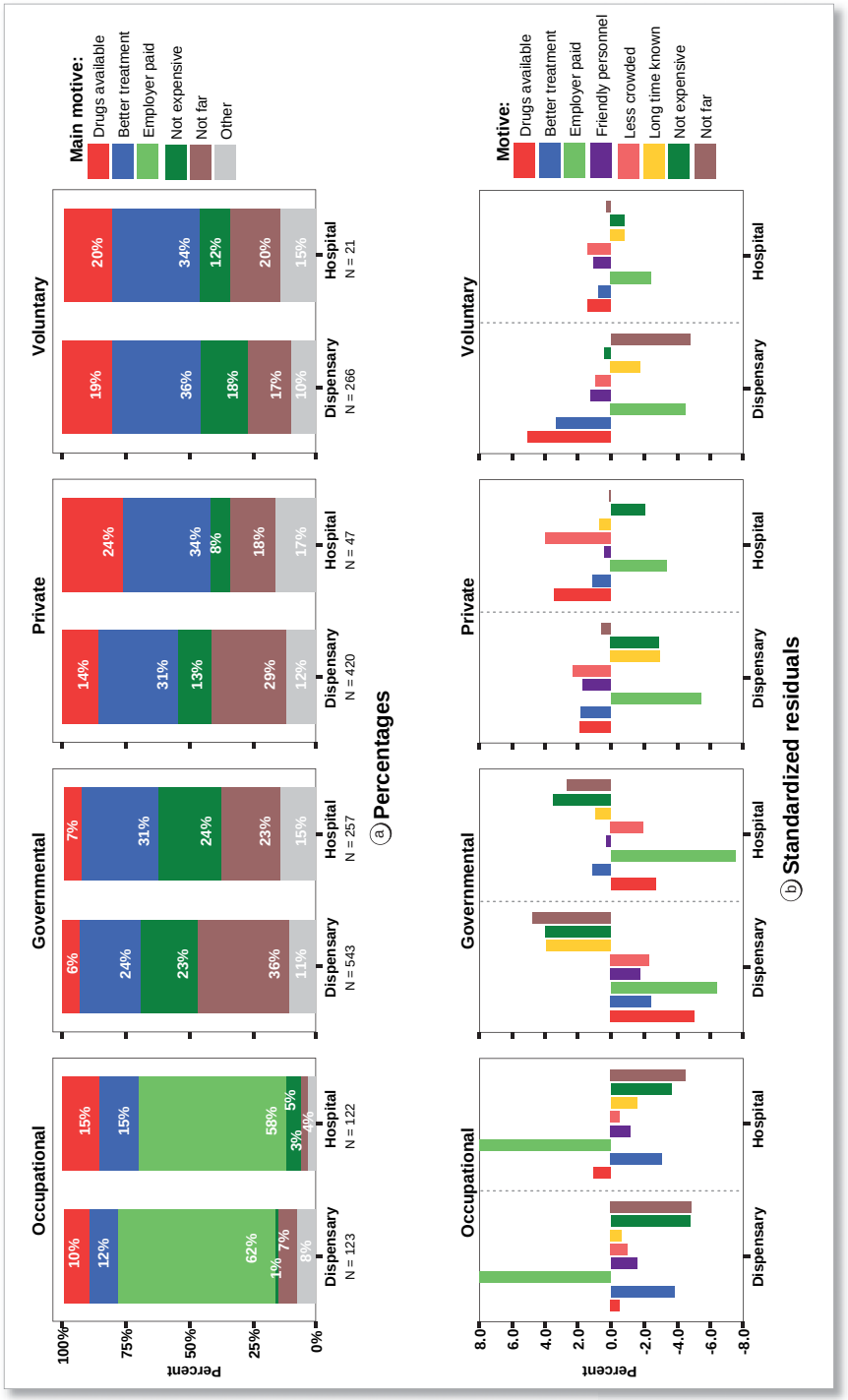


Figure 5.6: User preferences for provider type and level in the case of a mild health problem.

Positive residuals imply that a motive is mentioned more frequently than average, negative residuals mean the reverse. The leading outcomes are shortly discussed below.

Occupational health care
To begin with, it is apparent that the motives for choosing occupational health care differ very much from those mentioned for the other three provider types. By far the most important and imperative motive for choosing occupational health care is that the costs of treatment and medication are paid for by the employer. Availability of medication and perceived quality of treatment are mentioned occasionally but are no more than secondary motives. All other considerations - travel distance/time included - barely influence the choice of care. Motives for selecting a dispensary or a hospital do not differ significantly.

Governmental health care
Patients opt for a governmental dispensary mainly because *(i)* it is not too far from their home, *(ii)* they expect to obtain appropriate medical treatment, and *(iii)* the costs for treatment and medication are affordable. Availability of drugs is mentioned relatively infrequently. The residuals confirm that the main appeal of governmental dispensaries is geographical proximity and affordability. Although not a major consideration, patients more often go to governmental dispensaries because they are familiar with it. Patients that choose to go to a governmental hospital attach more importance to the expected quality of treatment and considerably less on travel distance than dispensary patients. This appears to indicate that - even for mild health problems - a difference in travel behaviour between dispensaries and hospitals can be expected (see section 5.4).

If user preferences are compared between hospitals, the residuals indicate that governmental hospitals - more than others - attract patients because of affordability and proximity.

The negative residuals, on the other hand, also point towards a number of (relative) weaknesses of governmental health care. Analysis of post-treatment consumer satisfaction (see Figure 5.7) confirms that patients using governmental health care are more often dissatisfied because of *(i)* a perceived lack of drugs, *(ii)* long waiting times, *(iii)* poor quality care and *(iv)* disrespectful behaviour of medical staff (rudeness, neglect, demands for bribes)[27]. Patients that do not make use of governmental care (see Figure 5.8) are more explicit in their opinions but avoid public facilities for the same reasons.

[27] Macintosh and Tibandebage (2002) report very similar findings.

Private health care

Patients go to a private dispensary mainly because of perceived quality of medical treatment and proximity from home. Availability of drugs and affordability are somewhat less important considerations. The residuals show that the competitive strength of private dispensaries is indeed related to drug availability and perceived quality of treatment. They also indicate that patients appreciate - as secondary reasons - that private dispensaries are less crowded and that the medical personnel treats them in a friendly manner. The very small group of respondents that opt for treatment at a private hospital for a mild health problem mainly go there because they believe in the quality of treatment obtained and because of the availability of medication. Travel distance/time and costs become less important considerations. The residuals show that private hospitals are also appreciated for being less crowded.

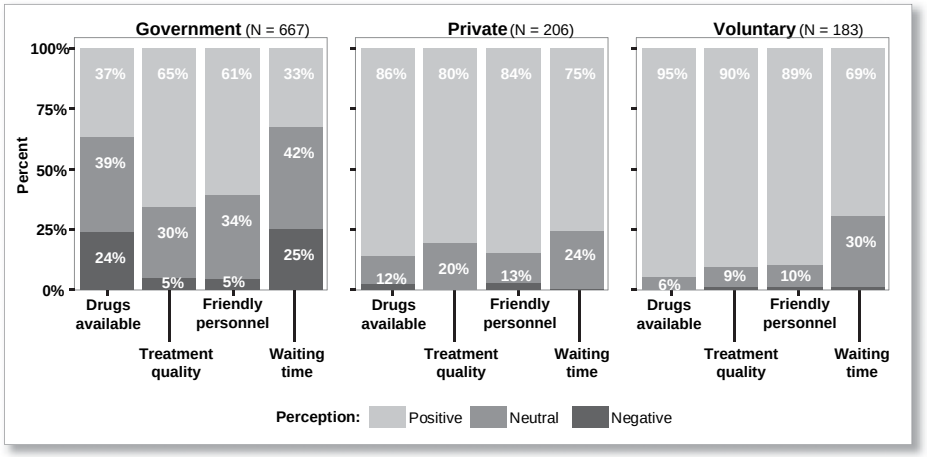


Figure 5.7: Post treatment consumer satisfaction on selected aspects per provider type.

Figure 5.7 confirms that private sector patients are generally satisfied with the availability of drugs, the quality of care, the friendliness of medical staff and mostly positive about waiting times as well. Patient that do not make use of private health facilities (see Figure 5.8), one the other hand, mention high costs as the prime reason for not going to private facilities. A number of respondents, in addition, are explicitly sceptical about the quality of the services provided by private facilities. Patients fear to be treated in a business-like manner by less-qualified or even incapable medical staff and suspect unethical behaviour with respect to the prescription of medication and fees. The mixed appreciation of the private sector confirms that the private health market of Dar es Salaam is indeed fragmented (see section 4.6).

Voluntary health care

Patients choose to go to voluntary dispensary because of a favourable combination of perceived quality, availability of medication and affordable costs. The residuals indicate

that the competitive strength of voluntary dispensaries is indeed very much associated with these factors. Patients also appreciate - again as secondary reasons - that voluntary dispensaries are less crowded and that the medical personnel treats them in a friendly manner. The combination of positive characteristics makes that travel distance/time is a much less important consideration for voluntary than for governmental or private dispensaries. This may indicate that users of voluntary facilities have deviating travel behaviour (see section 5.4). The motives for selecting a voluntary dispensary or hospital do not differ significantly.

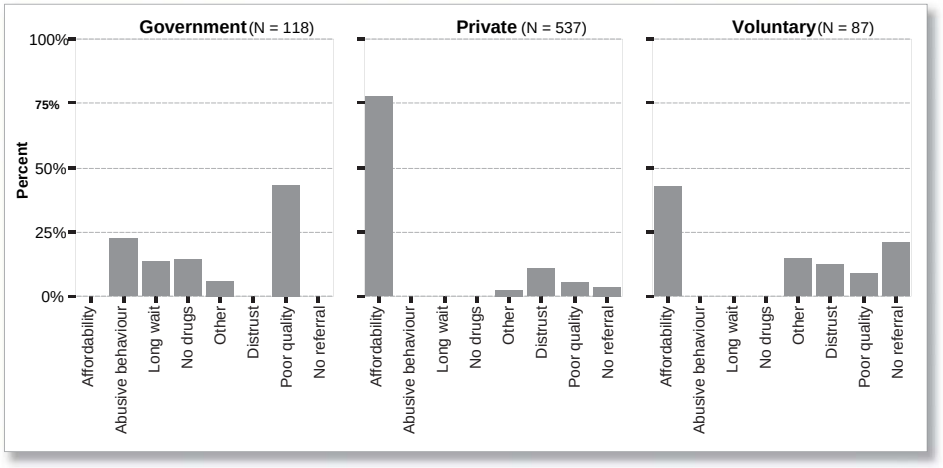


Figure 5.8: Main reasons for avoiding a particular provider type.

Figure 5.7 substantiates that voluntary sector patients are generally (very) satisfied with most aspects of the health services provided. Only a small minority of respondents report that they would not consider attending a voluntary facility because they consider treatment to be too expensive and of doubtful quality (see Figure 5.8). Again, these mixed outcomes point towards fragmentation of the Dar es Salaam health market in terms of prices and quality of services offered.

The *main outcome* of the preceding analysis is that - for mild health problems - the choice behaviour of governmental, private and voluntary health care users is mainly guided by the desire to attain affordable health care of adequate quality, with sufficient drugs, at a location not too distant from home[28]. In each of these cases, travel distance/time is an important consideration influencing choice. The competitive strength of governmental health care is associated with affordability and proximity.

[28] Less than 1 percent of all respondents go to a clinic because it is near to the workplace.

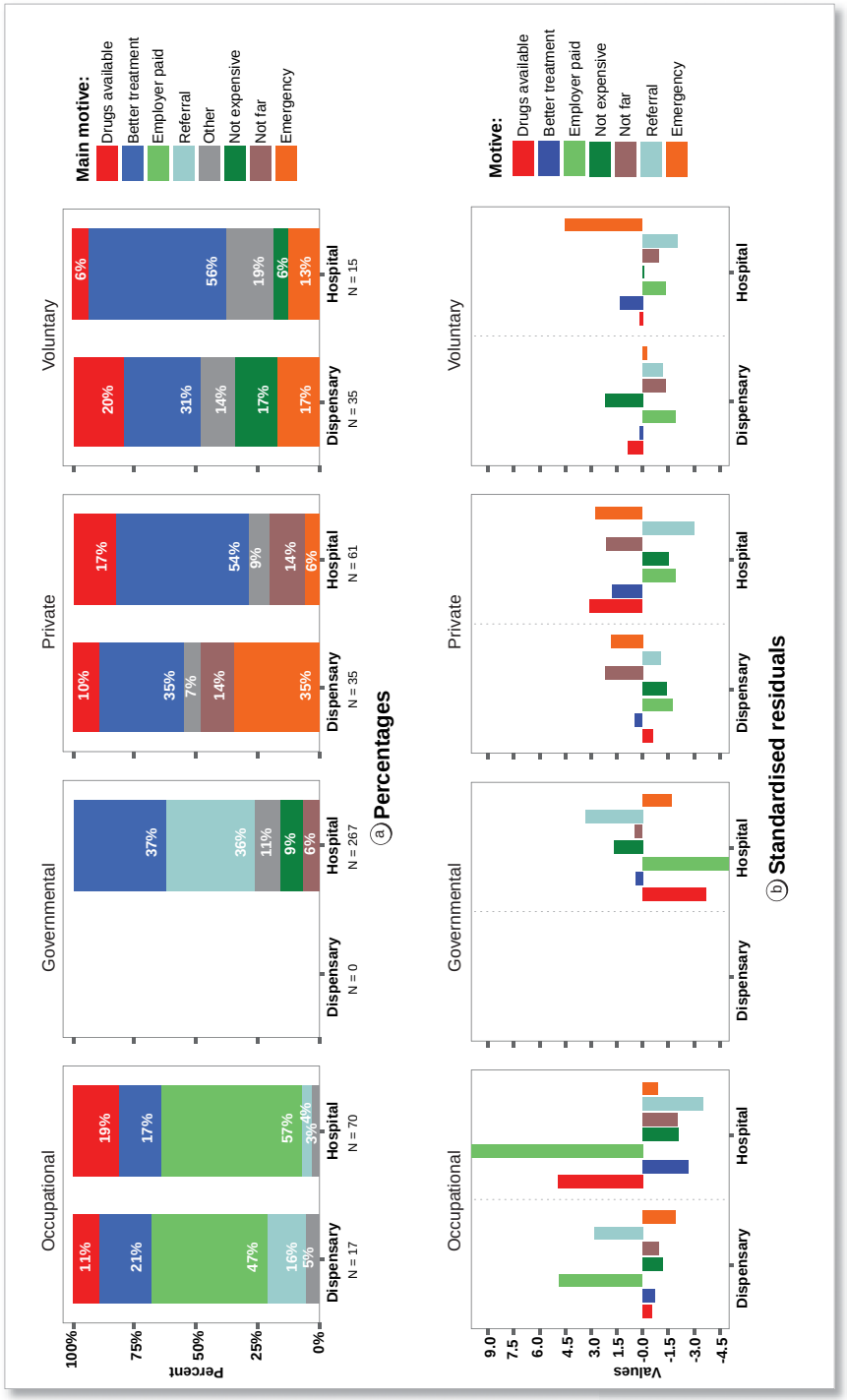


Figure 5.9: User preferences for provider type and level in the case of a severe health problem.

Seen from the patient's perspective, its main weaknesses are a lack of drugs, long waiting times and poor quality medical and interpersonal care. The competitive edge of private and, particularly, voluntary health care is related to drug availability and perceived quality of treatment. Private and voluntary health care are also appreciated because they are less crowded and because of the friendly manner in which the medical personnel treats patients. The main deterrents for using private health care are unaffordable costs and poor quality medical treatment. The voluntary sector appears to suffer from the same weaknesses but in a much lesser degree. The choice for occupational health is predominantly conditioned by the fact that it is paid for or provided by the employer.

Motives for provider choice in case of a severe health problem

Figure 5.9 depicts why patients select a particular type and level of health care provider in case of a serious health problem. Like before, it presents the relative importance of the main motivations and the residuals that help distinguish between providers. Data on consumer satisfaction were not collected in the case of severe health problems.

Occupational health care

Figure 5.9 shows that the main motive(s) for choosing occupational health hardly vary with the severity of the health problem. Like before, the overriding motive for choosing occupational health care is that treatment and medication costs are paid for by the employer. Availability of medication, perceived quality of treatment, and referral (in the case of dispensaries) are mentioned as secondary motives. Travel distance/time plays no role whatsoever. Motives for selecting a dispensary or a hospital do not differ much. On the basis of these and the previous findings it is clear that the health seeking behaviour of occupational health users is determined by the characteristics of the health service - provided or paid for by the employer - and does not vary with socio-demographic characteristics, severity of the perceived illness or travel distance/time.

Governmental health care

As identified earlier, governmental hospitals play a centrally important role in treating severe health problems for the majority of the Dar es Salaam population. Apart from referring patients, governmental dispensaries do not fulfil a role in treating severe health problems. The two overriding reasons for patients go to a governmental hospital are trust in the medical quality of treatment and referral[29]. Although cost considerations are not of primary concern, the residuals indicate that they are more

[29] Referral can mean that patients *(i)* are referred to a hospital after visiting a lower order facility, or *(ii)* bypass lower order facilities and immediately go to a hospital. The survey data do not separate the two.

influential for governmental than for private or voluntary hospitals. Noteworthy is that travel distance/time is hardly mentioned as a factor influencing choice.

Private health care
Only a small group of respondents - but coming from all strata - opt for a private dispensary in case of a serious illness. Because the number of respondents in this group is small, outcomes should be seen as indicative only. Two types of users, nevertheless, appear to exist. The *first* group opts for a private dispensary when confronted with an acute health problem requiring immediate medical attention. This would also explain why travel distance/time is mentioned relatively frequent. If such an emergency event occurs outside the opening hours of, for example, governmental health facilities (during the night or in the weekend) such behaviour directly links to the temporal component of accessibility described in section 2.3. The *second* group appears to go to a private dispensary mainly because they have confidence in the quality of the medical services provided, even in the case of a serious health problem. Respondents that opt for treatment at a private hospital, again, mostly go because they trust the medical quality of treatment and because of the availability of medication.

Voluntary health care
Generally speaking, patients go to voluntary health facilities (dispensaries as well as hospitals) for the same reasons as the private sector and primarily go because of perceived quality, availability of medication and in case of an emergency. Travel distance/time is not a consideration but affordability is. Because the number of respondents in this group is very small, abovementioned outcomes are indicative only.

The *main conclusion* that can be drawn from the preceding is that - for severe health problems - most health care users go to a governmental hospital. The main motivation for this choice is related to perceived quality of treatment and because of referral. The health seeking behaviour of occupational health users is, like before, determined by the characteristics of the health service and does not vary with socio-demographic characteristics, severity of the perceived illness or travel distance/time. Worth mentioning is that private and voluntary dispensaries are relatively often used in case of an emergency. Private and voluntary hospitals are mostly chosen because of perceived quality of treatment. A very important outcome for this research is that - apart from emergency cases - travel time/distance is not at all a decisive factor influencing choice behaviour in case of a severe health problem. This finding applies to all provider types.

5.4 Spatial aspects of health seeking behaviour

This section emphasises the spatial dimension of health seeking behaviour. Its objective is to identify and describe patterns and regularities in the observed travel

behaviour of respondents for the different types and levels of health care provision. Identified regularities in spatial behaviour are used as inputs in the modelling and analysis methods described in Chapter 6.

The findings of the previous section indicate that a reduction of the scope of the analysis is appropriate. *First*, it has become clear that in case of a serious health problem, travel distance/time - except for emergency cases - is not a factor that significantly influences the choice behaviour of respondents. *Second*, it was established that the choice behaviour of occupational health care users is determined by the characteristics of the health service and not influenced by travel distance/time. Because of this, the analysis of travel behaviour is restricted to mild health problems and to governmental, private and voluntary health care users only. In these cases, travel distance/time *is* among the primary factors influencing the choice for a particular health care provider. In the following, spatial behaviour is subsequently analysed in terms of the mode of transportation used, travel time and the degree of observed spatial rationality.

Transport mode

Overall, around three quarters of all respondents walk to the health facility of choice, 20 percent make use of public transport while only 3 percent make use of a private car (also see 4.5). Other means of transport such as bicycles or taxi's are virtually not used and therefore excluded from further analysis. The modal split of deprived, modal and starter households is nearly identical: 20 percent uses public transport, the rest goes to the clinic of choice on foot. Better off households are the only group that makes use of private cars (14%), 18 percent of this group makes use of public transport; the remaining 68 percent walks to the clinic of their choice.

Figure 5.10 disaggregates travel behaviour in terms of transport mode according to provider type and level of provision. The picture that emerges is that the overwhelming majority of patients in Dar es Salaam travel to the dispensaries of their choice on foot. With a pedestrian mobility rate of 92 percent this situation is most marked for governmental dispensaries. Users of private and voluntary dispensaries exhibit similar behaviour but the predominance of pedestrian mobility is less extreme. Users of private dispensaries make marginally more use of public transport (some come by car). Voluntary dispensaries attract considerably more patients - about one quarter - that make use of public transport.

Public transport is generally much more used for visits to hospitals. For governmental hospitals, public transport and pedestrian mobility are equally important. Hardly anybody comes by car. A quarter of all visits to private hospitals, on the other hand, are realized by means of a car, which is consistent with the earlier finding that better off households more often frequent private hospitals.

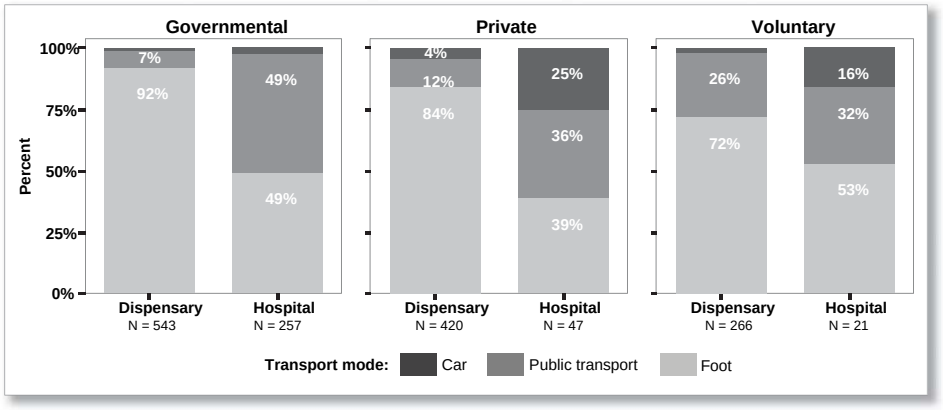


Figure 5.10: Main transport modes for different provider types and levels of provision.

The remaining visits to private hospitals are about equally split between pedestrians and public transport users. The modal split of patients attending a voluntary hospital is more or less similar to that of patients attending a private hospital. The outcomes for private and voluntary hospitals are indicative only because of the limited number of respondents in these categories.

Travel time

Using a proprietary GIS and *Flowmap*[30] the travel time for every trip is approximated for the two main modes of transport (walking and public transport). Travel time calculations are made from the place of residence to the chosen health facility along the street network. To realistically represent the friction of distance, the street network is categorised into several road classes for which different travel speeds are estimated for each transport mode on the basis of local knowledge. Public transport travel time estimates consist of walking time to and waiting time at the nearest bus stop, the main haul, and also include transfer, alighting and egress time. The methodology developed for estimating travel times is described in detail in Appendix C.

Figures 5.11 and 5.12 form the foundation for the analysis of travel time. Figure 5.11 depicts 10-minute intervals of estimated *walking* time and shows which transport modes are actually used as walking distances increases. In a number of cases, it nicely illustrates how patients walk on shorter distance but switch to using public transport as walking distance increases. Figure 5.12 is different in the sense that it represents the

[30] Flowmap is a specialized standalone software tool for spatial interaction analysis and spatial interaction modelling which can be loosely coupled (see section 2.3) to most proprietary GIS software.

frequency distribution of *actual* travel time - again categorised into 10 minute intervals - as well as the average travel time for each mode of transport.

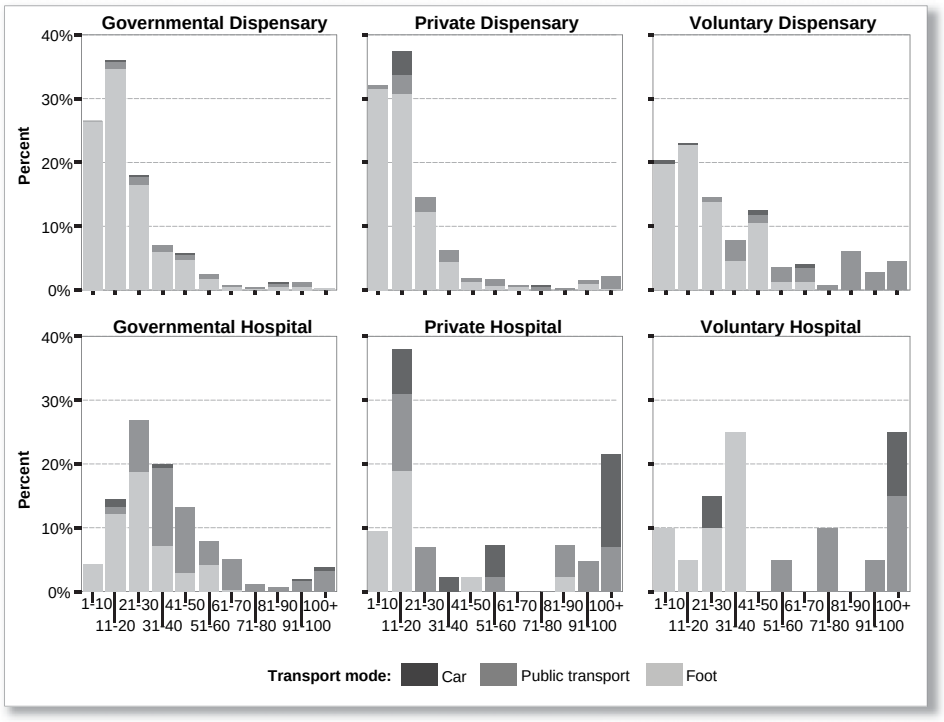


Figure 5.11: 10-minute walk time intervals and actual transport mode used per provider type and level.

Governmental health care

Figure 5.11 (and 5.12) show that the intensity of dispensary use sharply declines with increasing travel time. The average travel time is limited (just 19 minutes) and the large majority of dispensary patients (84%) do not walk more than approximately 30 minutes to reach the facility of their choice. Very few patients walk more than one hour. The fact that nearly all patients walk and only traverse relatively short distances indicates that governmental dispensaries have a strong local function and primarily serve the population in their immediate vicinity.

The observed travel behaviour of hospital patients shows similarity as well as difference. The similarity is that, again, a considerable group of patients walk short distances to reach the hospital of their choice. The distance decay curve, however, is less steep than that of dispensaries and around 30% of patients is willing to walk between 30 and 60 minutes - but not longer - to reach the hospital of their choice. The most notable difference, however, is that patients increasingly switch to using public transport as distance increases. Close to half of all patients actually come to a

governmental hospital by means of public transport and travel on average for about 30 - 35 minutes. In comparison to dispensaries, patients also make more frequent use of public transport on shorter trips. A plausible explanation for this is that governmental hospitals can all be easily reached by means of public transport. This is often not the case for governmental dispensaries.

The importance of public transport in combination with somewhat longer average walking times indicates that governmental hospitals attract patients from a larger area than dispensaries. This is consistent with the earlier finding (see section 5.3) that patients that choose to go to a governmental hospital attach more importance to the perceived quality of treatment and less on the disutility of travel distance

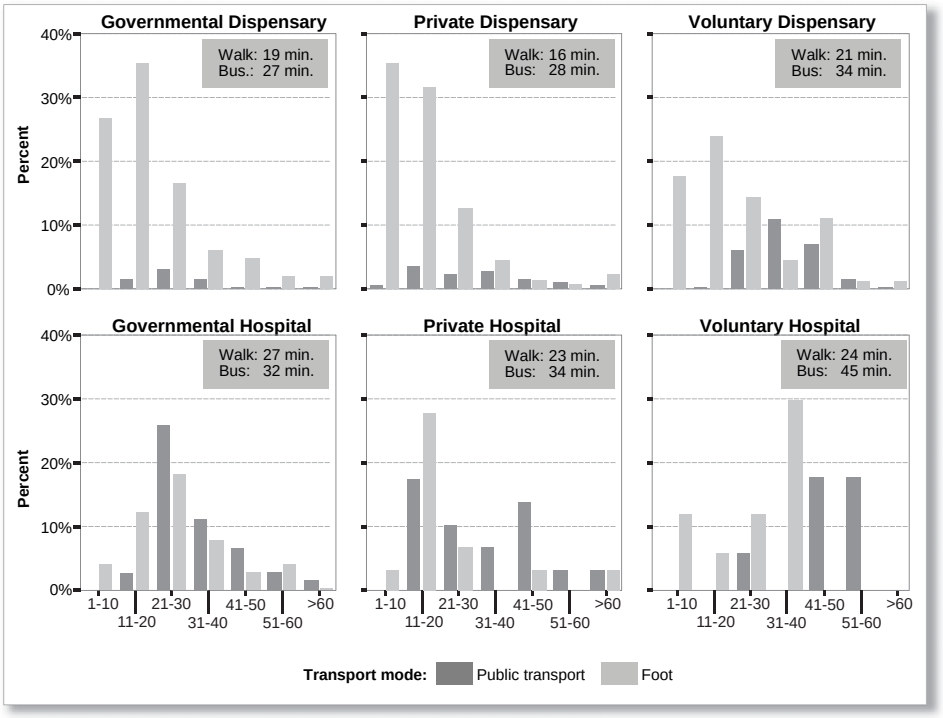


Figure 5.12: Actual travel time in 10-minute intervals per mode of transport, provider type and level of provision. Insets represent average travel time.

Private health care

Figure 5.11 demonstrates that the travel behaviour of private dispensary users is very similar to that of patients attending governmental dispensaries. Most patients come to the facility on foot, average travel time is short (16 minutes) and the intensity of use very rapidly declines with increasing walking time. The importance of public transport is also very limited and the intensity of its use seems unrelated to distance. The minute group of patients that comes by car do not live far away and appear to use the car for

reasons of convenience. Private dispensaries, in short, also attract most of their clients from neighbouring residential areas and have a very local function.

The travel behaviour of private hospital users shows that ease of access is mostly a consideration of secondary importance. Although most patients that walk live near to a private hospital, Figure 5.11 clearly shows that there is no clear relation between distance/travel time and intensity of use. This is in accordance with the observation made in section 5.3 that patients mainly go to private hospitals because they believe in the quality of treatment and because of the availability of medication.

Voluntary health care

The spatial behaviour of patients attending a voluntary dispensary deviates from that of governmental and private dispensary users in two ways (see Figure 5.11). *First*, although the average walking time (21 minutes) is equivalent to that of governmental dispensaries the intensity of use declines more gradually with increasing walking time. More importantly, public transport becomes an important alternative mode of transport when walking distance exceeds about 30 minutes. Public transport users are willing to overcome considerable distances but generally do not travel for more than 40 - 50 minutes. This behaviour is probably related to the popularity of voluntary health care (see section 5.3).

The travel behaviour of voluntary hospital users shows that travel time is not a very important consideration. On the one hand, voluntary hospitals serve clients within a walking distance threshold of up to 30 - 40 minutes. On the other hand, there is a group of clients that make use of public transport (and private cars) and is willing to travel for up to one hour.

Are there significant differences in travel time between population strata?

A question unanswered so far is whether or not the identified population strata have the same travel behaviour per provider type and level. The statistical technique used to test if average travel times vary between population strata is called analysis of variance (abbreviated ANOVA). Analysis of variance examines how much the observations within one group vary as well as how much the group means vary. If the sample means deviate more than expected based on the variability of the observations, one concludes that the population means are not all equal (Norušis, 2000). If group means vary significantly, the Bonferroni multiple comparison test is used to identify which groups differ from each other.

The outcome of the analysis of variance is that - with only one exception - the average travel time does not vary significantly between population strata per mode of transport, provider type and level of provision. The single exemption concerns patients that walk to a governmental hospital.

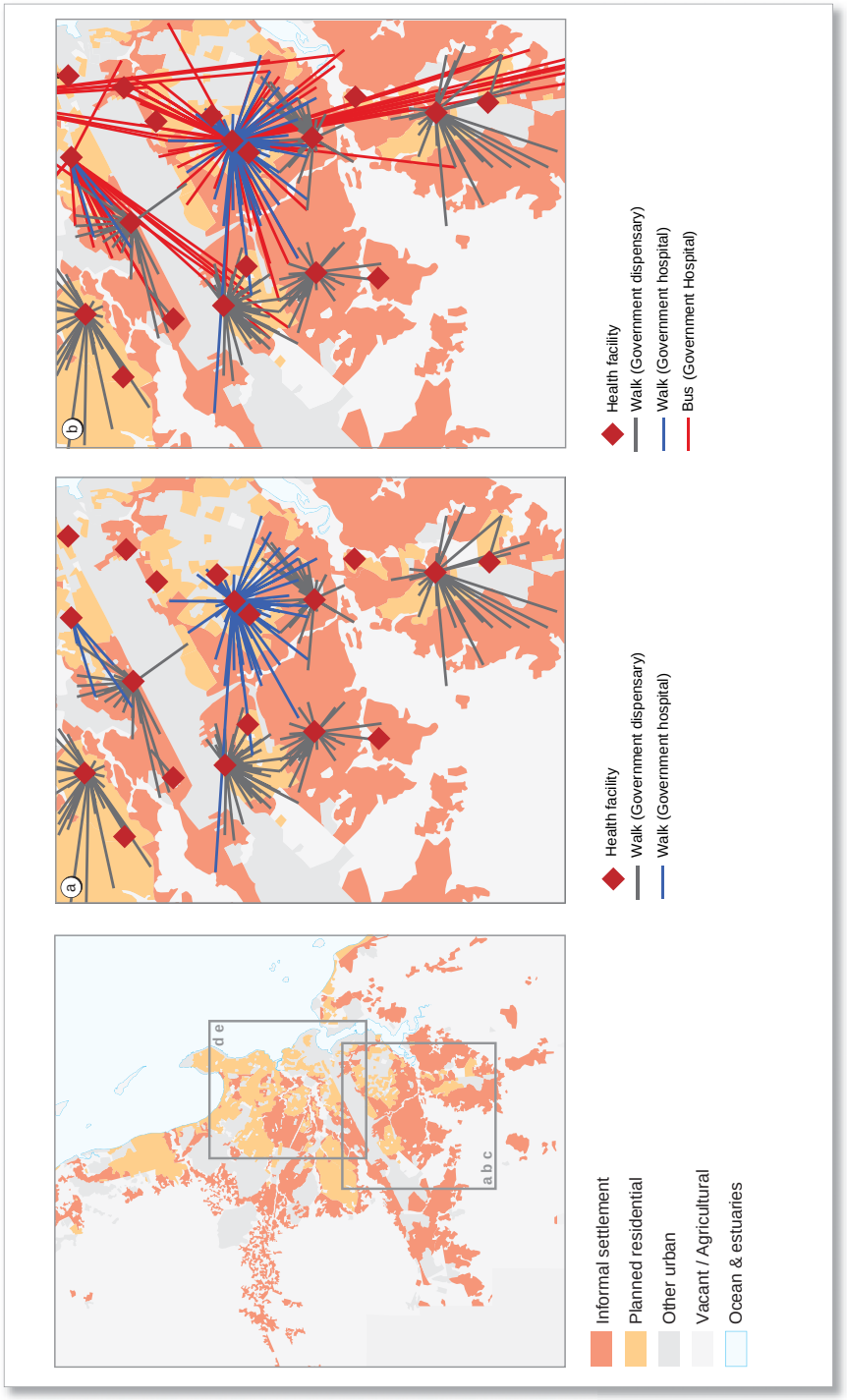


Figure 5.13A: Desire lines for different modes of transport, provider types and levels of provision.

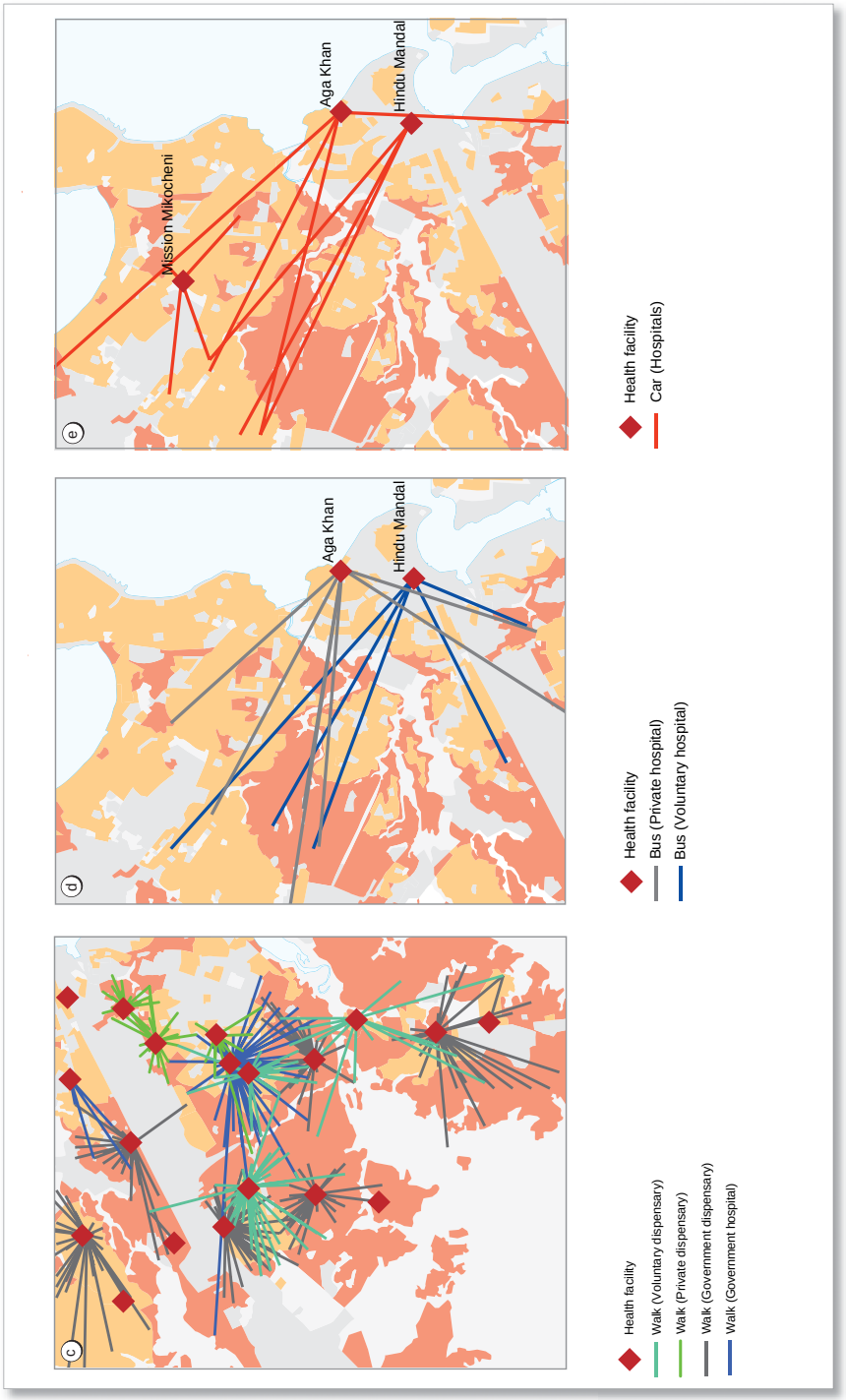


Figure 5.13B: Desire lines for different modes of transport, provider types and levels of provision.

In this case, the Bonferroni test establishes that average travel time does not differ for deprived, starter and modal households but that the better off walk significantly shorter distances than the rest (see Appendix D for the test values). Further scrutiny of the data reveals that the better off more rapidly switch to using public transport than the other population groups. Probably the higher income of the better off makes that they are more willing to pay for the convenience of public transport.

Spatial rationality in choice behaviour

So far, the analysis of travel behaviour has provided insight in transport modes and travel time for different provider types and levels of provision. In the following, observed travel behaviour is further analysed by more explicitly placing it in the spatial context in which it occurs. The discussion is based upon a visual and a quantitative technique.

The *visual* technique used is that of desire lines which depict spatial interaction by drawing a straight line between two discrete points in Euclidian space. Here, the desire lines connect the approximate location of the patient's home with the location of the visited health facility. Each desire line represents one or more patient trips. Groups of desire lines together provide an excellent spatial insight in utilisation patterns and in the approximate size and shape of the areas from which health facilities attract their clients. Figure 5.13 (A and B) shows a number of snapshot examples of observed utilization patterns for different modes of transport, provider types and levels of provision.

The *quantitative* technique is based upon the concept of spatial rationality (see section 2.2) and is termed proximity ranking. Proximity ranking means that for each individual trip, it is determined whether or not the chosen health facility is the closest in time to the place of residence, the second closest or the third closest and so on (also see de Jong and Amer, 2002). For the 'spatially sub-rational' patients - those that bypass the closest facility - the extra travel time is also computed. Following the analysis in section 5.3, the starting premise is that patients have a preference for a particular type of provider and then decide on which individual facility to go. This means that for the users of governmental health care, proximity ranking only takes governmental facilities into account. For private (voluntary) health care users the ranking only considers private (voluntary) facilities. Proximity ranking is based upon network travel time estimates for the actual mode of transport used. Table 5.3 displays the outcomes of the proximity ranking.

Governmental health care

Figure 5.13*a* illustrates that governmental dispensaries indeed mainly attract their clients from nearby residential areas. More revealing is that most patients appear to walk to the governmental dispensary that is the nearest to their place of residence.

Table 5.3 confirms that this user group indeed exhibits a very high degree of spatial rationality. Over 85 percent goes to the governmental facility, which is nearest to their home, 10 percent bypass the nearest clinic but on average only walks 8 minutes more. Patients that go to a governmental dispensary by public transport generally are also quite rational in terms of travel time. Again, more than 80 percent either travels to the nearest facility or travels only 7 minutes more to reach the second nearest governmental facility.

If the utilization patterns of governmental dispensaries and hospitals are considered in combination (again see Figure 5.13*a*), it is evident that most patients that live near to a hospital normally go there on foot. It can, however, also be observed that some patients walk larger distances to reach a governmental hospital even though they live nearer to a governmental dispensary.

Proximity Rank	Dispensary						Hospital					
	Walking			Public transport			Walking			Public transport		
	%	Avg. min.	Avg. extra min.	%	Avg. min.	Avg. extra min.	%	Avg. min.	Avg. extra min.	%	Avg. min.	Avg. extra min.
Government												
1	86	15	0	43	23	0	58	21	0	37	25	0
2	10	35	8	38	29	7	35	32	10	21	27	11
3	2	55	22	8	39	16	4	35	18	13	30	11
4	1	54	23	7	36	15	-	-	-	9	41	18
5 and over	1	77	40	4	37	7	3	58	40	20	48	28
Total	100	19	n/a	100	27	n/a	100	27	n/a	100	32	n/a
Private												
1	24	6	0	3	12	0	43	10	0	-	-	0
2	13	13	4	5	20	6	26	15	1	6	13	2
3	6	10	4	2	10	5	-	-	-	-	-	-
4	11	18	8	6	24	10	-	-	-	-	-	-
5 and over	46	23	17	84	33	25	31	51	39	94	35	28
Total	100	16	n/a	100	28	n/a	100	23	n/a	100	34	n/a
Voluntary												
1	42	12	0	1	11	0	73	22	0	-	-	0
2	25	18	7	41	32	18	8	30	8	16	28	3
3	17	36	13	2	28	4	-	-	-	-	-	-
4	4	26	13	14	40	17	19	30	10	-	-	-
5 and over	12	38	26	42	39	23	-	-	-	84	48	37
Total	100	21	n/a	100	34	n/a	100	24	n/a	100	45	n/a

Table 5.3: Proximity ranks and additional travel time per travel mode, provider type and level of provision.

Table 5.3 shows that as many as 42% of the patients that walk to a governmental hospital bypass the facility that is nearest to their home. This shows that the competitive strength of governmental hospitals in geographic space is stronger than that of dispensaries (where the same phenomenon occurs in only 14% of all cases).

Figure 5.13*b* provides further evidence of the competitive strength of governmental hospitals. The desire lines show that some patients live within reasonable walking distance of a governmental dispensary but opt to go to a more distant governmental hospital but now by means of public transport. Table 5.3, shows that patients that go

to a governmental hospital by public transport, very frequently (in 63% of all cases) bypass the nearest governmental facility. The extra travel time incurred by 'spatially sub-rational' patients, however, is mostly limited to about 10 minutes. This applies about equally to patients that walk or make use of public transport.

Private health care

As noted before, the average walking time to a private dispensary is short and comparable to that of patients that walk to a governmental dispensary (see Figure 5.13*c*). A fundamental difference between the two, however, is that about three quarters of patients that walk to a private dispensary actually *bypass* the facility that is nearest to their home (see Table 5.3). The choice behaviour of patients that go to a private dispensary by means of public transport is comparable: very few patients go to the facility that is closest in time and the very large majority (84%) travels up to 25 minutes more than needed.

What could be the rationale for this apparently sub-rational spatial behaviour? *First*, - unlike governmental health care - there is considerable variation between individual private facilities in terms of treatment costs and the type and quality of services provided. The private health sector, in other words, is not uniform which makes that some facilities can be more attractive than others even if they are located somewhat further away from the patient's home. *Second,* the private health sector has spread throughout most parts of the city and is widely present in planned as well as in informal residential areas (see 4.6). This means that normally a number of private dispensaries will be situated near to the homes of most people. Table 5.3 confirms this as even those patients that walk to the fourth nearest private dispensary on average walk only about 8 minutes more than strictly needed. The choice behaviour of private dispensary users is, thus, not explained well using the concept of spatial rationality. In stead, respondents appear to choose a facility that best matches their expectations/budget on the basis of the available options known to them in the environs of their home.

Table 5.3 and Figure 5.13*d* and *e* also give a glimpse insight in the spatial choice behaviour of the small group of respondents that attend a private hospital. Although the data are sketchy, those who know Dar es Salaam can observe that patients that go by bus or car (*i.e.* the better off) principally opt for the large up market hospitals.

Voluntary health care

The spatial choice behaviour of patients attending a voluntary dispensary appears to hold the middle between that of governmental and private dispensary users (see Table 5.3). The similarity with governmental dispensaries is that there is - less pronounced but still - a fair degree of spatial rationality. More than 40 percent of walking patients goes to the nearest facility; another 25 percent bypass the nearest clinic but on average

walk for only 7 minutes more. Public transport users are not very rational in terms of travel time.

The observed choice behaviour of voluntary dispensary users is probably influenced by the fact that the voluntary health sector - like the private - is not uniform. As argued in section 4.6, parts of the voluntary health sector are truly charitable in their orientation whereas others operate on a for-profit basis. This means that the voluntary sector is also characterized by variations in treatment costs and the type and quality of services provided. This appears to influence the spatial behaviour of patients. The spatial behaviour of the few respondents that attend a voluntary hospital appears to be similar to that of users of private hospitals in the sense that travel time does not appear to be an important consideration.

The *main conclusions* that can be drawn from the preceding analysis of spatial behaviour are as follows. To begin with, it has become clear that the overwhelming majority of patients in Dar es Salaam walk to the dispensaries of their choice. This behaviour is most marked for governmental and private dispensaries. The intensity of use sharply declines with increasing travel time indicating that governmental and private dispensaries have a predominantly local function. Most dispensary users do not walk for more than approximately 30 minutes. Users of governmental dispensaries exhibit a high degree of spatial rationality in their choice behaviour. Clients of private and voluntary dispensaries mostly do *not* go to the dispensary that is nearest to their home but opt for a facility within an action space of up to about 30 (private) to 40 (voluntary) minutes of walking time from their home. This behaviour is probably the outcome of the fact that the private and voluntary sector consist of a variety health care providers that deliver different packages of medical services of varying quality at different costs.

The observed spatial utilization patterns of governmental hospitals differ from that of governmental dispensaries in a number of ways. The most notable differences are that public transport is much more frequently used for visits to hospitals and that patients are willing to walk somewhat longer distances. Distance does not appear to be an important consideration for most users of private and voluntary hospitals. Apart from one exception, travel times do not vary significantly between population strata.

5.5 Changes in health seeking behaviour 1995 - 2000

Section 5.1 explained why it was not possible to present a fully comparative analysis of health seeking behaviour over time with the available data. The main restriction identified is the data cannot be used to asses if changes have occurred in the relative importance of the different provider types.

	Governmental health care		Private health care		Voluntary health care	
	1995	2000	1995	2000	1995	2000
Main motives for choice	Not far Not expensive Better treatment Drugs available	Not far Better treatment Not expensive Long time known	Not far Better treatment Drugs available Not expensive	Better treatment Not far Not expensive Less crowded	Better treatment Drugs available Not far Not expensive	Better treatment Not expensive Not far Drugs available
Competitive strength (residuals)	Not expensive Not far Long time known	Not expensive Not far Long time known	Drugs available Less crowded Better treatment	Less crowded Better treatment Friendly staff	Drugs available Better treatment Friendly staff	Drugs available Better treatment Friendly staff Less crowded
Consumer satisfaction:						
Drug availability	Mixed	Mixed	Very positive	Very positive	Very positive	Very positive
Treatment quality	Mixed	Mixed	Positive	Very positive	Very positive	Very positive
Friendly personnel	Mixed	Increasing dissatisfaction	Very positive	Very positive	Very positive	Very positive
Waiting Time	Dissatisfied	Increasing dissatisfaction	Positive	Positive	Positive	Positive
Reasons for avoiding	No drugs Abusive behaviour Poor quality	Abusive behaviour Poor quality	Affordability Distrust quality	Affordability Distrust quality	Affordability Distrust quality	Affordability Distrust quality
Mode of transport an average travel time	Dispensary 92% foot, 19 minutes 7% bus, 26 minutes Hospital 45% foot, 28 minutes 53% bus, 31 minutes	Dispensary 93% foot, 20 minutes 7% bus, 29 minutes Hospital 43% foot, 25 minutes 56% bus, 34 minutes	Dispensary 85% foot, 16 minutes 11% bus, 28 minutes	Dispensary 82% foot, 16 minutes 14% bus, 27 minutes	Dispensary 67% foot, 20 minutes 31% bus, 34 minutes	Dispensary 83% foot, 23 minutes 16% bus, 34 minutes
Spatial rationality in choice behaviour	Dispensary Foot: 86% rational Bus: 43% rational Hospital Foot: 56% rational Bus: 40% rational	Dispensary Foot: 83% rational Bus: 43% rational Hospital Foot: 59% rational Bus: 30% rational	Dispensary Foot: 25% rational Bus: 5% rational	Dispensary Foot: 24% rational Bus: 0%rational	Dispensary Foot: 48% rational Bus: 0% rational	Dispensary Foot: 32% rational Bus: 0% rational

Table 5.4: Generalized characteristics of health seeking behaviour in case of a mild health problem for 1995 and 2000.

In other words, we cannot establish whether or not different population strata make more, less or equal use of private, governmental or voluntary health care in 2000 than they did in 1995. It, however, *is* possible to assess if changes have occurred in *(i)* the motives that underlie choice, *(ii)* the degree of consumer satisfaction, and *(iii)* the spatial behaviour of respondents. Like in the preceding section, the brief overview presented below is restricted to mild health problems and to governmental, private and voluntary health care users only. For private and voluntary health care only dispensary use is considered, as the number of hospital users in the samples is too limited to allow for a comparison over time. Table 5.4 provides a primarily qualitative overview of the main characteristics of health seeking behaviour for 1995 and 2000 for different health care providers following the analytical lines of the previous sections.

Governmental health care

Table 5.4 shows that the main motives for choosing governmental health care have only marginally changed between 1995 and 2000. In both years, patients mainly opt for a governmental facility because it is not too far from their home, because they expect to obtain proper medical treatment, and because treatment costs are affordable. The main observable change is that the motive 'drug availability' is mentioned appreciably less frequently in 2000. This tendency can also be observed for private and voluntary health care. Why drug availability is mentioned less frequently in 2000 is hard to explain. One plausible explanation is that drugs were generally in shorter supply in 1995 making it a more decisive motive for patients choosing a particular provider. In 2000 - in part through the intervention of the DUHP - essential drugs had become more widely available. As a result, drug availability has become a less critical factor and is thus mentioned less frequently by patients. This would also clarify why the lack of drugs is no longer mentioned as a reason for avoiding governmental health care in 2000.

The competitive strength of governmental health care (again see Table 5.4) has not changed over time and remains primarily associated with affordability and proximity. On the negative side, patients using governmental health care are increasingly dissatisfied with long waiting times and with the bad-mannered behaviour of medical staff. Patients that do not make use of governmental care stay away from public health facilities for the same reasons. Dissatisfaction with mounting waiting time is very credible given that the governmental sector has increased its patient throughput with about 15 percent between 1995 and 2000 with about the same staff resources (see section 4.6).

If we consider the spatial behaviour of governmental health care users, it is evident that the patterns of user-provider interaction have largely remained the same over time. Table 5.4 very clearly illustrates that the modal split, the associated average travel times and the degree of spatial rationality in the choice behaviour of patients not significantly changed between 1995 and 2000.

Private health care
Section 5.3 identified that patients generally go to a private dispensary because of perceived quality of medical treatment, proximity from home and drug availability. In 2000, the availability of drugs has become a somewhat less important consideration (see preceding explanation). This also shows from the residuals, which indicate that the competitive strength of private dispensaries over time becomes more associated with the perception that they are less crowded and staffed with friendly medical personnel. Not surprising, therefore, is that private sector patients generally remain (very) satisfied with the availability of drugs, the quality of care, the friendliness of medical staff and waiting time. Patients that do not make use of private health facilities continue to mention high costs as the prime reason for not going to private facilities and also persist in their distrust in the quality of the services provided by the private health sector. Spatial patterns of user-provider interaction have not changed significantly between 1995 and 2000.

Voluntary health care
Section 5.3 concluded that patients choose to go to a voluntary dispensary because of a favourable combination of perceived quality, availability of medication and affordable costs. The residuals indicate that the competitive strength of voluntary dispensaries remains very much associated with these factors. Patients also appreciate that the medical personnel of voluntary dispensaries treats patients in a respectful manner. The outcomes for 2000 indicate that patients more often turn to voluntary facilities because these are less crowded than in 1995. Possibly this is a response to the increasing waiting times in governmental facilities. Overall, the popularity of the voluntary sector appears to be unchanged between 1995 and 2000: voluntary sector patients remain (very) satisfied with most aspects of the health services provided. Although there is some variation between 1995 and 2000 in the modal split of dispensary users (probably caused by the relatively small sample size), the overall picture is that the spatial patterns of user provider interaction have largely remained the same.

The observed overall stability of health care utilization patterns is not very surprising given that the time frame is relatively short and that there has only been limited change in the economic and living conditions of the majority of the population of Dar es Salaam.

5.6 Concluding remarks

This chapter analyzed the observed socio-spatial patterns of health seeking behaviour in the context of medical pluralism using survey data collected in 1995 and 2000. The analysis showed that - for mild health problems - the choice behaviour of governmental, private and voluntary health care users is mainly guided by the desire to

attain affordable health care of adequate quality, with sufficient drugs, at a location not too distant from home. In all cases travel distance/time is an important consideration. The competitive strength of governmental health care is associated with affordability and proximity. Its main perceived weaknesses are drug shortages, long waiting times and, poor quality medical and interpersonal care. If an explicitly spatial perspective is taken, the analysis reveals that most patients walk to the dispensaries of their choice and generally do not travel for more than about 30 - 40 minutes. Travel patterns to higher-order governmental facilities differ in the sense that *(i)* public transport is much more frequently used, and *(ii)* patients are willing to walk somewhat longer distances. The comparative analysis of the survey data revealed that socio-spatial patterns of health seeking behaviour have largely remained unchanged between 1995 and 2000.

6 Towards spatial justice in urban health services planning

6.0 Introduction

The prime objective of this chapter is to describe the GIS-based 'what if' type of planning approach that is developed to evaluate and improve the performance of the Dar es Salaam health system in terms of spatial equity and efficiency. In doing so it illustrates how more sophisticated GIS-based analytical techniques can be usefully applied in support of strategic spatial planning of urban health services delivery.

Health service planners must consider a range of issues when evaluating alternative geographical distributions of their services. From the perspective of the provider, a desired spatial configuration should ensure efficient use of scarce resources within a bounded region characterized by variations in the spatial distribution of health needs. Such variations occur as a result of variations in population densities, socio-economic, demographic and living conditions which all impact on the health status of people. Given the rapid pace of urbanization in Dar es Salaam, it will be clear that the spatial distribution of health needs also evolves over time which implies that health service planners should not only consider the existing extent and structure of the city but also its expected future state within a reasonable time span. From a patient's point of view, travel time should be within acceptable bounds (see section 5.4). The challenge thus is to achieve maximum health benefits to the greatest number of people while making efficient use of scarce health resources. The degree to which the health delivery system attains these parallel goals is an indicator of its performance. Given the spatial perspective of this study, performance is operationalized in terms of the overall level of accessibility of the health delivery system. The accessibility concept, in other words, is used as an indicator to assess in how far the joint objectives of spatial equity and efficiency are achieved (also see section 2.3).

The analysis presented in this chapter consists of two parts. The *first* part analyses the existing situation - using the most recent available data - and identifies in how far the health needs of the Dar es Salaam population are served by the current spatial arrangement of health facilities. Part one, in short, is an assessment of the health system performance under existing conditions.

The *second* part of the analysis explores how existing health needs can better be served by alternative spatial arrangements of provision using scarce health resources. The central concern is to improve system performance by reducing the spatial disparity between provision of health care and need for medical services. This is done by formulating a number of alternative policy options - 'what if' scenarios - and assessing

their expected impact in terms of their contribution towards improved health needs satisfaction. Potential policy options, for example, are the addition of one or more new facilities and/or the closing down of inefficient facilities that do not significantly contribute to spatial performance.

The two-staged approach described above focuses on *governmental* health service delivery only and does not include private or voluntary provision for three reasons. *First*, research objectives and data collection efforts - from the start - have placed emphasis on understanding the functioning of the governmental health sector as this is the sector for which spatial interventions can most actively be planned for by health officials[31]. *Second*, governmental health care is a coordinated hierarchical constellation of provision in which we are not so much concerned with the performance of individual service supply points, but rather how they collectively function in geographic space. The private and voluntary sector, on the other hand, primarily consists of atomic actors. The *third* reason for emphasizing the governmental health sector is that it remains the most important provider for a large proportion of the Dar es Salaam population in spite of the changes induced by the health sector reforms (see section 4.6).

The analysis emphasises the provision of *primary* care, which mainly concerns the treatment of mild health problems[32]. The motivation for this is that primary care is generally acknowledged as the most important form of medical care for maintaining population health. It is relatively inexpensive, can be more easily delivered than specialty and inpatients care, and if properly distributed it is most effective in preventing disease progression on a large scale (Guagliardo, 2004). The focus on primary care also makes it possible to incorporate the findings on observed spatial health seeking behaviour as described in Chapter 5.

The approach incorporates *better off*, *deprived*, *modal* and *starter* households. The motive to not differentiate between the four population groups is that their travel behaviour is mostly the same and that they all make use of governmental health care - albeit in varying degree. As in Chapter 5, travel time approximations are made for potential clients that walk or travel by public transport, as these are the two dominant ways of overcoming the friction of distance (see section 5.4).

This chapter addresses a central objective of this study. The analysis is firmly rooted in the theoretical (spatial welfare theory) and methodological (accessibility analysis)

[31] The reduction of scope is not very restrictive because suggested planning interventions can be provided by the public sector itself or via some form of collaboration between the public and the non-governmental health sector.
[32] As discussed in Chapter 4, primary care is provided at dispensaries, health centers and hospitals. Health centers and hospitals also provide inpatient and specialty care.

framework. It is based upon the purposely-built Dar es Salaam database and should be seen in the broader context of poverty, rapid urbanization and health sector reforms. It makes use of observed regularities in health seeking behaviour and acts as the basis for the discussion (see Chapter 7) on how analytical GIS approaches can best become embedded into strategic spatial planning of health services delivery. The structure of this chapter largely follows the two analytical stages discussed above. Section 6.1 is an assessment of the performance of the existing health services delivery system. Section 6.2 is about improving system performance by evaluating the impacts of alternative short term policy options. Section 6.3 briefly recapitulates the main findings.

6.1 Performance of the existing health service delivery system

This section evaluates the performance of the current governmental health system of Dar es Salaam in terms of spatial equity and efficiency. On the basis of quantitative indicators we assess how good or bad the existing spatial configuration of health services matches with the medical needs of the geographically dispersed population. The analysis is separated into three parts. The first part looks upon performance from the client perspective and thus emphasises the issue of *spatial equality*. The second part looks upon spatial performance from the perspective of the provider and, thus, focuses more on *efficiency of provision*. In the third part, the performance of the existing constellation is compared with that of a number of hypothetical optimal spatial distributions of health facilities - which act as a yardstick - to asses how good or bad the current health system performs.

Equality of access: the client perspective

As discussed in detail in Chapter 2, one of the driving objectives of publicly provided health care is to achieve what is considered to be a socially and spatially just distribution of scarce health resources. The intention, as argued there, is to aim for territorial justice which entails a distribution of scarce resources between areas proportional to the needs of the population in these areas. Some degree of geographical separation between users and providers, however, is inevitable given that health services are provided at discrete locations to a population which is geographically dispersed: some people will always be nearer the service node than others. Obviously, clients that only need to travel short distances incur less disutility and, thus, are in a better position than clients that have to come from far. The real question, therefore, is what degree of spatial inequality is acceptable and when it should be considered unjust. What is acceptable or unjust is not cast in stone but

generally depends on some socially acceptable norm which is mostly expressed in terms of a minimum standard of service delivery[33]. An official minimum spatial standard of health service delivery does not exist for Dar es Salaam. Because of this, 'standards' are as much as possible derived from observed regularities in spatial behaviour as described in Chapter 5.

A simple but good way for evaluating spatial inequality is to measure how long geographically dispersed clients have to travel to obtain treatment at the nearest health facility. In the following, existing access differentials are respectively evaluated in a quantitative and in a spatial manner. Table 6.1 provides a quantitative insight in the overall accessibility of the existing governmental health system by classifying travel time - on foot and by bus - into 10 minute intervals for residents of planned and informal residential areas.

Time interval (min.)	Walking				Public transport			
	Informal		Planned		Informal		Planned	
	Abs. (000)	Cum. %	Abs. (000)	Cum. %	Abs. (000)	Cum. %	Abs. (000)	Cum. %
1-10	162	10	104	17	162	10	104	17
11-20	429	38	246	56	495	42	265	60
21-30	376	62	108	74	550	78	136	82
31-40	246	78	49	81	256	94	64	92
41-50	156	88	48	89	50	97	23	95
51-60	105	95	29	94	24	99	17	98
60+	82	100	36	100	21	100	11	100
Total	1.558	-	620	-	1.558	-	620	-
Mean time (min.)	28		25		23		21	
Max. time (min.)	120		115		104		88	

Table 6.1: Travel time intervals for population living in informal or planned residential areas per transport mode (existing situation).

A number of observations can be made by looking at the table. To begin with, the mean overall walking time to the nearest governmental health facility is short - about 25 to 30 minutes - and reveals only a limited difference between informal and planned residential areas. About 80 percent of the population (planned and informal) lives within a 40-minute walking distance of a governmental health care facility. Only a minor share of the population - about 5 percent - has to walk for more than one hour.

[33] A minimum spatial standard for service delivery, for example, is that no person should live more than 30 minutes away from a primary care provider.

In relative terms, residents of planned areas more often have a governmental health facility in (very) close proximity of their home than residents of informal settlements. This relative advantage ceases to exist when walking time exceeds 30 minutes. Historic location decisions for situating health facilities, in other words, have favoured planned over informal residential areas but the discrepancy is not very large. At first sight, these outcomes suggest that the overall level of accessibility (read: performance) of the governmental health care delivery system in Dar es Salaam is reasonably acceptable.

A less favourable situation, however, unfolds if we look upon access differentials in absolute terms. Table 6.1 then shows that the number of people that have to overcome significant walking distances is very considerable. In case a minimum standard of 30 minutes of walking time is assumed, the under-serviced or 'spatially disadvantaged' population amounts to about 750,000 people (35 percent of the Dar es Salaam population).A minimum standard of 40 minutes[34] still leads to around 450,000 (20 percent of the total population) disadvantaged residents. In both cases, about three quarters of the spatially disadvantaged population resides in informal settlements.

Obviously, the number of people that is labelled spatially disadvantaged much depends upon the minimum standard adopted. Although in reality the choice for one or another minimum standard of service delivery will be a policy decision, the analysis of observed travel behaviour (see section 5.4) indicates that a - from the patient perspective - acceptable/desirable standard for Dar es Salaam would be in the order of 30 and certainly no more than 40 minutes of walking time[35]. Public transport users generally do not travel for more than about 40 minutes; less than 10 percent travels for more than 50 minutes.

If we consider access differentials for public transport (again see Table 6.1), the picture is not very dissimilar: overall mean travel time is short; travel time differences between planned and informal areas exist but are of limited magnitude. More than 90 (95) percent of all residents can reach a governmental facility within 40 (50) minutes of bus time. If a cut-off travel time of 40 (50) minutes is adopted, still about 145,000 (73,000) people are spatially disadvantaged. In absolute terms, residents of informal areas are again worse off than residents of planned areas but the difference is now less pronounced.

Figure 6.1 presents a spatial perspective on access differentials by visualising the walking and public transport time to the nearest governmental health facility.

[34] A minimum standard of 50 minutes leads to around 250,000 (12 percent of the total population) disadvantaged residents.
[35] Close to 90 percent of all sampled respondents do not walk more than 30 minutes; less than 5 percent walks for 40 minutes or more.

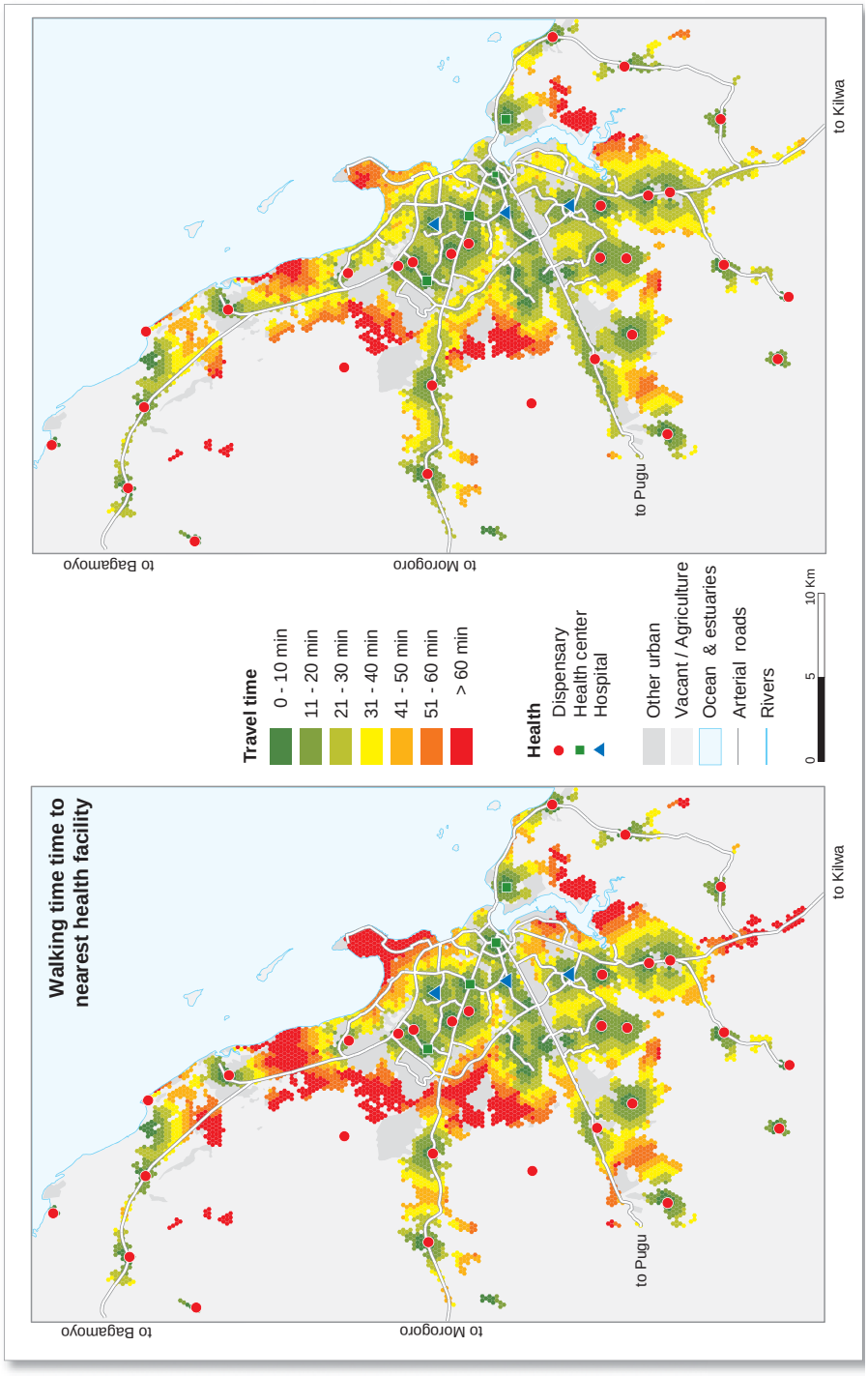


Figure 6.1: Travel time to nearest health facility on foot and by bus.

The colour scheme is chosen to reflect the regularities in observed travel behaviour (see section 5.4). Green colour tones represent areas with unproblematic access times of up to 30 minutes. Yellow coloured areas approach the - from the client perspective - maximum acceptable walking time of 40 minutes. Orange and red coloured areas represent areas which are increasingly disadvantaged in terms of access to governmental health care.

A closer look at walking time to the nearest health facility (see Figure 6.1) clearly shows that access to governmental health care is generally unproblematic in the more central parts of the city. The bulk of the disadvantaged areas, on the other hand, are situated in the more peripheral - and often more recently developed - parts of the city. A notable exception is the Msasani peninsula (see inset in Figure 6.1) which is a fully developed low density residential area predominantly inhabited by *very* high income residents who will generally not make use of governmental health care. If ease of access is evaluated in terms of public transport time (see Figure 6.1), similarities as well as differences can be observed. The main - and rather obvious - similarity is that access to governmental health care on the whole is not problematic in the city core. The major difference is that a considerable travel time reduction can be observed in areas situated further away from the city core but near to the public transport network. Peripheral areas away from the public transport network - mainly more recently established low density residential areas - remain the most disadvantaged.

The *conclusion* to be drawn from the above is clear. Although the actual number of individuals that is earmarked as 'spatially disadvantaged' depends upon the minimum standard adopted and on the mode of transport considered, it is evident that a significant degree of spatial inequality exists and that large numbers of people have to travel longer than desirable/acceptable to obtain governmental health care. Not surprising is that most of the spatially disadvantaged residents live in informal areas in the more peripheral parts of the city.

Efficiency of provision: the provider perspective

In the preceding pages, the performance of the Dar es Salaam governmental health care system was reviewed from the perspective of the client and provided insight in existing access differentials. In this section, we again look at spatial performance but now take the perspective of the provider, which means that efficient use of scarce resources becomes the most important consideration. The main indicator used to evaluate in how far individual health facilities are spatially efficient is the number of clients that each can be expected to serve (also see section 2.2). The general conception of the analysis is that health facilities that serve larger target populations are situated at more efficient locations than those that can provide for only a limited clientele. In the case of public service provision a policy norm usually prescribes the minimum threshold size of the target population that is needed to initiate or sustain service

delivery. Depending on the local situation a maximum limit or capacity constraint may also exist.

The prevailing national health policy of Tanzania stipulates that dispensary level medical care should cater for target populations of about 10,000 people (Ministry of Health, 1990). The Dar es Salaam Urban Health Project (DUHP), however, considers this norm as potentially suitable for sparsely populated rural areas but judges it unrealistic for a more densely populated urban area such as Dar es Salaam. The DUHP, in stead, stipulates that primary outpatient medical care should be provided for target populations of about 40,000 people (Pichette, 1996). An official capacity constraint could not be identified and in all probability does not exist.

Estimating target populations

A straightforward approach for estimating the target population of service supply points in a GIS environment is to assume that clients are spatially rational. In its simplest form clients make use of a single mode of transport only. In the above sketched situation, the competitive strength - or perceived quality - of all service supply points is assumed equal and target populations are simply calculated by assigning all potential patients to the nearest health facility.

Prior analysis (see section 5.4) indicates that such an approach would quite accurately reflect the spatial behaviour of *dispensary* users as these nearly all walk and go to the facility that is nearest to their home. The analysis of observed travel behaviour, however, also revealed that *hospital* users make use of public transport about as often as they travel on foot. Furthermore, it was found that a considerable proportion of the patients that choose to walk to a governmental hospital could have opted for a dispensary nearer to their home. Taken together, these findings show that the competitive strength of governmental hospitals in geographic space is greater than that of dispensaries. This means that an allocation approach which assigns all clients to the nearest health facility - irrespective of provision level and transport mode - would lead to erroneous target population estimates.

A way forward, is to devise an alternative allocation model which properly accounts for the use of different transport modes and is sensitive to the above-identified difference in competitive strength. Such a model would more accurately estimate the target population - the efficiency indicator - for individual health facilities in the Dar es Salaam situation.

It should be clear that the devised model is no attempt to conceptualise the individual decision process. In stead, it is based upon a limited number of simple assertions

which are all derived from and in very close correspondence with observed aggregate spatial choice behaviour[36].

The assertions or 'model determinants' are listed in Figure 6.2A. Their implication is straightforward. Potential clients that live within walking distance of public transport choose one of three alternatives: *(i)* walk to the nearest facility, *(ii)* walk to the second nearest facility or *(iii)* take the bus to the closest higher order facility. Potential clients that do not live within walking distance of public transport choose from only two alternatives and walk either to the first best or to the second best facility (see Figure 6.2B).

The *next* step is to assess how the travel time to and the level of provision of nearby health facilities influence choice behaviour and establish in how far the concept of spatial rationality is applicable (see Figure 6.2C). This is done using a three-staged approach. Stage 1 first computes the public transport time to the nearest higher order facility for every origin location. Using the survey sample data, it is then possible to identify - and set aside - the proportion of respondents that takes the bus to the nearest higher order facility for different travel time intervals. This approach is valid since nearly all (95%) respondents that travel by bus opt for the nearest higher order facility.

The remaining part of the respondents - those that travel on foot - form the input of Stage 2. Here, the walking time to and level of provision at the nearest and 2nd nearest facility is identified for every origin location. The outcomes demonstrate that observed choice behaviour is spatially rational to a very high degree *(i)* if the two nearest facilities are both dispensaries[37] and *(ii)* if the nearest is a higher order facility and the 2nd nearest a dispensary. In these situations an allocation method that presupposes spatial rationality will also generate sufficiently accurate results.

The outcomes, however, also demonstrate that spatial choice behaviour is more often spatially sub rational if the nearest facility is a dispensary and the 2nd nearest a higher order facility. In this particular spatial situation, the competitive strength of higher order facilities manifests itself which implies that an allocation approach that assumes spatial rationality requires correction. If not, it will underestimate the target population of higher order facilities and overestimate that of dispensaries that share their service area with a higher order facility.

[36] The fact that the sample size is relatively small is another reason for designing an uncomplicated allocation model.
[37] The number of respondents that have a higher order facility nearest and 2nd nearest is too limited to draw firm conclusions, for this situation it is assumed that patients - given the absence of a qualitative difference - will act in a spatially rational manner.

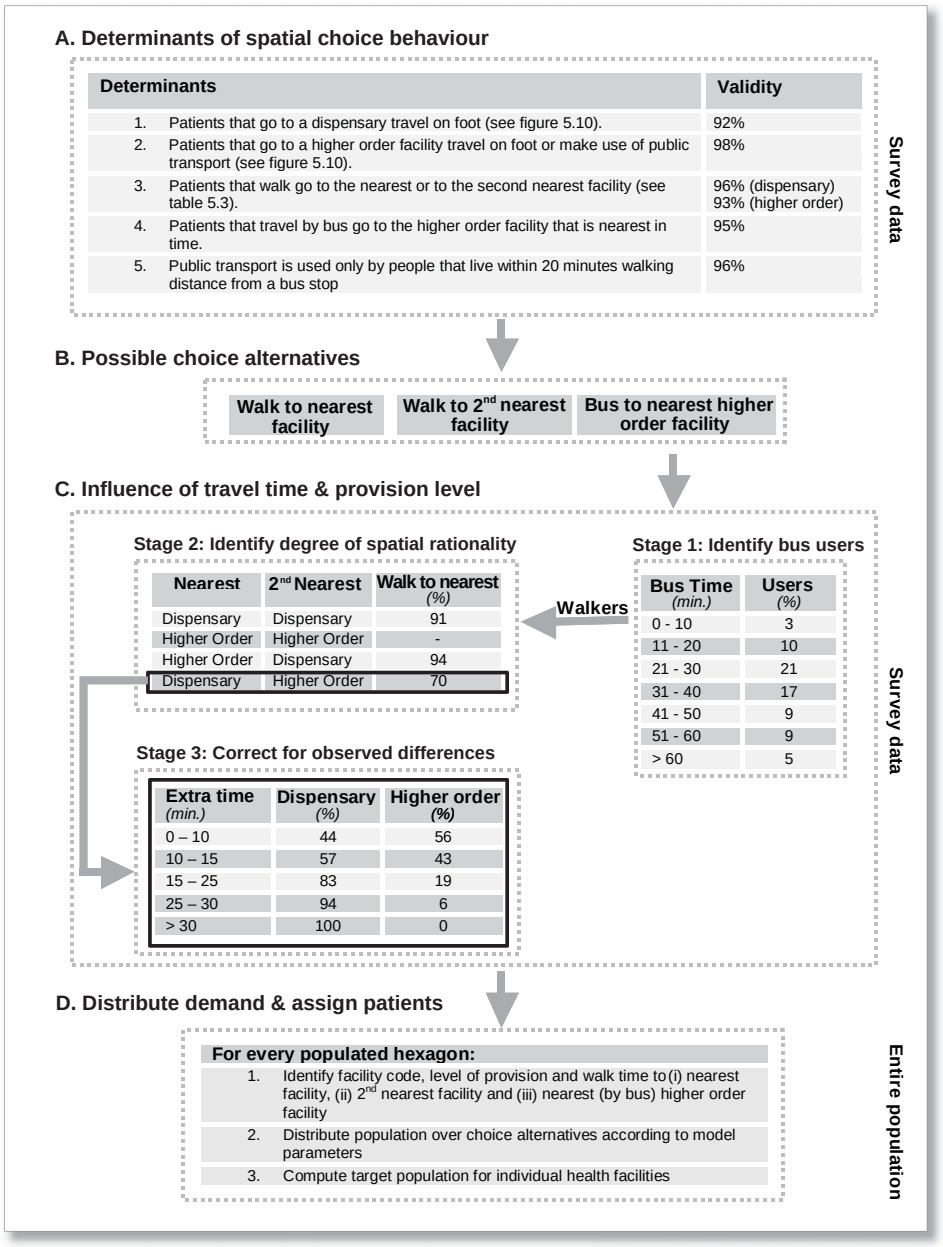


Figure 6.2: Estimating target populations using a simplified model of spatial behaviour.

Stage 3 of the allocation approach is the correction mechanism that accounts for this spatially sub rational behaviour. To identify more exactly where the spatial competition effect occurs, a two-dimensional table is constructed whereby one axis represents the extra time required to reach the higher order facility and the other the two possible

choice alternatives. The cross tabulation shows that the spatial competition effect *(i)* is most evident when the extra travel time is limited and *(ii)* rapidly weakens with increasing travel time differences[38]. The *final* step (see Figure 6.2D) simply extrapolates the above described overall spatial choice behaviour of sampled respondents to the entire population and - through a set of aggregation procedures - calculates the estimated target population for each individual health facility[39].

In how far do the target population estimates generated with this allocation model reflect reality? Obviously, this is an important issue since its outcomes are to be used as an indicator of spatial efficiency. A plausible validation approach is to compare - for each individual health facility - the size of the estimated target population with the observed volume of patients treated[40]. A high degree of association between the two variables would suggest that the allocation model generates realistic outcomes. The statistic used to describe how well estimated values fit with observed data is the Pearson correlation coefficient. Although the number of observations (*i.e.* health facilities) is just about sufficient to conduct this type of statistical analysis, the correlation analysis demonstrates that a very strong positive linear relationship exists ($R = 0.86$, significant at the 0.01 level) between the size of the estimated target population and the actual volume of patient throughput. In simpler terms, this means that overall about 75 percent (the adjusted R^2 value) of the variation in patient throughput is explained by the size of the estimated target population.

Although this result is quite assuring, it also demonstrates that other factors - apart from travel time and level of provision - influence health seeking behaviour as well. The influence of some of these factors, furthermore, will vary from place to place which explains why target population estimates and actual patient flows do not always correspond equally well at the level of the individual health facility (see Figure 6.4). Obvious factors causing discrepancies are *(i)* the simplicity of the allocation model itself, *(ii)* spatially varying competition effects from private and voluntary health facilities, *(iii)* the inherent uncertainty in the data sets used, and *(iv)* the fact that observed patient flows describe the 2001 situation whereas the population data depict the 1998 situation. With these reservations in mind it can, nonetheless, be concluded that the devised allocation model on the whole generates sufficiently convincing outcomes.

[38] The optimization approaches and the intervention framework presented in the following sections do not incorporate this correction mechanism since *(i)* differences in competitive strength only occur locally, *(ii)* its impact is generally relatively limited (see Appendix E) and, *(iii)* incorporating the correction mechanism would much increase the computational complexity. The benefits, in short, would not outweigh the costs.

[39] Note that this allocation method assigns the entire Dar es Salaam population to a health facility irrespective of travel time. This is done to illustrate all travel time intervals for individual facilities.

[40] Coppens (2001a, 2001b) counted patient throughput twice for one week at individual health facilities in 2001.

Spatial efficiency of governmental health care

In the following pages the outcomes of the previously described allocation method are used to analyse the performance of the Dar es Salaam governmental health delivery system in terms of spatial efficiency. As in the preceding section, this is done both in a quantitative and in a spatial manner.

Figure 6.3 provides a quantitative insight in spatial efficiency for individual health facilities. It not only depicts the total estimated number of clients that is served per facility but also visualizes the actual categorized travel time[41] that clients require to reach the health facility they are allocated to. The inclusion of the national and the DUHP threshold norms make it possible to evaluate in how far individual facilities are situated at spatially efficient locations.

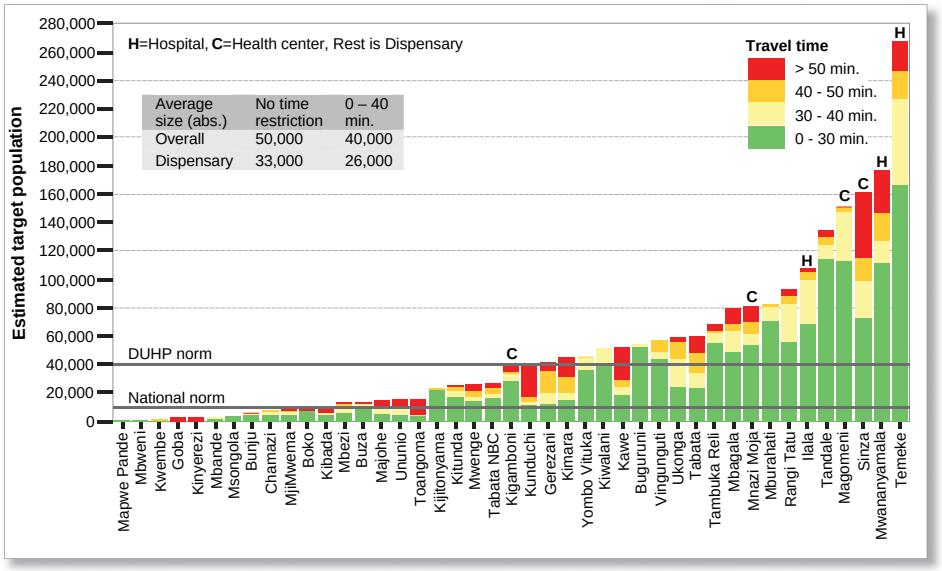


Figure 6.3: Estimated target population and travel time intervals per health facility.

A number of observations can be derived from Figure 6.3. *First*, a rather hefty variation in target population sizes exists which ranges from facilities serving less than 5,000 people to facilities serving very large target populations of over 100,000 - and up to 270,000 - people. Higher order facilities - apart from one notable exception[42] - serve large to very large target populations well above the national and the DUHP threshold

[41] Travel time is walking time for those patients that - according to the allocation model - will come on foot and public transport time for those that make use of the bus.

[42] The exception is Kigamboni health centre which - because of its relatively secluded location - serves just about 40,000 people (around 35,000 live within a cut-off travel time of 40 minutes).

norm and are, therefore, situated at spatially efficient locations. Dispensaries, on the other hand, come in all sizes. Some, such as Tandale, Mbagala Kizuiani and Mburahati, service populations comparable to those of higher order facilities.

Second, if target population estimates for dispensaries are looked upon from a purely normative perspective it can be seen that two thirds meets the national threshold norm but that only one third satisfies the DUHP norm. In case we also take into account that patients are generally unwilling to travel for more than 30 to 40 minutes - see previous section - just over half (56%) of all dispensaries satisfies the national norm but no more than roughly one quarter (28%) complies with that of the DUHP.

If we look at these outcomes from a spatial standpoint, Figure 6.4 shows that the DUHP norm is only attained by dispensaries that are situated in - or draw most of their clients from - areas of medium and high population density. For the most part these dispensaries are situated in the city core. Dispensaries situated in areas of low population density adjoining the city core mostly meet the national norm but not that of DUHP. Dispensaries with a target population below the national threshold[43] are all situated at the very periphery of - or even outside - the built up area. The latter category mainly concerns dispensaries situated in villages that are gradually engulfed by the expanding urban area.

Table 6.2 takes a simplified human resource perspective towards efficiency and shows in how far health facilities perform if their outpatient staff allocation is measured against actual outpatient turnover. It shows that dispensaries with small(er) target populations - below 40,000 people - are relatively costly in operational terms as their collective staff allocation is over dimensioned in comparison to realized patient turnover. Dispensaries with large(r) target populations, on the other hand, realise economies of scale as indicated by their favourable staff to patient ratio[44]. Health centres and hospitals score about neutrally in terms of operational efficiency.

What can be concluded on the basis of the outcomes presented above? If we think in normative terms, it is apparent that the DUHP threshold is set rather high and should be used with caution as a guideline directing future planning interventions. The main objection is that compliance basically precludes the establishment of additional facilities in un-served areas with lower population density.

[43] Target population estimates for these facilities will tend to be conservative because population data only exist for residential areas. In reality people also reside in areas classified as vacant/agricultural, meaning that some facilities may tend towards the national norm.

[44] Patients, however, might experience this as a disutility as they are confronted with overcrowding and long waiting times.

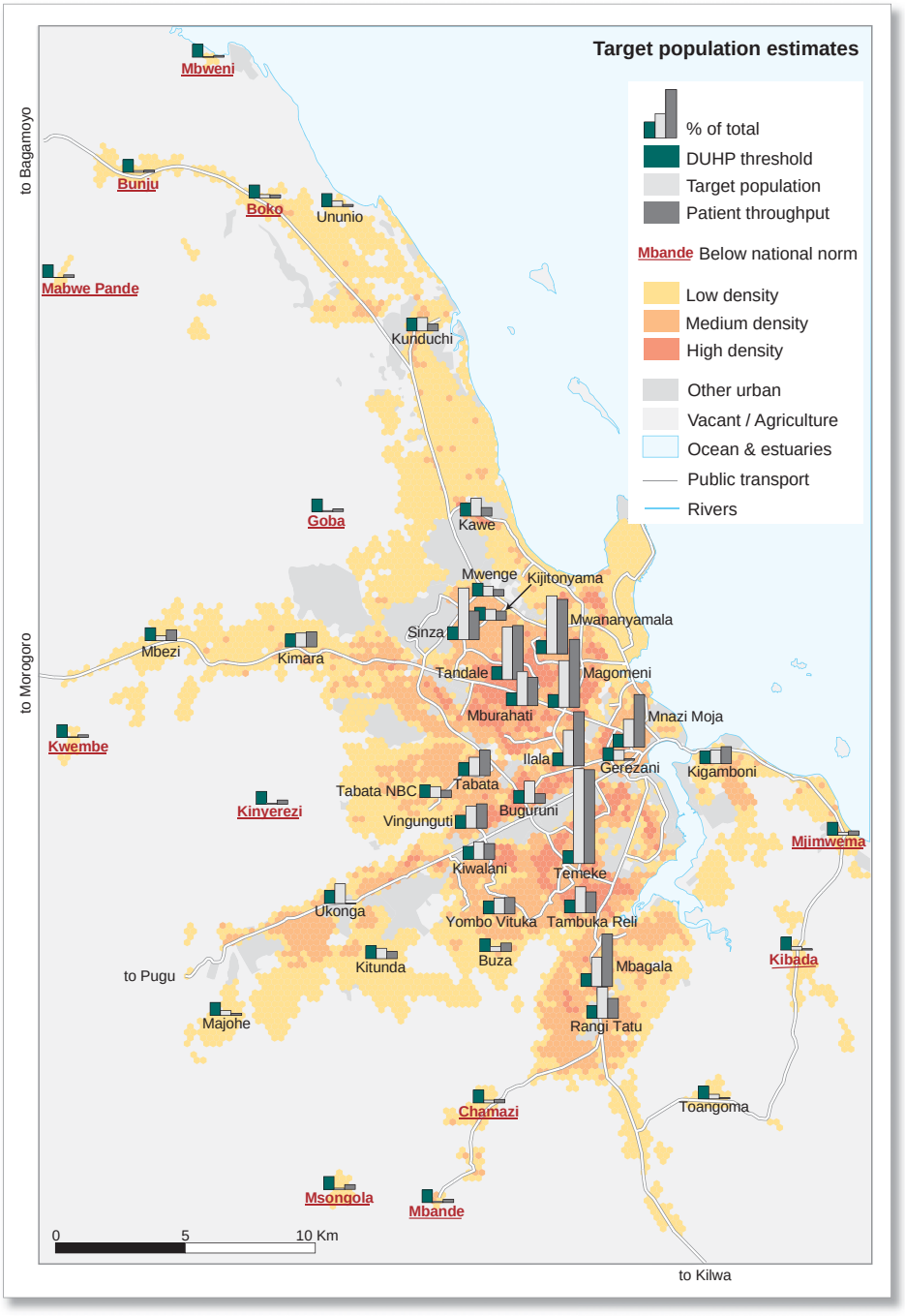


Figure 6.4: Population threshold of DUHP (abs.) estimated target population and observed patient throughput (as % of total).

Moreover, it would imply closure of a considerable number of existing dispensaries as their target populations would be considered too small to sustain service delivery even though this would lead to increased spatial inequality. The national norm, on the other hand, appears to be a more realistic planning guide, particularly for lower density and more peripheral areas where future planning interventions will mostly be required. Strict adherence to the national norm, nonetheless, might entail that a potentially prohibitive number of additional facilities would be required to remedy previously identified spatial inequalities (this issue is further taken up in section 6.2).

Estimated target population (000)	Dispensary			Health centre			Hospital		
	N	Patient %	Staff %	N	Patient %	Staff %	N	Patient %	Staff %
< 10	12	5	10	0	-	-	0	-	-
11 – 20	5	4	7	0	-	-	0	-	-
21 – 40	7	8	10	1	3	3	0	-	-
41 – 60	5	9	9	0	-	-	0	-	-
61 – 80	3	8	6	1	7	8	0	-	-
80+	4	18	12	2	13	11	3	25	25
Total	**36**	**52**	**54**	**4**	**23**	**22**	**3**	**25**	**25**

Sources: Outpatient throughput data (Coppens, 2001a; Coppens, 2001b). Outpatient staff data (The Dar es Salaam City Medical Office of Health, 2003)45.

Table 6.2: Outpatient staff allocation and realised outpatient turnover.

Above-mentioned observations clearly illustrate the inbuilt trade-off problem that exists between achieving the joint goals of spatial equity and efficiency. In general terms, maximization of access and equitable distribution of health resources requires the establishment of a larger number of dispersed facilities serving small(er) target populations. Maximization of efficiency, on the other hand, implies concentration of medical care in fewer facilities serving large(r) target populations. If looked upon in this way, it is unmistakable that the development of the existing location pattern of governmental provision - given its significant number of small scale dispensaries - was more strongly guided by egalitarian objectives than by efficiency considerations. This is even more evident if we consider that most governmental facilities were constructed more then two decades ago when the Dar es Salaam population and the urbanized area were considerably smaller.

The following pages further explore in how far the current spatial constellation of governmental health care as a whole provides services efficiently and equitably. This is done by comparing current performance with that of a hypothetical optimised spatial distribution of health facilities.

[45] Staffing figures differ between table 4.4 and table 6.2 but are not inconsistent. Table 4.4 presents all health staff whereas table 6.2 only considers staff providing outpatient medical care.

System performance: actual versus hypothetical optimized constellations

A question that logically follows from the preceding discussion is how good (or bad) the current spatial configuration of governmental health care as a whole is attuned to the needs of the population and how efficiently it is organised. The issue, in other words, is that we now have obtained insight in its current performance but do not yet know what performance would be attainable in the hypothetical situation that existing facilities would be organized (or: could be relocated) in such a way that the need for medical care and the supply of medical services is optimally attuned. By comparing the performance of the existing configuration with that of an 'ideal' spatial arrangement of provision we can then assess how well the current system functions. If the difference between the existing and the hypothetical ideal situation is limited the current system performs well. The larger the difference the more there is scope for improvement.

The systematic search for a location pattern of facilities that optimizes accessibility of services for the population is usually referred to as location-allocation. It asks how to select a set of locations for facilities and assign spatially distributed sets of demand to these facilities, to optimize some specified measurable criterion (Leonardi, 1981; Hanssen *et al.*, 1987). In simpler terms, it asks how the location of (public) facilities can be planned in the best possible way? The term 'best' can be interpreted in different manners and is usually referred to as the search criterion. The following three search criteria are generally used for optimally locating public facility systems. Although their conception of social/spatial welfare differs (also see section 2.2), each in its own way aims to maximize user benefits given a budget constraint on total costs (the equity-efficiency trade-off problem).

The *first* is the MiniSum criterion which (re)locates a given number of facilities in such a way that the total aggregate distance travelled by the population to reach a service is minimized. The smaller the total travel time, the less disutility the population incurs and the more accessible the system as a whole is to its users. Although the overall level of accessibility will generally improve, this criterion potentially leads to a situation in which accessibility becomes more unequally distributed. The MiniSum criterion, thus, is primarily oriented towards achieving spatial efficiency. The *second* is the MiniMax criterion which minimizes the largest distance travelled by anyone to a service. The maximum distance some person has to travel is viewed upon as the worst possible performance of the system; to minimize this can be viewed upon as an equity criterion. The drawback of the MiniMax criterion is that it may inflict excessive travel time on the majority in order to reduce travel time for a few spatially isolated users. The *third* approach towards maximizing user benefits is to make use of a Maximal Covering Model (Church and ReVelle, 1976). In this case, the point of departure is that the value of a service declines with increasing distance from the supply point and that a desirable standard of service can be defined in terms of a certain maximum travel time. In its

simplest form, a covering model minimizes the number of facilities to be located (the efficiency goal) subject to the requirement that each demand location has at least one facility within a given maximum range of travel time (the equity constraint). In case resources are fixed, a covering model can also be applied to locate a given number of facilities in such a way that as many people as possible are within the specified service standard. If the maximum acceptable travel time is relatively large, the solution will tend towards that of the MiniMax solution. The smaller the maximum acceptable travel time becomes, the more inequitable the solution will tend to become since facilities will increasingly be attracted towards areas with larger population concentrations.

The brief argumentation presented above demonstrates that the outcome of an optimization model much depends on its search objective and - in the case of a covering model - its travel time constraint. At the same time, it will be evident that the distinction between spatial equity and efficiency is not a rigid one as each of the three described models strikes a variable balance between both objectives (Hodgart, 1978). The selection of a model to apply in a particular case is partly an empirical question about what assumptions are appropriate, but it is also a matter of social value judgments which generally are politically made. Because of this, each of the three above described approaches is further elaborated below.

Although exact solution algorithms exist for the MiniSum, MiniMax and the Maximal Covering objectives, these usually require a prohibitive amount of computing time. Because of this, use is normally made of heuristic methods that more rapidly generate relatively good proxies of optimality. The standard design of the MiniSum and MiniMax heuristic is that they *(i)* start with an arbitrary spatial configuration of facilities, *(ii)* allocate the population to the nearest facility, *(iii)* relocate the facility to the location that optimizes the search objective for the population within each catchment area, and *(iv)* repeat steps *(ii)* and *(iii)* until no further improvement is realized (Hodgart, 1978; Floor *et al.*, 2001). The Maximal Covering heuristic follows a different approach. It *(i)* starts with arbitrary spatial configuration of supply points, *(ii)* for each supply point evaluates the potential gain in customer coverage if relocated to the location where it can serve the largest un-serviced clientele, *(iii)* relocates the facility that realizes the highest gain in customer coverage, and *(iv)* repeat steps *(ii)* and *(iii)* until no further improvement is realized.

The stepwise procedure developed to generate the hypothetical optimized spatial configurations for the Dar es Salaam situation follows the standard approach but is adapted to, as much as possible, accord with previously identified determinants of spatial choice behaviour.

To keep computing time within acceptable bounds[46], the presented optimization approaches only relocate dispensaries and, therefore, only considers walking time.

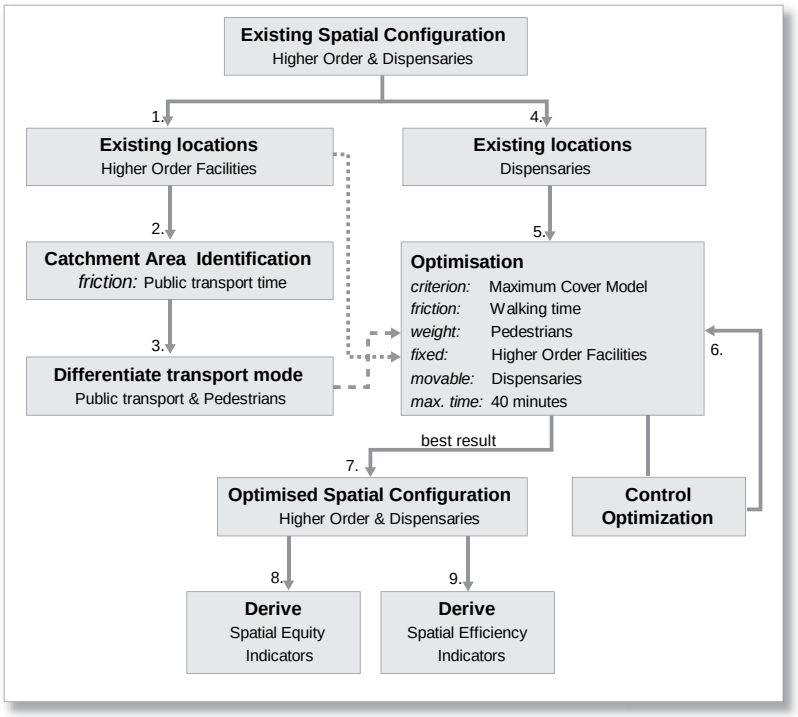


Figure 6.5: Generalized approach towards optimization (the MiniSum and MiniMax approaches are equivalent apart from the travel time threshold).

Figure 6.5 illustrates in some detail the procedure that was developed to generate the optimized spatial constellations. *First*, governmental provision is separated into higher order facilities and dispensaries. *Second*, the public transport time to the nearest higher order facility is computed for every origin location. *Third*, the survey sample data, are used to - again for each origin location - identify and set aside the proportion of the population that is likely to take the bus to the nearest higher order facility[47]. In this way, it is achieved that only those patients that are expected to travel on foot are considered in the actual optimisation procedure. The *fourth* and *fifth* stage consists of the optimisation heuristic which relocates existing dispensaries according to model

[46] A single run of the Maximal Covering Model, for example, required around 56 computing hours with a standard laptop. The MiniSum and MiniMax models require only a few hours of computing time.
[47] Note that the identification of bus users (Steps 1 - 3) is done in the same way as previously discussed/illustrated in figure 6.2C.

parameters[48] but considers the existing locations for higher order facilities as fixed. *Sixth,* since heuristic approaches can sometimes become 'trapped' in an overall sub optimal spatial solution, an additional 'control' optimization run is performed with an alternative spatial starting configuration. All control runs resulted in equivalent accessibility scores for the search objective.

The outcome of the above described computations consists of three separately optimized hypothetical spatial health service delivery constellations (Step 7). Each represents a realistic proxy of the spatial performance that is attainable with given health resources if 'ideally' distributed according to a particular search objective. For each of the optimized constellations a number of indicators of spatial equality and spatial efficiency is derived and compared with those of the existing configuration (Steps 8 and 9). All indicators are obtained in the same manner as described earlier on in this section. Equality of access, thus, is evaluated in terms of the time that potential clients have to travel to the nearest health facility. Efficiency of provision, like before, is evaluated in terms of target population volumes as estimated using the tailor made allocation method shown in Figure 6.2. Contrary to the approach taken earlier on in this chapter, spatial performance is compared in a quantitative manner only. This is done because accessibility indices of the optimal and near optimal constellations are highly similar whilst the associated spatial configurations can differ radically (for a detailed explanation see Floor *et al.* (2001). The results are as follows.

Equality of access compared

Figure 6.6 provides a comparative overview of accessibility indices for the existing and the hypothetical optimized constellations. Some of these indices are a direct reflection of the search objective of a particular optimization procedure. The maximum walking time of the MiniMax optimization, for example, is indeed the shortest whereas the mean overall walking time of the MiniSum optimization scores best. The Gini index[49], furthermore, confirms that the MiniMax approach generates the most equal spatial distribution and the MiniSum the one that is the least equal of all.

More interesting is that the optimization results make very clear that the existing configuration performs sub optimally both in terms of efficiency and equality. Comparison with the MiniSum solution demonstrates that the existing constellation could be organized significantly more efficiently - mean travel time can be reduced from 28 to 23 minutes - without increasing spatial inequality. Likewise, a comparison with the MiniMax solution demonstrates that the existing constellation could be

[48] The Maximal Covering Model is given a threshold travel time of 40 minutes to reflect the fact patients are generally unwilling to walk for more than 40 minutes. The MiniMax and MiniSum models do not consider a threshold value.
[49] The Gini index is a measure of inequality which can be used to measure any form of uneven distribution. It ranges from 0 to 100, with 0 representing perfect equality and 100 total inequality.

organized in a more equitable manner: the Gini index could be reduced from 35.0 to 25.0 - *and* realize a modest efficiency improvement. The MaxCover approach, finally, best deals with the trade-off problem between efficiency and equality as it unites a close to optimal mean travel time with a close to optimal Gini score. This very favourable result, admittedly, is achieved at the expense of a very limited number of spatially isolated users which would have to travel very long.

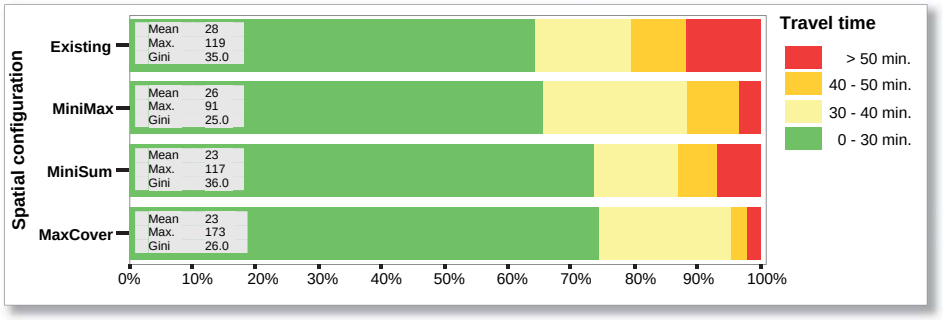


Figure 6.6: Equality of access compared (walking time only).

Although above described indices provide useful general information on travel time and equality of access, they do not give insight in the number of people that is spatially disadvantaged. Comparative figures, however, are simply generated by categorizing walking time and counting the number of people per walk time interval for each constellation. Once again, it must be stated that the number of people that is earmarked as spatially disadvantaged depends upon the minimum standard adopted and that the choice for one or another standard is largely a matter of social value judgment. Building upon previously discussed empirical findings (see section 5.4) it can, nevertheless, be concluded that a desirable standard for dispensaries for the Dar es Salaam situation is in the order of 30 but no more than 40 minutes of walking time.

In case a minimum standard of 30 minutes of walking time is assumed Figure 6.6 shows that the MiniSum and the MaxCover solutions both perform significantly better than the existing constellation and reduce the spatially disadvantaged population from about 750.00 to roughly 565,000[50] people. Although this is a sizeable improvement still about one quarter of the Dar es Salaam population would remain underserved. In case a minimum standard of 40 minutes of walking time is presupposed, all hypothetical constellations perform significantly better than the existing constellation. In the latter case, the MaxCover model generates by far the most preferable solution as it quite dramatically reduces the number of spatially disadvantaged people from around

[50] Close to 80 percent of the spatially disadvantaged reside in informal settlements.

450,000 to about 110,000[51] persons (5% of the Dar es Salaam population). Taken together, these results demonstrate that spatial welfare could be considerably improved - with existing health resources - if the need for medical care and the supply of health services would be more optimally attuned. It would *(i)* reduce overall average travel time, *(ii)* diminish spatial inequality, and *(iii)* very radically trim down the number of underserved city residents.

Efficiency of provision compared

Figure 6.7 provides a comparative overview of spatial efficiency for the existing and each of the hypothetical constellations. The bar charts depict the total estimated client base per (hypothetical) facility and the actual categorized travel time that clients would require to reach 'their' facility. The tabular insets present general performance indicators that describe how efficient facilities collectively function in geographic space.

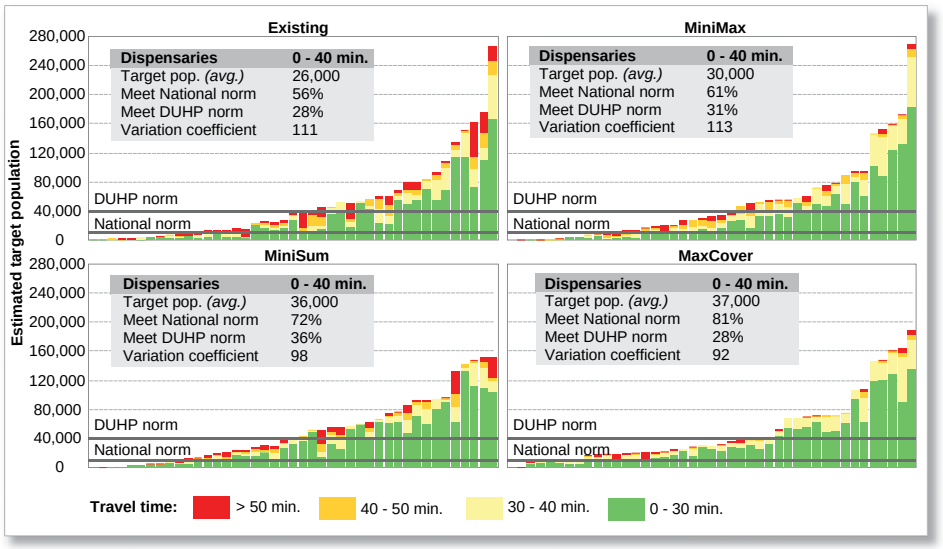


Figure 6.7: Efficiency of provision compared.

A number of observations can be derived from Figure 6.7. To begin with, the bar charts show that the variation in target population size amongst facilities is very considerable for all configurations. This is not surprising given that the estimates strongly depend on the geographical distribution and (uneven) density of the population to be served. At the same time, it is evident that the degree of variation is less pronounced in the case of the MiniSum and MaxCover solutions. The latter can be

[51] In this case, 85 percent of the spatially disadvantaged reside in informal settlements.

traced back to the search objective of these two models which make that facilities are attracted towards locations where they can serve larger population volumes. In each situation, higher order facilities (generally) serve target populations above the national and the DUHP threshold norm. Dispensaries, on the other hand, come in all sizes.

If we restrict our scope to dispensaries (only these were optimized) and impose a cut-off travel distance of 40 minutes (patients are generally not willing to walk longer) the indicators presented in Figure 6.7 demonstrate that all hypothetical configurations perform more efficiently than the existing constellation but that they do so in varying degree. The performance of the MiniMax solution is only marginally superior. The MiniSum and MaxCover solutions, however, perform substantially more efficient than the existing constellation. The MaxCover solution, for example, leads to *(i)* a significantly larger average target population size, *(ii)* a much higher proportion of dispensaries that meets the national norm[52], and *(iii)* the lowest variability[53] in target population size. The reduced share of very small dispensaries also signals that the MaxCover solution would also perform more efficiently in operational terms as staff allocations could better be adjusted to expected patient turnover (also see Table 6.2). Collectively, these outcomes make obvious that a more optimal spatial distribution of health facilities would not only much reduce spatial inequality but would also lead to considerably more efficient use of scarce health resources.

In this fairly elaborate section, *in summary*, a methodology was developed to evaluate the performance of a given public service delivery system on the basis of generic quantitative indicators of spatial equality and efficiency. The methodology was applied to assess the spatial performance of the Dar es Salaam governmental health service delivery system. The results indicate that spatial performance is currently deficient as *(i)* a large number of city residents have unsatisfactory access to governmental health care and *(ii)* a considerable proportion of dispensaries is situated at locations where they can only serve a (very) limited client base.

To assess what degree of spatial performance could *potentially* be attained with given health resources, a number of optimal hypothetical constellations were generated using three different - yet broadly acknowledged - conceptions of social/spatial welfare. The outcomes of these optimisation efforts make obvious that 'geography matters': a better spatial distribution of health facilities would much reduce spatial inequality *and* lead to considerably more efficient use of scarce health resources[54]. Although the results are

[52] The optimizations also confirm that the DUHP threshold is set too high to be usefully applied as a guideline directing future planning interventions.
[53] The coefficient of variation expresses the standard deviation as a percentage of the mean value which makes it a suitable measure to compare the variability of different variables. The lower the score the lesser the variability.
[54] This, however, does not automatically imply that the quality of past location decisions was poor. Urban expansion and densification processes have considerably changed the spatial distribution of demand over time.

revealing, it is recognised that the presented optimisation effort is essentially an academic exercise as it is unrealistic to look upon health facilities as 'mobile entities' which can simply be repositioned in geographic space without considering issues such as relocation costs, space requirements, the potential existence of nearby (competing) non-governmental health providers, opposition of affected residents and so on. The justification for presenting the optimisation approaches, nonetheless, is that they serve as a 'neutral' yardstick against which the spatial performance of the existing constellation could be evaluated.

In the pages that follow we move away from the *evaluative* framework presented in this section and proceed to develop an *intervention* framework which consists of a set of 'what if' planning instruments that can support health planners aiming to improve the spatial performance of a given health service delivery system.

6.2 Towards improved spatial performance: formulating alternative planning interventions and assessing their impacts

In the preceding section a framework has been formulated to evaluate the spatial performance of the Dar es Salaam governmental health service delivery system. In the pages that follow we move away from this *evaluative* (diagnostic) framework and proceed to develop an *intervention* (therapeutic) framework consisting of a set of planning methods that contribute to making informed spatial decisions. The aim is not to automate but rather to support parts of the planning process.

The approach taken is to develop a number of 'what if' type of planning methods that can support health planners to *(i)* identify where interventions are mostly needed and *(ii)* forecast and evaluate the spatial impacts of alternative interventions using the Dar es Salaam situation as example. Emphasis - like in the preceding section - is on the delivery of primary health services provided at dispensary level, as this remains the most probable form of future planning intervention.

Broadly speaking, health planners aiming to improve the spatial performance of a given public service delivery system will require appropriate instruments to deal with a number of important spatial questions or problems. *First*, they should be able to assess if a given delivery system contains facilities that do not significantly contribute to overall spatial performance. Such facilities - if existent - are superfluous, represent inefficient use of scarce health resources and health planners could decide to discontinue their operation (resources released in this way could potentially be reallocated to establish new facilities in under serviced areas). *Second*, health planners require instruments with which they can *not only* identify places and populations that

are not being well served by a given spatial constellation of provision *but also* help them to chart out priority areas for expansion of the delivery system. The *third* spatial problem with which health planners will be confronted concerns the hierarchical organization of public health delivery systems. In this case health planners should be able to assess if a given hierarchical organization is properly attuned to spatially distributed user needs. In the pages that follow, a planning instrument is presented that deals with each of the above-mentioned spatial problems using the Dar es Salaam situation as example.

Before doing so, it is important to reiterate that public health professionals generally plan for a spatial configuration of provision that generates as much user benefits as possible given a budget constraint. As previously discussed, however, this aspiration can be operationalized in different manners depending on the favoured conceptualisation of social/spatial welfare. Each conceptualisation deals with the equity-efficiency trade-off problem in a different way and planning outcomes will vary accordingly. As stated before, the choice for a particular conceptualisation is partly guided by empirical considerations but also a matter of social value judgement.

The planning methods presented in the remainder of this section are all based upon the so-called 'covering principle'. This means that potential interventions in the spatial constellation of provision are, in first instance, steered by their expected impact on the number of people that live within a desired threshold travel time of governmental health care. The threshold reflects the unwillingness of patients to make a journey greater than a certain distance or time.

The rationale for favouring the 'covering principle' is threefold. *First*, a covering approach strikes a flexible[55] balance between a purely equity and an entirely efficiency oriented approach. *Second*, the optimisation efforts presented in the previous section demonstrate that a covering approach generates comparatively favourable spatial equity *and* efficiency statistics (see Figures 6.6 and 6.7). The *third* reason for choosing a covering approach is that it reinforces the involvement of decision-makers since it requires them to make normative decisions explicit when deciding upon an acceptable maximum travel time.

Finally, all computations presented in this section are done using the *Flowmap* software and draw upon the simplified model of spatial behaviour as previously developed in section 6.1.

[55] By varying the travel time threshold, the balance between the equity and efficiency goals can be explored.

Identifying spatially redundant health facilities

The central issue addressed in the following pages concerns the identification of health facilities that do not significantly contribute to overall spatial performance. Such facilities - if existent - represent inefficient use of scarce health resources and health planners could decide to discontinue their operation. Such a type of analysis may be required in a situation where health planners are confronted with a budgetary cut. Alternatively, the closing down of inefficient facilities could be viewed upon as a way to adapt a delivery system to a changing spatial environment and redirect scarce health resources towards more efficient use (for example by establishing new facilities in under serviced areas).

How to identify such facilities? The simplest approach is to follow neoclassical location theory and just consider the size of the client base that a health facility will serve given a maximum distance or travel time. Facilities serving a population below a certain threshold are considered too small to sustain service delivery and become candidates for closure. Such a neoclassical approach, however, suffers from a number of drawbacks. *First*, it considers the performance of individual facilities in isolation of each other and does not take into account in how far individual service nodes contribute to the spatial performance of the delivery system as a whole. *Second*, it does not necessarily generate accurate information on the potential loss in customer coverage since clients assigned to a 'to be closed centre' could, in theory, also be in reach of another supply location. *Third*, it does not generate comparative information on the accessibility effects of facility closure: two facilities could have a similar client base but the accessibility effect of closing the one could be very different from closing the other. *Fourth*, in the Dar es Salaam situation a neoclassical approach would imply closing down dispensaries situated in areas of low population density in the more peripheral parts of the city (see Figure 6.4). Obviously, such a decision would be misguided, as these are the very areas where significant population growth is to be expected. On the basis of the above, it is fair to conclude that an exclusive focus on the customer base of a facility is a deficient indicator for evaluating which facility/facilities should be discontinued and which should not. In the following, a more appropriate approach is presented which - unlike the neoclassical perception - incorporates both efficiency and equity considerations.

Figure 6.8 illustrates in some detail the procedure that has been developed. The starting position is the spatially disaggregate population distribution. The *first* step computes - for every origin location - the public transport time to the nearest higher order facility. This is done to *(Step 2)* separate between those clients that - according to the survey outcomes - are likely to take the bus to the nearest higher order facility and those that can be expected to walk to the nearest health facility (for details see Figure 6.2C).

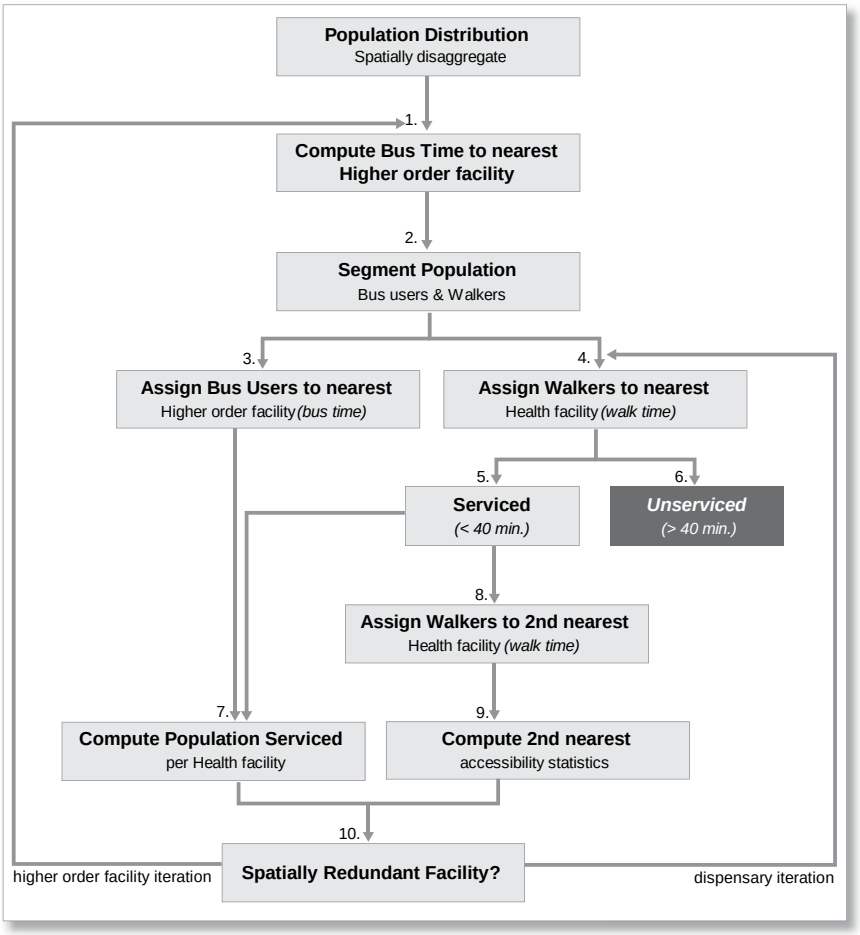


Figure 6.8: Generalized procedure for identifying spatially redundant health facilities.

After that, all bus users are assigned to the nearest higher order facility; walkers are assigned to the nearest health facility irrespective of the level of provision *(Steps 3 & 4)*. At this moment in the procedure a travel time constraint (value judgment!) is applied which partitions the study region into serviced and un-serviced - or spatially disadvantaged - areas and populations *(Steps 5 & 6)*. Obviously, the travel time constraint can be varied and outcomes will differ accordingly. In first instance a choice is made here for a cut-off travel time of 40 minutes as this is a reasonable reflection of the maximum time that patients are willing to walk (see section 5.4). Figure 6.9 visualizes which areas are serviced (in green) and which are un-serviced (in red). With the information generated so far the size and composition - walkers *vs*. bus users - of the client base can be computed for each facility *(Step 7)*. Until this stage, the described methodology is equivalent to a neoclassical approach that considers the use of multiple transport modes.

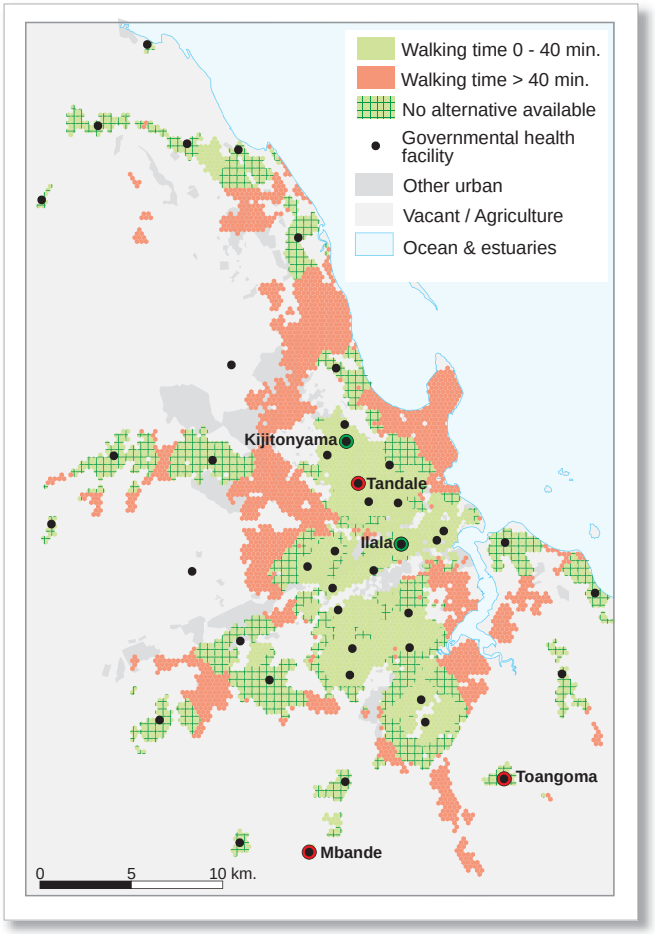


Figure 6.9: Area (un-) serviced by public health care: 40-min. walk time threshold.

The novelty and added value of the approach presented here is encapsulated in *Step 8*, which computes the walking time to the 2nd nearest supply location for all serviced origins. By comparing the results of *Steps 5* and *8*, one can now identify those locations and populations that are within a 40 minute reach of the nearest but out of reach of the 2nd nearest supply location (the cross hatched areas in Figure 6.9). The added-value of this last step is very significant as it makes it possible to - for each health facility - compute the accessibility effects of potential closure in terms of *(i)* the loss in customer coverage and *(ii)* the worst case travel time deterioration. The above-described method, thus, generates accurate accessibility indicators at facility level which incorporate equity as well as efficiency considerations. Because of this it is methodologically superior to a neoclassical approach when it comes to appraising whether or not a given facility could be discontinued.

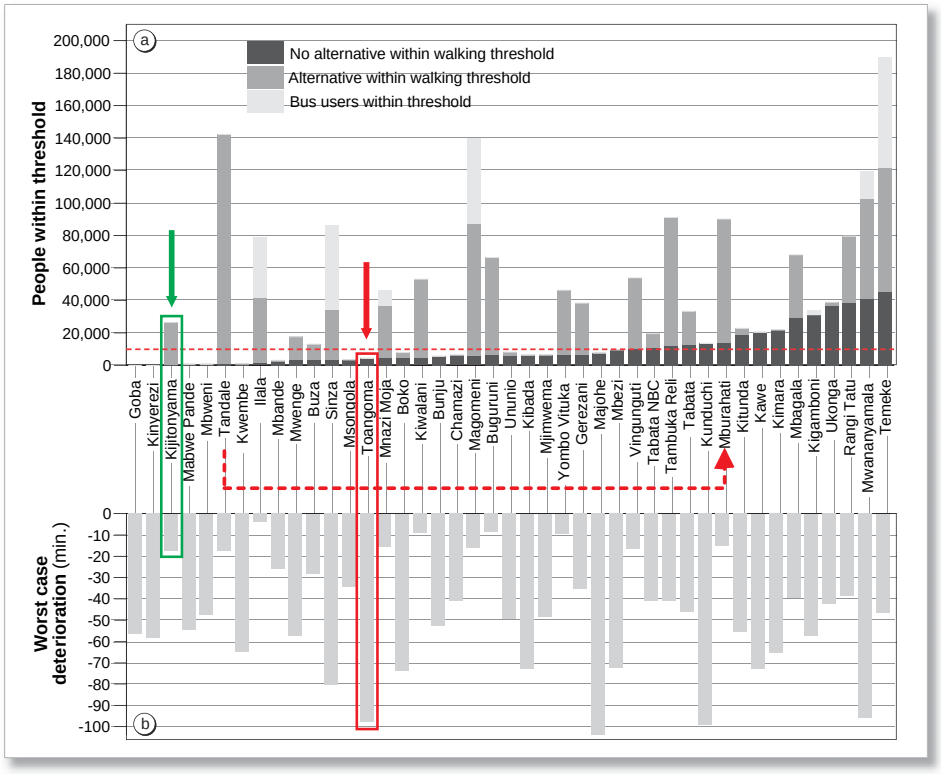


Figure 6.10: Serviced population, potential loss in customer coverage (a) and worst case walk time deterioration (b): 40-min. walk time threshold.

How this works out in the Dar es Salaam situation is further illustrated in Figures 6.10 and 6.11. Figure 6.10a depicts the total client population that is serviced by each facility within 40 minutes of walking time. The client population is segmented into *(i)* bus users, *(ii)* walkers that have an alternative supply location within reach and *(iii)* walkers that lack such an alternative. The latter category represents the potential loss in customer coverage in case a facility is closed: the lower the potential loss the more superfluous a facility is. The larger the loss, on the other hand, the more strategically a facility is situated in geographic space. In Figure 6.10a health facilities are sorted in ascending order of potential loss of customer coverage. Figure 6.10b illustrates the associated worst-case walk time deterioration that occurs in case of closure. Figure 6.11, finally, depicts how the shutting down of a given facility impacts on the client base of the facilities that remain.

To illustrate how this information could be of use to health planners we take a closer look at - by means of example - the dispensaries of Kijitonyama and Tandale and at Ilala hospital. Closer inspection of Figure 6.10a reveals that Kijitonyama dispensary is a prime potential candidate for closure even though it serves a customer base of approximately 27,000 persons (which is well above the national norm).

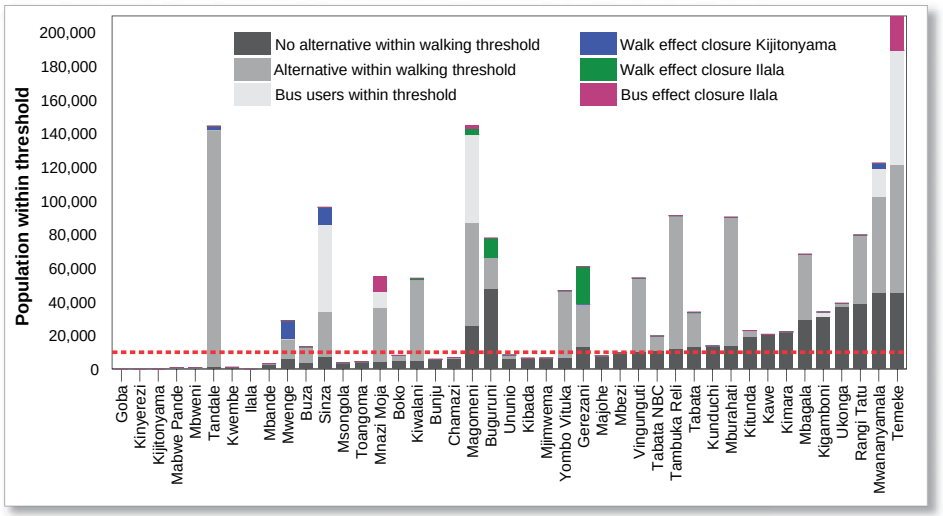


Figure 6.11: Impact of closure on remaining health facilities: 40-min. walk time threshold.

Its candidature for closure, nevertheless, stems from the fact that over 98 percent of its clientele has access to an alternative governmental facility within the selected travel time threshold. The extra travel time imposed on the very small group of people that has no alternative within reach, furthermore, is not excessive as the worst-case walk time deterioration is about 17 minutes (see Figure 6.10b).

How would closure of Kijitonyama affect the performance of the remaining facilities? This information is easily generated by removing Kijitonyama from the set of supply locations and redoing the computations illustrated in Figure 6.8 from Step 4 onwards. Figure 6.11 then shows that terminating medical service provision at Kijitonyama dispensary would mainly and moderately enlarge the customer base of Mwenge and Sinza. Closing down Kijitonyama dispensary, in other words, could be seen as a viable planning intervention since closure *(i)* hardly has negative accessibility impacts and *(ii)* would probably not bring about serious capacity problems at Mwenge or Sinza.

In the same manner, Figure 6.10a indicates that Tandale - by far the largest dispensary - is spatially redundant to a very large degree as well. Around 99.5% of its customers have access to governmental care at an alternative location within the selected walk time threshold and the worst-case walk time deterioration, again, is limited to about 17 minutes. Closure of Tandale, in other words, would not have a significant negative effect on overall spatial performance of the delivery system as a whole. However, in this case the customer base of the neighbouring dispensary of Mburahati would be boosted up from 90.000 to over 190.000 persons (making it about equivalent in size to Temeke, by far the largest hospital in Dar es Salaam). This would not only dramatically worsen the already considerable size imbalance amongst dispensaries but the associated increase in patient throughput at Mburahati dispensary would be immense

and lead to severe capacity problems. Because of the latter, closing down Tandale is not a plausible planning option.

Finally, figure 6.10a, reveals that the provision of outpatient treatment at Ilala hospital also is spatially superfluous to a very large extend: 96 percent of the clientele that comes on foot has an alternative governmental facility within reach. Those that lack such an alternative only have to walk for at most 4 minutes more than the selected threshold permits. Discontinuing outpatient treatment at Ilala hospital, in short, would hardly impact on accessibility. The second question is if termination of outpatient treatment at Ilala is expected to cause capacity problems at the facilities that remain. Estimating how closure of a higher order facility such as Ilala will impact on remaining facilities, however, is slightly more complex than for dispensaries. This is because the estimation procedure should not only consider how closure influences the utilization pattern of walking patients but also how it reshapes that of public transport users[56].

Computationally, this is achieved by removing Ilala hospital from the portfolio of supply locations and redoing the computations as illustrated in Figure 6.8, this time from Step 1 onwards. Figure 6.11 shows that the dispensaries of Gerezani and Buguruni[57] are the main alternatives for walking patients. Temeke and Mnazi Moja are the prime substitutes for those patients that would opt for public transport. Discontinuing outpatient treatment at Ilala hospital, in other words, could be considered as a realistic option as it would only barely reduce accessibility and would not require very major capacity adjustments at the aforementioned substitute facilities.

Indicator:	Candidates for closure:	Existing situation	Accessibility approach *Kijitonyama Ilala*	Neoclassical approach *Mbande Toangoma*
Threshold 40 min.	Population serviced *(%)*	78.0	77.9	77.6
	Loss in customer coverage *(abs.)*	-	2.500	6.750
	Share of pop. with alternative *(%)*	68	97	13
	Worst case walk time deterioration *(min.)*	-	17	98
Global indicators	Overall average walk time *(min.)*	27.7	28.2	28.2
	Worst case walk time *(min.)*	118	118	138
	Gini index	35.0	35.0	36.0

Table 6.3: Impacts of health facility closure on accessibility statistics in case of a 40-minute travel time threshold (walkers only).

[56] The analysis presented in section 5.4 demonstrated that clients of higher order facilities make use of public transport about as much as they travel on foot.
[57] Closure of Ilala would make that Buguruni dispensary becomes a much more strategically located facility (see figure 6.11).

Up to this point, quantitative accessibility indicators *at facility level* have been used to appraise whether an individual facility could be discontinued or not. The effect that closure of a particular facility/facilities would have on the spatial performance of the delivery system *as a whole* remains to be addressed. This is done in a comparative manner to illustrate that the methodology presented here produces more equitable results than a neoclassical approach. As argued above, both Kijitonyama and Ilala (outpatients only) are prime candidates for closure in case an accessibility perspective is taken. If a neoclassical approach is pursued Figure 6.10a demonstrates that Mbande and Toangoma[58] become prominent nominees for closure as both are small-scale facilities with a customer base well below the national threshold norm.

Table 6.3 summarizes - for each perspective - how closure would affect the overall spatial performance of the Dar es Salaam governmental health delivery system. The indices clearly show that the accessibility-based reduction methodology is superior to a neoclassical approach as *(i)* the total loss in customer coverage is significantly lower, *(ii)* the worst-case travel time deterioration is very much less and, *(iii)* spatial inequality does not (measurably) increase. It is important to underline that these favourable outcomes are achieved in spite of the fact that the combined customer base of Kijitonyama and Ilala is *very* much larger than that of Mbande and Toangoma.

As argued earlier on in this section, an important motive for favouring a covering approach is that it provides policy makers with a flexible planning framework that can be used to explore the effects of alternative policy options (norms). So far, the analysis has been based upon a minimum standard of 40 minutes of walking time; a realistic proxy of the maximum time that patients are willing to travel. Health planners, however, will also desire to investigate if a different policy norm leads to different planning propositions. To illustrate in how far this is the case in the Dar es Salaam context, the reduction approach - as illustrated in Figure 6.8 - is repeated using a more egalitarian minimum standard of 30 minutes of walking time. The outcomes of these computations are visualised in Figures 6.12 to 6.14 and in Table 6.4 and are obtained in the same manner as described before.

A number of observations - some very obvious - can be derived from them. *First*, a more egalitarian minimum standard makes that more locations and people become labelled as spatially disadvantaged (from 22 to about 35 percent). *Second*, it makes that fewer locations and people are considered to have access to more than one governmental facility. The overall degree of spatial redundancy thus reduces (from 68 to 37 percent).

[58] Both are situated in areas of low population density in the southern periphery of the city (see figure 6.9).

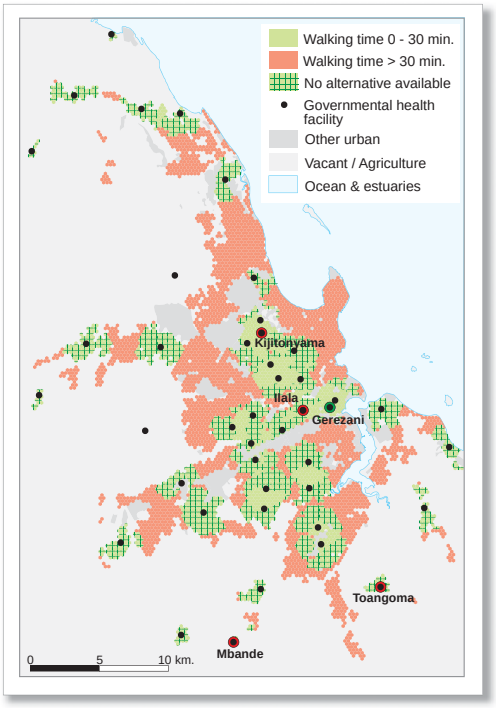


Figure 6.12: Area (un-) serviced by public health care: 30-min. walk time threshold.

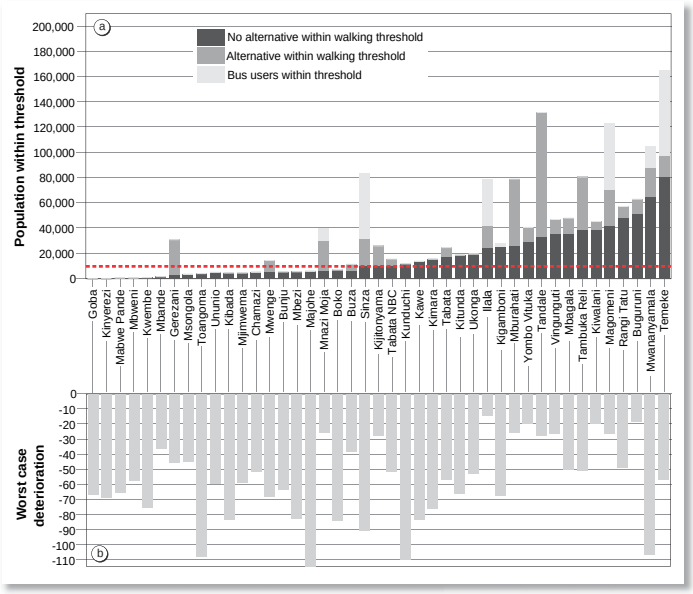


Figure 6.13: Serviced population, potential loss in customer coverage (a) and worst case walk time deterioration (b): 30-min. walk time threshold.

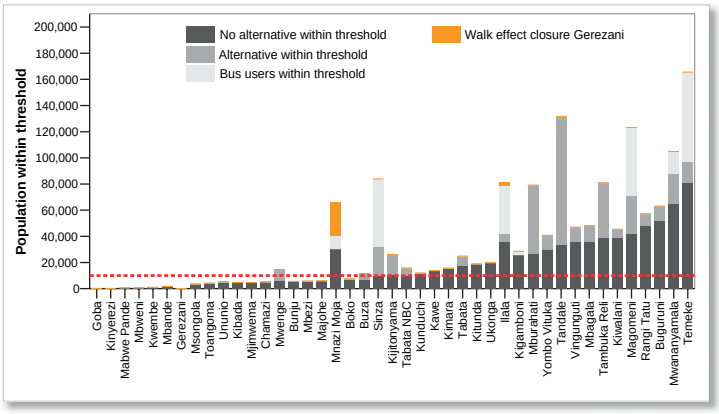


Figure 6.14: Impact of closure on remaining health facilities: 30-min. walk time threshold.

The *third* observation is that the accessibility-based reduction approach again generates superior accessibility statistics in comparison to a neoclassical approach. The *fourth* and by far the most revealing observation, however, is that the two policy norms generate very different and even incongruous planning propositions. In case of a 40-minute threshold we have seen that there are good arguments to discontinue the dispensary of Kijitonyama and outpatient treatment at Ilala hospital. In case of a 30-minute threshold this is definitely not the case. Likewise, the dispensary of Gerezani is the prime candidate for closure in case of a 30-minute threshold but hardly so in case of a minimum standard of 40 minutes (compare Figures 6.10a and 6.13a). These apparently incoherent outcomes do not mean that the methodology itself is unsound. In stead, it signals that an accessibility-based reduction approach is very sensitive to the threshold value selected[59]. This, in turn, underlines the importance of choosing a cut-off travel distance or time that truthfully reflects actual spatial behaviour. Failing to do so would lead to misguided planning interventions.

Although the methodology presented in this section is both sound and flexible, it is acknowledged that discontinuing public health facilities in a rapidly developing city such as Dar es Salaam will not be easy in practice. Politicians will not favour that health facilities be removed from their constituencies and local authorities may face opposition from affected residents. The resentment created by closing facilities, furthermore, could possibly be greater than the goodwill created by opening others (Rushton, 1984; Rahman and Smith, 2000; Kumar, 2004). The justification for using the described methodology to critically appraise a given spatial context, nonetheless, is founded in the principle that public service provision should aim to generate as much user benefits as possible with scarce resources. The presence of spatially redundant

[59] Particularly in spatial contexts characterized by large variations in population density.

facilities stands for inefficient use as well as inequitable distribution of available resources and should thus be avoided as much as possible, particularly in spatial contexts characterized by an overall shortfall in resource allocation.

		Existing situation	Accessibility approach	Neoclassical approach
Indicator:	**Candidates for closure:**		Gerezani	Mbande Toangoma
Threshold 30 min.	Population serviced *(%)*	65.2	65.0	64.8
	Loss in customer coverage *(abs.)*	-	3.000	6.000
	Share of pop. with alternative *(%)*	37	90	0
	Worst case walk time deterioration *(min.)*	-	45	108
Global indicators	Overall average walk time *(min.)*	27.7	28.2	28.2
	Worst case walk time *(min.)*	118	118	138
	Gini index	35.0	35.0	36.0

Table 6.4: Impacts of health facility closure on accessibility statistics in case of a 30-minute travel time threshold (walkers only).

With the approach described in this section, in summary, health planners are provided with a reliable and flexible planning instrument to identify spatially superfluous health facilities and estimate the effects that the closing down of facilities would have on the performance of those that remain. In the next section, attention shifts from serviced to un-serviced areas and emphasis is placed on developing a planning methodology that can be used to identify priority locations for establishing new health facilities in spatially disadvantaged city areas.

Identifying priority locations for establishing new dispensaries

This section presents a spatial planning method that can *(i)* identify areas and populations that are not well served by a given constellation of provision, *(ii)* chart out priority areas for expansion of a delivery system and *(iii)* estimate the expected improvement in spatial performance associated with proposed planning interventions. Health planners and policy makers will commonly require such a planning method, particularly, in the developing world where spatial contexts are highly dynamic as a result of rapid urbanization.

Before proceeding, it should be stated that in the following reference is always made to establishing *new* health facilities but it is evident that the same approach can also be used in an alternative manner. In case non-governmental health care providers are already operational in identified priority areas, health planners could decide not to construct a new governmental facility but in stead opt for some form of contractual agreement with an existing non-governmental provider to ensure that medical care of equivalent cost and quality becomes available to the inhabitants of spatially disadvantaged areas (also see section 4.6).

How to identify such priority locations? As before we first reflect how this would work out if a strictly neoclassical approach were pursued. In this case, the guiding principle for establishing one or more new health facilities is to identify areas/locations where the expected number of clients is the highest, taking the spatial competition effect of existing facilities into account. Computationally, spatial competition is accounted for by calculating - for every potential new destination - how the origins (or an associated weight variable) are divided between that potential new destination and the existing ones. Clients are only allocated to a potential new facility if it is nearer to their home than any of the existing facilities (this follows from the premise of spatial rationality). The typical result of a neoclassical expansion approach is that locations with a high market potential are found in areas of comparatively high population density. High-potential locations, furthermore, will frequently be situated near to an existing facility where the newcomer can successfully compete for market territory and 'steal' or 'cannibalize' a proportion of the competitors market (Ritsema van Eck and de Jong, 1999).

This makes that a neoclassical (competitive) approach is unsuited for distributing additional *public* resources in geographic space for two reasons. *First*, the search procedure aims to maximize the client share of the individual new facility without considering the potential impact on overall spatial performance. *Second*, a neoclassical approach easily leads to spatially redundant solutions which - as previously argued - is a signal that public resources are used in an inefficient and inequitable manner (Table 6.5 confirms that this would indeed occur in the Dar es Salaam situation).

A straightforward expansion approach for public services that does not suffer from above-mentioned shortcomings is elaborated in the following (see Figure 6.15)[60]. A closer inspection of Figure 6.15 shows that the expansion approach is a logical extension of the previously designed methodology to identify spatially redundant health facilities. It works as follows. Like before, the client population is first segmented into bus users and walkers and accordingly allocated to the nearest supply location *(Steps 1 - 4)*. After that, a constrained catchment area analysis is applied to partition the study area into serviced and un-serviced areas and populations using a maximum walk time constraint of, in first instance, 40 minutes *(Steps 5& 6)*. From here onward the approach is new. Based upon the un-serviced population, priority areas for expansion of the delivery system are identified by means of a proximity count *(Step 7)*. In general terms, a proximity count summates - for each possible destination - the number of origins (or an associated weight variable) within a user-defined maximum distance or travel time.

[60] The methodology described here is a blend of and extension to approaches described by (de Jong *et al.*, 1991; de Jong and Ritsema van Eck, 1996; de Jong and Ritsema van Eck, 1997; de Jong and Krygsman, 1999; Ritsema van Eck and de Jong, 1999).

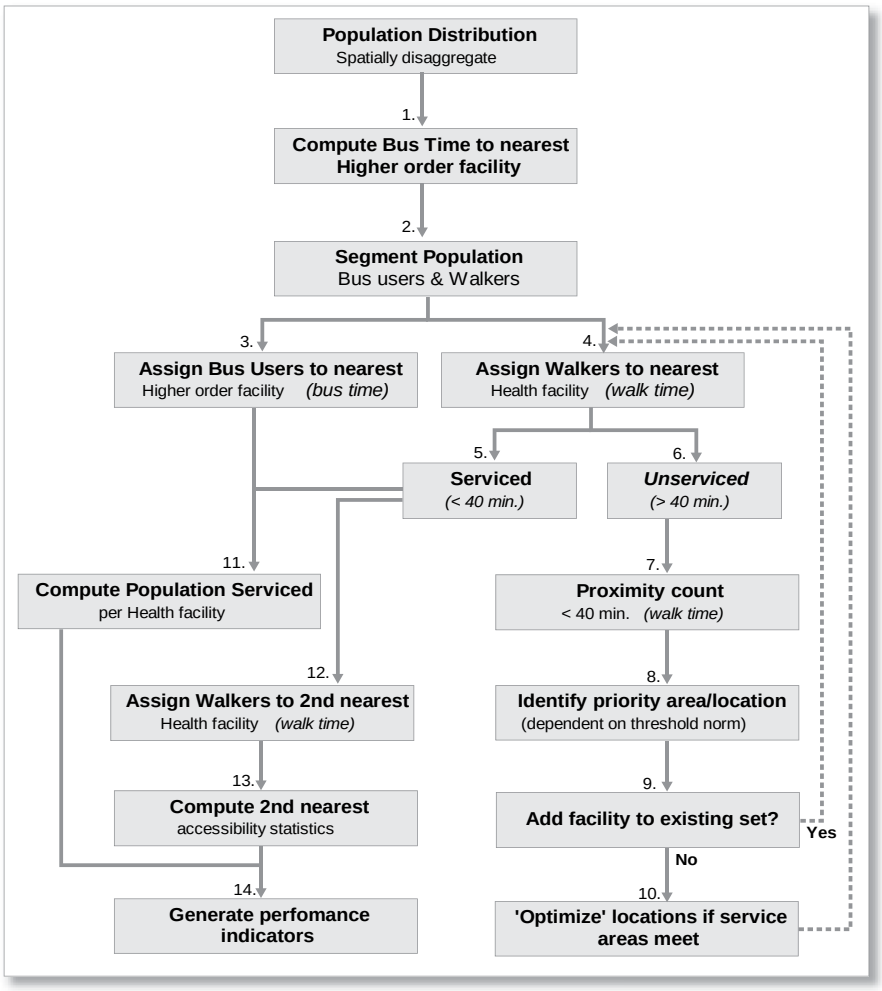


Figure 6.15: Generalized procedure for expanding a public service delivery system with additional dispensaries.

A proximity count does not take spatial competition effects into account (van der Zwan *et al.*, 2005). Here, the proximity count is used to compute - for each potential destination location - the number of un-serviced clients that live within a cut-off walking time of 40 minutes. The outcome, thus, gives an indication of the potential customer base for every un-serviced destination location. This information, in turn, can be used by health planners to determine whether or not the market potential of a prospective site is large enough to justify the establishment of a new facility *(Step 8)*. Depending on the prevailing policy norm and/or available resources, health planners may now decide to establish one or more new facilities in areas of high market potential.

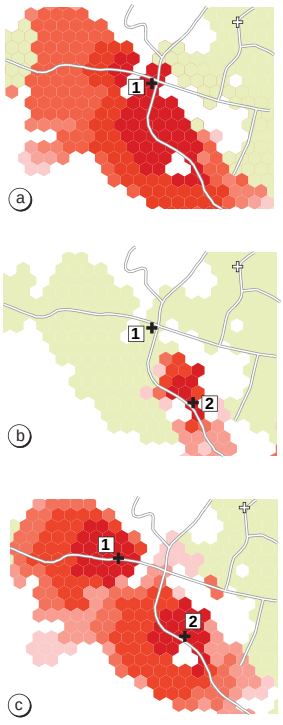
For informed decision making, however, planners also need to know what the expected improvement in spatial performance of a prospective planning intervention will be. This information is generated in an iterative manner as follows: *(i)* add the prospective site to the set of existing supply points *(Step 9)*, *(ii)* redo the constrained catchment area analysis (*Steps 4 - 6*), *(iii)* recalculate the population serviced per health facility *(Step 11)*, and *(iv)* re-compute the walking time to the 2nd nearest supply location for all serviced origins *(Steps 12 & 13)*. Note that the impact analysis procedure is largely equivalent to that used for the reduction approach.

When multiple new facilities are planned for, it is conceivable that large un-serviced areas with bigger populations require the establishment of more than one additional facility. In spatial situations such as this - where the service areas of prospective facilities will be contiguous - the expansion approach requires an additional procedure (*Step 10*) to ensure that spatially efficient and equitable outcomes are generated. As this is a more technical exercise it is separately detailed in Box 6.1.

Illustration A shows (in red) an un-serviced area where the proximity count is used to identify locations with a sufficiently large customer base. The darker the red, the larger the potential customer base (facility 1 is situated at the best scoring location).

Illustration B shows how the serviced area (in green) expands if facility 1 is established. It also illustrates that adjacent un-serviced area remains which has a sufficiently large customer base to justify the establishment of a second prospective facility (facility 2 is again situated at the best scoring location). The problem in situations such as this is that an optimal choice is made twice but that the two identified best scoring locations might together be sub optimally situated in terms of the customer coverage gain that could potentially be realized. The real question, thus, is to subdivide an un-serviced area into two - or more - service areas in such a way that the two best scoring locations together represent the maximum reachable gain in customer coverage.

Computationally, this is resolved via the following (optimization) procedure. After identifying the best scoring location for the second facility, the first is removed from the set of supply locations and a new constrained catchment area analysis and proximity count are performed to identify the now best scoring location. The new best scoring location is then added to the set of supply locations after which the second facility is removed and a new constrained catchment area analysis and proximity count is done for unserviced areas/populations. This procedure is repeated until no further improvement in customer gain is realized. Illustration C visualizes how this procedure segments an un-serviced area into multiple service areas and displays where new facilities should preferably (or: optimally) be situated.



Box 6.1: Segmentation of service areas in situations of spatial contiguity.

How the above-described expansion approach is works out in the Dar es Salaam situation is further illustrated in Figures 6.16 and 6.17. Figure 6.16 is a trend surface

map that visualizes the spatial variation in market potential. Areas in the light pink tone are serviced, cross-hatched areas are un-serviced but have a market potential which is too low to serve a viable customer base according to the national threshold norm (10,000 persons). The 'green to red' colour transition depicts un-serviced areas with increasing market potential and therefore represent priority areas for intervention. A closer look at Figure 6.16 shows that there are quite a number of un-serviced areas in Dar es Salaam with a sufficiently large market potential to establish a new facility. The most pressing priority areas are Kurasini, Mabibo and Msasani. Additional areas of concern are - from north to south - Tegeta, Mbezi, Kimanga, Segerea, Kipunguni, Mtoni Kijichi and Kilwa. Depending on the prevailing policy norm and availability of financial means, health planners may now decide to establish one or more new facilities in abovementioned areas.

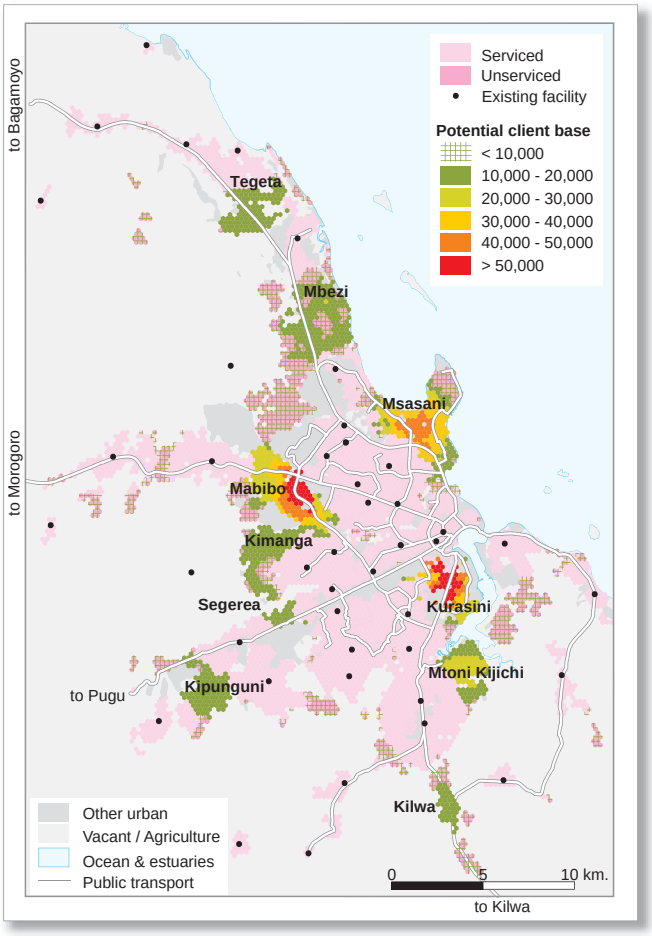
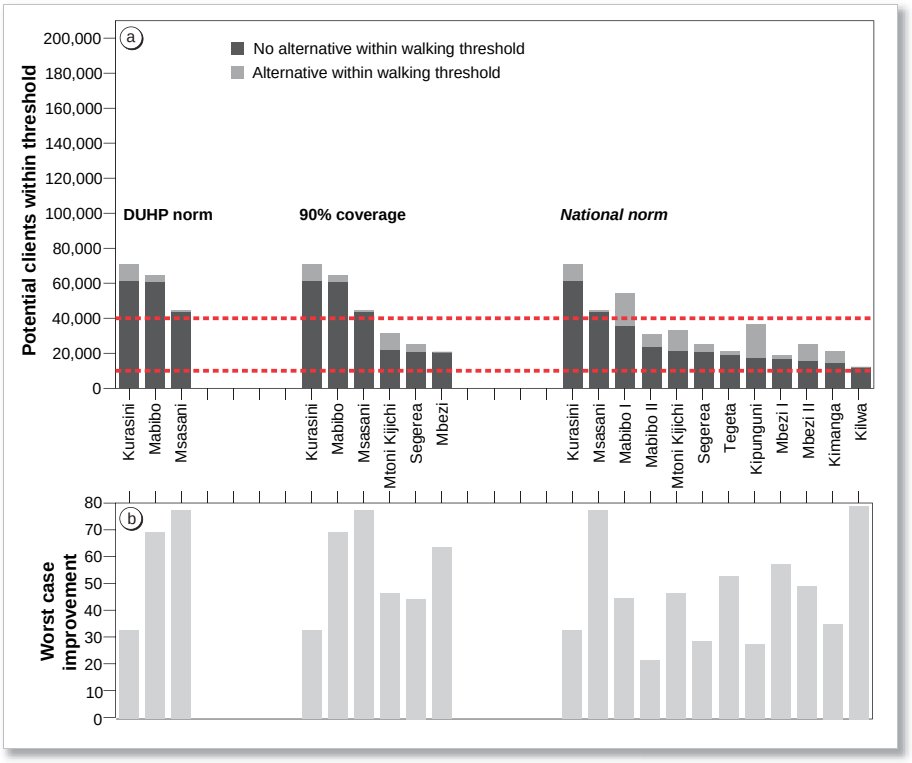


Figure 6.16: Trend surface map visualizing priority areas for expansion: 40-min. walk time threshold.

Although the expansion method can be used to add any number of new facilities, three possible expansion scenarios are briefly presented here by means of example (see Figure 6.17a)[61]. The *first* scenario takes the DUHP norm as the point of departure. This means that a new facility should be established whenever a target population of about 40,000 people can be serviced (also see section 6.1). Under these conditions, only three additional facilities would need to be established as all other potential destination locations do not reach this threshold norm. Priority target areas would respectively be Kurasini, Mabibo and Msasani.

The *second* scenario reflects a policy strategy that aims for 90% service coverage of the Dar es Salaam population. To reach this more ambitious aim, six additional facilities would need to be established. In addition to the three listed just above, new facilities would also have to be founded in Mtoni Kijichi, Segerea and Mbezi.



[61] In reality a suitable location should be identified somewhere within a priority area. Such a search effort would normally require further field investigation. As this is not possible within the framework of this research, the best scoring sites are selected here to demonstrate what the anticipated spatial impact of proposed planning interventions will be.

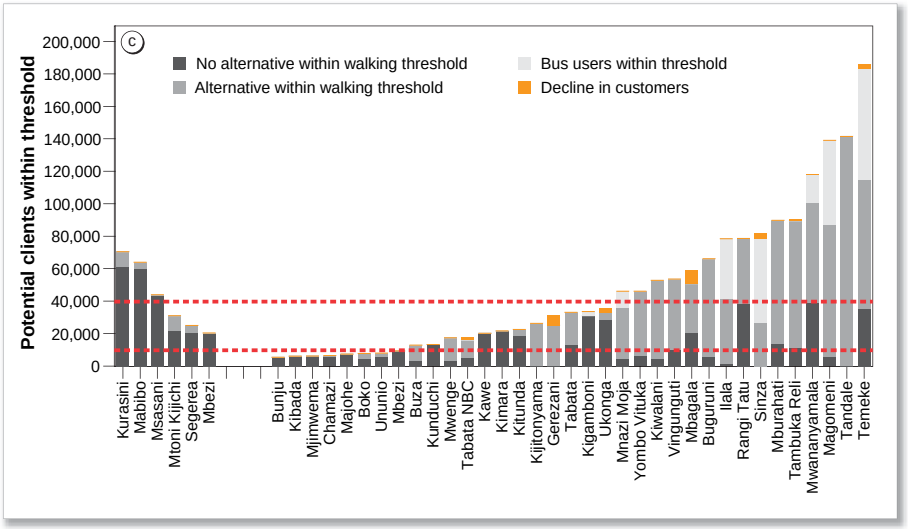


Figure 6.17: Expansion scenarios, expected customer base and anticipated impacts on system performance: 40-min. walk time threshold

The *third* and most striving scenario takes the national norm as the point of departure and aims to establish a facility whenever a population of about 10,000 people can be serviced. To reach the latter objective, twelve additional dispensaries would be required (see Figures 6.16 and 6.17 for the names and locations of the identified priority areas).

Figure 6.17a depicts - for each scenario - the total client population that is expected to be serviced by each prospective new facility within a cut-off walking time of 40 minutes. As before, the customer base is divided into *(i)* walkers that have an alternative governmental facility within reach and *(ii)* walkers that lack such an alternative. The first category represents the service overlap (redundancy) with neighbouring facilities; the latter represents the potential gain in customer coverage. Figure 6.17b illustrates the associated worst-case walk time improvement. Figure 6.17*c* depicts the expected impact of prospective facilities on the performance of the facilities that already exist.

If we take the 90% coverage scenario as example, Figure 6.17a shows that each of the six prospective facilities could serve an adequate number of customers. Future dispensaries in Kurasini and Mabibo could serve about 60,000 persons. A new dispensary in Msasani could reach a population of about 45,000. Dispensaries to be situated in Mtoni Kijichi, Segera and Mbezi could each service a population of about 20,000. Figure 6.17a, furthermore, illustrates that prospective facilities will only have very limited service overlap with existing facilities. New facilities, in other words, will primarily lead to increased customer coverage and improved overall spatial performance. Figure 6.17c, further confirms that spatial competition between

prospective and existing governmental facilities would largely be absent since new facilities hardly 'steal' clients from those that exist[62]. Finally, a combined look at Figures 6.17a and 6.17b shows that, for example, Kurasini and Mabibo score about equally in terms of customer gain but that Mabibo reduces the worst case walk time more and thus performs better in case an egalitarian perspective is embraced. In a situation where health planners need to decide where to put their priority the latter information could be used as a secondary consideration in the decision-making process.

So far, the discussion has focused on quantitative accessibility indicators *at facility level* only. The collective impact of prospective facilities on the spatial performance of the delivery system *as a whole* is briefly touched upon below. This is again done in a comparative manner to illustrate that the methodology presented here generates more efficient *and* more equitable results than a neoclassical approach. Table 6.5 presents a number of performance indicators for each approach and scenario.

		Existing situation	**Accessibility approach**			**Neoclassical approach**
Indicator:		43 facilities	DUHP norm (add 3)	90% coverage (add 6)	National norm (add 12)	Example: add 3
Threshold 40 min.	Population serviced *(%)*	78.0	86.8	90.1	95.3	80.4
	Customer base *(000)*	1,485	179	257	394	284
	Customer coverage gain *(000)*	-	166	229	303	45
	Spatial redundancy *(%)*	68	8	11	23	84
Global indicators	Average walk time *(min.)*	27.7	25.0	23.5	21.4	26.4
	Worst case walk time *(min.)*	118	118	118	105	118
	Gini index	35.6	33.1	30.9	28.8	36.6

Table 6.5: Impacts of prospective health facilities on accessibility statistics in case of a 40-minute travel time threshold (walkers only).

To begin with, the indices clearly show that a neoclassical approach indeed identifies locations with a very high market potential. At the same time, it is apparent that the degree of spatial redundancy is staggeringly high so that only a very limited gain in customer coverage would be realized. Also observe that the neoclassical expansion example leads to increased spatial inequality. Overall system performance, in short, hardly benefits from a neoclassical approach. The performance indices for the accessibility-based expansion scenario's, on the other hand, demonstrate that prospective facilities would mainly contribute to increased customer coverage and only have very limited service overlap with existing facilities.

[62] A new dispensary in Kurasini, however, would make the Gerezani dispensary spatially redundant.

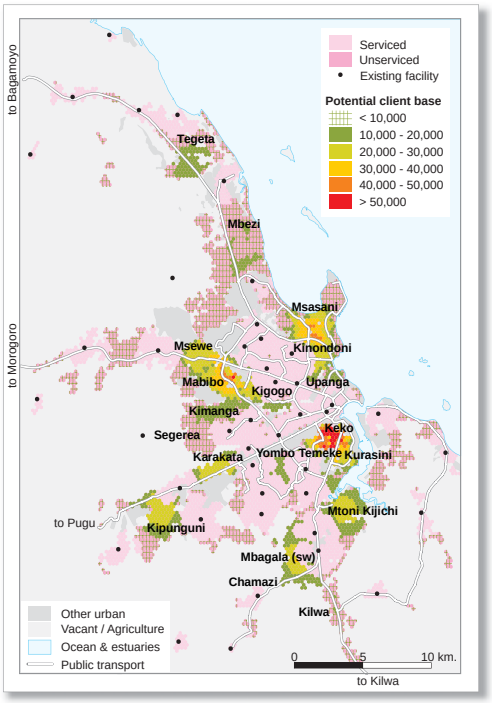
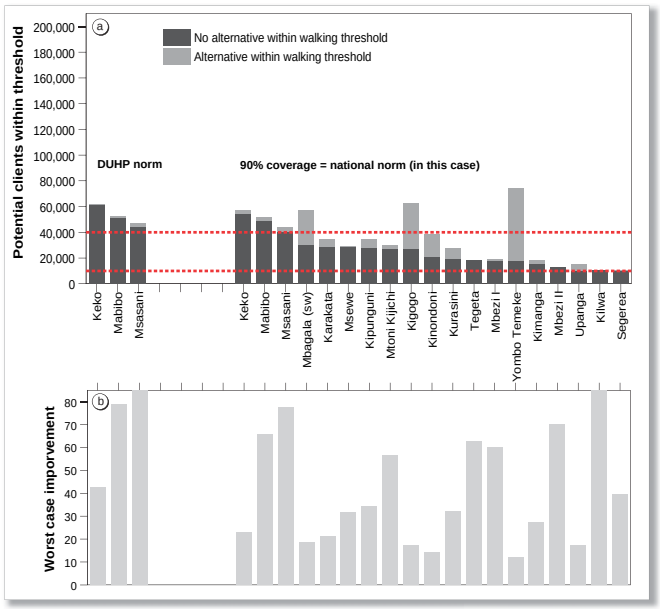


Figure 6.18: Trend surface map visualizing priority areas for expansion: 30-min. walk time threshold.



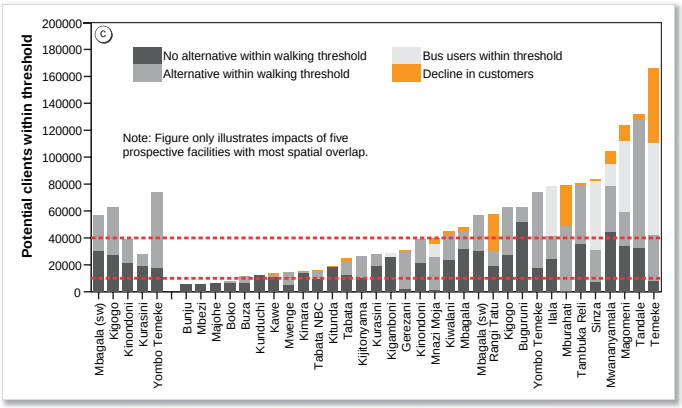


Figure 6.19: Expansion scenarios, expected customer base and anticipated impacts on system performance: 30-min. walk time threshold.

The system-wide performance indicators, furthermore, indicate that the average walking time decreases and that spatial inequality (see Gini index) reduces as more facilities are added. The accessibility-based approach, in summary, distributes scarce resources in a manner which is both efficient and equitable.

To illustrate in how far identified priority areas/locations are sensitive to the selected travel time threshold - a policy decision as well - the expansion scenarios have been replicated using a stricter threshold of 30 minutes of walking time. The outcomes are presented in Figures 6.18 and 6.19 and in Table 6.6. These outcomes are again generated using the procedure described in Figure 6.15.

A number of conclusions - some very obvious - can be drawn on the basis of these. *First*, a stricter walk time threshold implies that *(i)* more locations and people become earmarked as spatially disadvantaged, *(ii)* the degree of spatial overlap of the existing configuration declines and *(iii)* the extent of the un-serviced area with a market potential too low to serve a viable customer base increases. *Second*, the system-wide performance indicators presented in Table 6.6 once more underline that an accessibility-based expansion approach generates more equitable and efficient outcomes than a neoclassical approach. *Third* and more interesting is that a comparison of Figures 6.16 and 6.18 shows that outcomes are not particularly sensitive to the selected travel time threshold as the highest ranking priority areas (Kurasini/Keko, Mabibo and Msasani) remain the same.

It, on the other hand, is also evident that a policy choice that favours a 30-minute threshold and aims at 90% population coverage would require the establishment of considerably more additional facilities (19 in stead of 6). It is also clear that a more densely spaced health delivery system acquires slightly more spatial overlap (compare

Tables 6.4 and 6.5)[63]. Obviously, the establishment of such a more densely spaced health delivery system[64] would require substantially more financial means.

Indicator:		Existing situation	Accessibility approach		Neoclassical approach
		43 facilities	DUHP norm (add 3)	90% coverage & National norm (add19)	Example: add 3
Threshold 30 min.	Population serviced *(%)*	65.2	73.4	90.4	67.8
	Customer base *(000)*	1,240	1,397	1,719	1,276
	Customer coverage gain *(000)*	-	157	479	36
	Spatial redundancy *(%)*	38	3	27	86
Global indicators	Average walk time *(min.)*	27.7	24.7	18.7	26.9
	Worst case walk time *(min.)*	118	118	106	118
	Gini index	35.6	34.2	30.0	37.6

Table 6.6: Impacts of prospective health facilities on accessibility statistics in case of a 30-minute travel time threshold (walkers only).

The accessibility-based expansion approach described in the preceding pages, in conclusion, provides health planners with a flexible planning instrument to identify priority areas for establishing new dispensaries *and* estimate the expected - local and global - impact of potential interventions on the spatial performance of the delivery system. The next section, deals with a third important spatial planning question with which health planners have to deal with: the issue of the hierarchical organization of health delivery systems.

Reorganizing the health service delivery hierarchy

Up to this point, the presented planning instruments are designed for spatial interventions at dispensary level. In this section we broaden the scope of the analysis and acknowledge the fact that health care systems are generally organized - functionally *and* spatially - in a hierarchical manner. In the Dar es Salaam situation, dispensaries form the bottom of the hierarchy, health centres stand for the intermediate level and hospitals represent the apex of the hierarchy. All facilities are part of a successively-inclusive hierarchy whereby higher order facilities also offer the medical services provided by facilities at lower orders (also see section 4.6).

This section subsequently describes two planning instruments. With the *first*, health planners can assess in how far existing higher-order health facilities contribute to

[63] This, however, only occurs with a limited number of prospective facility locations (see figure 6.19). The clearest example would be a new facility in the Yombo Temeke area which would deflect a significant number of clients away from - the overcrowded - Temeke hospital.
[64] See figures 6.18 and 6.19 for the names and locations of the identified priority areas.

overall spatial performance. The basic idea is that higher-order facilities that do not contribute sufficiently represent inefficient use of scarce resources and could potentially be reduced in rank and become a lower-order service node. Resources released in this way could potentially be put to better use elsewhere. To avoid repetition the spatial performance of health centres is evaluated here only. The same approach, however, can also be used to appraise the spatial performance of hospitals. The *second* planning instrument considers the reverse situation: some dispensaries could be situated at locations with a very high service potential. Such strategically situated dispensaries could be good candidates to be promoted and become a higher-order service node (a health centre in this case). With these two tools health planners can reorganize the spatial hierarchy of provision in such a way that the spatial performance of the higher-order delivery system improves.

Although research design, primary data collection efforts (see section 3.3) and subsequent analyses have emphasized out-patient primary care as provided at dispensary level, the above-described spatial problems are considered to be within the scope of this research. The justification is that the spatial hierarchy of provision is an issue with which health planners will, in reality, also need to deal with when addressing the spatial organization of health service delivery systems.

Like before, the driving welfare objective is the 'covering principle' which means that the existing situation and the impacts of potential interventions are primarily evaluated in terms of their expected impact on customer coverage given a desired threshold travel time. Until now, these travel time thresholds could directly be derived from observed regularities in spatial behaviour (see section 5.4). Data collection efforts, however, made no explicit attempt to unearth spatial behaviour patterns for other than mild health problems. The travel time thresholds used in the following pages are, therefore, not empirically derived but do represent an 'educated estimation' and are felt to be sufficiently realistic. The outcomes of the analyses presented in the remainder of this section should, nevertheless, be seen in this light as different thresholds will tend to lead to different outcomes.

The discussion is structured in the same way as before and - for each of the two presented spatial problems - consists of three parts. The *first* is a step by step overview of the computational building blocks of the procedure itself. The *second* describes the spatial performance of individual facilities under different scenarios. The *third* focuses on the expected local and global effects of potential interventions on spatial performance. A comparison with a neoclassical approach is not made as previous discussions have adequately demonstrated that a neoclassical approach is not to be preferred in situations where maximization of customer coverage of a delivery system as a whole is the driving welfare objective.

Spatial problem 1: how good is the spatial performance of existing higher-order facilities?
The following pages present an approach that can be used to assess whether or not existing higher-order facilities - *i.e.* health centres - contribute sufficiently to spatial performance. The point of departure is that higher-order facilities that do not contribute sufficiently represent inefficient use of scarce resources. Such facilities - if existent - could potentially be demoted to become a lower-order service node. Demoting spatially inefficient higher-order centres is viewed upon as one of the possible ways to adapt a delivery system to a changing spatial environment and redirect scarce health resources towards more efficient use (for example by establishing a new health centre at a high-potential location).

Conceptually the approach presented here is equivalent to the reduction approach described earlier on in this section but, as explained below, it is less elegant in computational terms.

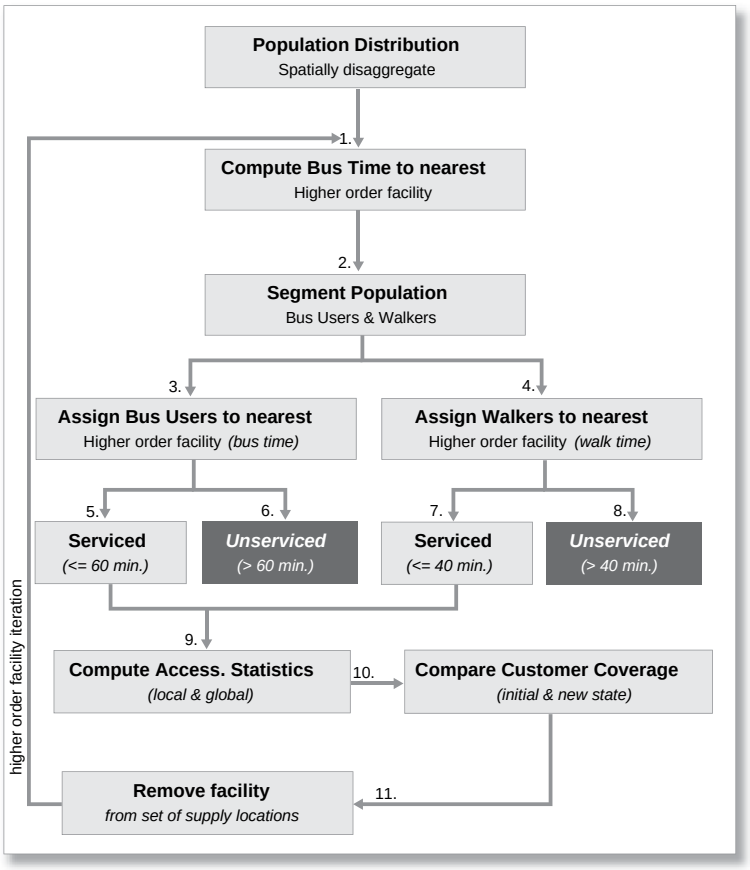


Figure 6.20: Generalized procedure for computing the spatial performance of health centres (figure illustrates threshold values of Scenario 1).

Figure 6.20 illustrates the method that has been developed to assess if individual health centres contribute sufficiently to customer coverage. The starting position is the set of existing higher-order facilities (four health centres and three hospitals). Hospitals form part of the set of supply locations as they also provide health centre level medical services. Dispensaries are not considered. The approach first categorizes the client population in each origin location into bus users and walkers. The proportion of bus users versus walkers varies with the public transport time to the nearest higher order facility (see Figure 6.2C for details). Then, it allocates each category to the higher-order supply location that is nearest in time *(Steps 1 - 4)*.

Since clients of higher-order facilities come on foot as well as by bus, *two* separate constrained catchments area analyses are required to partition the Dar es Salaam population into those that are serviced and those that are not *(Steps 5 - 8)*. The first assigns designated public transport users, the second those that are expected to walk. Each of the two catchment area analyses has its own travel time constraint (value judgment!). Here a choice has been made to further pursue two scenarios. The first presupposes a cut-off walking time of 40 minutes in combination with a cut-off public transport time of 60 minutes. The second scenario assumes a 60-minute walking time threshold together with a 60-minute public transport time threshold. Figure 6.21 visualizes how this looks like in the Dar es Salaam situation. It displays the unconstrained catchment area of each higher-order facility and - see map inset - shows the spatial extent of the walk and bus time thresholds used to compute performance indicators using Sinza health centre as example.

Step 9, then computes - for each scenario - a series of accessibility indicators and estimates the total number of customers within reach for every higher-order facility. Although these indicators provide a good insight in the collective performance of a given set of higher-order facilities, they do not show how much spatial overlap exists amongst individual facilities. This makes it impossible to assess what the added value of individual facilities is.

As previously argued, it is not only the total number of customers within reach that determines the added value of a facility but also the potential loss in customer coverage in case a facility is closed. The lower the loss the more superfluous a facility is; the larger the loss the more strategic a facility is located.

In the case of dispensaries, spatial overlap was simply identified by computing the walking time to the 2nd nearest supply location for all serviced origins and - for each facility - add up the number of walking customers that also have an alternative facility within reach. This method is perfectly valid as long as the spatial configuration of higher-order provision remains unchanged. Under this condition the number of public transport users per origin location *and* their higher-order destination facility remains the same so that the degree of spatial overlap can be computed unambiguously.

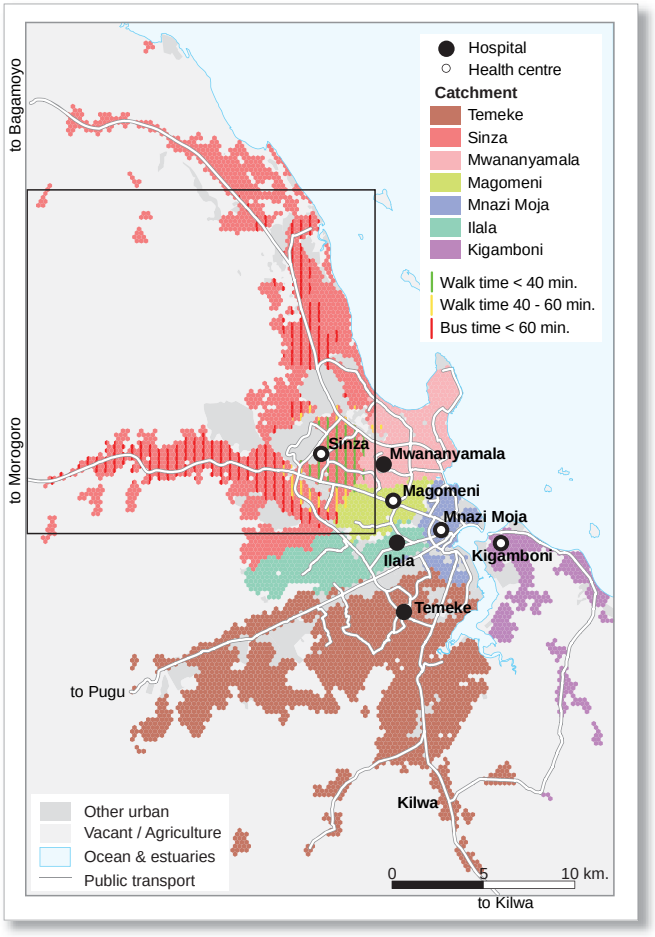


Figure 6.21: Unconstrained catchment areas and spatial extent of walk and bus time thresholds (example of Sinza health centre).

The complication that occurs in the case of higher-order facilities is that a change in the spatial configuration leads to changes in public transport time to the nearest higher-order facility and thus to changes in the proportion of public transport users and walkers in a potentially large subset of origin locations. This, in short, means that the 2nd best approach cannot be used to accurately compute the degree of spatial overlap between higher-order facilities.

Because of this, an alternative and computationally more intensive approach is required whereby health centres are - one at a time - removed from the set of supply locations *(Step 11)* after which the computations recommence from Step 1 onwards. After each iteration, aggregate customer coverage of the set of existing higher-order facilities *(n)* is compared with that of the spatial constellation with *n* - 1 facilities *(Step 10)*. The

difference between the two - the potential loss in customer coverage - represents the added value of the removed health centre. Altogether, the above described stepwise approach generates the same accessibility statistics as the earlier presented planning instruments.

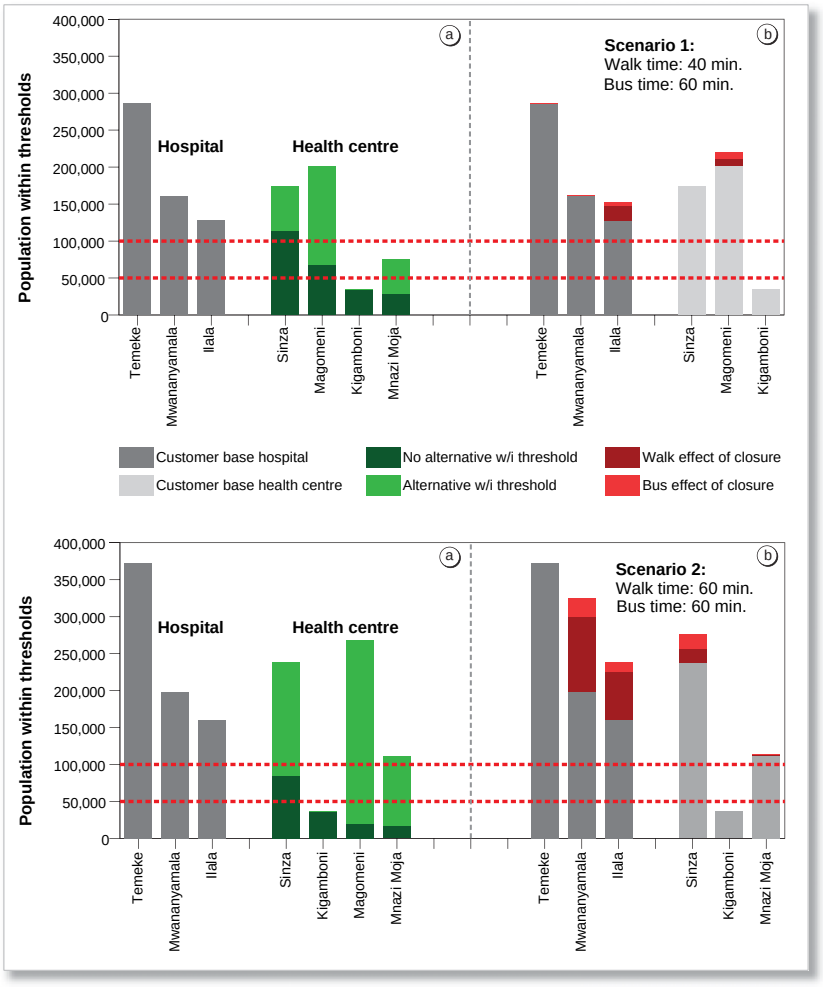


Figure 6.22: Serviced population, potential loss in customer coverage (a) and impact of closure on remaining higher order facilities (b).

How the governmental health centres in Dar es Salaam perform under both scenarios is illustrated in some detail in Figure 6.22. Figure 6.22*a* shows the total customer base for hospitals and health centres for each scenario. For health centres the clientele is segmented into those customers that have an alternative facility within reach and those that do not. The first category represents the degree of spatial overlap with

neighbouring higher-order facilities; the second group embodies the actual contribution to customer coverage for each facility.

If we take *Scenario 1* as the point of departure it can be seen that Magomeni health centre serves the largest number of customers (around 200,000), closely followed by Sinza health centre which reaches about 175,000 people. Mnazi Moja and Kigamboni health centres both serve a much smaller customer base (around 75,000 and 35,000 persons respectively). It can also be seen that all health centres, apart from Kigamboni, exhibit a very considerable degree of spatial overlap[65]. This makes that their contribution to customer coverage is much smaller. Sinza contributes the most with around 115,000 persons while Mnazi Moja[66] contributes the least with only about 28.000 people. Figure 6.22*b* illustrates, as an example, how a potential planning intervention that demotes Mnazi Moja to a dispensary would lead to a moderate increase in the customer base of Ilala hospital and Magomeni health centre.

Scenario 2 - with its less restrictive walk time threshold - logically leads to *(i)* a larger customer base for individual facilities and *(ii)* a further increase in the degree of spatial overlap. Under this scenario, the health centres of Magomeni and Mnazi Moja contribute the least to customer coverage (around 20,000 people). Figure 6.22*b* for this scenario illustrates, again as an example, that downscaling Magomeni would lead to a very substantial customer increase at Mwananyamala and Ilala hospital. The extra burden that would accrue to these two hospitals could be an argument for health planners to retain Magomeni as a health centre in spite of its limited contribution to customer coverage.

Up to this point the discussion has provided insight in the spatial performance of *individual* health centres and has indicated how customer flows are expected to redirect in case a given health centre would be demoted. Table 6.7 takes a more global perspective and presents - for each scenario - a comparative overview of the spatial performance of the existing set of higher-order facilities *as a whole* and compares that with the collective performance of a spatial configuration in which one health centre is demoted. This is done using the by now familiar set of accessibility indicators.

The two most salient observations that can be derived from Table 6.7 - for the existing situation - are as follows. *First*, aggregate customer coverage is deficient. Depending on the preferred scenario, only about one half to one third of the Dar es Salaam can be

[65] This particularly applies to Magomeni and Mnazi Moja which both have a spatial overlap of about 65 percent. Kigamboni health centre has virtually no spatial overlap because of its secluded location on the south bank of the harbour front.

[66] Downscaling Kigamboni, by comparison, would also have limited impact on overall customer coverage but the associated worst case travel time deterioration would be much higher for Kigamboni (81 min.) than it would be for Mnazi Moja (32 min.)

considered to have insufficient access to medical services as provided at health centre level. *Second*, the degree of spatial overlap amongst higher-order facilities is very considerable. In the case of *Scenario 1*, about half of the serviced population has another higher-order facility within reach. Under *Scenario 2*, this proportion increases to three quarters of the serviced population.

		Existing situation		**Accessibility based downscaling approach**	
		Walk 40 Bus 60 (min.)	Walk 60 Bus 60 (min.)	Walk 40 Bus 60 (min.)	Walk 60 Bus 60 (min.)
Indicator:	**Candidate for downscaling:**			Mnazi Moja	Magomeni
Normative Indicators	Population serviced *(%)*	48.6	63.5	47.3	62.6
	Loss in customer coverage *(abs.)*	-	-	28.000	20.000
	Serviced pop. with alternative *(%)*	49.4	75.9	39.4	51.1
	Worst case walk time deterioration *(min.)*	-	-	32	6
Global indicators	Overall average travel time *(min.)*		65.8	67.0	67.5
	Worst case walk time *(min.)*		416	416	416
	Worst case bus time *(min.)*		121	121	121
	Gini index walk		44.2	43.2	42.6
	Gini index bus		18.6	18.0	17.7

Table 6.7: Impact of down-scaling a higher-order facility on accessibility statistics for two travel time threshold combinations.

Although these outcomes must be seen in the light of the imposed travel time thresholds, it is evident that the spatial performance of higher-order facilities leaves a lot to be desired. The fact that limited customer coverage occurs *together* with considerable spatial overlap signals that the current constellation of higher-order provision is 'spatially overconcentrated' and not particularly well attuned to the spatial distribution of the population. The high percentage of spatial overlap indicates that the current distribution is spatially inefficient while the large Gini score - particularly for walkers - points to substantial spatial inequality. Figure 6.21 shows that the over concentration of higher-order provision occurs - as expected - in the more central parts of Dar es Salaam. Table 6.7 also illustrates that demoting a health centre with limited added value in terms of customer coverage will have only a restricted impact on overall spatial performance. If we take *Scenario 1* as example and demote Mnazi Moja, the main impact would be that *(i)* customer coverage declines only marginally, *(ii)* spatial redundancy diminishes but remains substantial and, *(iii)* spatial inequality *decreases* slightly.

The preceding illustrates that it is relatively uncomplicated to estimate how many people a given health centre (uniquely) services. To decide whether or not the size of a given target population is sufficient or not, however, is less straight forward and a

largely a matter of value judgment. On the whole, such a judgment can be based upon a normative or a comparative approach. A possible normative approach is to contrast the performance of individual health centres against an official policy norm. The prevailing national health policy speaks of a customer base of 50,000 people (Ministry of Health, 1990). The Dar es Salaam Urban Health Project (DUHP), on the other hand stipulates that health centres should cater for a target population as large as 400.000 to 600.000 people (Pichette, 1996). Neither of the two norms mentions a distance or travel time threshold.

It will be clear that the DUHP norm is unrealistic and set far too high to be of practical use. The national norm is attained by nearly all but also far exceeded by some health centres. This suggests that the national norm is probably set too moderately (a preview at Figure 6.25 confirms that this is indeed the case). An alternative and less arbitrary manner is to appraise the performance of health centres in a comparative manner. In this case, existing performance is compared with the performance that could *potentially* be realized at alternative locations. The next section describes a spatial approach that is capable of identifying locations for health centres with such a high service potential.

Spatial problem 2: identifying priority locations for additional higher-order facilities.
The preceding pages have demonstrated that the spatial performance of higher-order provision in Dar es Salaam is deficient in two ways: *(i)* there is oversupply of provision in the city core and, *(ii)* there is evident shortfall of higher-order provision outside the central parts of the city. A possible remedy for oversupply is to downgrade poorly performing health centres to a dispensary using the methodology presented in Figure 6.20. If so desired, the performance at dispensary level can subsequently be appraised using the earlier described planning instrument that identifies in how far dispensaries are spatially redundant.

The apparent therapy for the shortfall of provision is to expand the delivery system and provide additional higher-order medical care at locations with a high service potential. Like before, the question is how to identify such priority locations? The starting position of the planning instrument presented in the following is the insight that some dispensaries could be situated at locations with a very high service potential and that such strategically situated dispensaries are potential candidates to be up-scaled and become a higher-order service (a health centre in this case). A second essential element is that the developed procedure does not only evaluate the locations of *existing* dispensaries but also appraises priority locations for *prospective* dispensaries as identified using the methodology presented before in Figure 6.15. The higher-order planning instrument, in other words, builds upon the outcomes of the lower-order instrument. When used in concert, priority locations for additional health centres can unambiguously be identified throughout a given study area.

An additional - more practical - strength of this setup is that it is manageable in computational terms since the service potential needs to be evaluated for only a limited number of candidate destination locations.

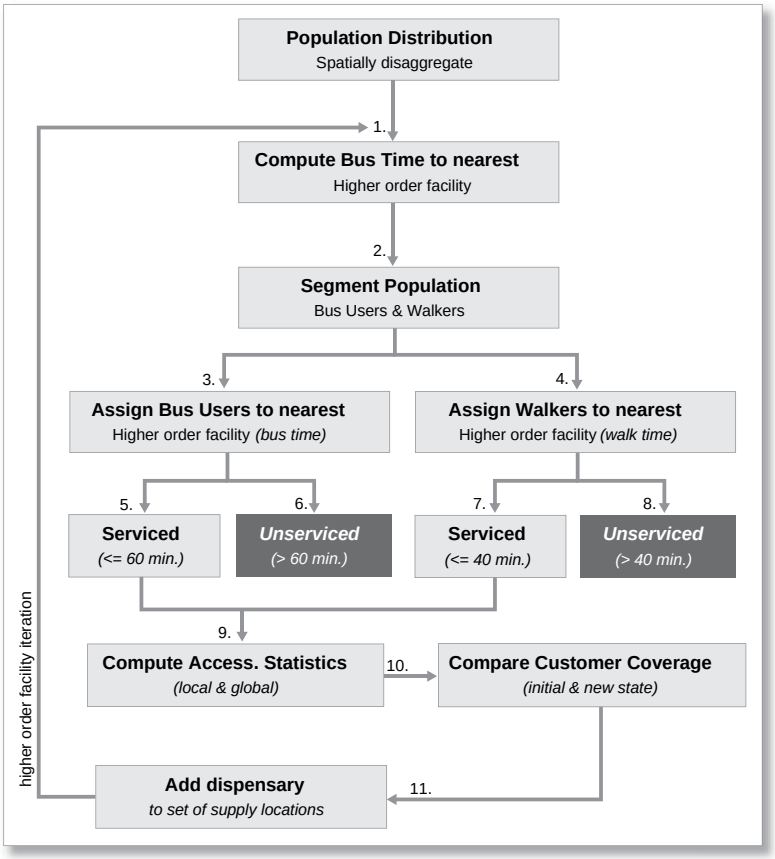


Figure 6.23: Generalized procedure to identify high-potential locations for health centres.

Figure 6.23 provides a stepwise overview of the method developed. Closer inspection reveals that the sequence of computations largely equals that of the higher-order downscaling approach. The starting position again consists of the set of existing higher-order facilities. Dispensaries are not part of the initial set of supply locations. The first part of the procedure categorizes the client population into bus users and walkers and allocates them to the nearest higher-order supply location *(Steps 1 - 4)*. After that the Dar es Salaam inhabitants are categorized into serviced and un-serviced populations on the basis of the same two assumed travel time scenarios used before *(Steps 5 - 8)*. *Step* 9, subsequently computes - for each scenario - the by now standard set of accessibility indicators which together provide insight in the collective performance of a given configuration of higher-order facilities. Up to this point the

sequence of computations is identical to that of the higher-order downscaling approach. The next step, however, is different and *adds* - one at a time - an existing or prospective dispensary location to the set of supply locations *(Step 11)* after which computations reiterate from Step 1 onwards. After each cycle, aggregate customer coverage for the existing set of higher order facilities *(n)* is compared to that of the configuration with $n + 1$ facilities *(Step 10)*.

The difference represents the gain in higher-order customer coverage if a health centre is established at that particular location. The larger the gain the more strategic the location is. Because of its iterative setup, the up-scaling approach adequately deals with changes in the proportion of walkers and bus users that occur as a result of spatial configuration changes.

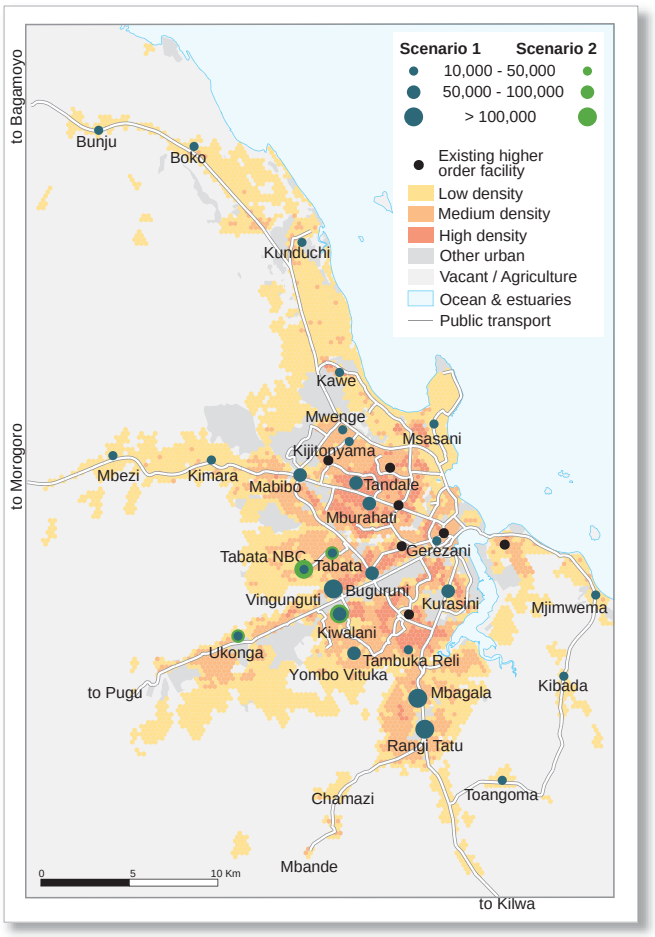


Figure 6.24: Spatial overview of expected customer gain in case of up-scaling for two travel time scenarios.

The results of the up-scaling computations for Dar es Salaam are illustrated in Figures 6.24 and 6.25. Figure 6.25 displays - for each scenario - the total customer base, the anticipated gain in customer coverage and the associated worst case walking time improvement for every potential destination location. Figure 6.24 takes a geographic perspective and visualizes where high potential locations are situated. The destination locations presented in both figures include *(i)* existing dispensaries with good access to public transport[67], *as well as (ii)* the three best-scoring locations for prospective dispensaries - Kurasini, Mabibo and Msasani - as identified using the lower-order expansion approach (see Figure 6.19*a*).

A number of conclusions can be derived from Figure 6.25. If we consider *Scenario 1* the best scoring candidate locations are the dispensaries of Vingunguti, Mbagala and Rangi Tatu. Since the latter two are very near to each other (see Figure 6.24) only one of the two should be considered for upgrading. A closer look at *Scenario 2* provides some important additional insights. To begin with, it further underlines that Mbagala and Rangi Tatu are both *very* strategically located.

It, however, also reveals that the dispensaries of Kiwalani and Tabata NBC are quite strategically located as well and could act as a substitute for Vingunguti as they are situated not very far apart. On the basis of both scenarios one could, therefore, carefully conclude that the first intervention priority would be to establish a health centre at either Mbagala or Rangi Tatu[68]. The second intervention priority would be the up-scaling of the dispensary in Vingunguti. If this would, for some reason, be unattractive the dispensaries of Kiwalani or Tabata NBS could alternatively be considered.

Another look at Figure 6.24 shows that the prime candidates for up-scaling are for the most part situated in areas of medium to high population density outside the - already serviced - city core. Some of the dispensaries situated in high density areas (*i.e.* Mburahati and Tandale) would serve a very large clientele but, as Figure 6.25 illustrates, this would largely be realized by 'stealing' clients that are already serviced by other higher-order facilities. Finally, figure 6.25 demonstrates that the priority locations for prospective dispensaries, as identified by the lower-order planning instrument, do not have a sufficiently large service potential to label them as priority locations for establishing a new health centre.

[67] Potential destination locations are all situated within a 10-minute walking distance from public transportation.
[68] Both would perform about equally: Mbagala would realize a slightly larger gain in customer coverage while Rangi Tatu would have a somewhat better worst case walk time improvement.

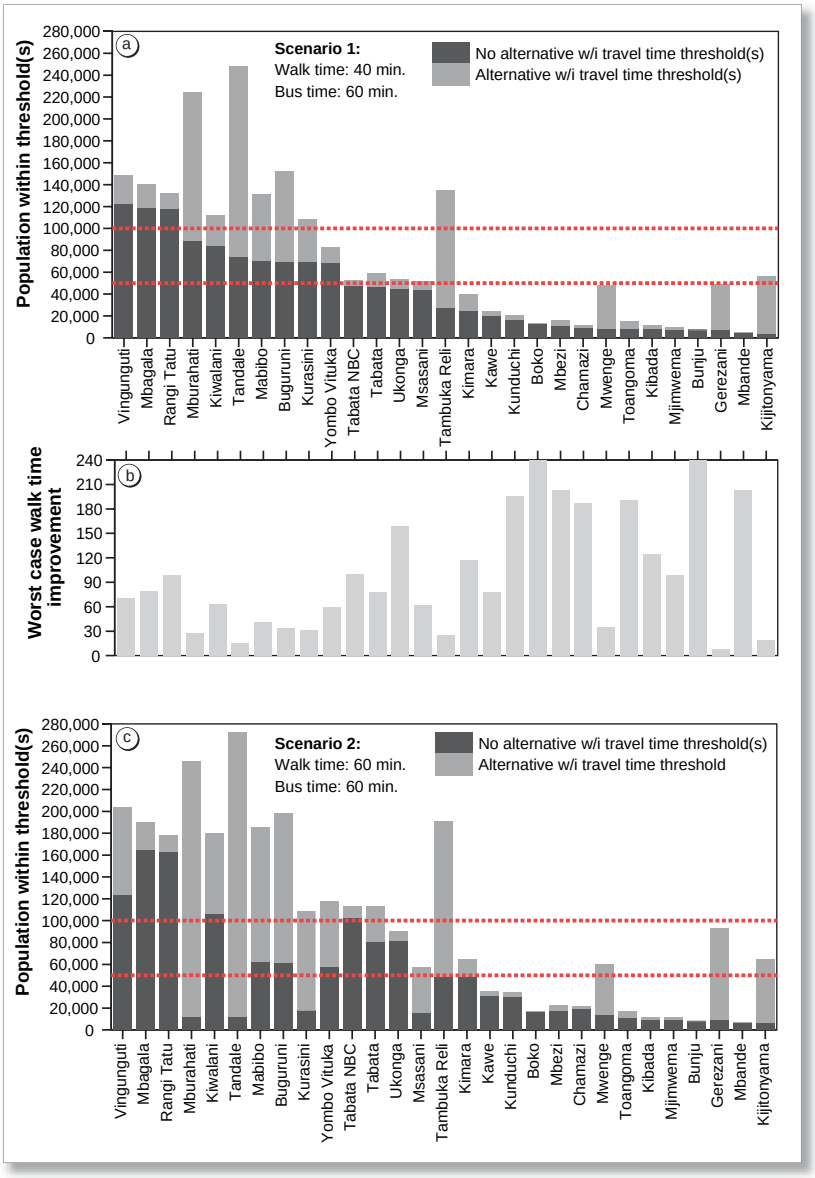


Figure 6.25: Expected customer gain (a & c) and worst case walk time improvement (b) for two travel time scenarios.

Figure 6.26 and Table 6.8 provide insight in the estimated impact that up-scaling of Mbagala and Vingunguti would have on the performance of the higher-order delivery system. It is evident that both facilities would service a very considerable clientele which *not only* is much larger than that of Mnazi Moja or Kigamboni *but also* far exceeds the national norm.

Mbagala and Vingunguti would together realize a coverage gain of about 240,000 (Scenario 1) to 290,000 (Scenario 2) thereby respectively raising overall customer coverage to about 60 to 77 percent. We can also observe that there would only be a (very) limited degree of spatial overlap with other higher-order facilities. Mbagala would deflect a limited part of the clientele away from Temeke hospital; Vingunguti would draw away part of the customers of Ilala hospital. The other higher-order facilities would remain unaffected. Additional anticipated improvements are *(i)* a significant overall average travel time reduction, and *(ii)* an impressive worst-case walk time improvement. Altogether, this signals that up-scaling Mbagala and Vingunguti to health centres would considerably improve the spatial performance of the higher-order health delivery system.

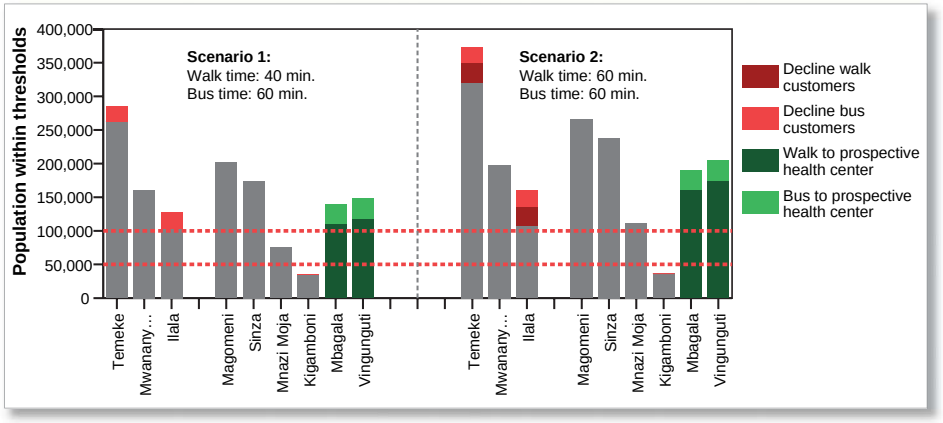


Figure 6.26: Customer base of prospective health centres and estimated performance impact on existing higher-order facilities.

In the preceding pages, *in conclusion*, two planning instruments have been presented with which health planners can investigate how good or bad a given constellation of higher-order health care provision is attuned to the needs of a spatially dispersed population. The *first* planning instrument assesses in how far existing higher-order health facilities contribute to overall spatial performance. The *second* planning instrument deals with situations in which a shortfall of higher-order provision exists. With these two tools health planners can reorganize the spatial hierarchy of provision in such a way that the spatial performance of the higher-order delivery system improves.

Both higher-order planning instruments, furthermore, logically connect to the lower-order planning instruments presented earlier on. Each planning instrument, finally, is of the 'what if' type and can *(i)* detect spatial deficiencies of a given delivery system, *(ii)* propose priority planning interventions and *(iii)* estimate the expected impact of potential interventions on spatial performance.

		Existing situation		Accessibility based up-scaling approach	
		Walk 40 Bus 60 (min.)	Walk 60 Bus 60 (min.)	Walk 40 Bus 60 (min.)	Walk 60 Bus 60 (min.)
Indicator:	**Candidates for upgrading:**			Mbagala Vingunguti	
Normative Indicators	Population serviced *(%)*	48.6	63.5	59.7	76.8
	Gain in customer coverage *(abs.)*	-	-	241,000	289,000
	Serviced pop. with alternative *(%)*	49.4	75.9	16.4	26.7
	Worst case walk time improvement *(min.)*	-	-	80	80
Global indicators	Overall average travel time *(min.)*		65.8		52.4
	Worst case walk time *(min.)*		416		416
	Worst case bus time *(min.)*		121		121
	Gini index walk		44.2		44.4[69]
	Gini index bus		18.6		17.4

Table 6.8: Impact of upgrading dispensaries to health centres on accessibility statistics for two travel time threshold scenarios.

6.3 Concluding remarks

This chapter consists of two main parts. The *first* presented a methodology for evaluating the spatial performance of the Dar es Salaam governmental health service delivery system on the basis of generic quantitative indicators of spatial equality and efficiency. The results clearly revealed that spatial performance is currently deficient as *(i)* a large number of city residents have unsatisfactory access to governmental health care and *(ii)* a considerable proportion of dispensaries are situated at locations where they can only serve a (very) limited client base.

The *second* part of the analysis is an *intervention* framework which consists of a set of 'what if' planning instruments that can support health planners aiming to improve the spatial performance of a given health service delivery system. The approach taken is to develop a number of flexible planning methods that can support health planners to *(i)* identify where interventions are mostly needed and *(ii)* forecast and evaluate the spatial impacts of alternative interventions using the Dar es Salaam situation as example.

[69] Paradoxically, the Gini index remains about as large as before whereas most other indicators signal that a substantial performance improvement is realised. The likely explanation is that the Gini is sensitive to spatial undersupply *as well as* to spatial overconcentration. The upscaling of Mbagala and Vingunguti reduces spatial undersupply but the spatial overconcentration that characterises the original configuration remains intact. A test computation that uses the extended configuration and then demotes Magomeni - a health centre with considerable spatial overlap - confirms this hypothesis as the Gini index then decreases.

The main thought behind the approaches presented is to contribute to making informed spatial decisions. The aim, in other words, is not to automate but rather to support parts of the planning process.

The concluding remarks are only brief here as we further reflect on the developed planning approach in the next chapter

7 Reflecting on research design and outcomes

7.0 Introduction

This research was primarily concerned with *(i)* the identification of theoretical and methodological constructs that can be used to analyse and improve the spatial performance of public health service delivery systems, and *(ii)* the development of a corresponding spatial-analytic and GIS-based planning approach using Dar es Salaam as a case study.

This final chapter *(i)* briefly recapitulates the overall research approach developed, *(ii)* reflects on the strengths and weaknesses of the analytical tools developed, *(iii)* considers the possibilities and limitations of embedding such planning instruments into strategic planning of urban health service delivery systems in sub-Saharan Africa and, *(iv)* proposes possible directions for future development and research. Each of the abovementioned topics is further elaborated in the following.

7.1 Reflecting on how the research aim and objectives are achieved

The discussion presented below provides an overview of the design and main building blocks of the research to illustrate how the overarching aim of this study - to develop a GIS-based planning approach that contributes to equitable and efficient provision of urban health services in sub-Sahara African cities - has been achieved.

The countries of the sub-Saharan Africa region are experiencing some of the highest urban growth rates of the world and have generally also exhibited weak economic performance over extended periods. Unlike other world regions - where urbanization and economic growth were interlinked - urbanization in sub-Saharan Africa is associated with the urbanization of poverty and with the proliferation of slums. The combined effect of poverty and substandard living conditions leads to high morbidity and mortality rates and boosts the need for urban health care. At the same time, the ability of governments to mobilize public resources for health programs has diminished as a result of prolonged economic stagnation and the international call for privatization of the public sector. The disparity between the increasing need for medical care and the declining carrying capacity of existing public health systems - the 'urban health crisis' - forms the broader context and practical justification for this research.

The point of departure of this research are the guiding principles of the primary health care approach which is widely adopted in the sub-Saharan region. The *first* guiding principle is to provide services in an equitable way. This immediately demonstrates that notions of social justice are a core element of public health care. The *second* principle is to provide services that are effective. The *third* principle is to provide services efficiently, *i.e.* to maximize health benefits to society while minimizing the cost of provision (Carr-Hill, 1994). Health care provision is thus inevitably tied up with issues of resource allocation, distribution and priority setting. Decisions have to be made about the nature and range of services to provide and how they are distributed amongst the members of society. Obviously, such decisions are informed by economic, political, medical and ethical considerations but - as this research aims to underline - should also consider the spatial dimension.

Abovementioned considerations on social justice, equity, efficiency and maximisation of health benefits are transposed into a spatial context through a discussion of two important bodies of spatial theory: neoclassical location theory and spatial welfare theory - 'who gets what where and how' - as formulated by Smith (1977). The contribution of neo-classical location theory - which seeks to explain and predict the location of economic activities - is threefold. *First*, it theorizes how an unregulated free-market society may achieve an optimal spatial resource allocation and thus maximize spatial welfare. *Second*, it provides us with the spatial equivalent of the market-mechanism via two important concepts: threshold value and range[70]. On the basis of these two concepts, the spatial relation between service supply and consumer demand can be captured. This relationship can be described in terms of spatial equity and efficiency. *Third*, it encompasses the notion of an interlocking spatial hierarchy of provision to meet the demand for both lower-order and higher-order services. Neoclassical location theory, in short, provides fundamental spatial concepts, which can be used to create a simplified model of how health care systems function in geographic space.

Spatial welfare theory objects to the normative nature and restrictive assumptions of neo-classical thought and demonstrates that an unregulated free market system does not culminate in welfare maximization but results in unacceptable social, economic and spatial inequality. Analogous to health care, spatial welfare theory focuses on quality-of-life issues, emphasizes questions of social justice, and highlights distributional issues with a spatial dimension. An important additional strength of spatial welfare theory is that it incorporates the notion of *public* services, demonstrates the need for a locational decision process to distribute public resources, and suggests an ethical framework

[70] The threshold value is the minimum level of consumer demand needed for the profitable production of a particular good or service. The range represents the maximum distance consumers are willing to travel.

('territorial justice') to guide their distribution in geographic space. To properly evaluate alternative spatial distributions in equity and efficiency terms and suggest improvements, spatial performance indicators are required. Spatial welfare theory, in short, makes it possible to move the simplified model of the spatial organization of public health care systems closer to reality.

Spatial performance indicators are generated via the accessibility[71] concept which according to (Moseley, 1979) consists of three components: *(i)* people, *(ii)* the activities or opportunities that they require, and *(iii)* the transport or communication link that connects the two. The strength of this framework is that it makes explicit that accessibility is a concept with a socio-economic as well as a spatial dimension between which important interactions exist. The accessibility concept can be operationalized using accessibility measures of varying nature and complexity. The most common approaches are evaluated in terms of their *(i)* theoretical and methodological soundness, *(ii)* ease of interpretation, *(iii)* data needs, and *(iv)* usability for urban health care planning in the sub-Saharan context.

The evaluation demonstrates that each operationalization has advantages and disadvantages but concludes that a sound way for evaluating alternative spatial health service configurations is to develop a 'what if' type of GIS-based approach on the basis of cumulative opportunity or gravity based measures of accessibility. The above represents the theoretical and methodological framework for this study and with it the first research objective[72] is fulfilled.

The analysis proceeds with a non-exhaustive - and by now slightly outdated - exploration of the empirical literature on accessibility analysis and (health) service planning. Its prime function is to investigate in how far academic advancement in the field of GIS-based spatial analysis translates into more practical real world applications. This 'contextual framework' reveals that a general uptake of GIS can be observed from about 1995 onwards but it also shows that the application of GIS for health services planning is still in an early stage of development. Many of the identified publications make use of rather simple accessibility measures and their focus generally is on the analysis of existing situations rather than on scenario development. There is a near complete absence of 'what if' type of strategic urban health planning applications in sub-Saharan Africa which signals that considerable scope remains for further research in this field. The latter observation can be viewed upon as an academic justification for conducting this research.

[71] Stated in general terms, accessibility relates to the ability of people to overcome the friction of distance to avail themselves of services at given points in geographic space.
[72] Objective 1: to operationalize urban health care as a problem of (in-) equality in urban space.

The remainder of the research is structured around an empirical case study of the city of Dar es Salaam in Tanzania. The assumption is that Dar es Salaam is a more or less typical example of a large city in the sub-Saharan region. The empirical part of the research commences with a two-level overview of the broader societal and economic context in which health care provision and utilization in Dar es Salaam occurs. At the *national* level, the overview identifies the main reasons behind the weak performance of the Tanzanian economy over time and explains how IMF/World Bank induced structural adjustment programmes have led to reforms of the Tanzanian health sector and the emergence of a pluriform health care system[73]. This part of the overview directly connects back to the *how* component in the 'who gets what where and how' of spatial welfare theory.

The *local* level overview zooms in on Dar es Salaam and consists of three parts which directly link back to the components of the accessibility concept discussed above. The *first* part connects back to the *people* component. It analyses the urbanization process of Dar es Salaam and its changing land use structure over time. It estimates that about 70-80 percent of the population lives in informal settlements (1998) of varying population density and concludes that the ongoing informalization of the urban fabric is the outcome of a general process characterized by *(i)* rapid population growth, *(ii)* a limited urban economic base, and *(iii)* inadequate institutional capacity to regulate and service urban development.

The *second* part discusses the characteristics of the road infrastructure and the main modes of transportation - the *link* in the accessibility concept - used by the residents of Dar es Salaam to overcome the friction of distance. It establishes that the very large majority of the Dar es Salaam population either walks or depends on public transport. In doing so, it illustrates how urbanization in poverty constrains mobility.

The *third* part analyses the functional and spatial dynamics in health care provision - the *opportunities* in the accessibility concept - that have occurred in Dar es Salaam up to the year 2000. As expected, the history of health care provision in Dar es Salaam mirrors the developments that affected the health sector nation wide. The Dar es Salaam health sector reforms, in brief, lead to the emergence of a pluriform health care delivery system which is characterized by *(i)* rapid and uncontrolled proliferation of for-profit private medical practice, *(ii)* a slow but steady downward trend in occupational and voluntary health care provision and, *(iii)* a non-expanding but more efficiently performing governmental health care delivery system.

[73] Pluriform health care system: simultaneous provision of decentralized government health services, for-profit private medical practice, and occupational and voluntary not-for-profit health care providers.

With the above described two-level overview this study achieves its second[74] and third[75] research objective.

The subsequent building block of the research is an assessment of the *interplay* between the three components of the accessibility concept. It consists of an analysis of observed socio-spatial patterns of health seeking behaviour in the context of medical pluralism using survey data collected in 1995 and 2000. Some of the main findings are summarised here. The analysis shows that - for mild health problems - the choice behaviour of governmental, private and voluntary health care users is mainly guided by the desire to attain affordable health care of adequate quality, with sufficient drugs, at a location not too distant from home. In all cases travel distance/time is an important consideration. The competitive strength of governmental health care is associated with affordability and proximity. Its main perceived weaknesses are drug shortages, long waiting times and, poor quality medical and interpersonal care. The competitive edge of private and, particularly, voluntary health care is related to drug availability, and perceived quality of medical and interpersonal treatment. The main deterrents for using private health care are unaffordable costs and doubtful quality of medical treatment.

If an explicitly spatial perspective is taken, the analysis reveals that most patients walk to the dispensaries of their choice and generally do not travel for more than about 30 - 40 minutes. Travel patterns to higher-order governmental facilities differ in the sense that *(i)* public transport is much more frequently used, and *(ii)* patients are willing to walk somewhat longer distances. For most users of private and voluntary hospitals distance is not an important consideration. A comparative analysis of the survey data reveals that socio-spatial patterns of health seeking behaviour have largely remained unchanged between 1995 and 2000.

Although it is acknowledged that the primary data collection efforts that are required to conduct the above-described analysis are considerable, the added value of establishing a firm empirical foundation is also evident. Not only does it give health planners valuable general insights in the factors that govern health seeking behaviour but it also provides them with valuable information (*e.g.* travel times, modal split, degree of spatial rationality in choice behaviour) that can be used for the planning of spatial interventions. The empirical base, in other words, makes it possible to move away from a purely normative planning approach towards one where planning instruments and decisions can be attuned to the existing social and spatial context.

[74] Objective 2: to explore the processes of Tanzanian economic development and urbanization of Dar es Salaam and to illustrate their impact on urban health and urban health care.
[75] Objective 3: to examine the dynamics of the Tanzanian health care delivery system over time.

With the analysis of the interplay between the components of the accessibility concept the fourth research objective[76] is achieved.

The different research threads all come together in the last part of the analysis which presents a 'what if' type of planning approach designed to evaluate and improve the spatial performance of the Dar es Salaam governmental health care system. In doing so it illustrates how more sophisticated GIS-based analytical techniques can be usefully applied in support of strategic spatial planning of urban health services delivery.

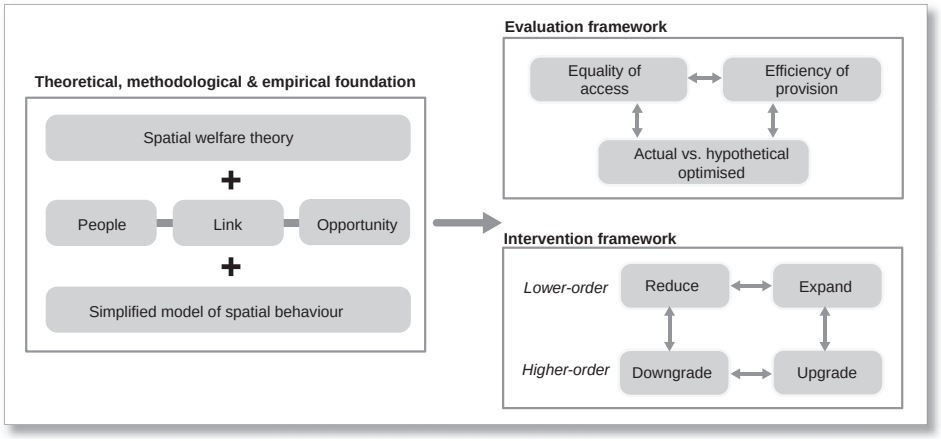


Figure 7.1: Foundation and main building blocks of the developed planning approach.

The developed planning approach is rooted in spatial welfare theory, makes use of the accessibility concept and is enriched with a simplified model of spatial behaviour that is derived from the survey data (see Figure 7.1). It consists of an *evaluation* and an *intervention* framework.

The *evaluation* framework is developed to appraise the performance of the existing Dar es Salaam governmental health delivery system on the basis of generic quantitative accessibility indicators. Spatial performance is viewed upon from the client (spatial equality) as well as from the provider (spatial efficiency) perspective. The analysis indicates that spatial performance is currently deficient as *(i)* a large number of city residents[77] have unsatisfactory access to governmental health care and *(ii)* a considerable proportion of dispensaries are situated at locations where they can serve only a limited customer base.

[76] Objective 4: to analyze socio-spatial patterns of user-provider interaction on the basis of empirical data on health care utilization in Dar es Salaam.
[77] In case a threshold of 30 (40) walking minutes is assumed, the under-serviced population amounts to about 750,000 (450,000) people. In both cases about 75 percent of the spatially disadvantaged reside in informal settlements.

To assess what degree of spatial performance could *potentially* be attained with given health resources, a number of optimal hypothetical constellations are generated using three broadly acknowledged conceptions of social/spatial welfare[78]. The outcomes demonstrate that 'geography matters': a more optimal spatial distribution of health facilities would much reduce spatial inequality *and* lead to considerably more efficient use of scarce health resources. It is noted that the presented optimisation effort is essentially an academic exercise since health facilities cannot be simply repositioned in geographic space without considering issues such as relocation costs, space requirements, political priorities, opposition from affected residents and so on. The justification for presenting the optimisations, nonetheless, is that they serve as a 'neutral' yardstick against which the spatial performance of the existing constellation can be evaluated.

The *intervention* framework explores how existing health needs can better be served by proposing alternative spatial arrangements of provision using scarce health resources. It consists of a set of 'what if' type of planning instruments that can support health planners to *(i)* detect spatial deficiencies of a given delivery system, *(ii)* propose priority spatial planning interventions and *(iii)* estimate the expected impact of potential interventions on spatial performance. To appropriately deal with the hierarchical nature of the health service delivery system, two lower-order (dispensary level) and two higher-order (health centre or hospital level) planning instruments are developed. The *lower-order reduction* instrument identifies health facilities that have a service area that largely overlaps with that of neighbouring facilities. Such facilities hardly contribute to spatial performance and stand for inefficient use as well as inequitable distribution of available resources. Although it is recognized that discontinuing such spatially redundant facilities will generate opposition from those affected it should also be noted that their closure will free resources that can be put to more productive use at alternative locations. The latter consideration is especially important in spatial contexts characterised by an overall shortfall of provision. The *lower-order expansion* instrument identifies areas and populations that are not well served by a given constellation of provision, charts out priority areas and locations with a high service potential and estimates the expected improvement in spatial performance associated with the establishment of additional dispensaries.

The *higher-order downgrading* instrument assesses in how far health centres or hospitals contribute to overall spatial performance. Like before this is done by identifying the degree of spatial overlap with neighbouring facilities but now only considering higher-order facilities. The basic idea in this case is that a higher-order facility that does not contribute sufficiently could be reduced in rank (downgraded) and become a lower-

[78] The Mini Max, Mini Sum and Max Cover approaches.

order service node. Its performance potential at dispensary level can subsequently be appraised using the lower-order planning instrument. The *higher-order upgrading* instrument considers the reverse situation: some dispensaries could be situated at locations with a very high service potential. Such strategically situated dispensaries are potential candidates to be promoted and become a higher-order service node. This procedure does not only evaluate the locations of existing dispensaries but also appraises priority locations for prospective dispensaries as identified using the lower-order expansion instrument. The higher-order instrument, in this case, builds upon the outcomes of the lower-order instrument.

When used in concert the developed planning instruments offer a flexible framework with which health planners can formulate and evaluate alternative intervention scenarios and deal with the most important problems involved in the spatial planning of urban health services. The planning instruments, finally, are designed to contribute to making informed spatial decisions; not to automate but rather to support part of the planning process. With the establishment of the above-described planning framework this study achieves its final research objective[79] as well as the overall study aim.

7.2 Discussion

This section consists of two main parts. It first reflects on the strengths and limitations of the planning framework developed. Then it takes a broader perspective and briefly considers the prospects of embedding GIS-based spatial analytic tools - as developed in this research - into strategic urban health planning in sub-Saharan Africa.

Reflecting on the planning approach developed

The preceding discussion demonstrates that the presented planning approach has a number of evident strengths. *First*, the evaluation and intervention framework have a firm theoretical, methodological and empirical foundation (again see Figure 7.1). *Second*, the presented approach is sufficiently complete to appropriately deal with the most common spatial planning problems with which urban health planners in Dar es Salaam are confronted in reality. *Third*, the analytical tools developed are designed to generate alternative 'what if' scenarios. This characteristic is particularly important as it enables health planners to analyse a given spatial context, generate their own solutions to problems and examine the potential consequences of such decisions. The choice for the 'covering principle' as guiding welfare objective reinforces the involvement of the

[79] Objective 5: to develop a GIS-based planning approach that can identify spatial inequality and inefficiency and suggest spatially just intervention priorities.

decision makers since it requires them to also think about and decide upon an acceptable maximum travel time and therewith make normative decisions explicit. *Fourth*, an effort has been made to develop planning instruments that are comprehensible and acceptable for decision-makers. This was an important shortcoming of the 'older generation' of spatial analytic approaches and one of the important reasons for their demise. To make the planning instruments as acceptable as possible a predominantly visual approach (bar charts, maps) has been pursued and use has been made of a set of accessibility indicators that are easily interpreted. By providing planners with more easily understandable 'what if' tools, the match between the problem as seen by the decision maker and the planning instrument gets better and the chances for acceptance and operational use improve.

Apart from strengths, the described approach also has a number of characteristics that deserve a more critical commentary. Some of the most important are further elaborated in the following. A *first* characteristic is that the planning approach focuses on *governmental* health services only while the overall health delivery context is characterized by pluriform provision. The rationale to nonetheless limit the scope is guided by the following considerations. To begin with, the governmental health sector remains the most important provider for a large majority of the Dar es Salaam population. Furthermore, the non-governmental sector is very fragmented, exhibits a high degree of turnover and mostly consists of atomic actors. Finally, reliable data on the non-governmental health sector are virtually non-existent. Because of this, explicit incorporation of the non-governmental health sector into the planning approach was considered to be unrealistic given the resources available for this research. On the positive side, the expansion and upgrading planning instruments can also be used to identify non-governmental health facilities with a high service potential in areas under-serviced by the governmental sector. If some form of partnership can be established with such non-governmental providers, health planners do not need to establish new facilities but can augment the provision network through collaboration with non-governmental providers. Prate *et al.*(2005, p. 274) favourably report on the use of what they term 'franchising networks' to supplement government programmes in the delivery of public health services in Africa.

A *second*, characteristic is that the analysis of the Dar es Salaam example is restricted to the present situation whereas health planning is an activity that also looks at the future. This indeed is a practical limitation and it would have been better to also account for the fact that the spatial distribution of health needs will evolve over time as a result of the ongoing process of urban expansion and densification. Such a future-oriented scenario would have illustrated how decision makers could develop alternative intervention strategies if a longer-term perspective is taken. The data used by the planning instruments would change but the instruments themselves would remain the same.

The reason for not presenting a future-oriented scenario is practical. Although a strategic urban development plan was released in 1999 (SDP, 1999), the envisioned spatial extent and internal structure of Dar es Salaam is simply too general and vague to serve as a basis for developing a future-based scenario[80]. A possible way forward would be to generate an urban growth simulation, theorize on the layout of a future public transport network and basically redo the computations presented in Chapter 6. The development of a proper urban growth simulation, however, is complex and time consuming, and essentially a separate research topic in itself. A 'quick and dirty' approach would have been feasible but it would include many uncertainties and, in the end, probably raise more questions than it would answer. Because of this, it was decided not to carry through a simulation approach. The above does make painfully clear that data availability in Dar es Salaam remains an important bottleneck (we return to this issue below).

A *third* characteristic is that the planning instruments are operationalized using accessibility measures of cumulative opportunity. The main generic advantages of this type of accessibility measure are that outcomes are easy to interpret, data requirements are relatively undemanding and that they are suited to generate alternative scenarios. Their main inherent weaknesses are that *(i)* all opportunities are treated as equally desirable despite potential differences in their characteristics, *(ii)* an appropriate - value judgement - cut off travel time needs to be determined, *(iii)* there is no differentiation between demand origins that are near to an opportunity and those just within the cut off travel time and *(iv)* they assume that customers will always visit the nearest opportunity.

The choice for a cumulative opportunity measure is justified in the context of this research since *(i)* the planning instruments could be tailored to deal with observed differences in travel behaviour between lower-order and higher order facilities, *(ii)* the cut off values used are for the most part empirically derived, *(iii)* the choice for the 'covering principle' as the guiding welfare objective implies that there is no need to differentiate between demand origins as long as they are within the specified travel time threshold and *(iv)* the simplified model of spatial behaviour shows that the assumption of spatial rationality is sufficiently realistic.

The important point to make here is not so much to justify that a proper methodological choice was made to analyse the Dar es Salaam situation but rather to clarify that the above described conditions may not apply in other spatial contexts and that other contexts may therefore require another type of operationalization. Different operationalizations (travel time threshold, guiding welfare objective, and type of

[80] For a more detailed discussion of the 1999 strategic urban development plan see Sliuzas (2004).

accessibility measure) will, in turn, tend to lead to different planning propositions. The bottom line, in other words, is that different spatial contexts will require different solutions, that normative decisions have to be made explicit, and that health planners have to be well aware of the assumptions embedded in the planning instruments that they (might) rely upon.

A *fourth* characteristic is that the planning instruments rely on a uniform model of spatial behaviour which does not differentiate between socio-demographic population strata. The motivation to opt for an aggregate approach is twofold. To begin with, the analysis of observed health seeking behaviour demonstrates that the travel behaviour (modal split and travel time) of deprived, modal and starter households is nearly identical. The travel behaviour of the small group of better off households - 12 percent of the sample population - differs but not very much. In the Dar es Salaam situation there, in short, is no pressing argument to pursue a disaggregate approach. The second motive is data related. Even if significant differences in travel behaviour would have been identified on the basis of the survey data, a disaggregate approach would still only be possible if the population in every origin location could be segmented into the identified socio-demographic strata. Ahmed (2004) researches this topic and concludes that such a segmentation can not be realised with the available data. More in general, accommodating for variations in travel behaviour between population strata would imply a multiplication of the computational effort required.

A *fifth* characteristic of the presented planning approach follows from its reliance on more advanced GIS-based spatial analytic techniques. The software used consists of a proprietary GIS which is loosely coupled to *Flowmap* which is a stand-alone software package dedicated to the analysis of spatial interaction data (Geertman *et al.*, 2003). The GIS mainly acts as the database management and visualisation system. *Flowmap* - primarily designed for expert use - represents the spatial analytic toolbox. This setup has made it possible to develop the presented planning approach but it also brings about some concerns that need to be recognized. To begin with, this setup not only requires solid GIS knowledge and skills but also calls for a thorough understanding of the available spatial analytic functionality *and* of their underlying concepts. Furthermore, to attune the planning instruments to the Dar es Salaam context a stepwise and mostly iterative sequence of computations had to be devised for each planning instrument in order to generate the desired results. Finally, because of the iterative nature of most procedures, significant post-processing is required to transform intermediate results into their final more appealing visual form. The above-mentioned issues are not intrinsically problematic but they do make clear that the overall approach remains relatively complex and certainly computationally intensive. The conclusion to be drawn from these observations is that introduction of this type of spatial planning instruments into the planning reality cannot be left to 'novice users' alone but should be guided by experienced professionals/specialists.

A *sixth* and essentially methodological limitation of the presented approach is that no sensitivity analysis has been conducted that ascertains in how far the outputs of the planning instruments depend upon the input parameters (Saltelli *et al.*, 2000). Here this issue mainly relates to the 'people' and the 'link' components but not to the 'opportunity' component. The deficiency with respect to the 'people' component is as follows. The spatial parameter for which demand/need is estimated is a hexagonal tessellation that subdivides the study area into about 5,500 hexagons. A hexagon size with an edge to edge diameter of 250 meter was chosen because it *(i)* is large enough to accurately capture the trip origins during the patient survey and *(ii)* remains sufficiently detailed to describe the spatial variation of demand/need for health care across the study area. The shortcoming referred to here is that the research did not assess in how far the spatial resolution of the tessellation influences the outcomes of the analyses. Time constraints and the fact that the available data are too crude to generate a population proxy at an even finer spatial resolution are the main reasons for not evaluating the potential effect of alternative tessellation sizes.

The deficiency with respect to the 'link' component refers to the travel time estimates that have been generated for walkers and for public transport users. In this case the issue is that different travel time estimations might make that the planning instruments generate different outcomes. The analysis presented indirectly indicates that this is indeed likely to occur in the case of the lower-order reduction planning instrument as it was shown to be very sensitive to the threshold travel time value selected. To a lesser degree this also applies to the higher-order downgrading instrument. The presented scenarios for the lower-order expansion and the higher-order upgrading instruments on the other hand indicate that they are not particularly sensitive to the selected travel time threshold. More in general, travel time estimates have been empirically derived and should therefore represent reality sufficiently well.

The *seventh* and final characteristic presented concerns the quality of the available data for Dar es Salaam. Whilst the research has demonstrated that the developed planning instruments are capable of producing valuable results it should be noted that the validity of the evaluation and intervention outputs is primarily dependent on the quality of the input data. Earlier on during the research it was described that the Dar es Salaam database was compiled using data from multiple sources of varying quality and scale and that its contents are certainly not free of limitations. At the same time it was argued that the current data compilation is of sufficient quality for the purpose of this research. Obviously, it would have been better if more complete, more detailed, more reliable, and more up to date data could have been used but such data were simply not available at the time the research itself was conducted. What has been compiled simply is the about the best that could be generated for Dar es Salaam. If and when new data become available these can be incorporated into the database and allow for a new sequence of analysis.

Given the dynamic nature of urban Dar es Salaam, the severe shortage of resources for routine data collection and the initial stages of geographical information technology adoption, the availability of up to date, reliable and spatially disaggregate secondary data is an important inhibiting factor which is not likely to change in the short term.

Reflecting on the prospects of embedding spatial-analytic GIS approaches into urban health service planning

The former section reviewed the strengths of and commented on the main inherent and contextual limitations of the developed analytical planning approach. In the following we place the preceding discussion in a broader perspective and briefly reflect on the possibilities and limitations of embedding GIS-based spatial analytic instruments - as developed in this research - into planning practice in sub-Saharan Africa. We do so by means of a three-step approach. *First*, we characterize the current state of affairs regarding the uptake of spatial-analytic approaches for planning purposes in general. *Second*, we describe the main inhibiting factors that constrain more widespread application of spatial-analytic techniques in strategic planning practice. *Third*, we shortly suggest possible ways to deal with the identified barriers in the short and medium term. Some elements of the discussion presented below have previously featured as part of the literature review presented in Chapter 2.

The current uptake of spatial-analytic techniques in planning is particularly well characterized by Geertman and Stillwell (2003, p. 4) who state that "there is no denying that planners have always wanted computer-based tools to enhance their analytical problem-solving and decision-making capabilities, but it should also be recognised that planning practice has never effectively embraced many of the methods, techniques and models developed over time in the research laboratory".

If we restrict the discussion to the use of GIS, it is evident that its application within planning practice has considerably increased in the past decade and half. Important underlying reasons for this more recent proliferation are that *(i)* hardware and software costs have come down considerably, *(ii)* GIS software has become Windows-based and less complex to handle and *(iii)* geodata - at least in the Western world - are becoming increasingly accessible and affordable (Geertman, 2002). At the same time, it is evident that GIS in planning practice is still primarily being used for more operation-oriented tasks (*e.g.* planning control, zoning) where the software is primarily applied for data management, simple data modelling, and preparation of thematic maps. The value of maps in understanding and communicating planning issues in decision-making processes is generally acknowledged (Masser and Ottens, 1999). Although this type of planning activity is important in itself, it only makes limited and superficial use of the potential of GIS technology.

More importantly, there so far is little evidence that GIS is becoming more widely applied to more strategic planning problems which require forecasting, analysis and evaluation. More sophisticated analytical and modelling instruments - as those developed in the framework of this research - are designed to perform such functions but their practical application, nevertheless, remains rather uncommon. The central conclusion that can be drawn is that GIS is currently underutilised as a support instrument for more strategic planning activities (Geertman, 1999; Nedovic-Budic, 2000; Harris and Batty, 2001; Klosterman, 2001; Geertman, 2002; Geertman and Stillwell, 2003)[81].

What then are the main inhibiting factors that constrain more widespread application of advanced GIS-based spatial-analytic and modelling techniques in strategic spatial planning practice? A scan of the literature suggests that some of these factors are more abstract whereas others are quite concrete. The more abstract factors mostly refer to the characteristics of the planning process itself. Geertman (1999), for example, draws attention to the fact that strategic planning is a complex process - involving a diversity of actors and interests - which is only partially informed by scientific analysis/information. Geertman (2002) also points to the disparity between the expectations of the planning community - that wishes flexible, easy to use and adaptable tools - and the current generation of GIS technology which possesses neither of these qualities. Klosterman (2001), furthermore, reports on the discrepancy between the highly structured outputs of computer approaches as opposed to the unstructured information needs of the decision-maker. He also highlights the diversity of analytical needs of the planner and contrasts that with the lack of commercial incentive to develop and embed easy to use functionality that satisfies those needs into proprietary GIS software. Geertman and Stillwell (2003), amongst others, bring in the deep-rooted resistance in planning practice towards quantitative modelling and analysis methods.

The more concrete and commonly recognised additional inhibiting factors point towards *(i)* software complexity, *(ii)* difficulty of data availability and data integration, and *(iii)* insufficient capacity and/or expertise in many planning departments and institutions (Masser and Ottens, 1999; Nedovic-Budic, 2000). We deal with the more concrete factors in a bit more detail as they can be compared with the identified characteristics of the planning instruments that have been developed in the framework of this research.

[81] Although the references used above all refer to the situation in the Western World, there is good reason to assume that the above described also pertains to the situation in sub-Saharan Africa given that the adoption of GIS is even more recent and still in its initial stages.

The issue of *software complexity* follows from the general recognition that the spectrum and nature of available spatial-analytic functionality of commercial GIS software is too limited for generating predictive information (scenarios, forecasts). To remedy this deficiency the GIS needs to be enhanced with additional analytical and modelling functionality. A commonly followed approach to achieve this is to loosely couple the GIS with external spatial modelling software. The extensive data manipulation and modelling functionality of such a combined software setup, however, leads to steep learning curves for users of these packages.

As already described in the preceding section, this also holds true for the software setup used for this research as quite some time was required to become conversant with the analytical software. The difficulty is not only to gain insight in the functionality of the software itself but also to acquire a proper understanding of the sometimes complex concepts that underlie the spatial tools. On the positive side, Flowmap offers a broad range of analytical functionality, has an easy to use user interface, allows for easy data exchange with the GIS, and proved to be a stable software environment that lives up to its promises.

Problems of *data availability and data integration* represent another important inhibiting factor. Planning studies represent a non-routine activity which often requires a considerable research effort. Data needs are difficult to precisely identify in advance but are generally elaborate. The latter implies that planners will normally have to draw on numerous secondary data sources and on primary data collection techniques to obtain the desired data. As data originate from different data sources with varying data formats, quality and scale, a considerable data integration effort is generally required to establish a useful GIS database with a shared geometric frame. Limited availability of meta-data does not only complicate the data compilation effort but also makes it hard for planners to assess the true quality of the data they rely upon for planning and policy making. Nedovic-Budic (2000) describes data collection and integration as one of the most time-consuming and difficult tasks performed by planners.

These general findings very closely mirror the data collection and data integration experiences of the Dar es Salaam case presented in this study. As previously described, the Dar es Salaam database was indeed established through surveys and secondary data compiled from different sources. Its establishment did require a considerable effort. An important difference with the Western World is that the paucity of data in the Dar es Salaam context is much more extreme. Given the dynamic nature of the urbanization process, the shortage of resources for institutionalised routine data collection and the initial stages of geoinformation technology adoption, the availability of up to date and reliable secondary data is an important inhibiting factor that is not likely to fundamentally change in the short term.

The preceding makes evident that *(i)* strategic planning studies deal with complex spatial problems, *(ii)* the associated need for forecasting, analysis and evaluation leads to complex software environments and *(iii)* the related data requirements are complex as well (Masser and Ottens, 1999). Successful application of spatial-analytic GIS in support of strategic planning studies, in other words sets rather stringent - but surmountable - boundary conditions. If we contrast this with the earlier made observation that the adoption of GIS in planning practice generally is a relatively recent phenomenon, it becomes apparent that *insufficient capacity and/or expertise* will in many (local government) planning departments represent another important inhibiting factor. This factor will be even more critical in planning institutions in sub-Saharan Africa as *(i)* their adoption of GIS is even more recent and *(ii)* their organizational, financial, technical and human resource constraints are undoubtedly more severe.

An important conclusion that can be drawn on the basis of the preceding discussion is that the prospect of embedding more advanced analytic GIS approaches into spatial planning practice in sub-Saharan Africa *at this moment* in time does not appear to be very realistic. To, nonetheless, reap the benefits from this type of approaches local planners and decision-makers should opt for a partnership approach and work together with external - if possible national[82] - research institutes or consultancy firms that do have the required expertise. In the Dar es Salaam situation, local partnerships have already been established along these lines - but so far in other application fields - with, for example, the University College of Lands and Architectural Studies (Sliuzas, 2004).

If a somewhat *longer term* perspective is taken, the prospects of successful embedding can be improved by mitigating the earlier described barriers. Given the overall complexity of the issue this, however, will require time and, in all likeliness, will be a gradual process of incremental improvement. *Education* is one essential component to prepare for the future application of spatial-analytic GIS approaches in planning practice. Educating and training a new generation of planners in understanding and applying GIS-based spatial-analytic and modelling techniques is probably the most effective way to achieve that these eventually become applied in spatial planning practice[83]. Another important component will be to locally gain policy support and mobilise resources to progressively *develop and maintain local databases* (*e.g.* baseline statistics, spatially disaggregate population data, streets, utilities and properties) as these are of great value to a variety of spatial planning problems. The availability of more

[82] The preference to involve local experts - if available - is guided by two motives. *First*, they will normally have a better understanding of the local context. *Second*, the prospect of establishing long-lasting working relationships is better than with international consultants that do a job as part of a - donor funded - technical assistance programme.
[83] More advanced spatial analysis and modelling techniques have become part of ITCs Master of Science programme in Urban Planning and Managements since a few years.

routinely collected data sources - and metadata - would considerably reduce the data collection and data integration effort. Such institutionalised data collection efforts will be varied and require coordination but do not need to be managed by planning agencies themselves as long as planners have access to the data sources (Nedovic-Budic, 2000).

Another challenge is to enhance the capabilities and *reduce the complexity of the software environment* that is needed to perform spatial-analytic and modelling tasks. In part, this will be a process of academic advancement in the field of spatial analysis itself. If we take *Flowmap* as example, it is evident that the software is continuously improved and enriched with additional functionality to meet the demands of planning practice and geographical research (Geertman *et al.*, 2003). If a broader perspective is taken reference can be made to the current interest in Planning Support Systems. Planning support systems *(i)* are designed to aid the planning process, *(ii)* usually consist of multiple technologies with a common interface and *(iii)* are expected to facilitate data management, analysis, problem solving, decision-making and communication activities (Nedovic-Budic, 2000; Brail and Klosterman, 2001; Geertman and Stillwell, 2003).

In the light of the overall discussion presented in this section, one may conclude that the applicability of spatial-analytical GIS techniques in sub-Saharan Africa is not without problems but in a better position than it was about a decade ago. Data availability is and can be expected to remain a bottleneck but - as this research has demonstrated - is an obstacle that can be overcome. The scarcity of sufficiently trained local personnel is another reality but this can in the short term be remedied through collaborative approaches between local planners and experienced GIS professionals. The computing environment, furthermore, has become more affordable and easier to use. Current analytical tools, finally, are more robust and more geared to the needs of the decision maker. In the longer term software enhancement, the gradual establishment of local spatial data infrastructures and educating planners in the use of spatial-analytic GIS tools will bring improvement. Ultimately, the success of spatial-analytic GIS approaches will depend on their ability to provide real support to decision-making by offering acceptable and robust methods of problem solving to the (health) planning community.

7.3 Reflecting on possible directions for future research and development

Following from the findings of this research a number of avenues for possible further research and development can be thought of. Research is viewed upon as being oriented towards discovering new knowledge while development is geared towards

applying existing knowledge to create improved or derived products. A number of possible directions for future development and research are suggested in the following.

Possible directions of future development

Given the interpretation of the term 'development' one could see that future development efforts could aim to *(i)* consolidate and improve what has been developed and *(ii)* broaden scope and search for related application opportunities. In the context of this research three important avenues of future development can be thought of.

First, it should be avoided that the results of this research remain confined to this report. In stead an effort is to be made to see that the proposed approach finds its way to planning practitioners - in Dar es Salaam and the region - and to potentially interested academic parties. Possible ways to pursue this are to raise awareness, to organise training courses, to publish and to actively search for possibilities for inter-institutional collaboration.

Second, an effort should be made to bring the data that underlie the analysis as up to date as possible. In this respect the largest benefit can be expected to be obtained by updating the spatial distribution of the population as sizeable changes will have occurred as a result of urban expansion and densification processes. Such an updating effort will not be an easy task but a possible approach is to investigate in how far the 2005 aerial photographs of the city - which have only recently become available - can be used for this purpose. Alternatively, the possibilities and limitations of extracting such information from high-resolution remote sensing imagery (*e.g.* Ikonos or Quickbird) can be further explored. Overall, more recent and better quality data will make that the developed planning instruments generate more accurate planning propositions.

Third, an effort should be made to broaden the scope of this research by investigating in how far the health care approach presented here can be transposed to deal with other types of public service provision where issues of spatial distribution also play an important role. Educational facilities would represent an evident example but other public services could also be thought of. An additional way of broadening scope would be to investigate in how far the health care approach developed for Dar es Salaam can be applied in - or attuned to the spatial context of - other cities in the region.

Possible directions of future research

If we proceed on the basis of the perception that research is oriented towards discovering new knowledge some suggestions for further research can be formulated.

First, the planning instruments developed in this research are operationalized using accessibility measures of cumulative opportunity. It is quite conceivable that the associated assumption of spatial rationality is less realistic in other spatial contexts. Because of this one possible avenue for future research is to establish a parallel set of planning instruments but now based on, for example, a gravity-based operationalization of accessibility. This would not only broaden the application scope of the approach presented in this research but also allow for comparative analysis of the strengths and weaknesses of the different operationalizations.

A *second* possible avenue of future research could be oriented towards developing models that can simulate urban expansion and densification processes at a spatially disaggregate level. The availability of such urban forecasts is generally important to planners given that *(i)* the urbanization process in sub-Saharan Africa is highly dynamic, *(ii)* planning is future-oriented and *(iii)* disaggregate population data play a centrally important role in a variety of spatial planning problems[84].

Given the considerable problems of data availability and integration, a *third* possible avenue for future research could be oriented towards the development of appropriate local spatial data infrastructures that support the data requirements of planners. Primary data collection efforts for this research, for example, could have been considerably reduced if a reliable and routine data collection mechanism would have been in place that registers basic data - including a simple geocode - of governmental health care customers.

[84] At the moment, researchers of the Dortmund University are attempting to generate an urban simulation for Dar es Salaam using for a considerable part the data that have been assembled in the framework of this research and that of Sliuzas (2004).

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Appendix A: Contents of patient questionnaire

Questionnaire (patient at public centre) **Q-number_____**

Urban Health Project - UHP - Dar es Salaam, Tanzania, May - June, 2000 (v. 15/05). Research into the Accessibility and Use of Health Facilities.

Interviewer name _____ **Date** _____ **Time** _____
Centre name _____
Cell facility _____ **Cell patient** _____ **Location**_____

Introduction
The purpose of this survey is to investigate the accessibility and use of the health facilities in Dar es Salaam. Because it is impossible for us to interview all patients at all facilities, we choose this facility and you. Your help is very important, because your answers will help us to improve health care in Dar es Salaam. Thank you for your cooperation.

0. **(don't ask) Interviewed person is:**
woman alone _____
man alone _____
woman and child (child is patient) _____
other, please specify _____

1. **Please specify for the patient:**

sexe	age (c)	age (i)	marital status	head of household
M / F			**S / M / L / D / W**	**Yes / No**

Marital status: Single, **M**arried, **L**iving together, **D**ivorced, **W**idowed.
Please circle choice!

2. **How many people belong to your household? _____ persons, of whom**
_____ under 1 year old
_____ 1 - 4 years old
_____ 5 - 15 years old
_____ 15 and above

3. **What is the highest education of the mother in the household?**
(If not finalized, please specify the number of years.)
no education _____ high school _____
primary school _____ college/university _____
secondary school _____ adult education _____

4. **What is the main occupation of the household head and partner?**
head _____ 1st job permanent / temporary
_____ 2nd job permanent / temporary
partner _____ 1st job permanent / temporary
_____ 2nd job permanent / temporary

5. **In which socio-economic group would you say your household belongs?**

Tajiri (wealthy) / **U**najiweza (comfortable) / **M**askini (poor) / **M**askini sana (very poor)

6. **What is the status of the house / rooms your household occupies?**

Owned / **R**ented / Supplied by employer or family / **O**ther, specify _____

7. **How many rooms does your household occupy? _____ rooms (do not count toilet, kitchen or bathroom). The house has _____ rooms in total.**

8. **What material is the house constructed of?**

   Cement bricks / **M**ud bricks / **W**ood / **O**ther, specify _____

9. **What type of toilet is used by the household?**

   Flush toilet used alone / **F**lush toilet shared / Traditional latrine / 'Go into the bush'

10. **Do you have electricity in the house? Yes / No**

11. **What is your households main water source?**

    Own tap / **P**iped or pumped well water: private / communal / Open **W**ell / **R**iver or rain water / **B**uy water

12. **What is the main cooking fuel used?**

    Electricity / **G**as / **K**erosene / **W**ood / **C**harcoal

13. **Do you or one of the members of your household possess a:**
    (please indicate for each item if possessed)
    car _____
    motor bike _____
    bicycle _____
    refrigerator _____
    television _____
    sewing machine _____

14. **How much is the average monthly income of the household (derive): TSh._____**

15. **How did you come to this facility:** (if a combination is used, please indicate the travel time for each)

foot	_____	dala dala	_____
bicycle	_____	taxi	_____
own car	_____	other, specify	_____

16. **How much time did it take you to get from your house to this facility?**
    _____ hours, _____ minutes

17. **Could you estimate the distance you travelled from your house to this facility? _____km**

18. **What is your main reason for choosing this facility today?**
    (Please rank this answer with **1**)

not too far from home	_____	less crowded / waiting time	_____
not expensive	_____	availability of drugs	_____
recommended by friend / relative	_____	friendly personnel	_____
(trust in) better treatment	_____	long time knowledge	_____
referred to from other facility	_____	employer paid	_____
working hours	_____	other,_____	

19. **Are there additional reasons that have motivated you to come here today?**
    (please rank them **2**, **3** and so on in the list above)

28. **What is your opinion of the service offered by this health facility in the last five years.**
Have they: **1** improved, **2** the same, **3** deteriorated (fill the number for each item below).

cost of drugs	_____	(trust in) quality	_____
cost of treatment	_____	availability of drugs	_____
working hours	_____	friendliness of medical staff	_____
waiting time	_____	other	_____

29. **If you were the Minister of Health, what do you think should be changed in the health system?**

_____

_____

21. **How many times did you visit a health facility in the last 3 months?** _____ **times**

22. **Do you or any other member of the household attend other health facilities as well?**
Yes Please give the name, location name, means of transportation used, reasons for visit, and the seriousness of illness (please choose from: **Mi**ld / **Mo**derate / Severe) for each of these facilities in the table below.
No Go to Question 24

Facility name	Location	Transport	Reason (many!)	Frequency	Mi	Mo	Se

23. **Which is the facility you usually go to?** _____

24. **Suppose you would have to pay (more) for treatment here, would you still come?**
Yes **No**

If 'no': Where would you go then? _____

25. **Suppose a new private facility (offering similar services) would be located at half the distance from your home as this facility now, would you consider to go to that new facility?**
Yes **No**

Why? _____

26. **Suppose a new missionary facility (offering similar services) would be located at half the distance from your home as this facility now, would you consider to go to that new facility?**
Yes **No**

Why? _____

27. **If the household income doubled, would you still attend the same facilities?**
Yes **No**

If 'no': Where would you go then? _____

Appendix B: Procedure developed to generate the 1992 and 1998 population proxy

Apart from describing population density (see Chapter 4), the spatially disaggregate proxy of population is - in the absence of more detailed data - used to describe the spatial variation in health needs across the city of Dar es Salaam (Chapter 6). The procedure that has been developed to generate the 1992 and 1998 population proxy is illustrated in Figure A1 and briefly explained below.

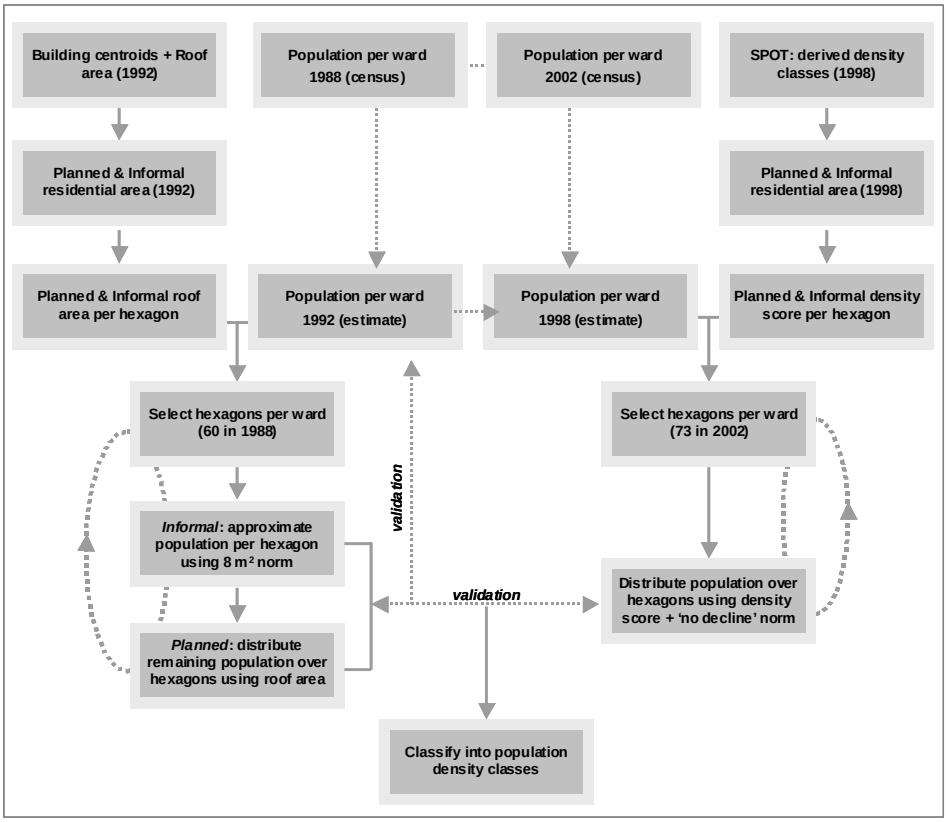

Figure A1: Generalized approach for establishing spatially disaggregate population estimates for 1992 and 1998.

The population proxy is derived using the following data sets which have been previously described in Chapter 3:

- land use snapshots of 1992 and 1998,
- census data of 1988 and 2002 with population totals per ward,
- building centroids with attribute data on building type and roof area in m2 for 1992

- hexagonal tessellation
- the Settlement Consolidation index derived from 1998 SPOT data as developed by (Sliuzas, 2004).

Method for generating the 1992 population estimate per hexagon

Procedure 1: generate total roof area per hexagon for residential areas in 1992
Extract all private buildings with their roof area in m² from the building centroid data set (attribute selection). In this way all public buildings were excluded.

Select only building centroids in formal and informal residential areas and - for each individual building centroid - determine if it is located in a planned or in an informal settlement (spatial selection).

Aggregate building centroid data to the hexagon level giving the total planned residential roof area and the total informal residential roof area per hexagon.

Procedure 2: generate population estimates per ward for 1992
Using the 1988 and the 2002 census data, the number of people per ward was approximated for 1992. Growth rates per ward were assumed to be constant during the inter-censal period. A complicating factor was that the ward boundaries of 1988 (60 wards) were not always the same as those used for the 2002 census (73 wards). In the case of unchanged boundaries, generating the 1992 population estimate was a straight forward interpolation. Whenever ward boundaries were different, wards were combined until the spatial units became comparable between 1988 and 2002; the growth rate was then calculated for the larger spatial unit but the population interpolation was still made at ward level. For the 1992 population estimates, the ward boundaries of 1988 were used.

Procedure 3: generate population estimates per hexagon for 1992
The idea here is simply to select all hexagons in a given ward and then distribute the 1992 population estimate over the total roof area of the selected hexagons. Three different approaches were, however, used:

If the selected hexagons *only* consist of planned residential areas the formula used is as follows: 1992 ward population estimate / total roof area of selected hexagons * roof area of the individual hexagon.

If the selected hexagons consisted of *a mix* of informal and planned residential areas a two-stage approach was used. Stage 1 sums the total informal roof area and then estimates the 'informal population' using the findings of Dangol (1998) who established that 8 m2 of roof area per person results in reasonably good population

estimates in informal residential areas[85]. Stage 2 sums the planned roof area and then distributes the remaining population over the planned roof area in all hexagons. Adding the two population figures per hexagon gives the population proxy per hexagon.

If the selected hexagons *only* consist of informal residential areas two estimates were made. *First* the standard distribution formula (1992 ward population estimate / total roof area of selected hexagons * roof area of the individual hexagon) is applied. *Second*, population is estimated using the 8 m2 norm of Dangol (1998). The reason for this dual approach is that according to Briggs and Mwamfupe (2001) the 1988 census had under-enumerated the population. In a few cases - particularly in high density informal areas - there were clear indications that the census had under-enumerated. In these cases, the estimate using the 8 m2 norm was used.

Method for generating the 1998 population estimate per hexagon

Procedure 1: generate population estimates per ward for 1998
Using the 1992 population estimates per hexagon and the 2002 census data per ward the number of people per ward was approximated for 1998. Growth rates per ward were assumed to be constant during the inter-censal period. For the 1998 population estimates, the ward boundaries of 2002 were used.

Procedure 2: derive density indicator per hexagon for 1998
The density indicator used is based upon a 1998 SPOT XS image which is classified into three density classes using a two-stage classification method developed by Gorte (1998) and the Settlement Consolidation Index approach developed by Sliuzas (2004).

The density data was originally stored as a raster data set with a spatial resolution of 100 meters but was converted to a point grid of 20 meters. On the basis of the point grid the total planned residential density score and the total informal density score was separately calculated for each hexagon.

Procedure 3: generate population estimates per hexagon for 1998
The 1998 approach is very similar to that of 1992: select all hexagons in a given ward and then distribute the 1998 population estimate over the total density score of the selected hexagons. Again, the scores were calculated separately for planned and for informal residential areas.

[85] If applied to the total roof area in informal settlements, around 80 percent of the population lives in informal areas. This figure is consistent with the estimate of Kyessi (2003).

Given that the density score derived from the 1998 SPOT data is considerably less accurate/sensitive than the 1992 roof area data, the 1998 approximations tended to underestimate the population in hexagons with (very) high population numbers in 1992. To reduce this smoothing effect it was assumed that the number of people living in a hexagon would as a rule not decline. If the 1998 hexagon estimate was below that of 1992, the 1992 estimate was used; the remaining population would be redistributed in an iterative manner. Because of this, the 1998 population estimates are somewhat less reliable than those of 1992, in particular in wards with residential expansion as well as densification.

In summary, the generated population proxies are based upon data of very different scale, accuracy and moments in time and include some inevitable assumptions. The implication is that the population estimates at hexagon level should be viewed upon as approximations only. At the same time, the proxies are accurate at the city and at the ward level and about the best that can be achieved given the significant data limitations.

Appendix C: Procedure developed to derive travel time estimations

The procedure that has been developed to generate the travel time estimates used in Chapter 5 is briefly explained below. Travel time calculations for respondents are made from the place of residence to the chosen health facility along the street network. The network has been established in such a way that it can and has been used to generate realistic travel time estimates for patients that *(i)* walk or *(ii)* make use of public transport. The network consists of four integrated components (see Figure B.1).

Component 1: the actual or physical street network

Road centrelines were originally digitized by Sliuzas (2004) using the 1:50,000 topographic maps. This road data set was further expanded and detailed - for the urban core area - using the 1:20,000 City Map (see Figure B.1*a*) and checked on topological consistency by de Jong and Amer (2002). To realistically represent the friction of distance, the street network is categorized into several road classes for which different travel speeds are assigned for each mode of transport on the basis of local knowledge (also see below).

Component 2: the virtual or 'walk support' network

Because the physical street network depicts the 1992 situation whereas the land use map describes the 1998 situation, de Jong and Amer (2002) created a virtual network for those areas in the city in which the street network was sparse and the original road centreline data most likely incomplete. The main purpose of the virtual network is to ensure that travel time calculations properly represent actual travel behaviour. The 'walk support' network was created only for the land use categories 'unplanned residential' and 'vacant and agricultural'. The motive for creating the walk support network for vacant and agricultural land is that there are no/few true roads but people do, nevertheless, traverse these areas on foot. The rationale for creating the walk support network for unplanned residential areas is to compensate for the fact that the available road centreline data for these areas are sparse and outdated/incomplete. For the other land use categories (planned residential, institutional) the road centreline data captured from the 1:50,000 topographic map and the 1:20,000 City map were considered to be sufficiently comprehensive as changes over time in these areas had generally been limited.

The virtual network was created in the following manner. *First*, the 1998 land use snapshot was generalized to represent the dominant land use per hexagon (see Figure B.1*b*). *Second*, only those hexagons are retained that represent unplanned residential or vacant and agricultural land; all hexagons that are traversed by a main river are

removed from this layer (see Figure B.1*c*). The latter is done to properly represent that rivers form a barrier to movement. *Third*, using *Flowmap* the adjoining centroids of the remaining hexagons are interconnected which results in a triangular shaped network (see Figure B.1*d*).

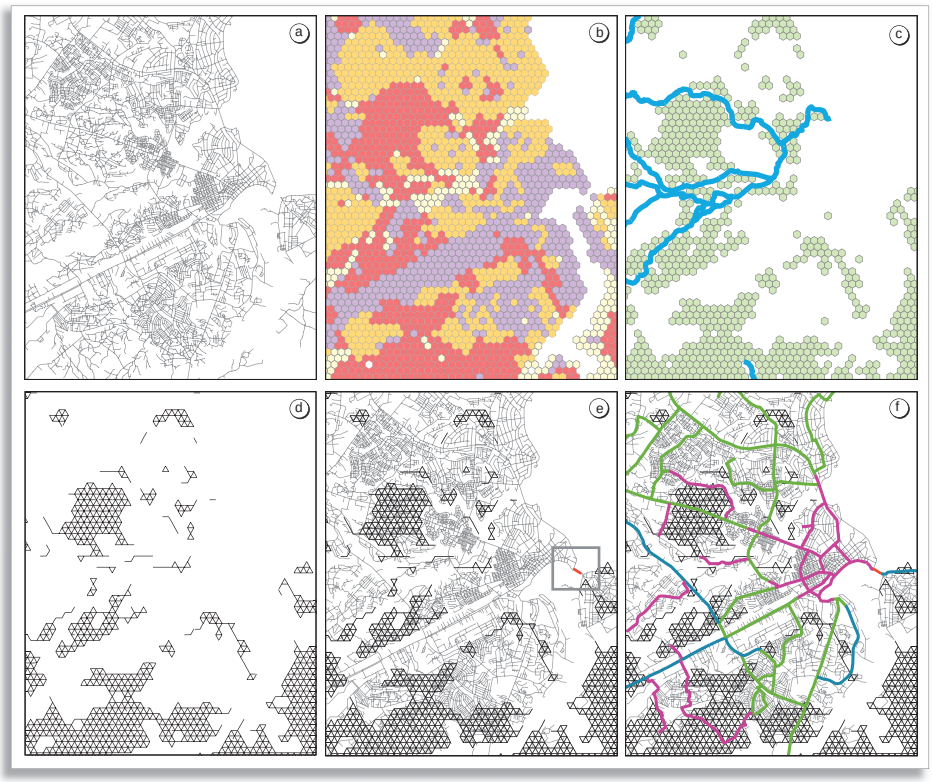

Figure B.1: Procedure for establishment and integration of the physical, virtual (walk support + ferry) and public transport network.

The virtual network is then merged with the physical street network (see Figure B.1*e*). The merged physical and 'walk support' network forms the basis for estimation of travel times for pedestrians. Walking speed is set at 3.5 km per hour for walking on the walk support network and at 4 km per hour for walking on the physical street network. By assigning a slightly higher impedance value to the virtual network pedestrians are 'stimulated' - but not forced - to walk on the physical streets. The assigned walking speeds are considered appropriate given that a considerable proportion of walking patients are females in their reproductive age often accompanied by their infants

Component 3: the ferry

To properly simulate the travel time incurred by people that make use of the cross-harbour ferry connection, a dummy link is added to the street network (see Figure B.1*e,* inset box). This link is assigned a fixed travel time of 30 minutes which - again on the basis of experience - is considered an accurate proxy for the average travel time of ferry users.

Component 4: the public transport network

Together with a group of urban planners of the City of Dar es Salaam, the complete public transport network - all roads and official bus stops used by public transport - and all operational bus routes were identified and georeferenced by Amer in 1995[86]. The public transport network was later updated by Kifle (1998) who also recorded bus travel speeds in the field for a number of bus routes (see Figure B.1*f*). In 2002, a group of ITC students coming from Dar es Salaam estimated travel times for a considerable number of public transport routes (a number of newer bus routes were also added). On the basis of this information, de Jong and Amer (2002) were able to derive realistic travel time approximations for public transport across the city. This was achieved in the following way.

The public transport model used
First, de Jong and Amer (2002) devised a public transport network model, which, with the help of Flowmap, could be used to calculate public transport travel times. The public transport model consists of a separate virtual network, which incorporates the main components of a typical public transport trip. The included trip components are (i) waiting time at the bus stop for the bus to arrive, (ii) driving time between bus stops, (iii) stop time at bus stops, (iv) transfer time (if required) and (v) alighting time (see Figure B.2). The blue circle in Figure B.2 represents one bus stop, which stands for a single physical location but consists of the abovementioned trip components, which are topologically connected in time. The public transport network is integrated as if it were an underground system meaning that the public transport network only connects to the physical/walk support network at bus stops.

A typical trip of a public transport user is, thus, conceptually modelled as follows:

- From the trip origin, an individual walks along the physical/walk support network to the nearest bus stop (access time)

[86] For a description of the dynamics in the public transport system see section 4.5.

- At the bus stop (s)he waits for the bus to arrive and gets on board (waiting time),
- The bus then departs for the next bus stop. The time required for this depends on the distance between the two bus stops and the travel speed on that part of the route.
- At the next bus stop the bus users has three options:
- Continue the ride to the next bus stop. In this case there is a stop time required for boarding and alighting of passengers at the bus stop.
- Transfer to another bus line. In this case, the user requires a transfer time to shift from one to another bus line before travelling to the next bus stop on the new bus line.
- Discontinue the bus trip and leave the bus at the bus stop. In this case some time is needed for leaving the bus (alighting time).
- After leaving the bus at the bus stop, the user again connects to the physical/walk support network and continues the trip on foot until the trip destination is reached (egress time).

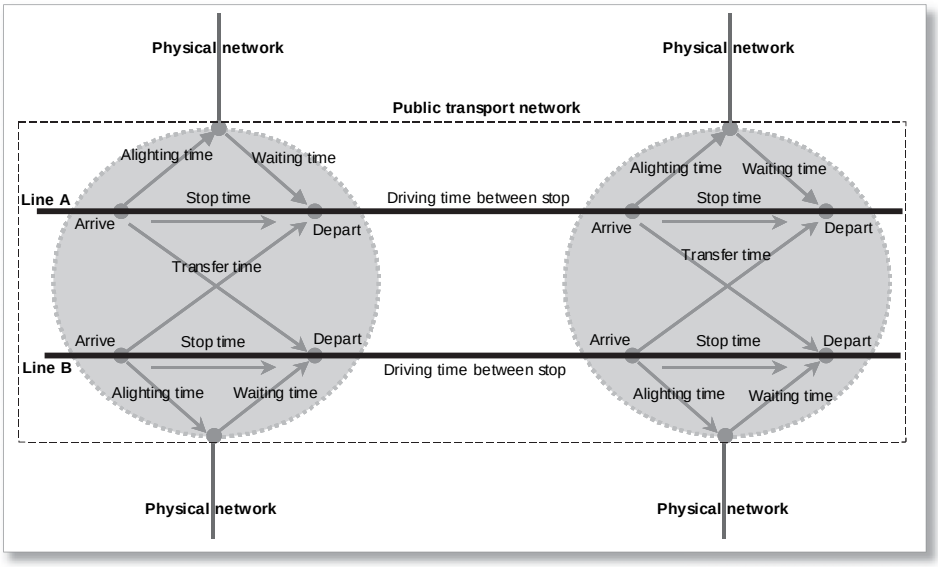

Figure B.2: Schematic illustration of public transport model.

Access and egress time are easily approximated using the set walking speeds for the physical and walk support network. The public transport time was estimated in the following way.

Estimating parameter values for the public transport model

Step 1: Estimate bus speed. To accommodate for variations in bus speeds, the public transport network is categorized into three speed classes. In the congested central parts of the city and on the unpaved routes off the main arterial roads the bus speed is generally low (estimate: 15 km p/h). In the ring around the city core, congestion is less problematic and buses can travel at medium speed (estimate: 30 km p/h). The higher bus speeds are generally realized on the main arterial roads further outwards of the city centre (estimate: 45 km p/h). Figure 4.8 provides an overview of the variation in bus speeds across the public transport network. Abovementioned speed estimates were made on the basis of *(i)* the findings of Berhie (1998), *(ii)* estimates made by ITC staff (Amer and Sliuzas) and *(iii)* local knowledge of the afore mentioned group of ITC students coming from Dar es Salaam.

Step 2: Estimate travel time for a selection bus routes. Off-peak hour travel time estimates were obtained from a group of ITC students coming from Dar es Salaam. The estimates of individual respondents were compared (if necessary verified) and averaged. In total, travel time estimates were obtained for about 30 public transport routes, which were all frequently used by the interviewees.

Step 3: Decompose selected bus routes in terms of their trip components. Each bus route for which a travel time estimate is available is then decomposed in terms of its trip components as follows:

Travel time = waiting time + (**# of bus stops** x stop time) + **driving time low speed + driving time medium speed + driving time higher speed + (# of transfers** x transfer time) + alighting time.

Trip components in **bold** are known or can be derived.

Step 4: Estimate values for unknown trip components. The final step is to generate estimates for the unknowns in the above-described equation. These estimates are generated using a technical and scientific computing software programme called *Mathematica*[87]. Estimates generated by *Mathematica* are then put into the public transport model and travel times estimates are generated for the selected bus routes. This process was repeated until *(i)* approximated travel times as generated by the public transport model become consistent with the estimates made by the group of students and *(ii)* plausible values are generated for each trip component.

[87] See: http://www.wolfram.com/products/mathematica/index.html

Table B.1 shows the values used to generate travel time estimates for patients that *(i)* walk or *(ii)* make use of public transport.

	Walking		Public transport	
Network	Km/h	Min	Km/h	Min
Physical	4	-	4	-
Walk support	3.5	-	3.5	-
Ferry	-	30	-	30
Public transport				
Low speed	-	-	15	-
Medium speed	-	-	30	-
Higher speed	-	-	45	-
Waiting time	-	-	-	5.3
Stop time	-	-	-	0.4
Transfer time	-	-	-	4.2
Alighting time	-	-	-	0.3

Table B.1

In *summary*, although it is acknowledged that above mentioned procedure remains a simplification of reality, travel time estimates generated in this manner are consistent with the control data provided by the group of individuals with local knowledge and do appear to represent realistic travel times.

Appendix D: Outcomes ANOVA for travel time of population strata

	Better off	Deprived	Starter	Modal		ANOVA[88]
	Average walking time *(min.)*				F	Sig.
Dispensary						
Governmental	16	20	19	21	1.15	0.33
Private	15	14	18	15	0.76	0.52
Voluntary	17	21	23	21	0.86	0.46
Hospital						
Governmental	15	30	30	29	10.47	**0.00**
Private	41	13	20	-	0.95	0.46
Voluntary	30	18	24	24	0.59	0.65
	Average public transport time *(min.)*				F	Sig.
Dispensary						
Governmental	24	35	26	28	0.46	0.71
Private	32	35	24	22	1.10	0.36
Voluntary	40	35	31	34	1.10	0.35
Hospital						
Governmental	29	34	31	34	0.99	0.40
Private	39	49	28	36	0.59	0.63
Voluntary	46	-	28	52	7.41	0.07

Table D1: Social strata, transportation mode, estimated average travel time and analysis of variance per provider type and level.

[88] If the average travel time is similar for the different population strata, the F ratio tends towards the value 1. The significance level tells if the observed F value is large enough to reject the null hypothesis. If the significance level is less than 0.05 at least one of the population groups differs from the others.

Appendix E: Comparison of allocation methods.

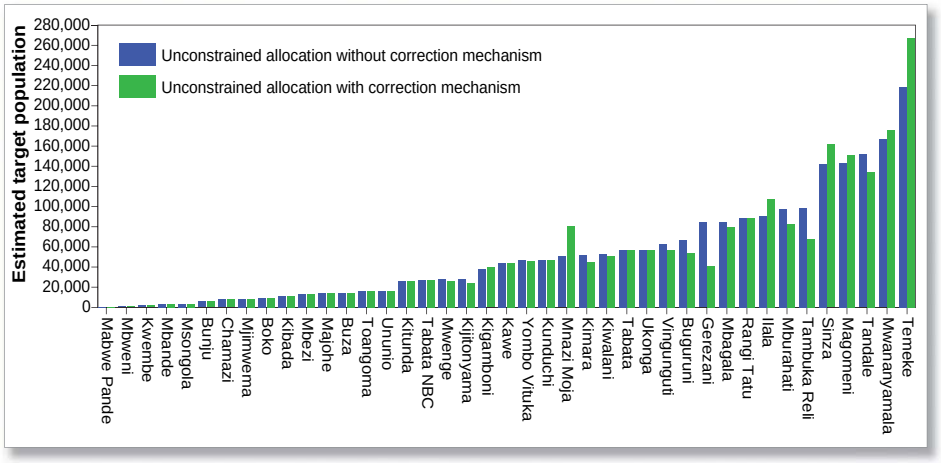

Figure E1: Comparison of allocation methods with and without correction mechanism that compensates for spatially sub-rational behaviour.

Summary

The overarching aim of this study is to develop a GIS-based planning approach that contributes to equitable and efficient provision of urban health services in cities in sub-Saharan Africa. Its prime concern is with *(i)* the identification of theoretical and methodological constructs that can be used to analyse and improve the spatial performance of public health service delivery systems, and *(ii)* the development of a corresponding spatial-analytic and GIS-based planning approach using Dar es Salaam as a case study.

The broader context of the study is the 'urban health crisis'; a term that refers to the disparity between the increasing need for medical care in urban areas against the declining carrying capacity of existing public health systems. The countries of the sub-Saharan region are experiencing some of the highest urban growth rates of the world and have generally also exhibited weak economic performance over extended periods. Urbanization in sub-Saharan Africa, as a result, is associated with the urbanization of poverty and with the proliferation of slums. The combined effect of poverty and substandard living conditions leads to high morbidity and mortality rates and boosts the need for urban health care. At the same time, the ability of governments to mobilize public resources for health programs has diminished as a result of prolonged economic stagnation and the international call for privatization of the public sector.

The point of departure of this research are the guiding principles (equity, effectiveness and efficiency) of the primary health care approach which is widely adopted in the sub-Saharan region. This demonstrates that health care provision is inevitably tied up with issues of resource allocation, distribution and priority setting. Decisions have to be made about the nature and range of services to provide and how they are distributed amongst the members of society. Obviously, such decisions are informed by economic, political, medical and ethical considerations but - as this research underlines - should also consider the spatial dimension.

Abovementioned considerations on social justice, equity, efficiency and maximisation of health benefits are transposed into a spatial context through a discussion of two important bodies of spatial theory: neoclassical location theory and spatial welfare theory - 'who gets what where and how' - as formulated by Smith (1977). Neoclassical location theory provides fundamental spatial concepts, which can be used to create a simplified model of how health care systems function in geographic space. Spatial welfare theory builds upon but criticizes the normative nature and restrictive assumptions of neo-classical thought. Spatial welfare theory - analogous to health care - emphasizes quality-of-life issues, questions of social justice, and explicitly addresses problems associated with the distribution of public resources in geographic space.

To evaluate alternative spatial distributions in equity and efficiency terms and suggest improvements, spatial performance indicators are required. Such indicators are generated via the accessibility concept which is seen as a notion with a socio-economic as well as a spatial dimension between which important interactions exist. The most common operationalisations of the accessibility concept are evaluated and it is concluded that a sound way for evaluating alternative spatial health service configurations is to develop a 'what if' type of GIS-based approach on the basis of cumulative opportunity or gravity based measures of accessibility.

A subsequent evaluation of the empirical literature on accessibility analysis and (health) service planning reveals that a general uptake of GIS can be observed from about 1995 onwards but it also shows that the application of GIS for health services planning is still in an early stage of development. Many of the identified publications make use of rather simple accessibility measures and their focus generally is on the analysis of existing situations rather than on scenario development. The near complete absence of 'what if' type of strategic urban health planning applications in sub-Saharan Africa signals that considerable scope remains for further research in this field.

The remainder of the research is structured around an empirical case study of the city of Dar es Salaam in Tanzania; a more or less typical example of a large city in the sub-Saharan region. The empirical part of the research commences with a two-level overview of the broader societal and economic context in which health care provision and utilization in Dar es Salaam occurs. At the *national* level, the overview identifies the main reasons behind the weak performance of the Tanzanian economy over time and explains how IMF/World Bank induced structural adjustment programmes have led to reforms of the Tanzanian health sector and the emergence of a pluriform health care system. The *local* level overview zooms in on Dar es Salaam and consists of three parts. The *first* analyses the urbanization process of Dar es Salaam and its changing land use structure over time. The *second* discusses the characteristics of the road infrastructure and the main modes of transportation used by the residents of Dar es Salaam. The *third* part analyses the functional and spatial dynamics in health care provision that have occurred in Dar es Salaam up to the year 2000.

The subsequent building block of the research consists of an analysis of observed socio-spatial patterns of health seeking behaviour in the context of medical pluralism. The analysis shows that - for mild health problems - the choice behaviour of governmental, private and voluntary health care users is mainly guided by the desire to attain affordable health care of adequate quality, with sufficient drugs, at a location not too distant from home. In all cases travel distance/time is an important consideration. The competitive strength of governmental health care is associated with affordability and proximity. Its main perceived weaknesses are drug shortages, long waiting times and, poor quality medical and interpersonal care. The competitive edge of private and, particularly, voluntary health care is related to drug availability, and perceived quality of

medical and interpersonal treatment. If an explicitly spatial perspective is taken, the analysis reveals that most patients walk to the dispensaries of their choice and generally do not travel for more than about 30 - 40 minutes. A comparative analysis of the survey data reveals that socio-spatial patterns of health seeking behaviour have largely remained unchanged between 1995 and 2000.

The different research threads all come together in the last part of the analysis which presents a 'what if' type of planning approach designed to evaluate and improve the spatial performance of the Dar es Salaam governmental health care system. In doing so it illustrates how more sophisticated GIS-based analytical techniques can be usefully applied in support of strategic spatial planning of urban health services delivery. It consists of an *evaluation* and an *intervention* framework. The *evaluation* framework appraises the performance of the existing Dar es Salaam governmental health delivery system on the basis of generic quantitative accessibility indicators. The *intervention* framework explores how existing health needs can better be served by proposing alternative spatial arrangements of provision using scarce health resources. It consists of a set of 'what if' type of planning instruments that can support health planners to *(i)* detect spatial deficiencies of a given delivery system, *(ii)* propose priority spatial planning interventions and *(iii)* estimate the expected impact of potential interventions on spatial performance. To appropriately deal with the hierarchical nature of the health service delivery system, two lower-order (dispensary level) and two higher-order (health centre or hospital level) planning instruments are developed. The *lower-order reduction* instrument identifies health facilities that hardly contribute to spatial performance and stand for inefficient use as well as inequitable distribution of available resources. The *lower-order expansion* instrument identifies areas and populations that are not well served by a given constellation of provision, charts out priority locations with a high service potential and estimates the expected improvement in spatial performance associated with the establishment of additional dispensaries.

The *higher-order downgrading* instrument assesses in how far health centres or hospitals contribute to overall spatial performance. The basic idea in this case is that a higher-order facility that does not contribute sufficiently could be reduced in rank (downgraded) and become a lower-order service node. The *higher-order upgrading* instrument considers the reverse situation: some dispensaries could be situated at locations with a very high service potential. Such strategically situated dispensaries are potential candidates to be promoted and become a higher-order service node. When used in concert the developed planning instruments offer a flexible framework with which health planners can formulate and evaluate alternative intervention scenarios and deal with the most important problems involved in the spatial planning of urban health services. The planning instruments, finally, are designed to contribute to making informed spatial decisions; not to automate but rather to support part of the planning process.

Samenvatting

De overkoepelende doelstelling van deze studie is het ontwikkelen van een op GIS gebaseerde methodiek ten behoeve van het plannen van een ruimtelijk rechtvaardig en ruimtelijk efficiënt aanbod van gezondheidszorgvoorzieningen in stedelijke gebieden in sub-Sahara Afrika. Het onderzoek richt zich daarbij in eerste instantie op het identificeren en beschrijven van theoretische en methodologische constructen waarmee het ruimtelijk functioneren van publieke gezondheidszorgvoorzieningen kan worden beoordeeld. Op basis hiervan richt het onderzoek zich vervolgens op het ontwikkelen van een ruimtelijk-analytische op GIS gebaseerde planningsmethodiek waarbij Dar es Salaam, Tanzania dient als studiegebied.

De algemene context van het onderzoek is de 'urban health crisis'. Deze term refereert aan de asymmetrie tussen enerzijds de sterk groeiende behoefte aan gezondheidszorg in steden en anderzijds de zeer beperkte middelen van (lokale) overheden om in die behoefte te voorzien. Een belangrijk kenmerk van de landen in de regio ten zuiden van de Sahara is dat zij een proces van snelle stedelijke groei doormaken welke gepaard gaat met langdurige perioden van zwak economisch presteren. Het urbanisatieproces in sub-Sahara Afrika gaat daarom gepaard met verstedelijking van de armoede en met de proliferatie van sloppenwijken. Het gecombineerde effect van snelle groei, armoede en problematische levensomstandigheden leidt tot een hoge morbiditeit en mortaliteit en tot een sterke toename van de behoefte aan stedelijke gezondheidszorg. Tegelijkertijd wordt het mobiliseren van publieke middelen voor gezondheidszorg problematischer als gevolg van economische stagnatie en de internationale druk om de publieke sector te privatiseren.

Als uitgangspositie voor het onderzoek is gekozen voor de sturende principes (rechtvaardigheid, effectiviteit en efficiency) van de 'primary health care' benadering welke wijdverspreid is in sub-Sahara Afrika. Deze principes geven duidelijk aan dat gezondheidszorg onlosmakelijk verbonden is met toedeling- en verdelingsvraagstukken en met het stellen van prioriteiten. Besluitvorming zal niet alleen moeten plaatsvinden ten aanzien van het spectrum aan medisch zorgaanbod maar ook hoe de zorg wordt verdeeld over verschillende maatschappelijke groepen. Het spreekt voor zich dat economische, politieke, medische en ethische overwegingen daarbij een rol spelen maar - zoals dit onderzoek betoogd - behoeft ook de ruimtelijke verdeling van het zorgaanbod expliciete aandacht.

Bovengenoemde principes worden in een expliciet ruimtelijke context geplaatst door middel van neoklassieke locatietheorie en ruimtelijke welvaartstheorie zoals geformuleerd door Smith (1977). Het belang van de neoklassieke locatietheorie is dat het een aantal fundamentele concepten aanreikt waarmee het ruimtelijk functioneren van gezondheidszorgvoorzieningen kan worden gemodelleerd. Ruimtelijke welvaartstheorie bekritiseert de strikt normatieve en restrictieve aannames van de

neoklassieke locatietheorie. Daarnaast behelst ruimtelijke welvaartstheorie ook expliciet ruimtelijke verdelingsvraagstukken van publieke voorzieningen.

Om alternatieve ruimtelijke verdelingen te kunnen beoordelen in termen van rechtvaardigheid en efficiency zijn ruimtelijke prestatie-indicatoren of kengetallen nodig. Dergelijke kengetallen kunnen worden gegenereerd middels het concept bereikbaarheid. Een evaluatie van de meest voorkomende operationalisaties daarvan leert dat alternatieve ruimtelijke constellaties van zorgaanbod goed kunnen worden geëvalueerd op basis van een 'what if' benadering die gebaseerd is op een 'cumulative opportunity' of een 'gravity-based' bereikbaarheidsmaat.

Een literatuurverkenning van de meer empirisch georiënteerde literatuur leert dat het gebruik van GIS voor de analyse van bereikbaarheidsvraagstukken zich vanaf ongeveer het midden van de jaren negentig manifesteert. Het overgrote merendeel van de geïdentificeerde studies is echter gebaseerd op (zeer) eenvoudige bereikbaarheidsmaten en is overwegend gericht op de analyse van de bestaande situatie en niet op het ontwikkelen van toekomstgerichte scenario's. Het vrijwel ontbreken van gepubliceerde 'what if' benaderingen ten behoeve van het plannen van stedelijke gezondheidszorg in sub-Sahara Afrika geeft aan dat nader onderzoek op dit terrein academisch relevant is.

Het empirische deel van dit onderzoek heeft Dar es Salaam, Tanzania als studiegebied. De achterliggende gedachte hierbij is dat Dar es Salaam een voldoende typisch voorbeeld is van een grotere stad in deze regio. Het empirische deel van het onderzoek begint met een algemeen overzicht van de sociaal-politieke en economische context waarbinnen zorgaanbod, zorgvraag en zorggebruik in Dar es Salaam zich afspeelt. Op het nationale niveau wordt allereerst ingegaan op de achtergronden die hebben geleid tot het langdurig zwak presteren van de Tanzaniaanse economie. Daarna wordt verklaard hoe Structurele Aanpassing Programma's - zoals voorgestaan door de Wereldbank en het IMF - hebben geleid tot herziening van het Tanzaniaanse stelsel van gezondheidszorg en de opkomst van een pluriform zorgaanbod. Op het lokale niveau wordt een drietal thema's behandeld. Als *eerste* wordt een voornamelijk kwantitatieve beschrijving gegeven van het urbanisatieproces van Dar es Salaam en van de veranderingen die in de tijd zijn opgetreden in de ruimtelijke structuur van de stad. Het *tweede* deel beschrijft de kenmerken van de wegeninfrastructuur en geeft inzicht in de voornaamste vervoersmiddelen die worden gebruikt door de inwoners van Dar es Salaam. Het *derde* deel analyseert de functioneel ruimtelijke ontwikkeling van het zorgaanbod zoals zich dat tot aan het jaar 2000 heeft gemanifesteerd.

Het volgende bouwblok van het onderzoek bestaat uit een analyse van waargenomen sociaal ruimtelijke patronen van zorggebruik in een context van pluriform zorgaanbod. De analyse concludeert dat - voor milde gezondheidsproblemen - het keuzegedrag van patiënten vooral wordt bepaald door betaalbaarheid, gepercipieerde kwaliteit, beschikbaarheid van medicatie en nabijheid van de voorziening. Reisafstand of -tijd is

in vrijwel alle gevallen een factor van belang. De concurrentiekracht van de publieke gezondheidszorg hangt vooral samen met betaalbaarheid en geografische nabijheid. De voornaamste genoemde tekortkomingen van de publieke gezondheidszorg zijn het gebrek aan medicatie en de gebrekkige kwaliteit van de medische- en interpersonele zorg. De concurrentiekracht van de private en, vooral vrijwillige, gezondheidssector is nauw verbonden met de beschikbaarheid van medicijnen, de gepercipieerde kwaliteit van de medische zorg en de persoonlijke aandacht van het medische personeel voor de patiënt. Het leeuwendeel van de patiënten gaat te voet naar de kliniek van hun keuze en is doorgaans niet bereid om meer dan 30-40 minuten te reizen. Een vergelijkende analyse geeft aan dat de sociaal ruimtelijke patronen van zorggebruik zich nauwelijks hebben gewijzigd tussen 1995 en 2000.

De verschillende onderzoekslijnen komen samen in het laatste deel van de studie. Hier wordt een 'what if' planningsmethodiek gepresenteerd waarmee het ruimtelijk functioneren van de publieke gezondheidszorg kan worden geëvalueerd en verbeterd. Het onderzoek illustreert hiermee hoe geavanceerde ruimtelijk analytische GIS technieken kunnen worden aangewend ten behoeve van strategische planning van stedelijke gezondheidszorg. De ontwikkelde planningsmethodiek kan worden onderverdeeld in een evaluatie- en een interventie kader. Het *evaluatiekader* is ontwikkeld om het ruimtelijk functioneren van de publieke gezondheidszorg te beschrijven op grond van generieke kwantitatieve bereikbaarheidsmaten. Het *interventiekader* bestaat uit een aantal 'what if' planningsinstrumenten waarmee een betere ruimtelijke afstemming tussen zorgvraag en zorgaanbod kan worden gerealiseerd.

Vanwege de hiërarchische opbouw van het zorgaanbod zijn een tweetal 'higher-order' en een tweetal 'lower-order' planning instrumenten ontwikkeld. Het *'lower-order' reductie*-instrument identificeert klinieken (dispensaries) die maar een beperkte positieve bijdrage leveren aan de bereikbaarheid van het zorgaanbod als geheel. Dergelijke ruimtelijk 'overbodige' klinieken representeren inefficiënt gebruik van schaarse middelen. Het *'lower-order' expansie*-instrument *(i)* identificeert ruimtelijke deficiënties in het zorgaanbod, *(ii)* beveelt ruimtelijke interventies aan en *(iii)* geeft een inschatting van het verwachte positieve bereikbaarheidseffect als gevolg van uitbreiding van het zorgaanbod.

Het *'higher-order' degradatie*-instrument beschrijft in hoeverre grotere klinieken (health centres of hospitals) bijdragen aan de bereikbaarheid van het zorgaanbod als geheel. In dit geval is de gedachte dat een hogere orde voorziening die maar beperk bijdraagt aan de bereikbaarheid zou kunnen worden 'gedegradeerd' tot een voorziening van lagere orde. Het ruimtelijk functioneren op dit lagere niveau kan vervolgens worden beoordeeld met het 'lower-order' reductie instrument. Het *'higher-order' promotie*-instrument, tenslotte, beschouwt de omgekeerde situatie: sommige kleinere klinieken (dispensaries) kunnen gelegen zijn op zeer strategische locaties. Klinieken gelegen op

dergelijke hoogwaardige locaties kunnen worden gezien als kandidaten om te worden gepromoveerd tot een zorgvoorziening van een hogere orde (health centre of hospital).

Met de beschreven planning-instrumenten kunnen beleidsmakers en planners de meest voorkomende ruimtelijke vraagstukken in de gezondheidszorg analyseren alsook alternatieve interventie-scenario's ontwikkelen en deze op hun verwachte ruimtelijke merites beoordelen.

Curriculum vitae

Sherif Amer was born on July 15th in Delft, the Netherlands. After graduating from high school (Atheneum A) at the Scholengemeenschap Zuid in Enschede in 1978, he studied Human Geography at Utrecht University. He continued his studies at the International Institute for Geo-Information Science and Earth Observation (ITC) and obtained a postgraduate diploma in land information systems for urban applications in 1989. After completing this study he was employed at the Netherlands Centre of Expertise for Geographic Information Processing (NexpRI) where he worked up to 1992. In 1992 he changed course and joined ITC as an assistant professor working on subjects related to the application of GIS for urban planning and management. He has been involved in projects in countries such as Indonesia, China, Tanzania, Malawi, Egypt and Rwanda.

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