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**AN EVALUATION OF THE PROVISION AND PERFORMANCE OF
ACUTE CARE HOSPITALS IN THE NON -METROPOLITAN
REGIONS OF THE WESTERN CAPE PROVINCE.**

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LIST OF ABBREVIATIONS

ALOS	Average Length of Stay
PAWC	Provincial Administration Western Cape
DOH	Department of Health
PAH	Provincial Aided Hospitals
HMC	Health Management Committee
PHP	Provincial Health Plan
HBWG	Hospital Bed Working Group
BOR	Bed Occupancy rate
TOR	Turn Over ate
NHFP	National Health Facility Planning
REHMIS	Regional Health Management Information System
COSTPDE	Cost per patient day equivalent
RAWP	Resource Allocation Working Party
DEA	Data Envelopment Analysis
SMT	Strategic Management Team
FMS	Financial Management System
PERSAL	Personnel Salary Administration System
GIS	Geographical information System
CSS	Central Statistical services
HSP	Hospital Strategy Project
ANOVA	Analysis of Variance

Declaration

I, Dr Uchechukwu Foster Onwuchekwa, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise), and that the work has not been published before.

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SUMMARY

Health Departments across South Africa face increasing financing constraints comparable to other developing countries and reported internationally. During the 1997/98 financial year, the Department of Health (DOH), Provincial Administration of the Western Cape (PAWC) faced huge cuts in its financial resource allocation from the National Department as policy shifted to wards addressing past inequity between the provinces. In the Western Cape Province, 200 regional hospital beds have already been closed with a further 500 beds located in academic health centres earmarked for closure. Hospitals in the province consume over 73% of the health care budget at PAWC and faced with budget cuts, research teams were approached to evaluate the supply of acute care hospital beds focusing on efficiency and equity in order to guide rational policy decisions to achieve savings from hospitals.

AIM AND OBJECTIVE

This study evaluated the performance and distribution of acute care public sector district hospital beds in non-metropolitan regions of the Western Cape Province. It applied some methodologies including use of norms recommended for monitoring performance in South African hospitals by the Hospital Strategy Project (HSP). Study results would be invaluable to managers at PAWC for planning hospital beds and resource distribution leading to savings from improved efficiency.

METHOD

All 25 public sector funded acute care district hospitals (either PAWC owned or Provincial Aided) are evaluated for performance. In addition, three regional hospitals were included in analysis that evaluated comprehensive the distribution of acute care beds with implications for equity. Several data sources including the use of census population data, hospital information system with utilisation data and costs are utilised after validation of the data has been performed.

The drainage populations for hospitals, districts and regions are determined, as are estimates of cross border flow of patients. Several hospital performance variables that included indicators of provision (beds per 1000 population), activity (average length of stay and turnover rate), and

service mix (surgical procedure and ratio of normal to complicated delivery), and hospital cost using cost per patient day equivalent. Data analysis was performed using STATA and Microsoft Excel and Access with results presented using graphic scatter plots to show distribution of variables across hospitals, districts or regions, Tables and Figures. Additionally, non-linear regressions, short run cost function curves and Pabon Lasso technique are used to analyse relationships and factors that influence hospital cost, bed occupancy and bed provision.

RESULTS:

Results obtained indicate that there is inequitable bed supply across and between hospitals, districts and regions of the non-metropolitan regions Western Cape, with some districts having no earmarked district beds. Using Pabon Lasso technique, most (17) of the 25 hospitals in the non-metropolitan regions could be described as inefficient. The cross border flow of patient from other districts to district hospitals is calculated to be from 1-9% for district hospitals, and up to 21% in regional hospitals. and this information could contribute to planning hospital service population.

The relationship between bed supply and hospital cost using average cost curve follows a U shape suggestive that efficiency is best optimally obtained for the district hospitals with sizes range of 65-120 beds. The result support motivation for mergers in smaller hospitals enhanced public private mix or outright reduction of hospital beds in some of the large district hospitals. Hospital cost appeared to be influenced by ownership of hospitals with PAWC owned hospitals appearing to be more expensive than Provincial Aided hospitals

RECOMMENDATION AND CONCLUSIONS

On the basis of findings of this study, there is inequitable distribution of hospital beds, according to hospital, district and region categories in the non-metropolitan regions of the Western Cape Province. Reallocation of resources such as beds between hospitals and districts, mergers for small hospitals and bed reduction for very large hospitals especially for those outlier hospitals identified in this study as under performing is warranted. In carrying out the changes, PAWC would be required to utilise principles of change management and communication techniques to win positive alliances needed to bring about the desired changes.

CHAPTER 1:

INTRODUCTION

1.1 BACKGROUND

International trends from several country experiences reveal declining figures for acute care hospital bed supply, increases in the number of inpatient admissions, with declining average length of patient hospital stay (ALOS). However, in contrast to the more general observation, a few countries have experienced declining numbers of inpatient admissions.^{1,2}

Health care costs consume a large proportion of total public expenditure in several countries. This observation is attributed to but is not limited to factors such as health sector inflation being much higher than that observed at general consumer levels. Some of the costs can be explained by the costs associated with use of newer and more expensive technology, an ever-rising consumer expectations and also consumer demand for health care. The nature of the cost increase have resulted in the use of terms such as “health care cost explosion” to express the cost increase.^{1,3}

Hospitals constitute one of the most expensive components of the health sector.^{4,5,6} Expenditure data from the Organisation for Economic and Development Co-operation (OECD) Countries, show that hospitals account for about 40-60% of the health care expenditure of member countries. Hospitals have been reported to account for over 70% of health care expenditures in several East European Countries and the Soviet Union.⁷ Hospitals in developing countries (including South Africa) have been reported to consume between 50% to 80% of the public sector health care expenditure, a figure much higher than those of developed countries and could in real terms account for up to 70% of district level health care facility expenditure.^{4,5,6}

To contain costs associated with providing hospital care, some measures have been deployed by managers to control or influence appropriate hospital utilisation. These may bring about expenditure reduction through targeted reduction of available beds for inpatient care, use of substitutes for long-term (chronic) care such as home based care, planned short term (non urgent or seasonal) bed closures, hospital in the home, ambulatory surgery, the use of improved hospital admission protocols and inpatient care routines. Choosing various combinations from available

options presents decision dilemmas for managers. Health care managers in both developing and developed countries are more likely to choose hospital bed reduction options when faced with rising health care costs and budget constraints.^{1, 2, 8} This is because beds have a direct relationship to hospital size and therefore costs. But negative consequences resulting from choosing this option from such varied choices are not uncommon.^{9, 10} Faced with short deadlines within which to make decisions that impact on resource allocation, wrong choices have been made in a hurry by managers that upon subsequent review are found to be underpinned by very little research base that support the plans.^{1, 7} Research thus has an important role to support decision making concerning hospital planning and could have several unique applications. These are suggested by Edwards et al 1999⁷ to include the following: contribution towards rational hospital bed planning; evaluating future demand for hospital care, elucidating aspects of hospital performance and also ALOS forecasting. Further contribution of research include, assessment of the impact of specialisation of hospitals and inputs on access to care, imaginative ways of hospital personnel staffing, aspects of change management occasioned by restructuring process, improved methods for planning new hospitals through the use of techniques that utilise scenarios, models, and sensitivity analysis.

In South Africa, the supply of hospitals and health services is skewed, a situation partly due to our legacy of a recent Apartheid government past, with its discriminatory health and other policies. These policies favoured urban relative to rural areas and was also race-based, favouring whites^a with the exclusion of all other racial groups in keeping with resource allocation policies existent during the apartheid years.^{11, 12, 13} This situation contributed to an existence of supply and demand mismatches in the availability and utilisation of public and private sector health facilities and hospital beds that may have been located in communities not needing them. Performance of hospitals could be compromised in such settings, contributed to by mismatches from under-utilisation and concomitant wastage of available resources. This may then present in the form of differing degrees of inequities in hospital care access. This scenario similarly observed in the Western Cape Province is not unlike other South African Provinces, warrants a re-evaluation of resource provision and efficiency in this component of the health service given resource constraints.

The catalyst for undertaking restructuring initiatives during the 1997/98 financial years in the Western Cape Province, is largely linked to changes introduced in the formula and principles for

^a Racial terminology here used only to illustrate the racial classification that was used during apartheid years and does not aim to convey acceptance of the use of race based terminologies in research.

determining allocation of funds to the provinces from the central government. These changes were aimed amongst other reasons, at ensuring a move towards achieving equity between the 9 provinces of South Africa.^{14, 15} On account of this, previously “over- resourced” provinces, anticipated and were greeted with considerable financial strains that threatened continued provision of health services in these Provinces more than ever before. The Department of Health (DOH) of the Provincial Administration Western Cape (PAWC), *henceforth referred to as PAWC in this study*, belonged in the category of “over-resourced” health provinces, and therefore sought strategies for efficiently managing the available revenue allocation in order to meet service needs and demand.

Great disparities are already existent in health care allocation in terms of funding by level of care at PAWC. During the 1995/96 financial year, a total of R2, 347,778,000 (1 US\$= R3.5) was spent by the PAWC for health service provision with the largest proportion (73.6%) of this amount being spent on tertiary and academic health centres (hospitals). Out of this figure, 20% was for district (including general and regional) hospital services, while primary health care accounted for only 15% of the expenditure budget [direct communication-Directorate of Policy and Planning, PAWC]. In terms of expenditure for district hospitals, personnel component accounted for 68.3% of the cost.

The above scenario highlights the existence of hospi-centric health care expenditure pattern at PAWC, which are unsustainable in the face of dwindling sources of revenue. These considerations prompted the Health Management Committee (HMC) of PAWC, to embark on several strategic policy reviews in anticipation of the changes envisaged. One of the strategic decisions emanating from these, led to a review efficiency of public hospitals across the Western Cape Province was made. This policy focus is reinforced by shifts in national and provincial policy direction that now placed more emphasis on primary health care and the development of district based health services as opposed to hospi-centric care of the past. The managers at PAWC also considered the change in the national allocation formula as an albatross on which they could anchor the transformation of hospital service and provincial hospital bed provision in line with objectives contained in the Provincial Health plan (PHP).¹⁶ The PHP sets out a blueprint to guide PAWC towards reorganising health (hospital) services based on considerations of efficiency, equity, affordability, effectiveness, appropriateness and accessibility.

Emanating from the HMC strategic decisions on the way forward, various task teams were set up such as the JIMS^b process, Kings fund (from the European Union), which reviewed and recommended models for rationalisation of tertiary and secondary level hospital services. Similarly a hospital bed-working group (HBWG) was set up in May 1997, from which this study emanated. The HBWG was tasked with the responsibility of reviewing current efficiency, bed provision and distribution of public hospitals in the Western Cape Province. Particular concerns to be addressed were the district hospitals located in the non-metropolitan regions of the province given that other members of the HBWG have been tasked with responsibilities to undertake similar studies in the Metropole region. Members of the HBWG were given a 2 months deadline to conclude its task from inception, with the timeframe later extended by a further 3 months following presentation of preliminary findings.

In the Western Cape Province, Hospitals are categorised according to PAWC classification into Academic, Regional and District (Community) types, with these connoting the level of care and referral position applicable to each hospital. By using indicators such as length of patient hospital stay and the nature of care provided, PAWC hospitals are further classified into Acute and Chronic care hospitals. Chronic hospitals are further sub-classified into other categories such as psychiatric hospitals, rehabilitation homes, nursing homes and tuberculosis hospitals. In terms of ownership, public sector hospitals in the Western Cape Province are subdivided into PAWC owned and the Provincial Aided Hospitals (PAH). The PAH derive about 90% of their expenditure budget from PAWC's transfer payments to them and they receive the remaining 10% balance through hospital fees collected from private fee paying patients.

This study evaluates the current supply of hospital beds and compares the operating efficiency at which district hospitals in the non-metropolitan regions function currently. Inter-district and inter-regional bed supply; distribution and relative performance of the hospitals is evaluated. The magnitude of cross border flow of patients in terms of movement from one district or region to another in connection with utilisation of district hospitals is investigated. Pabon Lasso Technique¹⁷ for assessing hospital performance recommended by the Hospital Strategy Project (HSP)¹⁸ is utilised in this study to assess relative performance of district hospitals. This technique has appeal because of its simplicity and utility as it encompasses the use of at least three commonly available and collected hospital activity indicators. This approach has the potential to promote better comparison of hospital performance using practical and common approaches

^b JIMS is acronym for Joint Implementation Management Strategy

recommended by the HSP for adoption by hospital administrators for public hospitals all over South Africa.

The research work presented through this thesis is organised into chapters for ease of understanding the study. **Chapter 1**, presents an introduction that outlines the study background,, problem, purpose, aims and objectives. **Chapter 2** presents literature review of relevant body of previous research work on hospital performance and commonly description of utilised performance indicators. **Chapter 3** provides discussion on methodologies utilised in this study with description of data sources and variables, research ethics and analysis performed. **Chapter 4** contains graphical, table and text-based presentation of results obtained in the study. **Chapter 5** contains discussions of research findings, study limitation, recommendations and policy implications and is followed by the **References** and **Appendix** sections.

1.2 **PROBLEM**

Expenditure on hospitals consumes about 73% of the health care budget at PAWC. Such expenditure pattern in the face of dwindling funding to historically “over-resourced” provinces such as PAWC is unsustainable.

The magnitude of the financial pressures referred to above, are revealed through its impact in causing health care managers at PAWC to close down about 120 regional hospital beds in 1997/98. Further proposals exists which would lead to closure of additional 500 beds from the academic hospitals in the Province, if targets of expected revenue savings could not be met by the time of conclusion of this study. Changes in National and Provincial policy commitments towards implementing a district based health care system, contributed as a catalyst to bring about this much desired change in resource reallocation choices.

Logical policy options to consider in the face of resource scarcity, representing the range of choices that the PAWC managers could choose from are; 1) to improve efficient use of available resources, 2) reallocation of resources within the health sector in a manner that will lead to maximum benefit and outcome, 3) reallocation of resources to the health sector from sectors outside health, and 4) any combination of the above. ¹⁹

Given that allocation of resources to the health department from other sources is not a feasible option for PAWC at the time, policy makers could only choose from the remaining options, or combinations thereof. It is expected that any efficiency gains made, would translate into financial savings, which could be utilised towards meeting the financial demands of other equally important programs of PAWC, such as combating the rising Human Immune Deficiency virus and Acquired Immune Deficiency Syndrome (AIDS).

1.3 PURPOSE

The purpose of this study is to provide a description of the current provision of acute care hospital beds and also assess performance of hospitals in health districts of the non-metropolitan regions of the Western Cape Province. Non-metropolitan regions of PAWC happen to be located in rural areas and are the focus of this research because other research team member's from the HBWG were tasked to evaluate hospitals in the metropole region using similar methodologies.

By using performance indicators and other HSP suggested methodologies for monitoring hospital performance, this study could promote more general use and adoption of these indicators by health care managers in the different provinces of South Africa. Further, the study could contribute to empirical discussion in the scientific literature through its application of methodologies for estimating population drainage and cross border flow of patients to hospitals. As pointed out by the HSP report, information on cross border flow is lacking in South Africa.

The study has relevance for PAWC given that hospitals consume a significant portion of its health care budget, and study results would facilitate decision-making choices concerning resource allocation to hospitals. It may influence increased awareness about efficiency in deployment of hospital resources. Every saving made through better informed and efficient deployment of available hospital resources could free some money for use in extending access to primary health care and overall health in the province. District and community hospitals are suggested to have very important contributions to make in a district health system such as is being currently implemented around South Africa, based on experiences from Sri Lanka and China, making these hospitals an important focus of research.⁶ The results obtained from this study could be utilised by senior health managers at PAWC for planning acute care hospital bed provision in the province.

Further, results from the study would contribute to the resource pool for researchers for purpose of making comparison of hospital bed supply and distribution, a research area where data is lacking among developing countries in the literature.^{1,6,20}

A final aspect of the motivation for this study is its potential to contribute towards advancing knowledge concerning behaviour and productivity of rural hospitals in South Africa. These have

not been well studied, ²¹ due to urban, metropolitan and academic hospital bias in previous studies that have assessed hospital performance in South Africa and many developing countries.

1.4 AIM

The study aims to evaluate the supply, and performance of acute care, public sector hospitals in the non-metropolitan regions of the Western Cape Province with recommendations for improvement leading to optimal utilisation of the available resources that could support the attainment of efficiency and equity in health care policy.

1.5 OBJECTIVES

The study objectives are as follows

1. Review the current supply of public hospital district beds in the non-metropolitan regions of the Western Cape Province in terms of equity and recommend changes.
2. Pilot a methodology to estimate cross border flow of patients and the drainage population of acute care hospitals in the non-metropolitan regions.
3. Evaluate factors associated with efficient or inefficient performance and utilisation of public beds for the hospitals in the study in comparison to norms
4. Perform comparative analysis of efficiency and cost across hospitals in the non-metropolitan regions of the PAWC using the Pabon Lasso technique, regression analysis and cost function curves.

CHAPTER 2: LITERATURE REVIEW

2.1 The Context of Hospital Service Provision

There is a rising demand for healthcare with equally rising consumer expectations on healthcare worldwide. Resulting from these, health care expenditures have been outpacing the rate at which financial and other resources needed to deliver healthcare are made available. Hospitals occupy an important place in healthcare delivery and this could be in terms of costs and the level of care provided, all of which cannot be easily ignored. Important roles for hospitals are noticeable even in the aspects of community development, because hospitals impact on and could be impacted upon by the communities in which they are located.^{9,22} In particular, hospitals compete with other community health care needs and resources for available money. In the attempts to curtail the exploding health care cost, managers have resorted to using innovative approaches.¹

Restructuring of resources deployed at hospitals could result in substantial changes in the number and distribution of hospital beds and facilities. International experiences have been quite variable as local peculiarities are taken into consideration, although it does appear that similar principles are usually applied. In Canada, restructuring initiatives were underpinned by considerations of health determinants and economics of rising health care costs^{9,24} used to guide policy decisions on rationalisation. This led to implementation of strategies that have ranged from adjustments to the payment mechanisms for health care, changes to formula based allocation to hospitals, and also outright hospital closures and mergers. To illustrate the magnitude of problem that reorganisation could pose, Saskatchewan in Canada, with 7.2 beds per thousand population in 1991 (compared to a national average of 4.7), having most of these beds located in rural areas, closed 52 small health facilities in 1993.⁹ Similar reorganisation initiatives have also occurred in the United States, the United Kingdom, East European countries and many developing countries.¹

Two important approaches to allocating resources are namely, an “economic approach” that considers efficiency as paramount, the other being allocation utilising a “needs based approach” in which values and need are determined by experts.^{23,24} However, there is no universally accepted approach to reorganising hospital services currently. According to Sheldon (1993),²⁵ a comprehensive, all-encompassing, statistically or empirically derived valid formula for resource

allocation base cannot be achieved, therefore researchers could use partial empirical models that could be gradually improved and subjected to periodic review in the future as additional information or data becomes available.

2.2 Characteristics of the Hospital Sector

Hospitals are very complex organisations, and attempts at determining characteristics or products that distinguishes them have generated intense debates in the literature^{26,27} A hospital's performance is a function of its "productivity" (ratio of input to outputs) and this could be described using a production function and its efficiency (cost per unit output such as represented by use of "*patient day equivalent*").

Hospital performance could be described using a systems theory approach encompassing inputs, process and outputs, including the interaction of the various components with the environment. Hospitals utilise *inputs* (personnel, finance, infrastructure, drugs) that are managed or put through a *process* (interfaces with patients seeking care) and these are all managed to produce outputs (products). Some of these could be directly captured through routine statistics such as bed admissions or outpatient visits. The overarching aim of hospitals in the system is to influence the final *outcome*, which is *health* of individuals or communities.^{23,28,29}

Flood (1994),²⁸ describes the attributes of performance to include, *efficacy* (ability to produce desired response or performance) 2) *appropriateness*- in terms of whether an *efficacious* treatment was applied in the right context 3) *effectiveness* In health care settings, the commonly used terminologies to represent performance are efficacy, effectiveness, appropriateness, productivity and efficiency.^{19,23,28} However, the biggest challenge has been how to measure outputs in health care, a problem made worse by the use of confusing terminologies that abound in descriptions of efficiency in the literature.²⁸

Factors reported to influence performance of hospitals include ownership (public or private), efficient staffing, high standards of practice and feedback.²⁸ Intuitively, setting of high standards could remarkably motivate personnel, especially where it is linked to a financial reward system that reinforces productivity and efficiency standards. However, too high, or inflexible standards may cause the converse and adversely affect performance, hence management techniques are relevant to understanding performance of hospitals. Policy makers may be able to directly affect performance through decisions affecting hospitals in parameters such as; i) Size of a hospital and its components, ii) hospital's scope of services and level of care iii) facility location iv)

appointment of medical staff and v) annual budget.³ An example of how policy makers have directly influenced hospital behaviour is found in the United Kingdom, where targeted administrative intervention introduced have been found to reduce total ALOS and lead to improved hospital efficiency. The increase in efficiency which resulted was attributed to measures leading to the following i) change in management of patients ii) improved clinical technique and iii) financial incentives for hospitals to reduce bed needs.¹

Hospital activity (as captured by output to input) indicators could be used to evaluate its performance. Illustratively, a study by Mahapatra and Bermen (1999),³⁰ incorporated input-output ratios of hospital activity and service mix to perform combined hospital utilisation and productivity analysis. Staffing levels have also been suggested for use to measure performance by Lehner et al (1995),³¹ who reported that efficiency could be affected adversely by low nursing and physician staffing levels and also by a surge in patient admissions.

2.3 Theoretical aspects of hospital performance measurements

Lee & Mills²⁴ describe efficiency as having two components as follows:

- 1) Allocative efficiency- this could be described as allocating resources between different patients or geographical areas, including the provision of services in a manner to attain maximisation of benefits to society.
- 2) Operational efficiency- this could be described as using the least costly or financial methods for producing and delivering a given set of health services to achieve improved health status.²⁸ Operational efficiency could be used interchangeably with technical efficiency and performance.

Technical efficiency as concerning provision of hospital services entails producing a given output of hospital services by deploying a minimum amount and mix of inputs (such as personnel, service mix and capital). It is no surprise therefore that it has been advocated for use in comparing performance of hospitals.³² Its importance in discussions on performance relate to how health care planners can choose from various combinations of inputs that have been shown to be technically efficient, in order to obtain the most economically efficient combinations capable of achieving objectives resulting in desired health care outcomes.

With the costs and also productivity of inputs varying over time, policy decisions have to keep pace with changes occurring in relation to constraints that the budget line poses. The demands for health services do similarly fluctuate over time as population characteristics change, such as its size, composition and health needs, resulting in demand-supply mismatch. Therefore health managers entrusted with managing hospital resources are obligated to determine periodically the current distribution of hospital beds and service provision. Within organisations, choices can be made from various combinations of input mix to produce a given output, implying the existence of varying degrees of substitution occurring amongst its components could be compared in efficiency assessments.²³ In South Africa as in other developing countries, health care reforms continue to be implemented with such programs as the comprehensive primary health care “one stop station” considered by PAWC. This has implications in terms of deployment of middle level health care workers besides doctors because of issues of affordability and sustainability. These workers are now being given more expanded scopes of practice in order to ensure that the few available doctors are appropriately deployed to duties requiring their skills given that this does not equate to a drop in quality.²³

Every commitment of money to a particular cause has opportunity cost associated with it, with inefficient outputs implying wasted expenditure that could limit resources for improving access amongst those in need.²³ However, choosing whether to weight measures of resource provision and utilisations on efficiency or rather on equity and effectiveness considerations are complex choices which have generated fierce debates.^{33,34,35,36} In some settings, appropriateness of care (having a bearing on costs), and the effectiveness of inputs for maximising health outcomes including hospital outputs, has become the focus of research on hospital performance as in South Africa.^{37,38,39,40}

Normative approaches for planning hospitals could be used in determining target hospital beds for communities, and for assessment of hospital productivity relative to norms such as for beds per population, ALOS, Bed Occupancy rate (BOR) and Turn over rate (TOR). While the use of norms may appear simple and require much less data or additional resources, norms may unexpectedly mask inefficiencies prevalent in hospitals. This may arise from their potential to hamper efficient use of resources the implied assumption that only one combination of inputs is to be used. Furthermore, norms have the tendency to curtail choices, discourage innovation and could even re-enforce inefficient stereotypes.²¹ Choices exist however in health care, as physician behaviour has been reported to influence ALOS.²³ Policy makers should therefore

exercise caution when drawing conclusions on the basis of norms alone considering that the use of norms could prevent achievement of economic efficiency in providing hospital services. A discussion of factors influencing performance indicators for district hospitals would be relevant to managers of PAWC, and therefore presented below.

2.4 Descriptions of commonly used hospital performance indicators.

Factors that influence hospital performance and relevant to evaluating performance of non-metropolitan district hospitals at PAWC are discussed below, with elaboration on drawbacks associated with the use of indicators. Some of these indicators have been recommended for South African hospitals by the HSP to allow for better comparability between hospitals and also Provinces due to uniformity of techniques and measurements obtained. These indicators including derived norm or ratios are grouped in categories as follows: *activity indicator* (inpatient days, inpatient admissions, outpatient head counts and emergency attendance); *efficiency indicator* (ALOS, BOR, theatre utilisation, staff turnover, admission rate per staff); *finance* (expenditure, cost per patient day and hospital income) and indicators of *service provision* (beds per 1000 population, health professional per bed, admission rate per bed and admission per staff member). At present, although several of these indicators are routinely collected at PAWC hospitals, these are not comprehensively collected for all the variables and may be incomplete for some hospitals.

Because of international, South African and PAWC relevance attached to particular indicators, discussions on ALOS, TOR, BOR, quality of care and population based norms are expanded in relevant paragraphs below, in order to provide useful insights that managers need to be aware of.

2.5 Hospital performance indicators

25.1 Admissions per 1000 (100, 000) population. This indicator provides information about community hospital utilisation. It could contribute to the understanding of a community's health profile and may be influenced by factors related to the adequacy or otherwise of supply, demand and equity of access to hospital services, including beds. Communities with closer proximity to

hospitals tend to have more admissions per 1000 population but this could change where physician remunerations are linked to volume of services produced, such as with capitation. In instances where doctors have stakes in hospitals, which is not the case at PAWC hospitals, the number of admissions per population reflects manifestations of supplier-induced demand. Problems can be encountered in defining the population base accurately with this performance indicator with potential for bias occurring with results obtained. Demographic data needed to help improve the accuracy of the estimates are not readily available, and appear not to be routinely collected by PAWC or any province to the author's knowledge. Population census result therefore becomes the only potential source of data with its inherent problem of not keeping pace with population changes, because the results are not released very promptly.

2.5.2 Health professional per bed and/ or staff per bed

The health professionals per bed ratio provides information about the potential level of care available at a hospital, although the results obtained could be distorted by factors that affect under or over supply of beds. The various ratios for professional categories may include "*doctors per bed*" or "*nurse per bed ratio*", for which the different hierarchical classifications in these professional grouping are collapsed into one group.¹⁸ The ratios are further indicative of the relative time available to hospital doctors and nurses that could be shared amongst patients. Indirectly, the importance of this indicator could extend to providing information on the number of procedures that could be performed without much strain on a hospital resource and even cost. When using health professionals bed ratio for policy decisions, caution has to be exercised in using crude estimates of the indicator, as this could be biased and mask the real situation since it does not truly take into account the skill-mix of doctors and other professionals in a hospital, factors that affect the overall nature of care they provide. As would be expected, hospitals with more skilled practitioners would tend to provide more health care output.

Personnel issues in rural areas are compounded by problems related to attracting and retaining highly skilled health professionals to rural hospitals. This appears to be one of the greatest factors militating against optimal performance of hospitals in several developing countries, including South Africa.^{1, 6} Global trends indicate the need to adequately staff district hospitals in comparison to other hospital services so as to enhance their performance, especially in the light of additional roles for district hospitals in a district health system model.⁴¹ Due to the potential difficulties in respect of recruiting and retaining staff at rural hospitals, substitution of personnel

types occurs and is an acceptable policy option aimed at ensuring that provision of hospital care to communities is maintained in the absence of adequately skilled manpower. But substitutability of personnel is not without drawbacks amongst choices of strategies to address personnel shortages. It is dependent on existing state regulations which govern registration of personnel but are however implemented by statutory councils and boards that do not consider personnel expertise, training policies and cost prices.² Frustrations with routinely utilised hospital performance indicators not capturing the true productivity of hospitals have led managers to apply alternative techniques of measuring hospital performance where skill-mix plays an important role.⁴²

Personnel norms for South Africa community (district) hospitals¹⁸ for the professional bands namely, nurses 0.7 and 0.89 (NHFP¹ and Rehmis² respectively) and that for doctors are low in comparison to international norms. The doctors per bed ratio for South Africa is 0.05 (NHFP and Rehmis) in comparison to 0.1 (Jamaica) to 0.4 (Indonesia), with an international average of 0.1

2.5.3 Average Length of stay (ALOS).

Of the indicators for comparing efficiency across hospitals, the average length of stay (ALOS) remains one of the most extensively used. It is defined as the averaged duration of stay that a patient who is admitted to a hospital stays in the hospital up to the time of discharge, by transfer (including home or other facility) or death. The ALOS is calculated by dividing the inpatient days spent (month or year) by the number of discharges and deaths that occurred in the month or year. Intuitively, the ALOS will appear shorter in acute care hospitals. It is longer at chronic care hospitals and rehabilitation centres because of longer patient stays in these facilities. The ALOS figures for acute care hospitals in South Africa recommended by the HSP are as follows: **district level (urban 4-6 days, rural 6-8days), regional (5-7 days) and tertiary (6-8 days).**

A falling ALOS trend observed internationally and applicable to South Africa is expected to lead to a concomitant drop in bed occupancy. Reduction in ALOS has the potential to free more beds for use by patients, enabling hospitals to retain additional flexibility to cope with seasonal surges in bed requirements and other random fluctuations that influence population bed demands.^{1,7}

Interpreting ALOS result for hospitals should take into consideration a potential for ALOS to be affected by patient factors, service factors and hospital system factors, including interaction

¹ National Health Facility Planning (NHFP) norm

² Regional Health management information system (Rehmis) 1994.

amongst the factors that could exert more influences on ALOS than individual factors. The ALOS is also affected by lack of access to referral or step down facilities that can lead to delays in connection with discharging of patients, and could be further confounded by patient variables such as gender, age, condition at discharge, number of diseases diagnosed, year admitted, insurance status of patients and the availability of home support.^{43, 44} Service factors include, the time of admission, complementary procedures that are also performed such as X-ray, patient disease group, emergency status, diagnosis, organisational and other management factors that influence care. The payment source could also predict ALOS, as could the adherence of clinicians to approved drug protocols and standard treatment guidelines as would be expected.⁴⁵ A reduction in ALOS could be achieved through deployment of adequate numbers and mix of personnel and Tagushi quality improvement methods have also been suggested for use in improving ALOS.⁴⁶

The ALOS could similarly be monitored through the use of computerised hospital patient tracking system to obtain real-time assessments of ALOS, an approach that is practical, although the complexity of such monitoring may make them unsuitable for use at PAWC and other South African district hospitals. When used for comparing performance across hospitals, ALOS is believed to influence a hospital's performance and cost, indicative of its total productivity, a reason that may explain why its reduction has continued to be targeted in efforts to improve efficiency internationally. In spite of its importance for performance assessments, ALOS reduction does not always translate directly to an appropriateness of care.⁴⁷ Such high bed occupancies which may result from reduced ALOS, could present opportunity cost concerns for patients if admission of acute cases is hampered by very high bed occupancy. Use of ALOS could be misleading as an indicator when applied to chronic patients on admissions at acute care hospitals whereby the use of an averaged length of stay may mask the actual lengths of stay with management implications.⁴⁸ It therefore appears as though the true ALOS for hospitals cannot be determined without categorisation by levels of care and the type of hospital stay such as acute or chronic when making comparisons across hospitals, so other indicators have to be used in addition to ALOS in determining performance. This is more so, because data needed to correctly calculate true ALOS as the foregoing reveals may be unavailable or cumbersome to collect in PAWC non-metropolitan and other South African district hospitals. Never the less, ALOS remains of the widely available indicator variable for comparing hospitals.

2.5.4 *Bed Occupancy Rate (BOR)*

Bed occupancy rate is another commonly utilised indicator of hospital efficiency for comparing performance across hospitals in different countries.^{1,49} It provides information on the estimated average utilisation of beds within a given period expressed as a percentage of total bed stock available at a hospital. It is calculated by dividing the total inpatient days, by the number of total bed days available during the interval considered. Errors in derived estimates may occur because hospitals could use different bed totals (approved or actual or actively used). In the Western Cape Province, both forms of bed total figures are readily available, and the beds in actual use is usually given more weight when making a choice between these, and the classification of beds used at PAWC are described elsewhere.⁵⁰

The use of BOR for comparing performance of hospitals as sole indicator has not been without drawbacks such as those pointed out by Phillip et al (1984),⁵¹ who argued from interpretation of results from regression analysis on occupancy rates of hospitals that “a uniform occupancy for hospitals may not be a good management strategy”. The reasons adduced to support this argument were that, BOR for hospitals is influenced by several factors such as hospital size, number of alternative facilities that impact on referrals, and also ratio of urgent to elective hospital beds. Further influences on this indicator include the number of hospitals within the area that services a community and fluctuations in the demand for the services provided by hospitals with seasonal variations in utilisation.⁵² According to the HSP, variations in BOR levels could result from change in the access to services, case mix and problematic referral patterns. All these factors may not be reflected in hospital information systems and periodic returns collected by administrative database, therefore BOR estimation used for comparisons, as sole indicator of efficiency may be fraught with errors from several confounders.

Bed occupancy rates which are **above 90% or those below 50% should warrant further investigation by managers**, as they depart from the international and South Africa norms which support ranges from **70-85%**.^{1,18} This also partially reinforced by findings from a study by Bagust et al (1999),⁵³ using simulation model to study dynamics of bed use in emergency admissions, with results showing that bed occupancy rates that are over 85% are associated with a potential for bed crisis and des-equilibrium occurring at hospitals.

2.5.5 Bed turnover rate (TOR)

The bed turnover rate (TOR) provides information on the average number of patients admitted or discharged per hospital bed, during the reporting interval implying throughput per bed. It captures bed utilisation and hospital productivity and is influenced by population demands on available hospital bed, range of services provided, skills of hospital personnel, case mix, the availability or absence of patient admission and discharge protocols. It could be influenced at district and regional hospitals by the prevailing doctor to patient ratio, diagnostic capacity of doctors, availability of beds and also urban-rural setting that hospitals operate in. It is derived by dividing the total number of admissions (inpatients) or discharges for the month/year by the total number of actual beds in use at the hospital. Bed turnover is expected to be higher at lower levels of care such as district hospitals in comparison to regional, academic or tertiary hospitals. This is because most of the patients requiring hospital care would usually require lower levels of care. The bed turnover rate for South African hospitals is reported by the HSP to range between 32 and 58.

Factors such as unnecessary admission of patients requiring short lengths of stay in situations of bed over supply may lead to inappropriately high bed turnover rates being observed, which are undesirable and affect performance. Also when admission of patients with chronic diseases associated and associated long ALOS predominate at acute care hospitals, inferred by observation of reduced throughput per bed (TOR) the information obtained becomes unreliable, this being a drawback in its utility for comparing efficiency of hospitals by managers.

2.5.6 Beds per 1000 population

This could be defined as the number of actually used or active hospital beds divided by the service population corrected to a population figure of 1000. For this, the actual beds supplied for residents in an area implies that usage occurs regardless of where the care was given and disregarding whether the usage is based on inpatient or outpatient forms of utilisation.³ Population based ratios depend on population densities, which relate to geographical dispersion patterns. The indicator provides information on the supply of beds and may be utilised to compare equity of access to hospital care among communities.

International norms seem to favour supply of about 4 beds per 1000 population in developed and middle income countries, this figure being exceeded in some East European countries and the Soviet Union where ratios of over 9 per 1000 have been reported.⁴⁹ However South African bed

per population ratios are quite variable across provinces and is below the international norms partly accounted for by rationalisation of hospital services that has been ongoing.^{11, 18}

Bay & Nestman (1989) in their study,⁵⁴ highlight the importance of determining service population. The study by utilising refinements to the methodology for studying beds used a service population model that considered beds per 1000 population with age and sex adjustments of district population, including estimates of service load of hospitals to determine hospital service population.

The indicator is affected by referral patterns, barriers to access and proximity to health centres.³ Factors such as lack of appropriate data, technical infrastructure and personnel to support such analysis in many developing countries including South Africa, poses barriers to using such methodology. Considering South Africa's apartheid past, it is practical to assume that the currently available bed to population ratios in the Western Cape Province like those of other Provinces may have been determined without considerations for the impact comprehensive primary health care services and changing population demographics will have on hospital bed utilisation. A baseline review of the current situation of bed supply as they relate to hospital performance is thus warranted leading to development of plans to ensure that current and future supply matches demand with reduction in resource wastage especially in the face of budgetary constraints experienced at PAWC. It is equally important to assess the proportion of patients moving across districts to seek care due to access problems.

2.6 Cross border flow of patients.

Cross border flow is closely related to hospital drainage population but refers specifically in this study, to patients moving across administrative boundaries that could be either hospital drainage areas, magisterial, health districts and even provinces in order to seek care. Its relevance in South Africa has been alluded to in previous publications.^{18,55,56} This measure has great relevance for planning acute care hospital beds as useful management information. It may contribute towards better understanding regarding equity of access, hospital performance, and may even be related to quality. Cross matching of attendance to hospitals by postal (zip) codes used as a proxy for residence is utilised with this methodology.⁵⁷ It has common application in situations where data on patient attendance to hospitals by postal code are readily available, such as at several PAWC hospitals. Postal codes are easier to group together in comparison to full patient addresses for analytical purposes. Arguments that have been put forward against the use of postal code in

research are that, they are arbitrary and could represent very large areas with potential for misclassification if the codes crosses political boundaries and with the possibility of confounding by residential area, race and other health related variables. Also population figures may not match those of postal codes. In spite of these drawbacks, postal code use for research continue to be favoured because Zip (postal) codes are common, are widely used numerical classification, and may comprise part of the easily captured component of hospital information systems. Their use could contribute to improving accuracy and analytical capabilities, especially as information on postal codes could be linked to geographical information systems (GIS) for spatial data analysis. It is likely that such types of analytical work would be in greater demand in the foreseeable future given the widespread availability of GIS data and software program in South Africa. Making census population data available in a format that makes them already geo-coded would facilitate this process and appears to be a realistic expectation.

2.7 Need, equity and efficiency concerning hospital bed provision.

Policy options concerning allocation of beds could be through choices that are based on need or demand based approaches. Need based allocation of beds suffers however from drawbacks arising because need is considered as being but a component in considerations of demand for hospital services. Such blurring of relationship could contribute to over supply of beds with excess bed supply resulting in higher bed utilisation and therefore demand.²³ Explanations for such observations are as follows; 1) that the current demand for beds may exceed supply. By increasing supply, the demand and therefore patient and physician needs are met leading to increased demand. 2) The further people live away from a health centre or hospital the less they are likely to attend the centre except in dire need. However, when additional beds are provided patients may be sensitive to the additional beds and associated increased hospital service that is closer to their homes (or work), with resultant increased preferences to use these facilities. This is influenced by reduced travel time and cost which may apply, given that time has elements of opportunity cost associated with forgone productivity. 3) With additional bed supply, doctor's practice styles may change with resultant increase in the use of beds, because previous constraints posed by bed scarcity is diminished and so the ALOS may actually increase.²³ It is thus acknowledged that the distribution, supply of services, characteristics and behaviour of the users or community can affect utilisation levels of hospitals as suggested by Kenneth and Mills (1985).²⁴

The survey on hospital bed supply may highlight inequitable distribution of available services that may take urban-rural or rich-poor dimensions which should make us consider how to evaluate, distinguish or un-bundle these from the attributes related to geographical location.

Excess bed capacity could be evaluated using approaches that are either based on population norms or on occupancy (such as by reducing beds until 80% occupancy is reached).²³ Beds supply per population and service load are stable across different statistical methods and data sources used for estimating bed requirements, and are sensitive enough to detect changes over years and could be used to identify inadequacies of bed supply.

Community bed utilisation is also affected by factors such as age distribution of population, payment status, availability of, and other options of care accessible (such as home based care) and cost shifting to patients that may result from bed reduction as experience from Canada indicate.⁹ This reveals that in places with predominantly older populations, the impact of hospital closure on health status are felt beyond the effects on accessing health services and could threaten the viability of the entire communities. These may be in the aspects of transportation difficulties, including increased cost of providing emergency services. Also the remaining hospitals may experience excessively high bed occupancy, all of which may hinder access to hospital care with associated longer travel distances and lost time for patients and their relatives.^{9,10,22} Emigration of community members may also ensue, and the doctors could similarly leave the community. To overcome some of these problems suggestions have been made that when planning for hospital beds in rural areas, important factors to consider could include; topography, geography, type of care to be provided, cost and benefits of alternative forms of care.²⁴

Performance of hospitals may additionally be affected by factors such as the size of the facility, diminishing rural population related to rural – urban migration, utilisation and low bed occupancy, state of equipments deployed, difficulty in recruiting and retaining physicians who may be reluctant to relocate to rural areas, financial problem facing hospitals, proximity to other hospitals, availability of more extensive range of medical and hospital services in large centres, and improvement in transportation system that impact on referral support, several of these factors being considered in closing hospitals in Canada.⁹

Socio-economic differences among population groups create barriers to access to care that may result in equal needs for health care not being met with a commensurate level of supply

(horizontal inequity) or the converse where unequal utilisation of services is prevalent for communities with equal need (vertical inequity).^{19,24}

Horizontal equity is defined as meaning equal access per capita for the purpose of this study. Further discussion of the definitions and application of equity considerations in resource allocation decisions can be found in the literature.^{25,58,59} With all these discussion in mind, consideration of all the stated factors that have a bearing on performance of hospitals within the time frame of decision-making facing PAWC managers in this study would be impossible, as enormous data collection often not routinely available is implied

2.8 Quality as an indicator of efficiency

There is no acceptable universal definition of quality nor is there agreement on the variables that define quality, especially as concern hospitals.^{60, 61} Health, the final outcome to be maximised is not easy to measure readily and has been approximated by proxy indicators and indices such as mortality, morbidity, disability, well being, quality of life, health status, patient education and patient satisfaction that have been used to approximate quality.^{28, 60,61,2,63} It is regrettable that individual diagnosis related group (DRG) mortality rates are poor measures of quality even when there is a perfect case-mix and also perceived quality has not been observed to predict admission even after adjusting for several variables that affect performance.^{61,62} Comparing performance across PAWC hospitals using quality indicators could be fraught with difficulties arising from choosing indicators to use, especially all the needed data are not readily available from the all hospitals.

Quality and costs are related to each other and affect performance of hospitals. Given the huge costs associated with running hospitals, it is to be imagined that any discussion of comparative hospital performance and rationalisation should address the issue of costs associated with hospitals. Indicators and methodologies for comparing hospitals based on hospital costs are thus relevant to management staff at PAWC, for planning district hospitals bed supply in the non-metropolitan regions of the Province.

2.9 Relationship between hospital efficiency and costs

An overview of commonly used indicators for comparing performance of hospitals with cost as a dependent variable is discussed below;

2.9.17 Cost per total beds. This variable reflects the total hospital cost and is derived by dividing total hospital costs by total beds. This may provide information on the cost of hospitals for comparative purposes, as beds are believed to indicate the size and productive capacities of hospitals.

2.9.2 Cost per patient day

This is a broader measure of hospital cost rather than using the absolute value of expenditure to reflect hospital costs, and it is used to assess the impact of hospital efficiency indicators on unit cost. Maclean and Mix (1991),⁶⁴ in a study of annual return of Canadian hospitals, used cost per patient day as the measure of hospital productivity and reported drawbacks with its use that could be attributed to the omission of outpatient care in its estimation of hospital output with resultant underestimation of hospital costs and productivity. Therefore a measure incorporating inpatient and outpatient hospital costs such as the cost per patient day equivalent is rather suggested for use in studies evaluating performance.

2.9.3 Cost per patient day equivalent

This indicator reflects the average (unit) cost of a patient stay or day during a specified interval. It has utility in hospital costing studies because it takes into account both inpatient and outpatient visits which could include emergency care. Further it is preferred because it makes for easy comparability across hospital facilities, as a measure of unit costs.^{18,201,65} It is reported to have better advantages for comparisons of hospital efficiency than cost per patient day, which is reported to have limitations attributed to its not correctly reflecting hospital productivity.⁶⁶ For PAWC hospitals, a "patient day" is calculated as the total inpatient days plus a third of outpatient attendance days. However, it has been argued that using a third of outpatient visits may underestimate hospital productivity in the Western Cape Province according to analysis by Lombard et al (1991),⁶⁷ who recommended that more weighting be given to outpatient visit. This suggestion has not led to changes in the methods for deriving this indicator at PAWC. The reason for this could be because of concern from managers that changing the proportions frequently may lead to a loss of credibility for what the estimates are meant to measure in the long term.

2.10 How efficiency is modelled using cost.

Several studies have evaluated efficiency and performance across hospitals with cost as marker of performance with many of these cost studies presenting their results in the form of a cost function curve. Using cost is an empirical approach for ascertaining efficiency of hospitals ⁶⁵ and has been reported to be superior to bed occupancy measures, ⁶⁸ and applicable to rural hospitals. ^{21,70} Cost functions provide information on the range and scale of production capacity that hospitals' may have. However only very few studies have been done in developing countries employing their use. ⁶⁵

Cost curves convey information on the relationship between hospital costs and its size, for which bed number is a good proxy. The cost curves could be short run or long run curves depending on the span of time being considered in the analysis. Given that some components of hospital cost is fixed, then only a minimum amount of the various components needed for efficient functioning would be required to enhance efficiency. In the short run, the scale of performance of a hospital could be altered through targeted policy changes, whereas in the long run with an abundant time interval, the scope of services and deployment of additional measures to influence performance can be implemented. With cost studies, a sub-type of operational efficiency known as economy of scale or scale efficiency is encountered. This implies that the larger a hospital becomes, the higher would its outputs be, resulting in higher turnover rates which result in lower average cost. ^{19, 24,71} Debates on the place of economies of scale for hospitals with arguments for and against concentration of services are not uncommon. ⁷²

Independent variables used in costs estimates may include measures of size, such as beds, ^{27,70} a proxy for capability (facilities or services), case mix, measure of quality (i.e. Nurse to bed ratio), severity of disease classification, adjustment for wage differences, differences in efficiency unrelated to hospital size and outpatient visits. For such analysis, beds and its square (bed square) has been used to convert the models to non-linear form in order to be able to check elasticity of cost with capacity of hospitals as costs would rise then fall as size increases. Patient day equivalent has been regarded as a composite indicator of total workload that combines inpatient days, outpatient days (where 3 outpatients visits are equivalent to one inpatient day at PAWC) and emergency visits. It is unexpected for this unit of cost measure to vary much between district hospitals. ^{18,21}

The relationship between hospital cost and bed size is U shaped curvilinear, utilised in the curve to check for economies of scale. The y-axis in the curve contains information on the cost estimate reflected in the cost per patient day equivalent, with the x-axis depicting information on the bed sizes or other variables of interest. Efficiency constraints are placed on such model cost curves in a manner that an increase in the total number of beds supplied, results in commensurate decrease in the average cost. An equilibrium is reached whereby supply and utilisation are matched resulting in minimal cost changes depicted as a plateau in the curve, and this is followed by a rebound rise in cost with increasing total number of beds beyond what could be managed efficiently at lower cost. Accounting for the finding of a rebound rise in costs as bed numbers rise are the following; greater specialisation of labour required in larger hospital facilities attracting higher competencies (demanding more wages) in both personnel and equipment use, greater co-ordination is needed in larger hospitals as bed number increases that could offset the gains to be made beyond the margin. The shape of the curve (including how rapidly a decline or fall occurs in the slope) is important in average cost curve estimates and depends on the length of time the economy of scale persist and also how soon the diseconomies of scale will occur as outputs rise.

Use of costs for comparing hospital performance is not without drawbacks. Some of these, stems from considerations recognising that hospitals do differ not only by size but also by other factors such as quality. These may not have been adjusted for in derived cost-curves, although mention has been made in the literature that the type of hospital (indicated by size and scope) doesn't inevitably result in differences in unit cost and so hospitals in similar categories could be expected to have similar unit cost.²¹ There could be difficulties with measuring and costing non-patient care output of hospitals compounding the problems encountered with using costs to compare efficiencies of hospitals. Further, the costs reported may not reflect actual hospital cost or opportunity cost and could have ignored shadow pricing and other forms of non-monetary transfers, as these may not have been accurately captured in the accounting methods used. Also the perspectives chosen in measuring cost of hospital services, which may be that of patients', government, provider and society and various combinations thereof may affect how the estimates of costs are calculated. Additionally, there are limitations in using single point estimate of costs, because they may not capture the variability amongst hospitals in terms of cost attributed to for example case mix.^{65,73} Moreover, single point estimates may be unable to explain either variations of cost under different levels of output, or the influence of ownership on cost. The behaviour of doctors in terms of prescription practices and decisions affecting patient stay

influence hospital output as are other factors such as patient's distance from hospitals, all of which could be confounding factors that remains unaccounted for in costing studies.

In spite of all the concerns noted above with interpretation of results from cost studies in decision making concerning hospitals, Kenneth and Mills (1985) ²⁴ advocate their use. They recommend that information relating to the cost of providing health services be linked with those of coverage, service population and the uptake of services (as captured by utilisation) in decision making with considerations for equity and efficiency in service (hospital bed) provision. Therefore more research regarding cost distribution, determinants and allocation between different types of hospital is still to be encouraged. ⁷⁴

2.11 Determination of hospital efficiency and performance using statistical models

Parametric (regression based), non-parametric techniques and combinations of these, have been utilised to compare performance across hospitals. ^{26, 27, 32,74,75,76,77} Visual aid approaches such as Pabon Lasso technique and Barber Johnson diagram utilising ratio based indicators for monitoring performance across hospitals are also reported in the literature. ^{17, 78}

Model based approaches utilise stochastic parametric based techniques or the application of non-parametric computer simulations and programming methods (such as Data Envelopment Analysis - DEA).

The HSP provided brief overviews of *Data Envelopment Analysis (DEA) methodology*. The DEA approach, used in a study by Puig-Junoy (1998), ³² has been gaining more widespread use and allows scores of relative inefficiency amongst hospitals to be obtained. It requires the use of a non--parametric programming method, which allows multiple inputs and outputs in its model specifications to better characterise a hospital's productivity.

Study by Linna M (1998), ⁷⁷ utilised a strategy incorporating parametric component utilising a stochastic cost frontier analysis with time varying efficient components and also a non-parametric component utilising various DEA models to calculate efficiency scores. Their conclusions suggest that results from parametric and non-parametric methods compared well with respect to individual efficiency scores for the hospitals studied.

Although the use of DEA has relevance because of its application as a distribution free statistic and the efficiency score obtained is not affected by changes in the specification of hospital output, comments from Magnussons, (1996) ⁷⁵ highlight limitation to its use. These result from wrong interpretation of DEA outputs. Other limitations to DEA use include those presented by Dittman et al (1991), ⁷⁹ who argue that the assumptions concerning controllable and non-controllable input variables need to be met amongst other factors such as the following; 1) efficiency scores are relative and depend on other hospitals that are being compared and need not be assumed to be absolute; 2) The ratings assume causal influence of the impacts of the inputs on the outputs; 3) DEA is based on the notion of convexity, with assumptions that performance is arrived at by relating any performance to combination of a hospital, other input and outputs which represents those that may be achievable considering available technology; 4) The DEA efficiency score resource conservation potential is based on units called contraction paths, which assume that all the controllable units are to be reduced by the same factor, and this is not the case. Another disadvantage of using DEA is its inability to measure inefficiency in organisations that have multiple but differing output dimensions such as hospitals.³² The technique itself requires appropriate training and also the use of appropriate econometric computer packages that would not make it easily adopted as a common approach by several policy makers in South Africa.

The graphical approach for comparing relative performance across hospitals by Pabon Lasso (1989), ¹⁷ is a much simpler technique requiring relatively little prior learning. The technique requires availability of only 2 variables, namely turnover rate and the bed occupancy, and because of the relationship amongst the different variables, the third variable (ALOS) could be derived from the curve drawn.

In plotting the Pabon Lasso curve, turnover rate is plotted on the y -axis (derived from admission divided by the number of beds), with the bed occupancy rate plotted on the x-axis) and the ALOS automatically derived from the right border of the curve plotted. This is from oblique ray lines drawn from the origin angle outwards to the corner and due to mathematical relationship amongst the variables (TOR, BOR and ALO), the ALOS is obtained and increasing from left to right, on the top part, and from top to bottom, on the right hand corner of the graph.

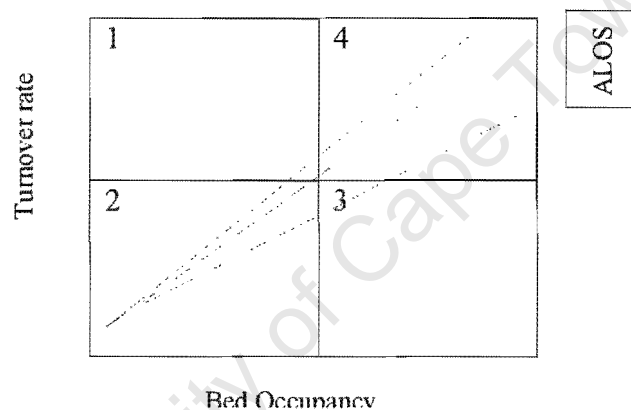
The averages of the turnover rate and bed occupancy rates are used as vertical and horizontal bars to define the borders of the four quadrants that contain the hospital performance groups. The

quadrants created by the subdivisions using the average points are used to describe and compare relative efficiency across different hospitals.

The advantage of utilising this graphical method for comparing performance across hospitals is that it utilises three commonly collected and widely used indicators of hospital productivity to evaluate efficiency. This is in contrast to choosing only one variable, as is the current practice in many provinces in South Africa and PAWC.

The four quadrants of the Pabon Lasso grid are represented in Figure 1 below.

Figure 1. An illustration of Pabon Lasso graph for comparing hospital performance



The particular quadrant occupied by a hospital provides information on its relative performance that could be summarised into the following quadrant categories;

- 1) Hospitals with excess bed provision, low BOR, unnecessary hospitalisations and possibly predominance of normal as opposed to complicated deliveries.
- 2) Excess beds provided, in relation to low demand for hospitalisation, capacity and demands produced by patients being diverted to other facilities.
- 3) High proportion of severely ill patients, a predominance of chronic cases and unnecessary long stays are commonly observed in these hospitals.
- 4) Hospitals with above average performance and regarded as efficient. These have only small a proportion of unused beds operating.

2.12 The Hospital Strategy Project and efficiency in South African hospitals

South African hospitals are reported to be generally inefficient according to findings of the Hospital Strategy Project.¹⁸ The HSP proposed common definitions and indicators for hospitals that takes into account the hospital type, and level of care. The advantages of having common definitions include, ease of grouping data for comparison, clarified roles and functions in terms of referral pathways, and the potential of using levels of care as a proxy for proportional care and expenditure for hospitals. In its recommendation, the HSP suggested that provincial and national departments of health undertake detailed analysis and planning to develop strategies aimed at restructuring hospital services according to national affordability guidelines that consider development of lower levels of care. This hasn't occurred in the Western Cape before inception of this study.

Numerous hospital episode 'appropriateness' and required 'level of care' studies have been conducted internationally and in South Africa with inappropriate utilisation of hospital beds reported to be in the range 30% to 71%.^{37,38,39,40,80,74,80} Some of these studies utilised the appropriateness evaluation protocol,^{74,81} that has to be validated. Several of these studies have evaluated inappropriate utilisation patterns observed at regional and academic hospitals but did not include the assessment of district level hospitals, and even omitted the PAH facilities. But community (district) hospitals do have relevant positions in a district health system as envisaged for South Africa. This view is supported by recommendations in a study by Vallabhjee et al (1997),⁴⁰ who advocated for the expansion of district level hospitals so that they may cater for patients referred from higher levels of care and beyond

Studies assessing the appropriateness of care are useful in situations where ALOS in acute stay hospitals is observed to be lengthy, which is not the case that presents at most of the acute care hospitals in the Western Cape Province.

Appropriateness studies recruit patients into study on their basis of needing hospital stay, and consider factors such as ALOS for different disease categories, and they require the use of judgement by health professionals or a panel to assess appropriateness of service, stay or admission level of care required. However the appropriateness methodology is not favoured for measuring efficiency compared to utilisation reviews (that use indicators of productivity) because of inability of appropriateness approach to show that benefits would be realised for patients or hospitals if the alternatives recommended are used in practical terms.¹

The HSP recommended norms for public and private bed to population ratios for different levels of hospital care by proportions of public and private mix are presented in Tables 3. According to HSP, ¹⁸ the minimum staffing levels derived on the basis of expected levels of public sector provision is calculated, drawing from international experience. Because the cost of providing public health care using such minimum ratios may exceed projected budgets, HSP remodelled these ratios to reflect optimum levels. Ratios for optimum levels therefore appear less than minimum ratio levels. Optimum levels are suggested for use where budgetary constraints occur as in PAWC.

Table 1. HSP recommended proportions for affordable public and private beds

Source: Hospital Strategy Project (1996), Johannesburg. - affordability of staff establishment

Level of Care	Ideal Total Beds / 1000 population	Ideal Private Sector Beds per 1000 Population		Ideal public Sector Beds per 1000 Population	
		20% Coverage	30% Coverage	20% Coverage	30% Coverage
Level I	2.00	0.4	0.60	1.60	1.40
Level II	1.00	0.20	0.30	0.80	0.70
Level III	0.30	0.06	0.09	0.24	0.21
Sub-total	3.30	0.66	0.99	2.64	2.31
Chronic hospitals	0.40	0.00	0.00	0.40	0.40
TOTAL	3.70	0.66	0.99	3.04	2.71

Table 2: Affordable and optimal hospital bed per population ratio for South Africa

Level of Care	Affordable acute public beds per 1,000 total population	
	Minimum staffing level	Optimal staffing level
Level I	1.321	1.108
Level II	0.661	0.554
Level III	0.198	1.166
Total	2.180	1.829
Total as % of ideal public bed ratio (20% population served by the private sector)	82.6%	69.3%
Total as % of ideal public bed ratio (30% population served by the private sector)	94.4%	79.2%

Source: Hospital Strategy Project (1996), Johannesburg

In the tables above, minimum staffing implies the lower limit of the norms while the optimum level implies that resource constraints would require optimisation and so it represent the affordability norm .

CHAPTER 3:

METHODOLOGY

In order to evaluate the performance of PAWC non-metropolitan hospitals, research questions and hypothesis were developed to help focus the study techniques and methodology.

3.1.1 Study questions

The study questions are as follows:

- Does the current distribution of hospital beds and resources in the non-metropolitan regions support attainment of equity in the Western Cape Province?
- How does the performance of acute care, district level public hospitals in the Western Cape province compare in terms of efficiency considerations using HSP norms?
- What factors are associated with and affect efficient performance of acute care district hospitals?
- What is the level of cross border flow of patients to district hospitals from other districts, regions and provinces with the Boland/Overberg Region chosen as a model region to pilot the analysis?

3.2 Study hypothesis

1. District and regional level acute care hospital bed supply are not evenly distributed in the non-metropolitan regions of the Western Cape province.
2. Non-metropolitan district level hospitals are operating inefficiently as measured using hospital performance indicators.
3. The proportion of patients attending non-metropolitan hospitals from districts outside their district of residence is at least 10% of the population.

3.3 Study design

A cross-sectional study design methodology with descriptive and analytical components was chosen to evaluate all the acute care (public sector) district hospitals in the non-metropolitan regions of the Western Cape Province.

3.4 Study setting

Amongst the nine provinces of South Africa, the Western Cape Province is regarded as one of the more structurally and economically developed provinces and considered to be “richly endowed” with many more health facilities (including hospitals) and personnel in comparison to several other provinces in South Africa.⁸²

The Western Cape province has four health regions, namely, the Metropole, with three non-Metropolitan regions (Boland / Overberg, Southern Cape / Karoo and West Coast / Winelands). Health regions are further subdivided into health districts, whose borders may or may not coincide with the current magisterial district boundaries or demarcations. The Metropolitan region accounts for about 65% of the population in the province and has a higher population density than the three non-metro regions. The province experiences a high tourist influx at certain times during any given year causing seasonal population surges in some towns, several of which are located in the non-metropolitan regions. Non-metropolitan regions are not homogeneous as they vary in their population densities and spatial dispersion of residents, but several of the towns are rural.

Hospitals may have been built in communities where utilisation and need may have changed over time, a factor that would be more noticeable in a district health care system. As stated earlier, hospitals at PAWC are classified into tertiary, regional, and district hospitals, based on the level of care commensurate with what services they are expected to provide reflecting corresponding staffing level. The referral chain network is such that patients are first expected to be initially consulted at a primary health care centre (day hospital or clinic) and referred there from to district hospitals, from where they could be referred to regional hospitals and finally to tertiary hospitals depending on the severity of the presenting illness.

A record review of routinely kept administrative databases (described below) was utilised in the study as was relevant to the objectives. Supplementary data was obtained from the regional offices of PAWC, and through visits to hospitals, telephone calls and facsimile communication, including discussion with key personnel. All these approaches were conducted to improve the accuracy of data available for analysis.

3.5 Study population, selection and sampling strategy

Through the selection process, all the public sector acute care district hospitals in the non-metropolitan regions that are listed in the 1996/97 annual statistical reports published by the PAWC Directorate of Information Management were included (**see Appendix 1**). The choice of district level hospitals as the focus of research in non-metropolitan regions has been commented on earlier in the introduction chapter above. This is based on needs identified within the hospital bed-working group (HBWG) of PAWC to fill gaps in knowledge desired by PAWC managers. The selected hospitals are either wholly managed by the PAWC officials (*PAWC hospitals*) or were *Provincial-Aided hospitals*. For provincial-aided hospitals (PAH), these are privately owned (by hospital trustees), but they however recover about 90% of their operating cost from the PAWC, while raising the remaining 10% of their operating cost through user fees from private patients.¹⁰ A few hospitals that are listed as district hospitals in the statistical report were excluded from the selection process following discussions with officials of the PAWC. These excluded hospitals are those functioning either as chronic, rehabilitation, tuberculosis or psychiatric hospitals, and are thus not designated as acute care hospitals. Regional hospitals were also selected for inclusion for subsets of analysis carried out in the study on the basis that they could be anticipated to provide some degree of district level care and also affect overall acute bed supply situations in different districts and regions. Sensitivity analysis are performed so as to take account of different proportions of district level care and bed supply that could be operating in the regional hospitals. Assumptions that district level beds exist operationally at varying proportions at the Regional Hospitals enabled a comprehensive overview of the acute bed supply situation to be made especially for regions with no district hospitals or with too many hospitals.

Using the exclusion and inclusion criteria described above, a total of 8 out of 10 PAWC and PAH hospitals (Boland /Overberg region), 9 out of 10 (West Coast /Winelands region) and 11 of 12 (Southern Cape /Karoo region) were thus selected, these constituting a total of 25 district and 3 regional hospitals. Summaries of baseline statistics and results from the hospitals can be found in **Appendix 3**

3.6 Data Sources

Data sources included the following

- Population Census data. At the early phase of the study, the 1991 South Africa Census data was used with projections to 1996. This was later corrected to reflect population changes expected for 1997, based on population figures from the 1996 preliminary population census data for South Africa (**see Appendix 2 and Tables 3-4 in the results section**).
- Hospital patient utilisation summary collated by postal code from Unicare electronic hospital information system known as Delta 9 was used (**see Appendix 3-5**). A month's utilisation data (from 1 – 31 May 1997) was utilised. Data from this source contributed towards the analysis of hospital drainage population as it affects cross border flow of patients between districts in the Boland Region. Analytic task associated with using such large datasets considering the number of hospitals influenced the choice of a month's utilisation data, as it would be too cumbersome to analyse several months' utilisation data for the hospitals in the time frame of the study.
- Personnel Salary Administration System (PERSAL) an electronic database of employees working paid a salary by PAWC, and containing categories of employed personnel for each hospital was utilised to compute the number of personnel at PAWC hospitals.
- Financial Management System (FMS), an electronic database that keeps record of financial transactions for PAWC hospitals and facilities with regards to hospitals expenditures for 1996/97 financial year at book closure.
- Original entry file documents used by the Strategic Management Team (SMT) of the Western Cape Province, containing information that relates to proximity and preference of hospitals by residents in the non- metropolitan regions as at 1993.
- Hospital performance indicator norms proposed by the HSP. The norms included figures for beds per 1000 population ratio for district hospitals (level 1). For the purpose of improving measurement accuracy in this study, the optimal norm for district hospitals (1.108 beds per 1000) and minimum (1.321) norms are summed together to obtain an average (**1.2145 approximately 1.2**). For regional hospitals, the average is **0.608 beds per 1000 population** obtained from optimum and minimum values that are 0.555 and 0.661 respectively. Senior managers from PAWC approved these values for use and indicated they were reflective of current policy directions at PAWC.

Pertinent details concerning some of the above data sources and the types of variables they contributed to the research are discussed below.

3.6.1 Hospital performance and activity data.

The data elements for hospital activity and performance estimates in the study were obtained from the annual statistical report of PAWC for the year 1996/97 and the Directorate of Information Management at PAWC. Contacts with the regional offices of PAWC and the respective hospitals helped to complete missing gaps or outright errors from this source. Data validation was improved by contacting hospital staff and other relevant people, to make corrections to entries in the annual statistical report.

Variables created thus included primary variables such as, number of actual beds for selected hospitals, hospital type (district or regional) and level of care. It also allowed for derived variables such as ALOS, BOR, inpatient days, admissions, and cost per patient day equivalent. The BOR was derived from inpatient days and total number of beds. To account for differences between the hospitals and variation in hospital capacities, the number of operative procedures performed was collected and captured in the form of ratios for surgical operations less than 30 minutes versus those over 30 minutes. Additionally, the ratio of normal to complicated obstetric deliveries contributed to knowledge concerning hospital case mix and capacity.

Further elaboration on the approaches for managing personnel data and estimate drainage population for each hospital is provided below.

3.6.2 Personnel information.

3.6.2.1 PAWC hospitals.

Personnel data for PAWC hospitals are obtained from printouts of the May 1997 Personnel Salary Administration system (PERSAL) administrative database, owned by PAWC. This source was crosschecked with locally provided information obtained from hospitals and regional offices of non-metropolitan regions to ensure accuracy of the information obtained. From the source, we calculated total numbers of staff, nurses and doctors (in full-time and sessional hospital) appointments. Only posts designated as “filled post” in PERSAL were counted in the

summations. Printouts for May 1997 were chosen, as it would correspond best with the month that hospital performance indices were collected. Although staff employments could be circular events, in the public service especially in rural and remote areas, the frequency of month-to-month variation is less. The result from estimated totals for personnel is reflective of the true staffing at respective hospitals because of the attention given during the study, by cross validating figures obtained from PERSAL as explained above. Figures for Nurses and doctors were uniquely collected and the approaches used is discussed below

Nurses.

The categories of nurses listed in the PERSAL printouts (Professional, Matron, and Staff nurse) were collapsed into one major category "Nurses" for analytical purpose. Nursing assistants were not included in this total for the nursing staff. While it could appear plausible that their exclusion may affect the true level of nursing care available at some hospitals (if significant substitution amongst nursing personnel categories occurs) this could not be investigated on the advice of senior managers who indicated that the exclusion is in line with PAWC staffing policies for hospitals and quality assurance. The ratio of nurses to bed indicates available nursing capacity at the hospitals.

Doctors.

The different professional classifications for doctors (medical superintendent, principal medical officer, senior medical officer and medical officer) available in PERSAL were collapsed into one category "doctors" and represents acute care physician pool. Dentists were not included in the totals for doctors. To account fully for the availability of doctors at hospitals, the number of filled and sessional posts for each hospital was converted into full time equivalent (**FTE**) to properly compute the number of doctors. For conversion of available numbers to FTE, it was assumed that doctors work for 56 hours per week, according to information obtained from PAWC. Have we not used FTEs to incorporate sessional and full time post classes, the number of medical doctors at some hospitals would have been incorrectly reflected in the study, as some hospitals have no full time doctors listed against in their PERSAL printouts for full time staff. Therefore, FTE aided better understanding of the availability of medical doctor cover at respective hospitals.

3.6.2.2 PAH hospitals.

Provincial Aided Hospitals are essentially private in their ownership, and their personnel figures are not captured within PAWC's PERSAL system. Personnel data for PAH are therefore obtained by contacting each hospital to provide data on staff numbers. These data were collected in formats to make them comparable to those for PAWC hospitals in respect of total number of staff, nurses and doctors. Similar assumption made for FTE estimation and categories of staff for PAWC hospitals were also made for the PAH facilities.

3.7 Hospital drainage population calculation

A drainage (catchment) population reflecting the total population (in terms of utilisation) that a hospital services was derived. To facilitate this, assumptions were made concerning patient's selection and utilisation of hospitals as follows:

- I. Community residents would utilise hospitals that are located closest to them for care when they are ill, but cross-district drainage to seek care could still occur.
- II. Hospitals located close to the adjoining provinces (Eastern Cape and Northern Cape) are to receive or have credited to it an additional drainage population, equal to 10% of the population of the adjoining magisterial district in the nearby province.

The population figures for health districts or magisterial districts were obtained with the aid of the following sources;

- a. Statistics South Africa (formerly Central Statistical Services (CSS)) census figures using 1991 and 1996 South Africa population figures. At the time of commencement and duration of analytical work in the timeframe of this study, a detailed breakdown of population distribution for towns and districts from the 1996 Census results were yet to be released
- b. Population figure estimate used for planning services and held at regional offices of PAWC for the year 1997.
- c. Population estimates of hospital towns as recorded by the SMT in 1993. These were used to adjust CSS estimates where there is more than one hospital in a district.
- d. Use of the original completed datasheets compiled by the SMT in 1993 concerning non-metropolitan district hospitals' in terms of proximity to towns and districts, with

information pertaining to preferred choices by towns, and it is used to aid adjustments made to census derived estimates.

- e. Large-scale (1:500 000) maps obtained from the Cape Town Land Affairs office in Mowbray for visually ascertaining proximity of towns and communities to hospitals.

For hospitals whose drainage population correspond directly with associated towns in the surrounding magisterial districts, the population figures for the towns were applied directly to it from the census figure, already adjusted to reflect 1997 population estimates (see Table 3-4 and Appendix 2). For hospital's whose drainage did not appear to wholly correspond to its adjoining towns and associated magisterial districts, the population for the relevant magisterial districts and towns were summed together to obtain its drainage population. These derivations were aided by cross-referencing the original drainage and population figures contained in the SMT documents.

Where two or more hospitals are located in the same magisterial and or health districts, the drainage population was estimated by calculating a proportion of district population served by the hospital aided by the SMT data, with the proportions applied to the 1997 Census estimate for the magisterial district.

Adjustments for population growth changes from the 1991 census to the 1996 census were catered for in the data analysis by applying the proportion of population increase in the Metropole Region to those of non- metropolitan regions. To further account for differential population growth changes between the metropolitan and non-metropolitan regions, two population adjustments estimates were made. This takes into account reported population change between 1991 and 1996 with refinements applied to reflect population estimate for 1997. The calculations obtained are namely **adjustment 1 and adjustment 2**. For adjustment 1, the non-metro populations figures was multiplied with 1.20358, whereas in adjustment 2 the increase was by 1.6677. Adjustment 1 assumes that non-metropolitan regions experience similar increases in their population as was indicated by the growth between 1991 to 1996 Census population. The analysis performed for estimation of beds per population used figures from adjustment 1 (1.20358% increase) throughout the study. Adjustment 2 assumes that the non-metro regions experienced population increases that were 10% less than the Metropolitan region because of rural urban migration and also in-migration to the metropolitan region from other provinces and beyond.

The influence of public sector dependency on the drainage population and bed supply for individual district acute care beds was evaluated. For this, a sensitivity analysis was performed in which the white population from the Census figures with the adjustments applied as described above for adjustment 2, were excluded (using only the none white population figures) in calculating totals for population to derive beds supply per 1000 population. The reasoning behind this calculation is that in the absence of reliable database or information containing medical aid membership figures for the communities, known to the researchers at the time of this study, the approach was used to obtain a proxy for membership.

3.8 Cross border flow evaluation

The study estimated the degree to which non-metropolitan public hospitals receive cross border patients (**refers to district borders and related to postal codes for districts, see appendix 3-5 for details**).

For this calculation, the Boland region was chosen to pilot a technique for estimating hospital drainage population, by using postal code addresses of patients as a proxy for residence. This region is unique because it has mostly PAWC hospitals and these have the relevant information systems, required to provide the data elements for this estimation. Underlying this is an assumption that postal codes from patient hospital utilisation episode records are indicative of the residential areas from which care was sought. The assumptions are further supported by what would seem common logic, in that patients prefer to use hospitals located closest to them and that the hospitals have relatively few patients coming from other districts. Data source containing patient utilisation records by postal codes for one month (May 1997), collected from delta 9 information systems was used. Patient attendance data with postal codes as major identifier for each patient was linked to the type of attendance (inpatient, emergency or outpatient care) for each hospital. For analytical purpose, inpatient data was used. These were available in the ASCII format from Delta 9 and exported easily into Microsoft Access. Proportions were calculated for attendance to hospitals by postal code. Examples from steps employed in the analysis are contained in Appendix 3-5.

3.9 Ethics

Officials from PAWC management granted approval for the study. Permission for the study was also obtained from respective hospital managers and the study protocol was submitted to the Ethics Committee of the University of Cape town and also the Postgraduate Dissertations Committee for approval. Efforts were made to ensure the documents obtained from PAWC and other sources were properly protected and stored. At the conclusion of the study and peer review process, materials that contain identification labels to facilities or individuals would be destroyed. This study did not directly involve participatory enrolment of individuals. PAWC management officials were regularly informed about findings from the study and their input considered in focusing the direction of the study, to make it more relevant to policy demands regarding district hospitals in the Western Cape Province. Preliminary findings from the study have been presented at the Epidemiological Society of Southern Africa Conference⁸³ (see **Appendix 6**) in keeping with the process of broadening the peer review that could promote better understanding and stimulate interest in similar research work in other Provinces.

3.10 Analysis

Completeness of datasets used in the analysis for accuracy was painstakingly checked for. Data preparation and analysis was performed using STATA, Microsoft Access and Microsoft Excel computer programs.

All the analytical work and results presented in this thesis reflect work undertaken to evaluate bed supply affecting 25 acute care district hospitals in 3 non-metropolitan regions. An exception to this only occurs in the instances where regional hospitals are added to allow for inter-regional comparisons of total bed supply and such explicitly highlighted in the reports.

Normality testing of the variables was performed using swilk command of STATA to check for skewness in the data set (**see Appendix 7 for summary information about performance indicators of each hospital**). Results are presented using scatter plots for hospital performance indicators where necessary, because of their graphical appeal in highlighting variations and can be more readily understood by policy makers at PAWC. Tables and rank tables are also used to present study result.

Text code references for each hospital is used in graphical plots to avoid cluttering which could occur if using hospital names in full in such graphs and are found in Table 5 of the Results Section. Summary and descriptive statistics using totals, ratio, means, medians, standard deviation and inter-quartile ranges, are applied according to variable types as to whether continuous, discrete and also based on normality test.

Results are presented for single indicators of hospital performance, which are relevant to PAWC (beds per 1000 population, TOR, ALOS, BOR, personnel (doctor, nurses and total staff numbers), and cost per patient day equivalent with relevant comments about limitations for their use, where applicable. Cross border flow of patients for PAWC owned hospitals in the Boland /Overberg region was computed from postal code utilisation records for respective hospitals, extracted from hospital information system (Delta 9).

Some of the analytical work require that hospital bed capacities be grouped into 3 categories, and which were as follows: 1) Less than 50 beds, 2) 50 – 99 beds and 3) and over 100 beds. Such

grouping was done to check if groups of hospitals based on their bed capacities had similar characteristics. Groupings were also done according to regions and districts.

The Pabon Lasso graphical technique for comparing relative performance across hospitals was utilised to compare efficiency across the non-metropolitan district hospitals. This technique allowed for the TOR, BOR and ALOS across hospitals in the study to be compared graphically at the same time and allows for weaknesses inherent in use of single indicators to be overcome.

One of these (short run average cost curve for non metropolitan hospital) evaluated the relationship between hospital beds and hospital cost using a cost function curve. Cost is represented by cost per patient day equivalent as the dependent variable in this model. For this model, bed and bed squared were considered explanatory variables. The variable “bed” in the model represents total bed number, which is regarded as a good proxy of hospital size, indicating the possible scale of operation a hospital possesses. The variable “squared bed”, indicates a restriction term in the model equation that transforms it into a non-linear regression, which allows hospital costs to change as the scale of operation changes, allowing for elasticity to be observed between size and cost. ^{26,27,68,84}

A second curve was fitted to evaluate relationship between bed occupancy and bed supply for the hospitals to obtain optimum required levels of hospital size to obtain desired bed occupancy outcomes for PAWC district hospitals. This simple model, analysis required only bed and bed squared into the regression equation as independent variables to check elasticity of bed supply and its influence on hospital bed occupancy used as the dependent variable. It is to be stated that bed occupancy is chosen as a dependent variable because of its importance to PAWC managers and drawing on its importance as literature from previous research indicates. ^{6, 26,27,68,84}

A third model to evaluate the influence of capacity and efficiency classification on hospital cost was performed. The variables considered as explanatory variables in this model are beds (an indication of hospital capacity), bed squared (introduced into the model to cause it to be non-linear and allowing elasticity's to apply), bed occupancy rate (influenced by its use in previous studies and its importance to current practice of evaluating hospitals at PAWC). Dummy variables are used for hospital ownership (0 if PAH hospital and 1, if a PAWC hospital) and hospital efficiency rating (0 if classified as efficient and in quadrant 4 of Pabon Lasso analysis of performance and 1, if in quadrants 1-3).

The study results are presented as tables and figures, with hospital, district or region units of description considered. Results from single indicators of hospital activity and performance are presented in compressed reporting format so that the information they convey in highlighting inequities could be understood. More extensive comparisons of hospital performance are carried out using results from Pabon Lasso technique and the cost function curves and other regression techniques and these are presented below.

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CHAPTER 4:

RESULTS

Results from performance comparisons across non-metropolitan hospitals are presented below.

4.1 Derived drainage population and cross border flow estimates.

Derived population estimates for non-metropolitan regions are presented in Tables 3 and 4 (see Appendix 2-5 for more details). Table 3 shows estimate of hospital drainage population based on the 1991 South African Census results after incorporating adjustments made on the basis of population growth inferred from results of the 1996 Census. Two different adjustments are used to take account of differing estimates of population growth rates over the period 1991 to 1997. Adjustment 1 is used throughout the study.

Regional population estimates are presented in table 4 (details are discussed in appendix 2).

Moderate discrepancy is observed between the derived estimate for the Boland / Overberg and the West Coast regions in comparison to that provided by PAWC management. These may have arisen because of excision of some towns (40,000 population at Grabouw plus Bot River in the Boland region and 70,000 from Mamre /Atlantis in the West Coast region) to the metropolitan region. Residents from these towns utilise hospitals in the metropolitan region due to geographical proximity as indicated by data obtained from the SMT records.

Generally, the population estimates used in this study appear higher than those from the 1996 CSS census for the Western Cape. This may have due to inclusion of 10% of population of Eastern Cape districts from adjoining inter-provincial boundaries where a hospital in the Western Cape appears to be closer for residents than similar district hospital located further in the nearby provinces to take account of cross drainage (see Appendix 2 -5 for details of the calculation done).

Table 3: Non-Metropolitan district hospital drainage population using 1991 Census with adjustment for population changes to reflect 1997.

Hospital	District ^a	CSS 91 ^b	Adjustment1 ^c	Adjustment2 ^d
Boland / Overberg region				
Ceres	1	63939	76956	74602
Eben Donges	2	122509	147449	142940
Robertson	2	32331	38913	37723
Montagu	2	21674	26086	25289
Hermanus	3	21610	26009	25214
Caledon	3	42152	50733	49182
Bredasdorp	4	23076	27774	26924
Swellendam	4	26797	32252	31266
Southern Cape / Karoo region				
Mossel Bay	1	59170	71216	69038
Riversdale	1	36540	43979	42634
George	2	95597	115059	111540
Knysna	3	54220	65258	63262
Ladismith	4	12705	15291	14824
Uniondale	4	9354	11258	10914
Oudtshoorn	4	74852	90090	873350
Beaufort West	5	33354	40144	38916
Murraysburg	5	5960	7173	6954
Laingsburg	5	5781	6958	6745
Prince Albert	5	8567	10311	9996
West Coast /Winelands region				
Stellenbosch	1	72839	88871	86153
Paarl	2	173553	208885	202496
Piketberg	3	26562	31969	30992
Porterville	3	16035	19299	18709
Malmesbury	3	54119	65137	63144
Vredenburg	4	48730	58650	56857
Vredendal	5	41777	59282	48744
Clanwilliam	5	20847	25091	24324
Citrusdal	5	7297	8783	8514

^a District implies health district number in use at PAWC.

^b CSS 1991 population figures with adjustments incorporating hospital drainage population

^c Adjustment 1 (boldened with CSS 1991 estimates multiplied by 1.20358 to reflect population in 1997 (used throughout the study)

^d Adjustment 2 with CSS 1991 estimates multiplied by 1.16677 to reflect 1997 population

Table 4. Drainage population estimates for Districts and Regions incorporating adjustments in Census estimates to reflect 1997 population.

DISTRICT	CSS91	Adjustment1^a	Adjustment2^b	PAWC 1997 (CSS)
Boland / Overberg region				
District 1	63939	76956	74602	n/a
District 2	176514	212449	205951	n/a
District 3	63762	76743	74396	n/a
District 4	49873	60026	58190	n/a
Total	354088	426173	413139	481008
Southern Cape /Karoo region				
District 1	95710	115195	111672	n/a
District 2	95597	115059	111540	n/a
District 3	54220	65258	63262	n/a
District 4	96911	116640	113073	n/a
District 5	53662	64587	62611	n/a
Total	396100	476738	462158	469186
West Coast /Winelands region				
District 1	73839	88871	86153	n/a
District 2	173553	208885	202496	n/a
District 3	96716	116405	112845	n/a
District 4	48730	58650	56857	n/a
District 5	69921	84156	81582	n/a
Total	462759	556967	539933	629784
Metropolitan region				
Total	2210153	2660109	2704686	2538022
Western Cape Province total				
GRAND TOTAL	3421474	4119987*	4119916*	4118000

*Totals for the Western Cape are slightly discrepant from the CSS total of 411800, because of rounding off.

n/a Indicate data that are unavailable

^a Adjustment 1: using CSS 1991 estimates multiplied by 1.20358,

^b Adjustment 2: CSS 1991 multiplied by 1.16677

As can be shown on Table 5, most (19) of the 25 non-metropolitan district hospitals are 100% owned and managed by the Department of Health, PAWC. The total number of actual beds in the non-metropolitan district hospitals ranges from 33 (Piketberg- Radie Kotze and Murraysburg) to 277 beds (Paarl). Text based identification codes used for easy of graphical display of variables to avoid cluttering in contrast to use of full hospital names are also shown.

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Table 5: Background characteristics and code used to represent hospitals in analyses

Hospital	Hospital Code ^a	Text code ^b	Health district	Owner ^c	Actual beds ^d
Boland Over berg region					
Ceres	1	Ceres	1	PAWC	66
Ebon Donges (Worcester)*	2	EbonDo	2	PAWC	232
Robertson	3	Robert	2	PAWC	66
Montagu	4	Montag	2	PAWC	49
Hermanus	5	Herman	3	PAWC	29
Caledon	6	Caledon	3	PAWC	71
Bredasdorp (Otto DuPlesiss)	7	Bredas	4	PAWC	48
Swellendam	8	Swelle	4	PAWC	65
Southern Cape /Karoo region					
Mosselbay	9	Mossel	1	PAWC	98
Riversdale	10	Rivers	1	PAWC	75
George*	11	Georg	2	PAWC	200
Knysna	12	Knysn	3	PAWC	117
Ladismith	13	Ladism	4	PAWC	35
Uniondale	14	Uniond	4	PAH	32
Oudsthoorn	15	Oudsth	4	PAWC	159
Murraysburg	16	Murray	5	PAH	33
Beaufort West	17	Beaupo	5	PAWC	96
Laingsburg	18	Laings	5	PAH	22
Prince Albert	19	Prince	5	PAH	56
West Coast/Winelands region					
Stellenbosch	20	Stelle	1	PAWC	95
Paarl*	21	Paarl	2	PAWC	277
Piketberg (Radie Kotze)	22	Piketb	3	PAH	33
Porterville (Lapa Munik)	23	Lapa M	3	PAWC	35
Swartland	24	Swartl	3	PAWC	122
Vredenburg	25	Vrebrg	4	PAWC	56
Vredendal	26	Vredal	5	PAWC	84
Clanwilliam	27	Clanwi	5	PAH	66
Citrusdal	28	Citrus	5	PAWC	46

* Represents regional hospitals

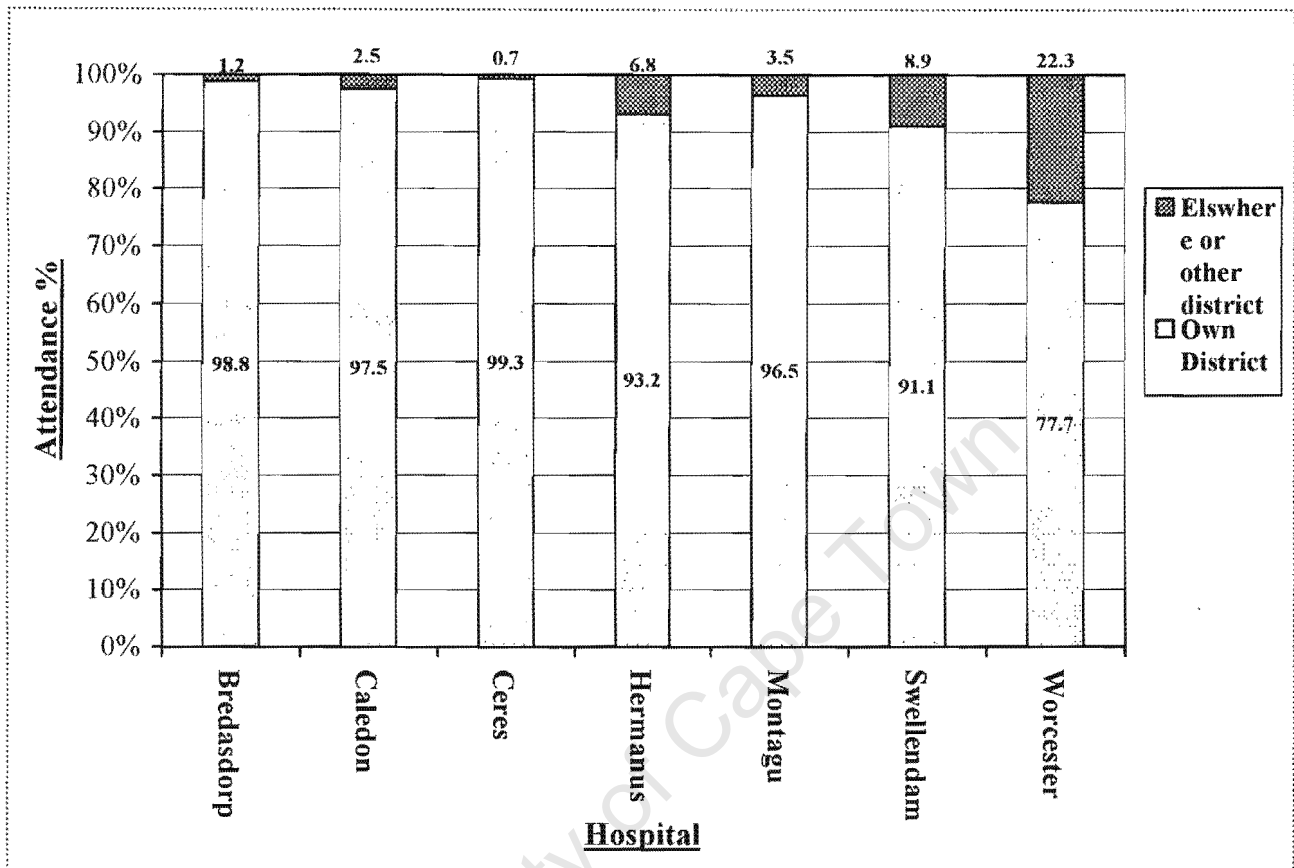
^a The Hospital numeric code assigned,

^b Text code used to identify hospitals in subsequent presentation of results.

^c Ownership of hospital which is either Provincial Administration of the Western Cape (PAWC) or Public Aided Hospital

^d Actual number of beds in use at the hospital

Figure 2: Proportion of cross border flow of patients to hospitals from outside the local district for Boland / Overberg hospitals.



As shown in Figure 2 (and Appendix 5), about 91 to 99% of inpatient admissions at district hospitals in the Boland region are from patients seeking care presenting from their respective districts. Only a small proportion (1-9% of district and 22% for regional hospital) of patients attend district hospitals through cross border travel, and presumably residing beyond the districts where the hospitals are located. Worcester regional hospital is noted to have recorded the highest proportion of cross border patients from districts outside its locale. This is not unexpected, considering this hospital provides some level 2 care, operating as a referral hospital for the region and beyond. The hospital is located in a busy transit town. Results from the analysis presented would have implications for how managers fund hospitals on the basis of providing care for an imaginary population beyond its locale.

Errors in entry of postal code data were noted during calculation of the attendance to hospitals using postal codes as proxy of residence (Appendix 3-5). These errors caused loss of between

0.2-3.2% of inpatient attendance data across the various hospitals in Boland /Overberg region, which could not be used because the postal code data were incorrect. The nature of the errors included, use of 1- 3 digit postal code entry instead of 4, use of text character O instead of numeric 0, which were the commonest observed. We believe that typographical errors by the data Clerks was responsible for these errors. This finding has implications for recommending training of data entry clerks to minimise such errors and improve the utility to which this source of utilisation data can be put for future studies.

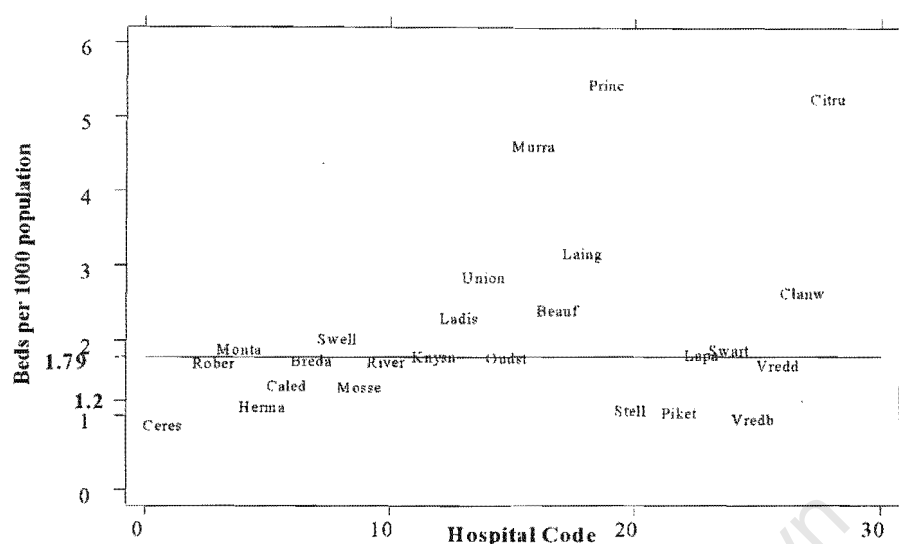
4.2 Supply of beds for non-metropolitan district hospitals

4.2.1 Provision of beds by population

The denominator for population data used in subsequent calculation of bed population ratio is derived from adjustment 1, Table 3 above. The supply of acute care beds per 1000 population amongst non-metropolitan hospitals is presented in Figure 3. This ratio ranged from 0.8 (Ceres) to 5.5 (Prince Albert). The rate ratio between hospitals having the highest and lowest bed supply is 6.8, with an absolute difference of 4.7 between them. Of the 12 hospitals with beds per 1000 population exceeding the median 1.79, six (*Prince Albert, Murraysburg, Laingsburg, Uniondale, Beaufort West and Ladismith*) are located in the Southern Cape Karoo Region. Four of these (*Clanwilliam, Citrusdal, Porterville and Swartland*) are located in the West Coast /Winelands region, with only two from the Boland region (Swellendam and Montagu).

Nine out of the 25 hospitals (*Prince Albert, Citrusdal, Murraysburg, Laingsburg, Uniondale, Clanwilliam, Ladismith, Beaufort- West and Swellendam*) are observed to have bed population ratios that are higher than the HSP ideal bed to population norm (2.0). Of particular note is the finding showing that majority (6) of these hospitals are located in the Southern Cape/Karoo region which could be indicative of an over supply of beds in relation to the existing population demand, and requirements for hospitalisation in this region. Applying a sensitivity analysis in which the stricter 'affordable' HSP bed population norm (1.2) is used, revealed about two thirds (twenty hospitals or 80%) showing bed population ratios above the norm.

Figure 3: Beds per 1000 population for non-metropolitan district hospitals



The horizontal bar signifies the median beds per 1000 population (1.79), for the hospitals.

The dotted faint line indicates position for the HSP affordable norm (1.2)

For codes refer to Table 5

4.2.2 District bed provision per population

The currently available bed supply per district is summarised in Table 6. This includes a sensitivity analysis (adjustment 1,2 and 3) to take account of three scenarios depicting various proportions of secondary level care being provided at regional hospitals, in order to obtain a more complete knowledge of acute care bed supply. As can be shown, there are wide variations across districts, and between non-metropolitan regions in terms of bed supply. A difference in the ratio of beds per population between health districts with no dedicated district hospitals (district's 2 in Southern Cape/Karoo and in West Coast/ Winelands region) to districts with highest bed population ratio (district 5 in Southern Cape/ Karoo region) is 3.21. Most (4 out of the 7) of the districts with bed to population ratios that exceeded the mean for all regions combined, (1.4 beds per 1000 population) are observed to be from the Southern Cape region, suggestive of excess bed supply operating in these districts. Applying the HSP ideal norm (2 beds per 1000 population) would identify 2 districts (districts 5 in South Cape and Boland respectively) that appear to have exceeded these norms. While the results would be indicative of

bed supply-utilisation mismatch, interpretation of this finding is difficult in the absence of information on the influence of geographical dispersion and environmental constraints that could impact on access.

Table 6: Beds per 1000 population estimates for districts and regions with sensitivity analysis for levels of care.

Health District/ Total	Beds/1000p at 50% ^a	Beds/1000p at 25% ^b	Beds/1000p at 0% ^c
Boland /Overberg region			
1	0.86	0.86	0.86
2	1.09	0.81	0.54
3	1.30	1.30	1.30
4	1.88	1.88	1.88
Region total ^d	1.20	1.06	0.92
Southern Cape/ Karoo region			
1	1.50	1.50	1.50
2	0.87	0.43	0.00
3	1.79	1.79	1.79
4	1.94	1.94	1.94
5	3.21	3.21	3.21
Region total ^d	1.93	1.73	1.62
West Coast /Winelands region			
1	1.07	1.07	1.07
2	0.66	0.33	0.00
3	1.63	1.63	1.63
4	0.95	0.95	0.95
5	2.33	2.33	2.33
Region total ^d	1.21	1.09	0.92

Sensitivity analysis with Models incorporating different proportions of regional beds used for district hospital level care with scenarios as follows:

^a Adjustment 1: 50% of beds at Regional hospitals allocated as District level

^b Adjustment 2: 25% of beds at Regional hospitals allocated as District level

^c Adjustment 3: 0% of beds at Regional hospitals allocated as District level

^d Total District bed per 1000p for the Region

Note: Ratios falling below HSP affordable norms are appear in bold.

Two districts with regional hospitals located within them (districts 2 in Southern Cape/Karoo and West Coast Winelands region respectively), also appear not to have earmarked district beds on the basis of current PAWC policy. This assumes that the regional hospitals located in these districts only cater for patients requiring secondary level hospital care, in spite of having no designated district hospitals in these districts. Under such scenario, access to care might be hampered for residents of these communities if the regional hospitals are expected to provide care that is totally commensurate with their intended level of care (secondary hospital).

The above observation influenced the researchers into considering different proportions of regional hospital bed allocation earmarked for district level of care by using a sensitivity analysis. The adjustments performed (adjustment 1-3, with 0%, 25% and 50% allocation as district level beds), and the results are presented in Table 6. For the scenario of allowing 25% regional hospital bed allocation for use in providing district hospital care, the supply of beds per 1000 population would vary from 0.33 to 3.21 in the lowest district (2 of West Coast region) to the highest (5 of South Cape region). It thus appears imperative on the basis of this finding, that PAWC managers consider earmarking some beds at regional hospitals to function at district hospital level care, with funding arrangements commensurate with such changes made.

4.2.3 Regional bed: population ratios in relation to district level beds

Evaluation of the overall supply of district and regional level beds per 1000 population was undertaken. For the estimates, sensitivity analysis considering scenarios for regional hospital beds providing district level care (Adjustment 1-3, similar to discussion above) was performed and the results are presented in Table 7. As can be shown, the unadjusted bed supply figures for Boland/ Overberg and the West Coast/ Winelands regions are equal (0.92). The Southern Cape region's bed supply of 1.62 per 1000 population exceeded the HSP affordable norms (1.2) for district beds. This observation could lend itself to suggestions for reduction in the bed supply currently available in the Southern Cape/Karoo region. It could benefit from targeted policy changes that would achieve allocative efficiency, translate to savings for PAWC and promote attainment of equity.

Table 7: Beds per 1000 population by region considering different proportions of district levels beds used at regional hospitals.

Health Region	Bed Type	Adjustment 1: 50%	Adjustment 2: 25%	Adjustment 3: 0%
Boland	District Beds	1.20	1.06	0.92
Overberg	Regional Beds	0.27	0.41	0.54
South Cape	District Beds	1.93	1.73	1.62
Karoo	Regional Beds	0.21	0.31	0.42
West	District Beds	1.21	1.09	0.92
Coast	Regional Beds	0.25	0.37	0.50

Sensitivity analysis is performed above, with models incorporating different proportions of regional beds used for district hospital level care with scenarios as follows

Adjustment 1: 50% of beds at Regional Hospitals allocated to District level

Adjustment 2: 25% of beds at Regional Hospitals allocated to District level

Adjustment 3: 0% of beds at Regional Hospitals allocated to District level

Note: Ratios falling below HSP Affordable norms are in bold (*HSP Affordable Norm 1.215 District level and 0.608 Regional hospital level*).

Results presented in Table 8, reveal that bed supply at regional hospital level of care per population is between 0.42 beds per 1000 population (Southern Cape/Karoo region) to 0.54 (Boland / Overberg), with these figures all below the HSP affordable norm (0.608). The shortfalls in bed supply are more pronounced assuming a proportion of regional hospital beds are utilised to provide district hospital level care. From the results, it appears that shortfalls of between 1 to 159 beds are found, with oversupply of beds (up to 244 beds) in some scenarios. This in particular indicates that there are prevailing shortfalls of bed supply at regional level, against a backdrop of relative oversupply of district level beds across all the non-metropolitan health regions.

Table 8: Actual and expected bed totals with estimated deviations in bed supply in comparison using HSP affordable norm values.

Bed type	Expected (Norm -based) *	Beds Actual (50%) **	beds Bed Variance (at 50%)	Actual beds (25%) §	Bed Variance (at 25%)
	a	b	b – a	c	c-a
Boland /Overberg region					
District beds	518	510	-8	452	-66
Regional Beds	259	116	-143	174	-85
Southern Cape Karoo region					
District beds	579	823	244	773	194
Regional Beds	259	100	-159	150	-109
West Coast /Winelands region					
District beds	677	676	-1	607	-76
Regional Beds	339	138	-201	207	-132

*Expected number of beds (a), by applying HSP norms to the population. HSP Affordable Norm for District level beds taken as 1.215 with the HSP Affordable Norm for Regional level beds = 0.608

** Actual beds available (b), with assumptions that 50% of beds at Regional hospitals are allocated to district level care

§ Actual beds available (c), with assumption that 25% of beds at Regional hospitals are allocated to district level care

Sensitivity analysis for population dependence on the use of public sector health services was performed, using ranks assigned to districts, starting from the lowest bed per population district to that for district highest ratio in each region. The results are as presented in Table 9. This does not appear to cause changes in the overall rankings of district bed supply (from least resourced to most resourced district), except in the Boland/ Overberg region.

**Table 9. Ranking of district beds per 1000 population ratios, with sensitivity analysis
(Excluding non-black population as proxy for public sector dependence)**

Health district	District beds/1000p (No exclusions) ^a	Rank in own region	District beds/1000p (with exclusion) ^b	Rank in own region
Boland /Overberg region				
1	0.86	1	0.97	1
2	1.09	2	1.37	2
3	1.30	3	2.96	4
4	1.88	4	2.51	3
Southern Cape/Karoo region				
1	1.50	2	2.48	2
2	0.87	1	1.22	1
3	1.79	3	3.40	4
4	1.94	4	3.18	3
5	3.21	5	3.50	5
West Coast/Winelands region				
1	1.07	3	1.63	3
2	0.66	1	0.81	1
3	1.63	4	1.97	4
4	0.95	2	1.29	2
5	2.33	5	2.88	5
Mean(SD) 1.51(0.69) 2.16(0.94)				

Ranking implies ascending order from least resourced to more resourced districts using the bed: 1000 population ratio (a) for total population and (b) excluding the white population

ASSUMPTIONS

1. Using adjustment of 1991 Census by multiplying with 1.20358 for Non Metro Population
2. Assume Scenario 3 ; 50% of Regional Beds as District Level Beds
3. Northern Cape Population (1628) allocated to Beaufort West
4. Grabouw plus BotRiver (36900) drain to the Metro Region so not included
5. Darling, Mamre, Atlantis, Melkos (population 70490) drain to the Metro Region (not included)

4.3. Performance Indicators for Non-Metropolitan District Hospitals.

The study explored potential effects which categorisation of hospitals by bed number could have on activity and performance indicators, further undertook analysis of result using single hospital performance indicators to compare hospital performance, followed by more elaborate comparison with composite measures of relative performance such as Pabon Lasso, cost curves and other regression analysis.

4.3.1 Grouping of hospital performance indicators assessed according to bed number.

The influence of district hospital categorisation using total bed number that is linked to activity and performance indicators was evaluated, with the results as shown in Table 10. It is apparent from the result that bed occupancy rate, fulltime equivalent for doctors and turnover rates vary according to sizes of district hospitals (reflected in bed numbers).

Table 10: -Summary statistic for non-metropolitan hospitals by hospital size

INDICATOR	HOSPITAL BED CATEGORY			
	<50 beds	50- 99	> 100	COMBINED
Hospitals in the group	10 (40%)	12(48%)	3 (12%)	25(100%)
ALOS (mean)	3.66 (SD 0.73)	3.94 (SD.92)	4.60 (SD 0.85)	3.91 (SD 0.86)
Bed Occupancy rate	56.94 (SD 14.15)	74.10 (SD 17.44)	70.05 (SD 2.14)	66.75 (SD 16.83)
Staff: bed ratio	1.16 (SD 0.44)	1.45 (SD 0.53)	1.87 (SD 0.04)	1.38 (SD 0.50)
Nurses: bed ratio	0.42 (SD 0.22)	0.45 (SD 0.23)	0.51(SD 0.02)	0.44 (SD 0.20)
Doctor (FTE)	1.18 (SD 0.54)	2.49 (SD 2.59)	7.21(SD 1.57)	2.53 (SD 2.63)
Doctor (FTE) per bed*	0.04 (0.04-0.05)	0.02 (0.02-0.35)	0.06 (0.04- 0.08)	0.02 (0.02 - 0.06)
Turnover rate*	5 (49-76)	62 (50-77)	62 (47-64)	60 (50 -73)

Means and standard deviation (SD) are reported for normally distributed variables

* Median and interquartile ranges are reported for data that is not normally distributed

- FTE indicates full time equivalent staffing is assumed in the calculation
- 'Combined' column refers to data for all hospitals.

The findings above, have implications for policy concerning hospitals, and could indicate that considerations for hospital size (reflected by bed number) have to be factored into decision-making options for providing hospital services at PAWC. This is because bed size appears to have bearings on performance.

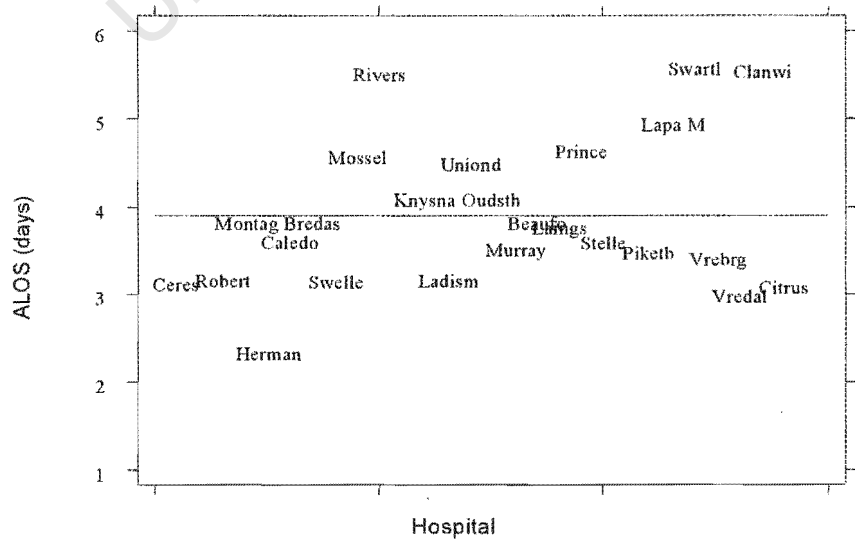
4.3.2 Single indicators of Hospital Activity and Performance

The study compared hospital performance across non-metropolitan district hospitals through the use of single indicators that are routinely collected by PAWC for evaluating hospitals, such as ALOS, BOR and derived TOR with results presented in Figures 4-6. Reporting on hospital performance using these single indicators would help place components of this research work in line with related evaluations done in the past.

4.3.2.1 Average Length of Stay (ALOS) for Non-Metropolitan District Hospitals

The distribution of ALOS for non-metropolitan district hospitals is presented graphically in Figure 4. As the result indicate, the hospitals have a median ALOS of 3.91 days (range 2.3 to 5.6). This is well within the recommended HSP norm (4-6 days) for rural district hospitals in South Africa. Most hospitals in the Boland / Overberg region in comparison to the other 2 regions, appear to have ALOS that are below the average value for all the hospitals, however this differences is not statistically significant. Outlier hospitals characterised by having longer lengths of patient stay include Riversdale, Swartland and Clanwilliam.

Figure 4: Average Length of Stay for non-metropolitan district hospitals



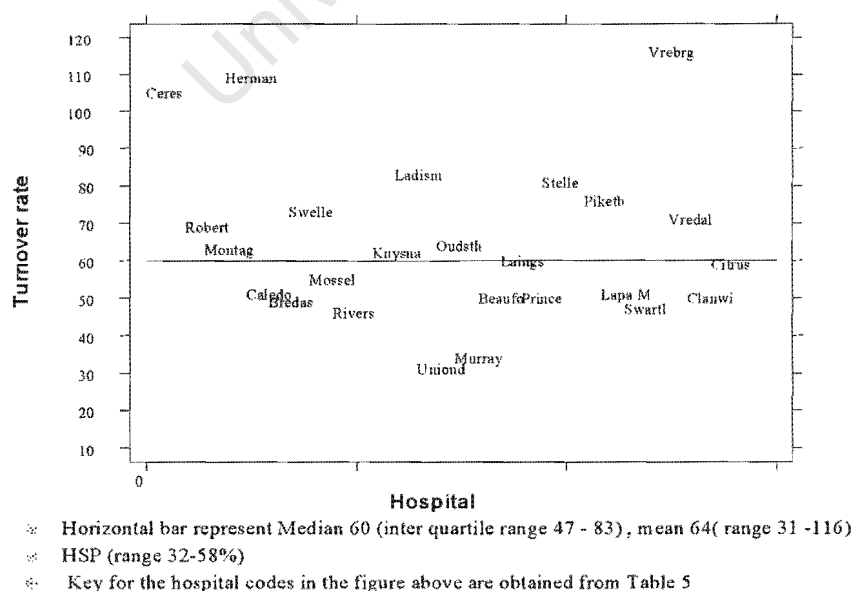
- ◆ Median 3.91 days (range 2,3 - 5,6) indicated by horizontal bar
- ◆ HSP norm 4 - 6 days
- ◆ Reference for towns represented by codes in the figure are as in Table 5

4.3.2.2 Bed Turnover Rate (TOR) for Non-Metropolitan District Hospitals.

The turnover rate (TOR) for the non-metropolitan district hospitals is presented in Figure 5. The average TOR is 60, ranging from 31 (Uniondale) to 116 (Vredenburg). Three of the 25 district hospitals (Ceres, Vredenburg, Hermanus) with the lowest bed supply per population are also noted to have the highest TOR (over 100 patients per bed). These three hospitals also have ALOS below the average for all the district hospitals (Figure 4). In particular, one of these hospitals (Ceres) is observed to have the shortest ALOS.

While a short length of stay is desirable, extremely short lengths of stay may be indicative of unnecessary admission of patients that do not necessarily require admission, which may constitute inappropriate care. However, this concern could not be investigated further in this study as clinician profiles and the appropriateness of admissions was not included as study objectives drawn from PAWC brief. Other researchers could explore this further. As can be observed, the outlier district hospitals of concern are Murraysburg and Uniondale, which have the lowest turnover rates (less than 50) and warrant a closer review by PAWC managers regarding supply and demand factors that affect productivity in these hospitals.

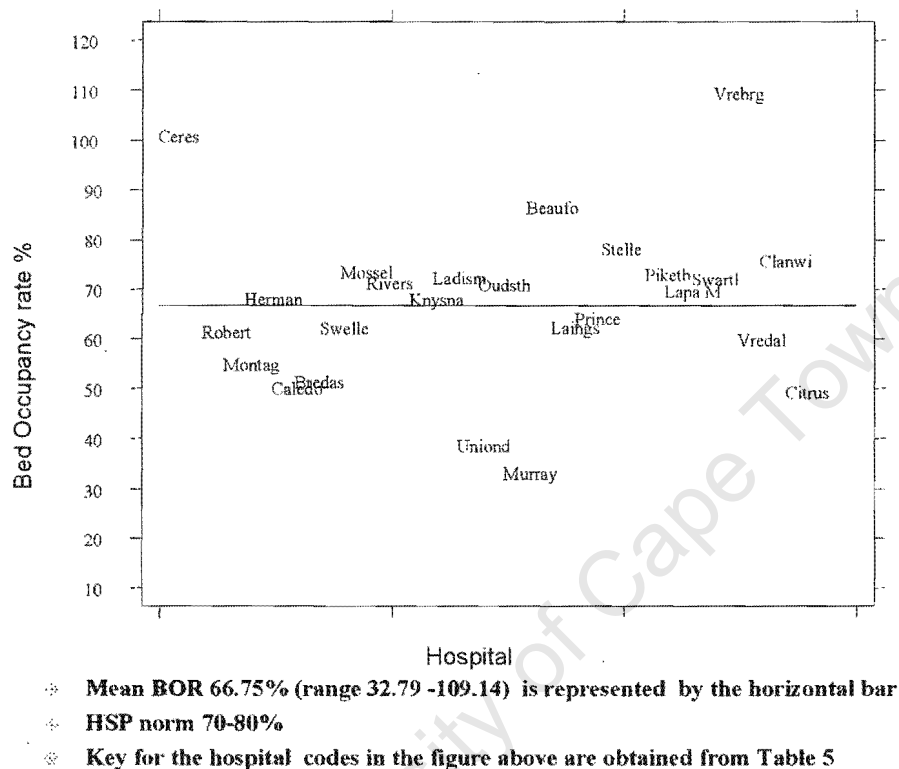
Figure 5: Turnover rates for non-metropolitan district hospitals



4.3.2.3 Bed occupancy rate (BOR) for non-metropolitan district hospitals

The bed occupancy for the non-metropolitan district hospitals is presented in Figure 6. The mean occupancy is 66.75%, and BOR ranges in value from 31(Murraysburg) to 109 (Vredenburg).

Figure 6: Bed occupancy rates for the non-metropolitan district hospitals



Six hospitals (Vredenburg, Ceres, Beaufort West, Stellenbosch, Clanwilliam and Piketberg) have BOR close to HSP norm (70 - 80%). Two of these, (Vredenburg and Ceres) exceeded 90% BOR, which could be indicative of a potential for problems of bed crises occurring in the communities with this hospitals. Such crisis could pose problems of access to acute care beds in the districts during the course of a year. As data on referrals to other hospitals, including waiting lists for admission to hospitals is unavailable to the researchers at the time of the study, this concern could not be investigated further. It is noteworthy that the two hospitals with the lowest BOR (Uniondale and Murraysburg) are also observed to have the lowest TOR. Both hospitals are located in Southern Cape Karoo region and happen to be in districts that have recorded the highest district bed per population ratios (Figure 3). The findings could be suggestive of an existing over concentration of hospital beds in communities where the hospitals are located. It does appear that the current epidemiological and disease profiles in these affected communities

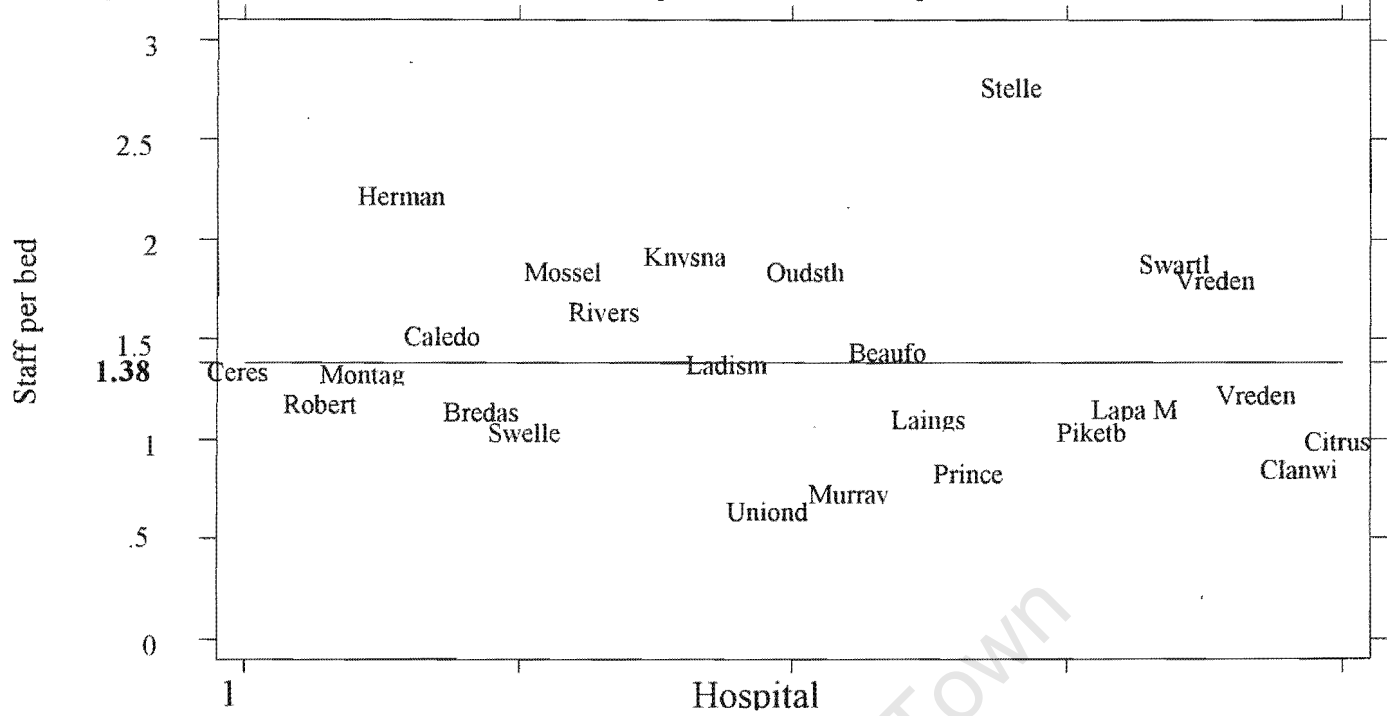
do not support a need for maintaining the current number of supplied hospital beds, due to lesser population need for hospitalisations. Given PAWC's current financial constraints, and its desire to achieve efficiency gains from savings on hospitals, the spare beds in these district hospitals with apparent oversupply of beds could be targeted for saving by PAWC managers.

4.4 Personnel

Comparative review of personnel (nurses, doctors and total staff) distribution amongst the non metropolitan district hospitals are presented in Figures 7- 9, showing variations on the basis of staffing levels and capacity.

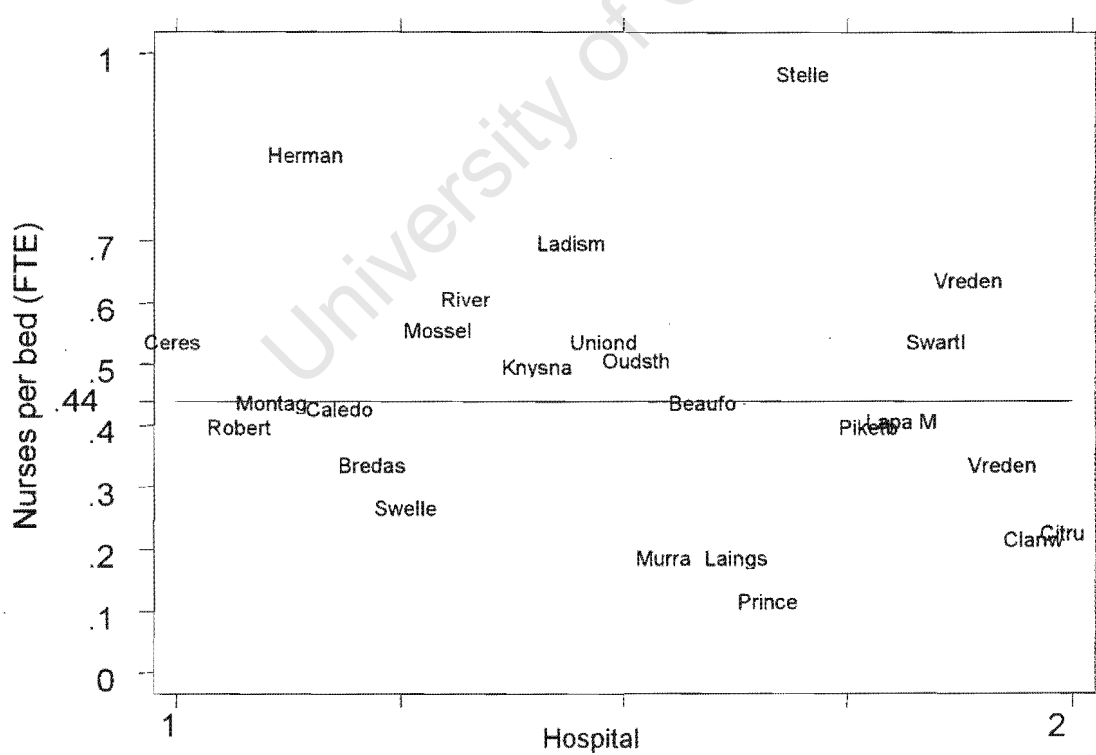
Eleven of the twenty-five hospitals as seen in Figure 7, have staff per bed ratios above the median (1.38). Hermanus (code 5), Stellenbosh (code 20), Uniondale (code 14) and Murraysburg (code 16) hospital are identified as outliers. Stellenbosch has the highest ratio of staff to beds, although this did not translate to greater bed turnover rate (Figure 8). It could be that, its role as a hospital linked to a university teaching hospital (Tygerberg) may have contributed to the high staffing ratio observed but this could not be completely explained.

Figure 7: Staff to bed ratios for non-metropolitan district hospitals



Mean (1.38) is indicated by the horizontal bar
Key for the hospital codes in the figure above are obtained from Table 5
Refer to section 3.6.2.1 for definition of staff

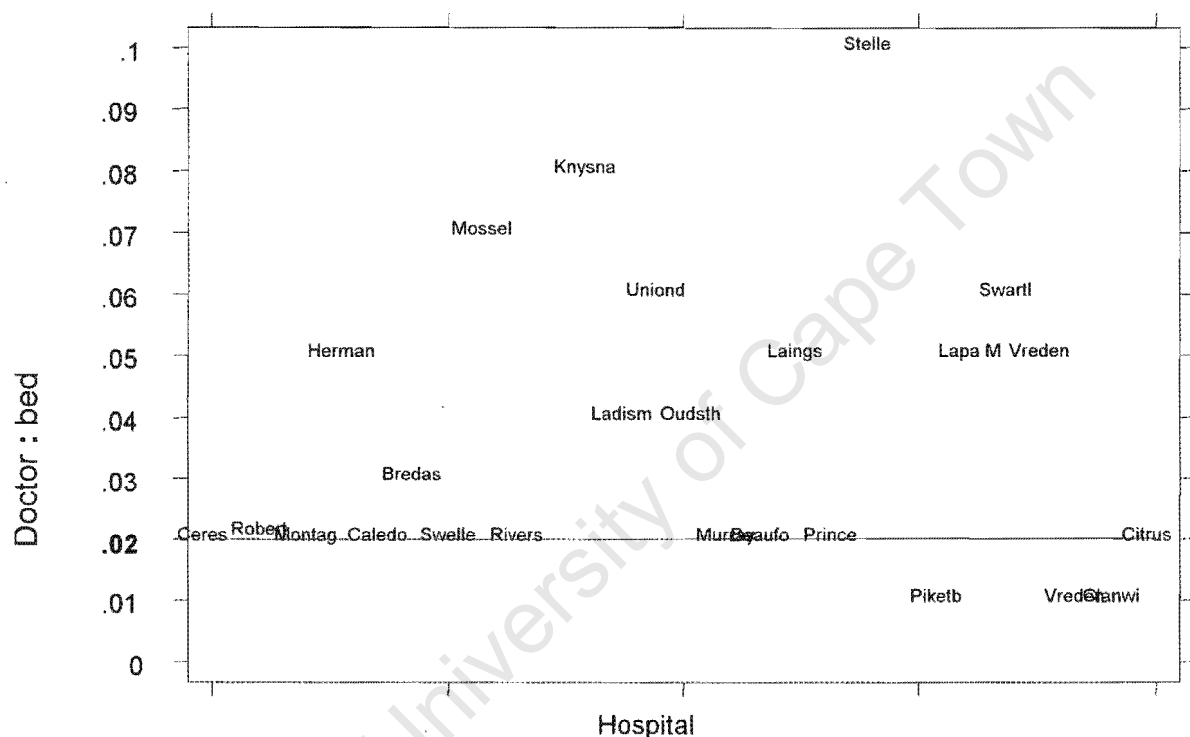
Figure 8: Nurse personnel FTE to bed ratio for non-metropolitan district hospitals



Mean (0.44) is indicated by the Horizontal bar.
The key for hospital codes are found in Table 5
Refer to section 3.6.2.1 for definition of Nurse

Distribution of doctor supply per bed across the non-metropolitan hospitals was evaluated, and the results are presented in Figure 9. For this, the full time equivalent time of doctor supply is utilised is explained in appropriate sections of methods above. The findings reveal three hospitals namely Piketberg, Clanwilliam and Vredendal, to have observed ratios that are less than the average (median = 0.02, is equal to the HSP norm), with all these located in the West Coast region. Stellenbosch, Knysna and Mosselbay are observed to have the highest ratios. The ratio between the highest and lowest district hospitals is 10, a figure depicting great variation existent between hospitals.

Figure 9. Doctor to bed ratio for non-metropolitan hospitals



Median (0.02) indicated by Horizontal bar.
Refer to Table 5 for hospital name from the codes
Refer to sections 2.5.2 and 3.6.2 for Description of FTE for doctors.

Interpretation of results from individual hospital performance indicators is presented above. It becomes apparent that depending on the indicator chosen, the hospitals that could be considered inefficient could vary in proportion. Single indicators are also fraught with limitations as highlighted in the literature review section above. Also it would appear logically impossible that any single indicator can completely explain a hospital behaviour and productivity. Analytical techniques that evaluate performance across hospitals using multiple performance indicator variables simultaneously are thus preferred. This research work therefore evaluated hospital

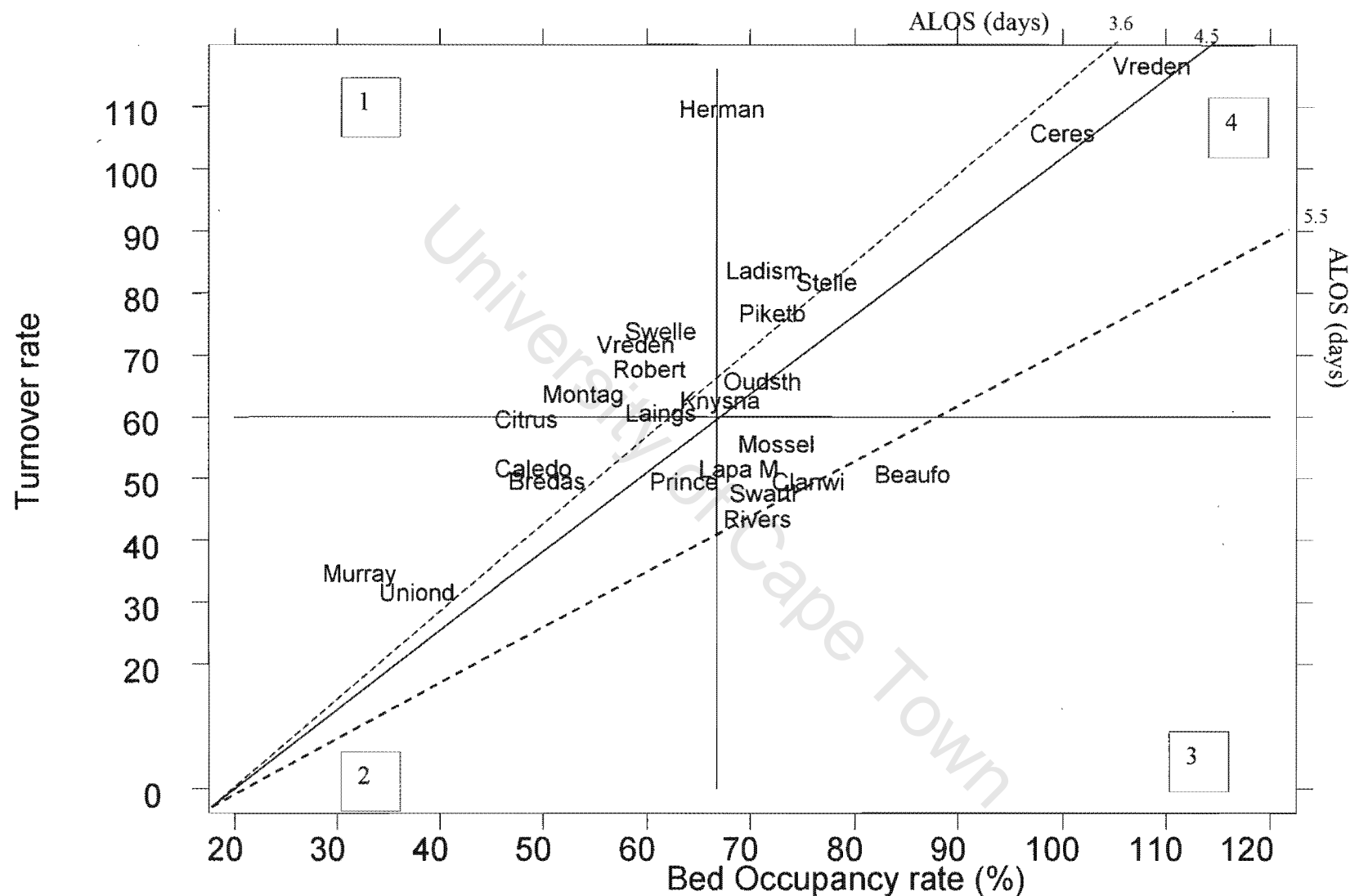
performance using Pabon Lasso Technique, short run hospital cost function curves and regressions.

4.5 Relative efficiency comparison amongst non-metropolitan hospitals using Pabon Lasso Technique

The Pabon Lasso graphical technique for evaluating relative efficiency district hospitals in the non-metropolitan regions was used to compare performance across the district hospitals results and presented in Figure 10. The cut-offs for making this analysis is taken to be the midpoint for the respective indicators TOR and BOR for all the hospitals combined. With oblique ray lines from the origin angle drawn outwards to a corner, due to mathematical relationship amongst the variables, ALOS is obtained and increases from left to right. On the top part and from top to bottom on the right hand corner.

As can be ascertained from this, only eight out of 25 hospitals could be described as efficient and are these are observed to occupy the most desirable “efficient” quadrant 4. Hospitals in this quadrant have utilisations matching the corresponding supply of beds. They have a high bed occupancy rate and turnover rate. Some of these hospitals including Vredenburg, Ceres, Hermanus, Stellenbosch and Piketberg have very small ALOS. It is noteworthy that five of these hospitals have bed per population ratios that are below the HSP affordable norm (1.21), with seven of the eight hospitals being below the HSP ideal bed per population norm figure (2.0). Only one of these hospitals has its ownership defined by being a Provincial Aided Hospital. It is not known why there were only few PAH facilities amongst the efficient hospitals, as it would have been expected that being partly privately owned, PAH facilities would be more efficient than PAWC hospital facilities. The outlier hospitals for this quadrant are namely, Ceres, Vredenburg and Hermanus, and these are also hospitals observed to have the lowest bed per 1000 population ratios (Figure 3). This may be indicative that efficient bed allocation commensurate with utilisation occurs for these hospitals. Evaluation of patient waiting times for admission into hospital beds at the district towns is warranted in future evaluations in order to confirm the this finding of optimal bed supply, and to rule out negative consequences existent from stretched capacity. Ceres and Vredenburg hospitals, observed to have occupancies that exceeded 100 (Figure 6) have equally very high turnover rates (Figure 5), the cause of which could not be immediately established in this evaluation performed.

Figure 10: Pabon Lasso graphical technique classification of relative efficiency across non-metropolitan district hospitals



- Quadrants 1-4 above are defined by the average bed occupancy (66.75- vertical bar) and the average turnover rate (60)
- The thick oblique line indicates average ALOS position for the hospitals,, with the dotted lines representing ALOS values at 3.6 and 5.5

Refer to hospital text codes in Table 5

For the 17 district hospitals classified using the technique and found to be relatively inefficient, these are located in quadrants 1 to 3. For these, their distribution is as follows; five hospitals located in quadrant 1, and with six district hospitals each in quadrants 2 and 3 respectively.

The hospitals in quadrant 1 (Swellendam, Vredendal, Robertson, Laingsburg and Montagu) are defined by characteristics indicating excess bed supply or may have low demand for patient hospitalisation and hospital utilisation. These hospitals have been reported above to have BOR (Figure 6), staff to bed ratio (Figure 7) and nurse to bed ratio (Figure 8) that are below the mean for all hospitals and equally exceeded the HSP affordable norm for beds per 1000 population (1.2).

Of the six hospitals in quadrant 2 (Citrusdal, Caledon, Bredasdorp, Prince Albert, Uniondale and Murraysburg) with low BOR and TOR, three are located in the Southern Cape Region. In particular, Prince Albert and Murraysburg, belong to the same health district (district 5), which recorded the highest bed per 1000 population ratio (Table 6). Both of these hospitals provide coverage to areas that are sparsely populated with wide distances between towns, which may pose barriers to accessing care and influence patient willingness to accept hospitalisation in these facilities.

Quadrant 3 defines hospitals (Beaufort West, Clanwilliam, Lapa Munik, Riversdale, Swartland and Mosselbay) with above average bed occupancy, but displaying very low turnover rates and longer ALOS than other hospitals. Other than Lapa Munik, all these hospitals have between 50 to 99 beds (Table 5). Clanwilliam and Beaufort West district hospitals are located in districts with wide geographical dispersion and it may be possible that doctors practicing here keep patients longer to be sure they are well before discharging them, as difficulties with patient transport are common problems encountered in the rural areas of the Western Cape Province. The actual practices obtained in these hospitals require further evaluation in future assessments of bed provision to confirm this is the case.

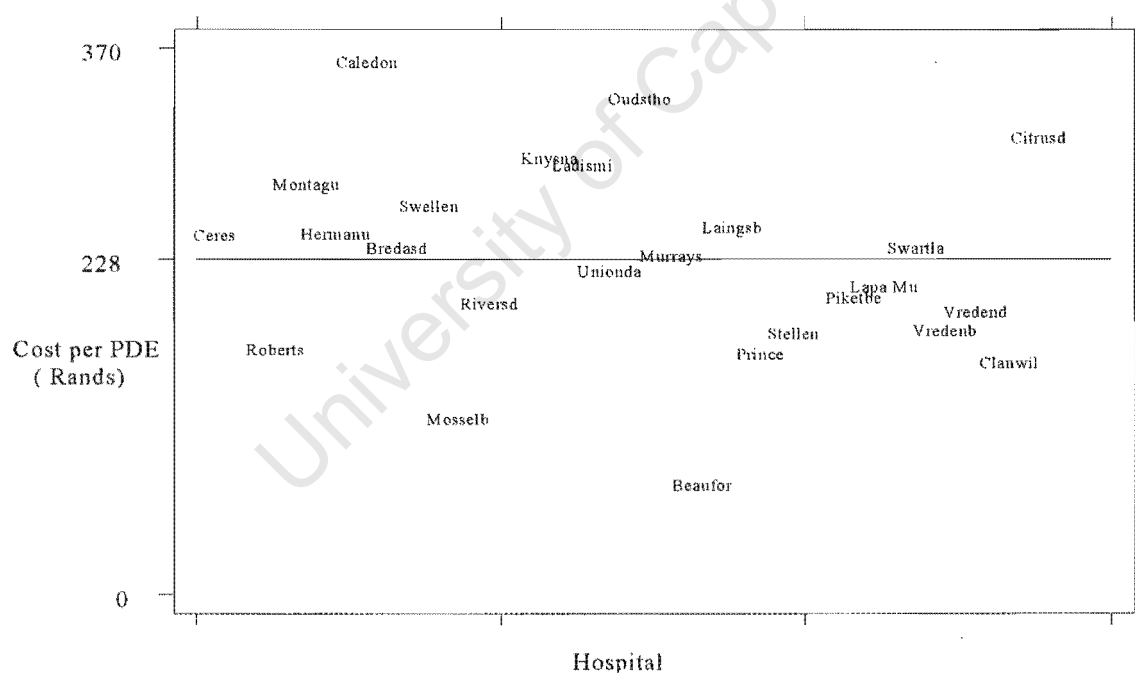
Performance is related to hospital productivity and influences hospital costs, therefore cost comparisons across hospitals to assess performance using this indicator for the non-metropolitan hospitals is important and so is evaluated by the researchers.

4.6 Comparisons of Non-metropolitan District Hospital Costs

The influence of costs on efficiency at PAWC and PAH non-metropolitan hospitals was evaluated by plotting the distribution of average costs across the hospitals and also using polynomial regression to fit short run average cost curves. For this analysis, cost per patient day equivalent was taken to represent unit cost of production for each hospital. Hospital beds represented a proxy for hospital stock and capacity. Results from the analysis performed are presented in Figures 11 to 13, with the variables influencing hospital costs presented in Table 11.

As can be shown in Figure 11, outlier hospitals with respect to costs include, Caledon, Oudstho and Citrusdal (high unit cost hospitals), while Beaufort West and Mosselbay have the lowest hospital unit costs. Unit cost comparisons between the highest and lowest cost hospitals reveals absolute differences as much as R285.00 and a ratio of 4.9 to 1.

Figure 11. Cost per patient day equivalent for district hospitals



Mean cost per patient day (R228.0) indicated by the horizontal bar

Key for the hospital codes in the figure above are obtained from Table 5

The relationship between hospital cost (reflected in cost per patient day equivalent) and provision of beds with a short run average cost curve is presented in Figure 12. As can be seen, the cost per

patient day equivalent drops rapidly as bed size rises until 65 beds, thereafter the cost curve plateau's, this being followed by a rebound and rapid incline until it reaches 120 beds. This would indicate that 65 and 120 beds is the optimal bed number in hospitals, which would promote gains in efficiency, and savings through lower average costs. Given that hospital bed numbers may not practically be increased as a management option (because it relates to hospital scope, required staffing levels and other associated costs), the research findings support grounds for suggestions that PAWC consider mergers of hospitals that have smaller bed numbers and are not performing efficiently. Conversely, reducing bed numbers in very large hospitals, which have not been performing efficiently, could contribute to a return to scale and efficiency gains in these, leading to financial saving for PAWC.

Cost functions could vary according to differences in hospital characteristics, which may include the degree of complexity of hospital case mix, managerial styles and other hospital routines but this could not be immediately investigated as reliable data on case mix is unavailable.

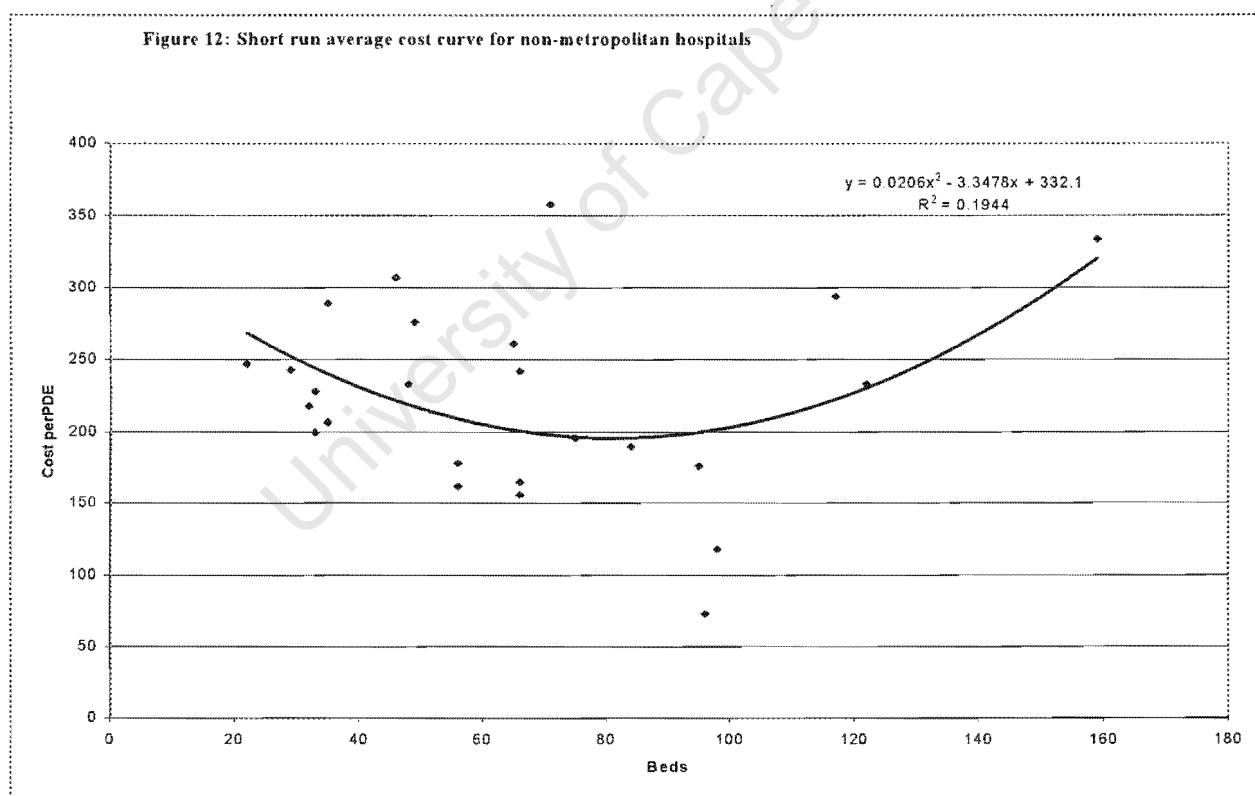
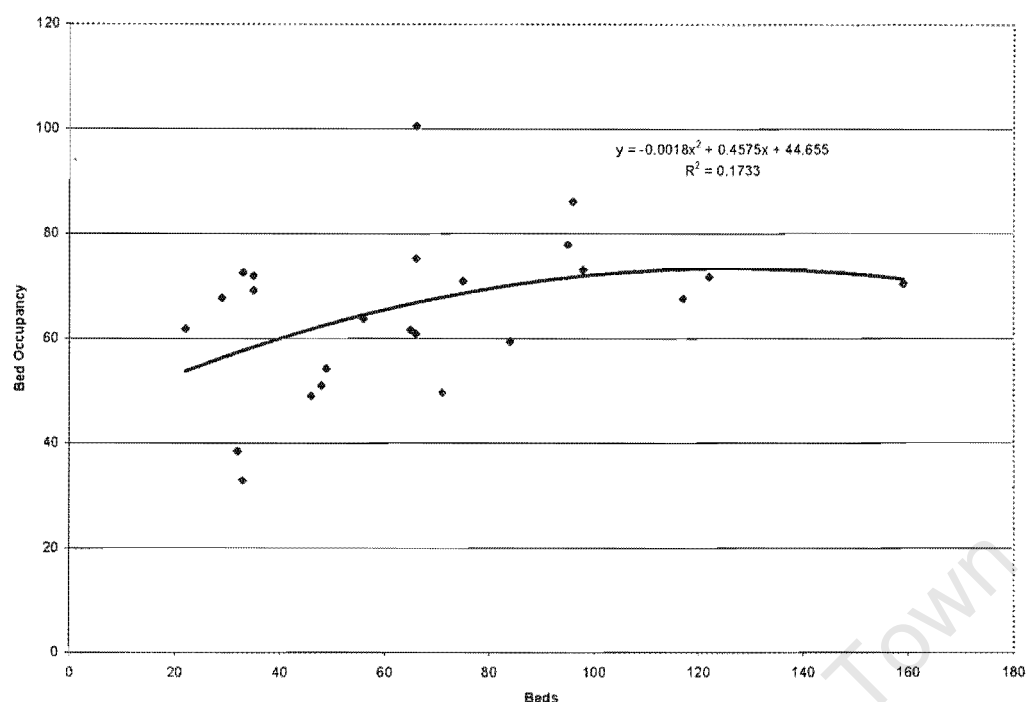


Figure 13. Relationship between bed occupancy and bed supply



Curve excluded Murraysburg and Vredenburg, which are not well fitted by the curve because they were Outliers. (Adjusted $r^2=0.29$)

4.7 Efficiency of scope and scale

The relationship between bed occupancy and hospital bed supply is evaluated using non-linear production curve to test for optimal levels of BOR for district hospitals in the non-metropolitan regions and results from this are presented in Figure 13. This reveals that bed occupancy rate rises rapidly as bed number increases until it gets to 70 beds corresponding to occupancy of about 70%, thereafter BOR incline slows down at around 100 beds, plateaus between 100-130 beds. Above 130 beds, BOR declines for the hospitals.

The relationship between bed supply and hospital cost was evaluated and the results are presented in Table 11. As can be shown, increases in bed size by 1 unit result cause the cost per patient day equivalent to decline by R2.26, although this was not statistically significant. An explanation for this observation could be that most of the hospitals in the study are in the bed size range where

economies of scale could be gained if the bed numbers increased (Figure 12). This observation support suggestions for PAWC to increase bed numbers in hospitals that are performing well until the optimum population utilisation is reached, as this would be compatible with efficiency gains and savings.

Table 11: Non -Linear regression analysis evaluating influence of capacity and efficiency on hospital costs.

Variable	Coefficient	P value	95% CI
Beds	-2.26	0.178	-5.6 - 1.12
Bed Occupancy rate	-2.51	0.009*	-4.32 - 0.71
Ownership ^a	61.04	0.047*	0.94 - 121.13
PL Efficiency rating	-57.98	0.076	-122.5 - 6.62
Beds squared	0.01	0.166	-0.006 - 0.03

Adjusted $R^2=0.3965$, Prob> F =0.0102 (Statistically significant)

Bed squared indicates that bed is squared in the model (this makes the model non- linear)

PL Efficiency rating assumes 1 if hospitals are located in quadrants 1-3 of Pabon Lasso analysis and 0 if they are located in the efficient quadrant (4)

^a Ownership. Provincial aided hospitals used as referent group and PAWC hospitals as estimated group

* Indicates variables that are statistically significant at 5% level.

As could be further gleaned from Table 11, increases in BOR are associated with lower costs per patient day equivalent such that a unit increase in BOR leads to a reduction in the cost per patient day equivalent by R2.51. If it were possible to increase the mean bed occupancy for these hospitals through improved efficiency from the mean BOR (67%) for non metropolitan hospitals to the lower limit recommended by HSP (70%), implying a 3% increase, the cost per patient day equivalent would be reduced a unit of R7.53. Policy changes aimed at increasing BOR would appear to translate into huge savings on hospitals that could be channelled into other health fund requiring segments for PAWC. Cost per patient day would appear to be reduced by up to R57.98

if hospitals are in the category classified to be efficient by the Pabon Lasso method, although this finding was not statistically significant ($P=0.076$)

On the basis of the finding, cost per patient day equivalent is affected by hospital ownership, and results above suggest, PAWC hospitals appear to be more costly in terms of unit cost per patient day, in comparison to the PAH hospitals. Explanations for this could be that PAWC hospitals are staffed with more professional bands and categories and have more costly equipments. An alternative reason could be that PAWC owned hospitals are more inefficient in their use of resources, but this could not be evaluated.

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This study evaluated efficient performance and the distribution of district hospital resources across twenty-five district hospitals, and it included 3 regional public sector acute care hospitals in some of its analysis to obtain a comprehensive overview of bed supplies in the Western Cape Province of South Africa. Drainage population for hospitals and districts, including cross border patient flow of patients to hospitals from other districts were evaluated which would greatly help fill gaps in knowledge identified by the HSP. The research work utilised the Pabon Lasso method¹⁷ in the assessment of relative performance across district hospitals in non-metropolitan regions of the Western Cape Province. Variables influencing hospital performance are assessed and short run hospital cost curves plotted to ascertain scopes for efficiency gain in the hospitals evaluated. Graphical displays of the distribution of performance and activity indicators for the hospitals and districts are plotted, with the objective of revealing opportunities for attaining equity and improving efficiency. On the basis of results obtained it can be stated that the non metropolitan district hospitals (including districts and regions in which they are contained) have differing levels of hospital bed supply and performance, to the extent these may have bearings on efficiency gain and financial savings from targeted policy actions by PAWC managers.

5.1 Equity and efficiency in the distribution of acute care beds in the non-metropolitan region.

A relative under supply of regional acute care hospital beds coexistent with oversupply of district beds exists in the non-metropolitan regions. There exist also, a remarkable mal distribution of the available acute care hospital beds on the basis of comparisons done according to hospital (Figure 3), districts (Table 6 to 9) and health regions in relation to the HSP affordable norms. These norms have been accepted in line with PAWC policy direction on hospital bed supply. Therefore inequity is considered to be strongly evident in hospital care provision in the non-metropolitan regions. This view is supported by results from this study in which the difference in ratios between the least and best-resourced districts in terms of bed supply per population ratios are in the order of 7, and those between the least and best resourced districts of the order of 4.

Over 50% of district hospitals in the non- metropolitan regions exceeded the HSP affordable norm for supply of beds per thousand population for district level care (1.2) indicating an over capacity in terms of acute care beds in the non-metropolitan regions. Targeted policy actions on these by PAWC aimed at reducing expenditure on hospitals to meet other health sector financing needs is warranted. In particular, study finding concerning Prince Albert, Murraysburg and Citrusdal hospitals that are observed to be outliers in terms of bed population ratios strengthens this view. It is noteworthy too that Murraysburg and Prince Albert hospitals are located in the same health district (district 5 in Southern Cape/Karoo region). As analysis using Pabon- Lasso technique (Figure 10) revealed, most of the efficient hospitals also have bed population ratios that are below the HSP affordable norm.

It is tempting to suggest that the wide geographical distances and difficult terrain between towns in the Southern Cape / Karoo region would be contributing to study observations for towns such as Murraysburg that is located at a distant end of the Western Cape province. However this explanation does not appear adequate to account for the relative over supply of beds observed for district hospitals. Rather, inefficiencies appear to be prevailing in the demand-supply situation in these towns. While it is to be acknowledged that residents in these communities are entitled to equal access for hospital care to ensure vertical equity, logistical technicalities for maintaining community health through provision of a range of services need to be explored to pacify the affected districts.

The definition of equity as 'equal resources per capita' that underpins interpretation of results from analysis in this study, takes no account of the needs, socio-economic status, or rural-urban characteristics of the communities, hospitals or regions that have been studied. To do so would have required much more time and resources and was not possible, given urgent pressure from PAWC for a policy decision supported by the research work presented here. Also, focusing on hospital resource use and activity alone should not be the sole objective in policy considerations as the epidemiological profiles of the communities should be equally important in formulating policy. Such analysis could be done for hospitals and districts that have been highlighted to be inefficient outliers and is invaluable in understanding common determinants of hospital usage and the actual population needs as opposed to wants for hospital-based care.

Study findings show that some health districts with regional hospitals have inadequate numbers of district level beds (Table 7). This has important policy implications for planning of an equitable distribution of district level acute care hospital beds in the non- metropolitan regions of PAWC.

Residents in affected districts are bound to experience difficulties with obtaining care if the regional hospitals operated optimally at the required secondary level of care. Also, there are financial and other problems associated with providing lower levels of care at secondary hospitals as several South Africa studies have shown.^{18, 37,38,39,40} Managers at PAWC should now consider re-designating and staffing some beds at regional hospitals as though these provide district level hospital care, resulting in tiered levels of care at regional hospitals. This approach would be compatible with efficiency gains that could translate to monetary savings and lead to attainment of equity. Decisions to reallocate beds should be guided by the variance in current supply from expected for each hospital, district and region (based on the HSP norm) presented in Table 8.

From study findings, the proportion of cross border flow of patients to district hospitals from other districts is between 1 to 9% for district hospitals, and may be up to 21% for regional hospitals. This information has implications for planning, in terms of funding of hospitals in a manner that captures more accurately, the movement of patients across districts and regions. This particular finding helps to fill some of the gaps in knowledge concerning performance of district hospitals in South Africa identified by the HSP.

5.2 Performance of Non Metropolitan Acute Care Hospitals.

5.2.1 Hospital efficiency measured from single performance indicators.

Whereas study results show BOR for most of the non-metropolitan district hospitals to appear high, the mean occupancy (66.7%) is observed to be lower than expected, in comparison to the HSP norm (70%). This could be indicative of existing scope for improving performance and productive capacities of several of the district hospitals evaluated.

Most of the non-metropolitan hospitals according to ALOS criteria could be regarded as efficient, relative to HSP norm for rural district hospitals (4-6 days). Majority of the hospitals with ALOS higher than the average, are from the Southern Cape Karoo region. Contributing to this observation may be a tendency by the medical doctors in this region to admit patients for longer hospital stays because of wide geographical dispersion of towns. Although this seems unlikely from our experience, the possibility of this occurring could not be evaluated in this study. An alternative explanation could be that it is the excess supply of beds that makes clinicians more

inclined to keep patients for longer, a situation that may promote inefficiency in these hospitals. It also seems plausible that constraints on hospital bed availability may influence behaviour of doctors leading to reduction in observed ALOS, so spuriously increasing efficiency. It is then suggested on the basis of this finding that PAWC chooses from amongst the affected hospitals in this region a model facility for testing these hypothesis further. Increases in BOR that arise from the increased ALOS may lead to unnecessary prolonged stay of patients in hospitals, a situation that is not desirable with its attendant opportunity cost. Further, while increases in ALOS may reduce hospital unit cost (reflected in cost per patient day equivalent), it would actually push up the costs per admission. The Boland / Overberg region, noted to have the lowest beds to population ratio, also has the most hospitals with shorter ALOS when compared to other non-metropolitan regions. This finding supports our view that lower number of hospital beds in this region in relation to the population size and utilisation needs, may influence doctors to keep patients for shorter periods per admission episode and promote efficiency. Again this could not be evaluated in this study.

The average (median =60) TOR for the non-metropolitan hospitals of PAWC is observed to be higher than those obtained by the HSP for South Africa hospitals (32 to 58). This may be indicative that the productive capacities of acute care hospitals of the non-metropolitan regions appear to be higher, in relation to the South African average.

Discussions' concerning the usefulness of single indicators to compare performance above shows how they provide different categorisations of efficient hospitals depending on which indicator is chosen. It is emphasised herein that the use of single indicators to reflect hospital productivity and thus performance or efficiency, might lead to erroneous conclusions that are misleading. Such problems are encountered with the use of bed occupancy rate, ALOS or turnover rate as individual stand-alone indicators of hospital efficiency. Therefore in evaluating hospital performance, techniques that simultaneously incorporate many indicators of performance such as Pabon Lasso are preferable, ⁶ as they would produce better comparisons and eliminate the difficulties associated with choosing a particular indicator to best characterise hospital productivity for efficiency comparisons and policy action.

5.3 Pabon Lasso analysis of Hospital efficiency in the non metropolitan regions.

Results from Pabon Lasso technique applied to PAWC non-metropolitan acute care hospitals reveal that only eight out of the 25 hospitals are in desirable 'efficient' zone 4, which are hospitals that are characterised by a high TOR, high BOR and relatively shorter ALOS. When the midpoints of HSP norms for BOR (75%) and TOR (45) are applied to the non-metropolitan district hospitals, only 4 of the 25 hospitals would be classified as efficient by this revised analysis.

Three hospitals (Ceres, Vredenburg and Beaufort West) with BOR above the HSP norm and the four hospitals (Uniondale, Murraysburg, Citrusdal and Caledon) with BOR's that are below 50%, would benefit from a detailed closer evaluation of the prevailing bed supply and efficiency situation occurring in these.

Ceres and Vredenburg are characterised by having very low supply of bed per 1000 population and a high BOR. Beaufort West is noted to be an outlier and is characterised by having a relatively high bed to population ratio coexistent with a raised BOR. While explanations for this finding are not immediately obvious to the researchers, they may relate to geographical dispersion of residents in the drainage communities and also the possibility that this hospital is providing a slightly higher level of care than it is designed for

For hospital towns that span wide geographical dispersion areas but are found to have a higher than expected bed population supply (such as Prince Albert, Murraysburg and Clanwilliam), mobile health centres and clinics could be established to provide health care to the dispersed population. Additionally, ambulance services may be reconfigured to provide for emergency transportation of patients if hospitals are downgraded in new policies that aim to achieve bed reduction. The above findings indicate that redistribution of some of the available beds in the non-metropolitan regions would promote efficiency in several hospitals and could also promote equitable access for other communities with inadequate bed supply. However, any decisions on bed reduction for non-metropolitan hospitals of PAWC, should be guided by consideration of the total number of available acute care beds for each district, and should take into account the regional peculiarities, epidemiological profiles, and performance of each hospital.

The study findings using this technique therefore have implications for the methodology used for comparing performance across several hospitals. A cautionary note could be sounded to policy

makers at PAWC and elsewhere in South Africa to be careful when using single indicators to measure hospital performance.

However, in interpreting the relationship between ALOS and BOR for the non-metropolitan district hospitals, caution is needed because longer lengths of stay may lead to inappropriately higher bed occupancy.^{6, 26,27} This may inevitably result in higher cost per admission with inefficiencies translating through inappropriate patient days.^{6,68,84} Consistently, study results have shown hospitals with the lowest BOR to be located in districts with the highest beds per population ratios, suggesting the existence of inefficiencies involving oversupply of beds.

5.4 Hospital costs and potential savings.

Hospital costs are observed to increase with bed numbers. As study findings reveal, the optimal number of bed capacity is between 65 and 120 for PAWC hospitals. The cost curve highlights that economies of scale may be gained in the short run for the small hospitals whereas larger hospitals may experience diseconomies of scale with increases in bed numbers and a return to scale with reduction in bed numbers in under performing hospitals. The shape of the curve conforms to that expected.⁷¹

It appears that improved performance of district hospitals are to be expected with hospital bed capacities around 65 to 120. As the bed capacity increases, there is a resultant gain in economies of scale until an optimum level is reached, beyond which diseconomies of scale begin to emerge with increasing bed numbers. Given that personnel expenditure consume over 50 % of hospital running cost, it would appear logical to assert here that increases in the number of hospital beds would attract increased requirements for more technical staff such as doctors, nurses and other health team members. All of these, attract a high salary cost to be factored in when policy decisions to increase capacities to achieve improved performance is taken.

Drawing from the findings above, it could be suggested for PAWC to consider different operational strategies for bringing about improved efficiency and savings on all affected categories of acute care hospitals, small or large. For smaller hospitals, options such as mergers, downgrades to community centres or outright closures would be more appropriate in order to gain efficiencies of scale in the short run, given budgetary constraints faced by PAWC. However, choosing this approach could draw civil and political backlashes with negative comments from critics, including orchestrated community outcry against policy makers. It is not uncommon for

residents from communities in which hospital downgrades (to community health centres) occur to complain about consequent unequal access to hospitals (in terms of vertical equity), and associated staff relocation cost for staff that remains in a hospital set-up. Given the expected community outcry against policy decisions that result in resource re-allocation, non-threatening approaches to achieving efficiency and equity gains could be adopted with implementation of necessary changes conducted in a slow and graduated manner. This would allay community fears while ensuring that the availability of adequate additional support services are put in place.⁶ These may include ambulance services, mobile clinics and referral networks. By involvement of community leaders in participatory decision-making process concerning the affected hospitals, confrontation and resistance could be avoided or minimised. However, techniques of negotiation, including principles of change management are invaluable management skills required by PAWC management to steer all aspects of the interventions to achieve improved performance of the non-metropolitan district hospitals.

For larger hospitals the favoured policy approach would be bed reduction strategies. Any targeted interventions would have to be applied in a hospital-specific manner taking into account the current performance of the respective hospitals.

Less than 10% of in patients at district hospitals are from neighbouring and other districts/regions a finding that has important implications for funding hospitals and understanding utilisations across hospital boundaries.

Important limitations that should be considered when interpretations of results from this study are made are presented below.

The number of district hospitals studied (25) is relatively small, but given the time span allowed for the research due to constraints posed by urgent policy decision needed by PAWC managers, the analysis appear to be reflective of the prevailing situation of district hospitals in the Western Cape Province. The study estimated hospital drainage population using a methodology, which assumes that neighbouring provinces may utilise health services in adjacent towns of the Western Cape Province, but this does not appear to be the case for district hospitals. Some of GIS analytic aspects of the study could not be completed due to the technical problems encountered. As the estimation of cross border flow of patients across districts to use hospitals in the Boland region indicates, stating that district hospitals may receive at least 10% of patients from cross border flow may be an overstatement for the non metropolitan hospitals as this figure appears to be much lower. Provincial Aided Hospitals do not have Delta 9, hospital information systems installed and so may continue to be left out in studies of this nature unless fresh data is collected, and this could be very expensive to embark upon and time consuming too, hence this aspect of the study was limited to the Boland region.

Also there could be errors in calculations of population drainage for hospitals, districts and regions, which may have resulted from errors in the initially released results of the 1996 Census figures, and later was amended by Statistics South Africa with corrections that meant a lower population than initially reported for the Western Cape Province. This would not have affected the study significantly as the changes in the figures affected the non-metropolitan region populations only slightly.

The accuracy of study results is equally dependent on the accuracy of some of the sources of data used in the study. Guided by the referral patterns and choice of hospital towns obtained from documents referred to be the Strategic Management Team,¹¹ errors in the original data could similarly affected the study results. The study used several administrative databases as described in the Methodology section, these may contain unknown (unmeasured) errors, given that errors not uncommon from such sources of data a feature described in similar studies.²² The study results

concerning cross border flow estimates and errors in postal code entries is exemplary of such errors, though an easily detectable one. However the influence of this would not be large because great efforts were made by the researchers to validate most of the data obtained with the respective hospitals, health facility and regional management, as well as relevant directorates at PAWC as practically possible.

In making resource re-allocation decisions, it must be recognised that a community's need for hospital services may not be captured totally from routinely collected administrative data. Assessment of the epidemiological profiles of communities identified to be over-resourced would be warranted, as these could contribute very valuable information (disease burden and health needs) that may impact on, or be impacted upon by decisions on resource re-allocation. This is of additional importance considering that the study did could not find case mix variables to be used for improvement of the estimates. It was not possible to obtain information on patient waiting times and number of patient turned away at hospitals, which recorded high BOR and TOR. In the absence of these important quality indicators currently in all the hospitals, cautious interpretation should be given to the efficiency gain anticipated from hospitals with very high BOR and TOR.

Other factors that could affect the results obtained are the influence of confounders such as managerial styles and staff attitude at the hospitals, which can also affect efficiency but were not evaluated in the study. Further, models are not always able to capture all relevant predictors and the limitation placed by the large but relatively small (for analytical purpose) number of hospitals studied and time frame allowed by PAWC, hampered collection of additional variables, which may have improved the quality of study results obtained.

Cost curves and regressions analysis also have their limitations (see Chapter 2; literature review). The number and characteristics of variables that could be chosen may equally affect the results from this. There is no agreement on the particular variables to include in such regression equations in the literature. ^{6, 26,27,68,84}

Finally, associations do not imply causation; therefore although various factors have been associated with efficient performance of hospitals from the findings of this study, the associations do not necessary translate to an assertion of cause- effect relationship. Nevertheless, the findings have important uses for influencing policy directions concerning efficiency in non-metropolitan district hospitals in the Western Cape Province.

Chapter 7. Policy Implications, Recommendations and Conclusion.

On the basis of the findings of this study, the following policy implications are drawn, with recommendations for change and further research suggested.

1. There is inequality in the geographical distribution of hospital beds in the non-metropolitan regions of the Western Cape Province. This indicates the need for a policy action by PAWC managers to redress the inequality. In effecting this change, however, caution must be exercised, by ensuring that factors such as population densities, 'ruralness', and epidemiological disease profile of communities with poorly performing hospitals are investigated. Change management principles, communication techniques and negotiation skills should be deployed to seek a positive realisation of the objectives through creation of more positive attitudes to change.
2. Several small sized district hospitals in the non-metropolitan region of PAWC can benefit from improvement in economies of scale by increasing the number of available beds. Given that it may not be logical to increase beds in many of these hospitals in the face of a low utilisation (partly due to excess bed capacities), potential exists to gain considerably in economies of scale by merging these small hospitals into larger units. Alternative mechanisms for improving hospital performance through public- private mix agreements should be explored by PAWC where options of hospital mergers are not feasible due to political and other considerations.
3. Large capacity hospitals having more beds with raised ALOS indicating low performance is worrying as cost per admission increases for such hospitals. Therefore, targeted policy actions aimed at bed reduction by PAWC would have the potential to lead to reduced length of stay and translate to savings.
4. Emanating from limitations of the study, it is recommended that PAWC consider including in its routinely collected data for hospitals the following i) statistics on waiting lists at the hospitals and ii) number of patients turned away. These indicators are also suggested for use in monitoring hospital performance by the HSP and could be used in similar studies carried out in the future, as indicators of community bed needs to be factored into the overall bed plan for the Province.

5. Inefficiency is strongly evident in the supply of beds for the non-metropolitan acute care district hospitals (17 out of 25 classified as such using a Pabon technique). Hospitals classified as inefficient using this technique are observed to appear more costly overall (Table 11). Comparing performance using the method allows more intelligible interpretation of performance across hospitals to be made. PAWC managers should therefore consider adopting the use of Pabon Lasso technique for evaluating efficiencies across hospitals in the Province henceforth, given that interpretations obtained from use of single indicators (as is currently the practice) could be misleading.
6. Hospital planning should take into account cross- border population flows of patients. The population proportions that could be added to estimated drainage populations' ranges from 1 to 9% of the district population, for district hospitals and up to 20% for Regional level hospitals. This finding fills some of the missing gaps in knowledge concerning cross border flow for South African hospitals identified by the HSP. It is also recommended, that on the basis of errors found in the Delta 9 hospital information system printouts, PAWC should develop a continuous process of retraining data entry Clerks across hospitals. Such training would improve the accuracy of the data and improve their utility for monitoring cross border flow on a regular basis, as the software allows data from several hospitals to be analysed together after appropriate transformations. Provincial Aided hospitals should be supported (financially and with logistically) to consider installing Delta 9 computer program at the hospitals so that better comprehensive analysis of cross border flow could be obtained for the Province.
7. It is recommended for PAWC to consider re-designation of some regional hospital beds as district hospital to improve equitable distribution of district level care, as study finding show that some districts have no designated beds. Suggestions for layering of beds in hospitals are not uncommon in South Africa and have been suggested elsewhere before.⁴⁰
8. Further research concerning the effects of case mix, community disease profiles and managerial styles for hospitals in the Western Cape Province is recommended as this would help fill missing gaps identified in this study.

This study has evaluated efficiency and distribution of acute care beds in non-metropolitan regions of the Western Cape and the results obtained suggest that there is ample scope to improve hospital efficiency and reduce costs associated with beds and services.

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APPENDIX 1.

Table showing all the hospitals in the non-metropolitan regions in terms of inclusion and exclusion status.

HOSPITAL	REGION	TYPE	OWNER	INCLUSION STATUS
Ceres	Boland/Overberg	District -A [#]	PAWC	Yes
Robertson	Boland/ Overberg	District -A	PAWC	Yes
Montagu	Boland/ Overberg	District -A	PAWC	Yes
Hermanus	Boland/ Overberg	District -A	PAWC	Yes
Caledon	Boland/ Overberg	District -A	PAWC	Yes
Bredasdorp (Otto	Boland/ Overberg	District -A	PAWC	Yes
Swellendam	Boland/ Overberg	District -A	PAWC	Yes
Mosselbay	South Cape/Karoo	District -A	PAWC	Yes
Riversdale	South Cape/Karoo	District -A	PAWC	Yes
Knysna	South Cape/Karoo	District -A	PAWC	Yes
Ladismith	South Cape/Karoo	District -A	PAWC	Yes
Uniondale	South Cape/Karoo	District -A	PROV-AIDED	Yes
Oudsthoorn	South Cape/Karoo	District -A	PAWC	Yes
Murraysburg	South Cape/Karoo	District -A	PROV-AIDED	Yes
Beaufort West	South Cape/Karoo	District -A	PAWC	Yes
Laingsburg	South Cape/Karoo	District -A	PROV-AIDED	Yes
Prince Albert	South Cape/Karoo	District -A	PROV-AIDED	Yes
Stellenbosch	West Coast/ Winelands	District -A	PAWC	Yes
Piketberg (Radie Kotze)	West Coast/ Winelands	District -A	PROV-AIDED	Yes
Lapa Munik (Porterville)	West Coast/ Winelands	District -A	PAWC	Yes
Swartland	West Coast/ Winelands	District -A	PAWC	Yes
Vredenburg	West Coast/ Winelands	District -A	PAWC	Yes
Vredendal	West Coast/ Winelands	District -A	PAWC	Yes
Clanwilliam	West Coast/ Winelands	District -A	PROV-AIDED	Yes
Citrusdal	West Coast/ Winelands	District -A	PAWC	Yes
Eben donges	Boland/Overberg	Regional-A	PAWC	Yes- Partially
George	South Cape/Karoo	Regional-A	PAWC	Yes- Partially
Paarl	West Coast/ Winelands	Regional-A	PAWC	Yes- Partially
Brewelskloof	Boland/Overberg	Chronic -TB [§]	PAWC	Excluded
Regina clinic	Boland/Overberg	Chronic	PROV-AIDED	Excluded
Harry Comay	South Cape/Karoo	Chronic- TB	PAWC	Excluded
Nelspoort	South Cape/Karoo	Chronic - TB,M [§]	PAWC	Excluded
Die Wieg	West Coast/ Winelands	Chronic/ Special	PROV-AIDED	Excluded

A[#] Acute care

M[§] Mental health

TB[§] Tuberculosis

1 South Cape / Karoo

Census population estimates were taken from 1991 estimates for magisterial districts.

1.1 Beaufort West

CSS: Beaufort West(31726) , Murraysburg(5960) with Victoria West and Fraserburg (Northern Cape) added to its drainage area. We had used 10% of the CSS estimates for Fraserburg (4367) and Victoria West (11910) populations-Total of 1628.

SMT estimates summarized Beaufort west (33000), Leeu Gamka (1700), Merweville(1550), Nelspoort (1000) .

1.2 Prince Albert

CSS: As for Prince Albert in CSS

SMT: Added Prince Albert (8400) to Klaarstroom(250) and Prince Albert road (100)

1.3 Lainsburg

CSS: Used CSS estimate.

SMT: Added Matjiesfontein (250), Vleiland. (650)

1 4 Uniondale

Used CSS and SMT direct estimates. No additions or subtractions.

1.5 Oudtshoorn

CSS: Used Oudtshoorn (68093) and Calitzdorp (6759).

SMT: Added Oudtshoorn (65600), Calitzdorp (6800), De Rust (5700), Dysseidorp (15000).

1 .6 Knysna

CSS: Used Knysna estimate direct (54220)

SMT: Included Sedgfield (8000), Rheenendal(4100), Knysna(40000), Kranshoek(3010), Plettenberg Bay(30000), Crag(6150), Wittedrif (550).

1 .7 Ladismith

CSS: Ladismith direct (12705)

SMT: Ladismith (9900) and Van Wyksdorp(1050)

1 .8 Mossel Bay

CSS: Mossel Bay direct(59170)

SMT: Mossel Bay(45500), Brandwacht(1000), Hartenbos(2500 but more with tourist influx), Buisplaas(250), Gonnakraal(1250), Herbertsdale(3000).

1 .9 Riversdale

CSS: Direct estimate(25021) plus Heidelberg (11519)

SMT: Riversdale(28000), Albertina (3000), Heidelberg(11200), Slangrivier(2500), Stillbaai (3000 tourist influx)

1. 10 George

CSS: Direct estimate (95597)

SMT: George (95000) plus Avontuur(unavailable), Harlem(5000), Noll(2000), Hoekwil(1200, Kleinkrantz(600), Pacaltsdorp(18500), Touwswanten(500), Wilderness(2200), Great Brak Rivier(8500 with increase from tourist).

2. Boland / Overberg

2. 1 Bredasdorp

CSS: Direct estimate(23076)

SMT: Napier(2250) plus Bredasdorp(21950), Arniston(800), Elim(1150) and Struisbaai(1700).

2.2 Caledon

CSS: CSS estimate for all Caledon (79052) MINUS Grabouw (34600 from SMT / estimate) and Bot River (2300 from SMT estimate), (leaves 42152) - the proportion of the balance for Caledon = proportion of total for Caledon(14900/34600) and Villiersdorp (19700/34600) from SMT documents.

Assumptions- Used SMT estimates Villiersdorp 19700 and Caledon 14900 with Population ratio Villiersdorp = $19700/34600 = 0.569$ and Caledon = $14900/34600 = 0.431$). Applied this to CSS estimate of 42152}.

SMT: Caledon(8000) plus Genadendal(3900), Greyton(700) and Riviersonderend-2300 (Total14900). Bot River(3300) and Grabouw(34600) go to Somerset West.

2.3 Villiersdorp

CSS: See above - prorata of CSS estimate for Caledon (less Grabouw-34600 and Bot River-2300) based on SMT proportions.

SMT: Villiersdorp alone-19700.

2.4 Hermanus

CSS: Direct CSS estimate(21610)

SMT: Hermanus (24500 but more during tourist influx) plus Gans Bay(5000), Hawston(4650), Kleinmond(3220), Onrus(800), Stanford(3860).

2.5 Ceres

CSS: Ceres and 2/3 of Tulbach (1/3 went to W Coast as Saron, Gouda drain to Lapa Munik) on CSS estimates

SMT: Ceres plus Prince Alfred's Hamlet(2040), Wolseley(4600) and Tulbach 16500.

(Gouda drain in west Coast with Lapa Munik and also Saron drain in West Coast with Lapa Munik)

2.6 Montagu

CSS: direct- 21674
SMT: direct(14550)

2.7 Robertson

CSS: Direct - 32331
SMT: Robertson(30650), Bonnievale(8750), Ashton(28500), McGregor(1550), Nkqubela(1800)

2.8 Swellendam

CSS: Direct CSS , Swellendam(32147) Less Barrydale (SMT -5350) = 26797
SMT: Swellendam(14700), Suurbraak-1700 (Barrydale allocated to Worcester; Heidelberg allocated to S Cape Region!)

2.9 Worcester

CSS: Direct, Worcester(117159) plus Barrydale (5350) = 122509
SMT: Worcester(119,800) plus Barrydale(5350), De Doorns(10850), Rawsonville(7610), Touwsriver(6750).

3. West Coast / Winelands

3.1 Porterville

CSS: One third of the Tulbach district (Saron pop) plus prorata (6/27) of the Piketberg district (8445+7590). This is based on population of Porterville $SMT_{Population} = 6050$ divided by Porterville plus Piketberg plus others in SMT = 27100 .{Gouda +Saron not counted in the denominator because they are different CSS districts} Hence a proportion of 6/27.
SMT: Porterville(6050) plus Saron(3650) and Gouda(1500).

3.2 Piketberg

CSS: Prorata of Piketberg district (26562 of 34152 being 21/27 of the district population).
SMT: Goedverwacht(2000), Elands Bay(1200), Aurora(1760), Piketberg(15120), Redelinghuys (220) and Wittewater(750).
(Elands Bay should be out of the Clanwilliam CSS district). Note also that lots of areas in Piketberg CSS district drain elsewhere (see below - Dwarskersbos, Veldrif, Eendekuil).

3.3 Malmesbury

CSS: Malmesbury and Moreesburg, but excluding Atlantis (53 200), Melkbos (5140), Darling (6750) and Mamre (5400) all data from SMT docs.
SMT: Abbotsdale(1600), Malmesbury(16200), Moreesburg(11050), Riebeeck Kasteel(2300) and Riebeeck West(2600), Kalbaskraal (720), Hermon (Unspecified).

3.4 Vredenburg

CSS: Vredenburg and Hopefield

SMT: Vredenburg(43000), St Helena Bay(4800), Dwarskersbos(210 , ex-CSS Piketberg Magisterial district), Veldrif (ex-CSS Piketberg Magisterial district), Hopefield(7400) and Langebaan-2000 (both Hopefield Magisterial CSS district), Paternoster(800 , increased with tourist influx).

3.5 Clanwilliam

CSS: Prorata of Clanwilliam district . Seventy four percent (74.1%) based on Regional directors estimate of municipal population: Citrusdal = 3224, Clanwilliam=5434, Lambertsbay =3778 with total =12436 (Population of Clanwilliam = 9212/12436. This was applied to CSS total of 28144 hence approximates to $0.741 * 28144 = 20847$

SMT: Derived by applying CSS estimate for clanwilliam(20847) as numerator and CSS estimate of population [Vrendendal Magisterial district plus Clanwilliam magisterial district] as denominator and then this population applied to SMT global population estimate {See Provincial Health plan} for population of Clanwilliam + Vrendendal+ VanRhynsdorp(69000) to derive SMT estimate for Clanwilliam.

3.6 Citrusdal

CSS: Prorata of Clanwilliam district(26 % based on same $0.259 * 28144 = 7927$).

SMT: Derived by applying CSS estimate for clanwilliam(20847) as numerator and CSS estimate of population [for Vrendendal Magisterial district plus Clanwilliam magisterial district] as denominator and then this population applied to SMT global population estimate {See Provincial Health plan} for population of clanwilliam + Vrendendal+ VanRhynsdorp(69000) to derive SMT estimate for Citrusdal. Include Eendekuil 600(ex-Piketberg magisterial district).

3.7 Paarl

CSS: Paarl and Wellington

SMT: Paarl(100,000), Wellington(30240) and Franschoek(10330)

3.8 Stellenbosch

CSS: Stellenbosch

SMT: Stellenbosch(98500)

3.9 Vrendendal

CSS: Vrendendal(28962) + Van Rhynsdorp(12815) with total = 41777

SMT: Derived by applying CSS estimate for clanwilliam(20847) as numerator and CSS estimate of population [for Vrendendal Magisterial district plus Clanwilliam magisterial district] as denominator and then this population applied to SMT global population estimate {See Provincial Health plan} for population of clanwilliam + Vrendendal+ VanRhynsdorp(69000) to derive SMT estimate for Vrendendal.

Appendix 3. Example of raw data printout from delta 9 hospital information system for a hospital

VER:140
OPR:

CERES HOSPITAAL

OPSOMMING VAN BESOEKE VOLGENS AREA
=====

25/07/1997
09:36:49

01/05/1997 --> 31/05/1997

Area Description	Outpatient			Inpatient			Casualty			T O T A L		
	New	Rep	Tot	New	Rep	Tot	New	Rep	Tot	New	Rep	Tot
-----	---	---	---	---	---	---	---	---	---	---	---	---
H1												

1449	1		1							1		1
6529	1		1							1		1
6812	1		1	1		1				2		2
6820	3	1	4	9	1	10				12	2	14
6821	1		1	3		3				4		4
6830	8	1	9	18	5	23				26	6	32
6835	251	143	394	122	95	217	23	5	28	396	243	639
6836	63	36	99	45	32	77	4		4	112	68	180
6837	7		7		1	1				7	1	8
6840	37	30	67	28	20	48	4	2	6	69	52	121
6875	2		2							2		2
6880	1		1							1		1
7100	1		1							1		1
7160	2		2							2		2
7234	1		1							1		1
7310	2		2							2		2
7480	1		1							1		1
7569				1		1				1		1
7570				1		1				1		1
7600	1		1							1		1
7764	1	1	2							1	1	2
7785	1		1							1		1
8290	1		1							1		1
8801	1		1							1		1
8870	1		1							1		1
UNKN	4		4		1	1	1	1	2	5	2	7
H2												

6840				1		1				1		1
HCF												

6820				2		2				2		2
6830				7	1	8				7	1	8
6835	25	19	44	41	16	57	2	1	3	68	36	104
6836	6	4	10	12	6	18				18	10	28
6840	3	7	10	4	8	12	1		1	8	15	23
7785	1		1							1		1
8190	1		1							1		1
PRI												

6835					1	1					1	1
6837				1		1				1		1
6840		1	1	3		3				3	1	4
-----	---	---	---	---	---	---	---	---	---	---	---	---
Total :	429	243	672	299	187	486	35	9	44	763	439	1202
=====	===	===	===	===	===	===	===	===	===	===	===	===

*Represents unknown, missing or incorrectly entered postal codes.

Appendix 4. Example of aggregated postal code related utilisation by hospital and for all attendance types (inpatient, outpatient and emergency) applied to the Boland region

Sum of intTotalAll	strHospitalName							
strPostalCode	Bredasdorp	Caledon	Ceres	Hermanus	Montagu	Swellendam	Worcester	Grand Total
0			4	7	74	7	27	253
1			1				1	2
9						1		1
153							1	1
157	1							1
1097							1	1
1449				1	1			2
1459						2		18
1501					1			1
2000						1		1
2001	1							1
2158								2
2196					1			1
2400						1		1
3325							1	1
3370							2	2
5247	1							1
5643			1					1
6025	1					2		3
6050								2
6070					10			10
6410								1
6529	3		1	1		1		6
6530							1	3
6603					1			1
6620	1							1
6650						1		1
6655								2
6660								1
6665							14	14
6666							1	1
6670							3	3
6674							1	1
6685								1
6690								3
6700								5
6705						3		151
6707						1		1
6708						1		20
6715						203	1	60
6720						463	1	51
6730			1			82	10	124
6740	3		10				711	39
6741							3	3
6742			2			1	118	1

6743					72	1	73
6750				15	52	20	87
6785						1	1
6812		2					2
6820	1	16	1	1		16	35
6821		4					4
6830		40				99	139
6835		744	2		1	100	847
6836		208				10	218
6837		9				1	10
6840		149				14	163
6845						386	386
6848	10				2	203	215
6849				1		18	19
6850				1		4694	4695
6852			1			409	410
6853						109	109
6854						124	124
6855						92	92
6856						72	72
6857						37	37
6858						92	92
6859						15	15
6860						4	4
6862						5	5
6870						126	126
6875		2				510	512
6876						1	1
6880		1	1	1		144	147
6885						6	6
6886						1	1
6900						16	16
6920						10	10
6940						1	1
6970			1			1	2
7100		1	2			1	4
7130			1				1
7139	1						1
7140					2		2
7141			3				3
7160	16	2	7	1	2	3	31
7170	2					35	37
7171						1	1
7180	3		1				4
7185	70		38				108
7195	18		32			1	51
7200	4		1641			3	1648
7201	2		141				143
7202			375				375
7203			27				27
7210	2	2	103				107
7220	1	10	103				114
7230	1	439	10			2	452
7232		11					11
7233		43					43
7234		61	1	6			68

7250	1	91	2	2		96
7270	64	3	5			72
7271	1					1
7280	446	19	3	1	3	472
7281	13			2		15
7283	10				2	12
7284	21	2				23
7285	44	2			1	47
7287	5					5
7299					1	1
7310	1		2			3
7320					2	2
7340					2	2
7349					3	3
7355					3	3
7406					1	1
7430			1			1
7435					1	1
7475				1		1
7480			1		1	2
7490	1	1	2	1	2	7
7499				1		1
7500					1	1
7506					2	2
7507			1			1
7530			1		2	3
7535			2			2
7550		1		2		3
7551				1		1
7560					1	1
7561					2	2
7569			1	1		2
7570			1	4	4	9
7580					2	2
7581					1	1
7599			1	1		2
7600	1		1	1		3
7602					2	2
7620					1	1
7645		2				2
7646			1		2	3
7655	1					1
7690		1				1
7700	1		2	1		4
7750			1			1
7764			2	1		3
7779		1				1
7780					3	3
7785	1	4	2	1		8
7788		1				1
7789					2	2
7800	2		1			3
7888					1	1
7925			2		1	3
7945			3		1	4
7965					1	1

8000				1				1
8001	1			1			1	3
8040				1				1
8060							1	1
8135							1	1
8160						1		1
8190			1				2	3
8240		1						1
8290			1					1
8655				1				1
8801		1	1					2
8870			1					1
9301							9	9
9795							3	3
Grand Total	629	843	1202	2623	798	1038	8186	15319

University of Cape Town

Appendix 5. Result from calculated cross border flow in the Boland region using inpatient data from Delta 9 system referenced by postal code as proxy for residence

Hospital	Attendance to Hospitals							
	Own District	Other Districts in same region	West coast	South Cape	Metropole	Gauteng	Northern cape	Estern cape
	%							
Bredasdorp	98.8		1			1		
Caledon	97.5		2	6				
Ceres	99.3		3			1		
Hermanus	93.2	1						1
Montagu	96.5	1	2		1	2		
Swellendam	91.1	11		13			1	1
Worcester	77.7	201	6	11	7	8		

Note:

There were some postal code error entry for all the hospitals in terms of 1 to 3 digit postal codes instead of 4 and also O (text) in place of 0(zero) which varied from 0.2 - 3.2% of the total attendances.

**A METHODOLOGY FOR ASSESSING HOSPITAL DRAINAGE,
EFFICIENCY AND BED PLANNING**

Authors: Onwuchekwa U, London L, Department of Public Health, University of Cape Town, Observatory 7925, South Africa.

Introduction:

Re-organisation of hospitals services in South Africa places emphasis on the improvement of efficiency, equity of access and effectiveness amongst other key indicators. Hospital expenditure accounts for a significant proportion of the health care expenditure worldwide. This paper will describe a study reviewing methodological issues and applicability of proposed indicators and norms from the Hospital Strategy Project in South Africa as a managerial tool for hospital efficiency and bed planning for regional and district hospitals in the Western Cape Province of South Africa.

Materials and Methods:

The study utilises a cross sectional design. All twenty-six non-metropolitan hospitals (Regional and district level) in three of the four health regions of the Western Cape Province of South Africa were evaluated. Efficiency and quality indicators were obtained to record the utility of the indicators as managerial tools for hospital drainage estimation, bed planning and restructuring. A methodology integrating the use of administrative databases (personnel, utilization and expenditure), population and geographical information systems will be described.

Results:

Hospital drainage population, quality and performance indicators will be presented with limitations to their use discussed. Observed variations in district and regional bed provision will be highlighted. Results of sensitivity analysis, influence of level of care classification and challenges posed by policy implications of choices between optimal versus resource dependent affordable norms will be discussed.

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Appendix 7: Reference for baseline and derived activity and performance indicators

hospital	health dist	hospital code	beds	bed occupcy	alos	bed/1000p	Number of nurses	nurs:bed	staf_bed	FTE Doctors	FTE bed	Doctor: admission	dischrg	normal:Complic ated obstetric delivery	Surgery <30>30 minutes	expenditure	turnover rate	pde	costpde	Inpatday
Prince Albert	5	19	56	63.82	4.66	5.43	6	0.11	0.82	1	0.02	2816	2760	6.67	2.5	2309643	50	14282	162	13044
Hermanus	3	5	29	67.79	2.34	1.11	24	0.83	2.21	1.46	0.05	3167	3125	5.88	3.85	4656732	109	19163	243	7423
Laingsburg	5	18	22	61.94	3.79	3.16	4	0.18	1.09	1.04	0.05	1315	1283	12.5	2.33	1510900	60	6120	247	4974
Bredasdorp (Otto Duplessis)	4	7	48	51.04	3.84	1.73	16	0.33	1.13	1.2	0.03	2350	2251	3.33	0.89	4290096	49	18396	233	8943
Glanwilliam	5	27	66	75.4	5.55	2.63	14	0.21	0.84	0.71	0.01	3269	3211	7.69	2.04	3313073	50	21178	156	18163
Murraysburg	5	16	33	32.79	3.54	4.6	6	0.18	0.72	0.53	0.02	1114	1088	4.17	1.5	953882	34	4188	228	3950
Riversdale	1	10	75	71.01	5.52	1.71	45	0.6	1.63	1.57	0.02	3443	3425	4.35	3.7	7986808	46	25403	196	19440
Crusdal	5	28	46	49.01	3.1	5.24	10	0.22	0.98	1.03	0.02	2704	2608	5.9	2.78	2762902	59	8997	307	8229
Swellendam	4	8	65	61.73	3.16	2.02	17	0.26	1.03	1.04	0.02	4771	4695	4.76	1.92	4890127	73	18739	261	15097
Vredendal	5	26	84	59.51	3	1.67	28	0.33	1.21	1.12	0.01	6005	5919	3.23	1.92	6215509	71	32756	190	18247
Ladismith	4	13	35	72.02	3.18	2.29	24	0.69	1.37	1.34	0.04	2889	2827	2.56	2.27	3020979	83	10469	289	9201
Vredenburg	4	25	56	109.14	3.43	0.95	35	0.63	1.79	2.54	0.05	6517	6390	5.56	1.06	7172669	116	40327	178	22309
Lapa Munik (Porterville)	3	23	35	69.32	4.96	1.81	14	0.4	1.14	1.87	0.05	1795	1748	11.11	1.96	2304945	51	11147	207	8855
Mosel Bay	1	9	98	73.21	4.59	1.38	54	0.55	1.83	6.61	0.07	5347	5551	5	1.3	10786364	55	49566	118	26187
Knysna	3	12	117	67.69	4.11	1.79	57	0.49	1.91	8.83	0.08	7288	6857	3.85	0.93	16931377	62	57535	294	28907
Montagu	2	4	49	54.43	3.84	1.88	21	0.43	1.32	1.16	0.02	3089	3055	14.29	1.05	4171174	53	15139	276	12118
Uniondale	4	14	32	38.41	4.51	2.84	17	0.53	0.63	2	0.06	1006	968	9	2.22	1115986	31	5119	218	4536
Swartland	3	24	122	71.95	5.59	1.87	65	0.53	1.87	7.09	0.06	5718	5513	6.25	1.72	15617644	47	66926	233	31993
Ceres	1	1	66	100.58	3.13	0.86	35	0.53	1.33	1.35	0.02	6954	6926	3.23	2.22	6542335	105	27001	242	22027
Piketberg (Radie Kotze)	3	22	33	72.68	3.5	1.03	13	0.39	1.03	0.21	0.01	2498	2443	3.45	4	1900299	76	9502	200	8754
Robertson	2	3	66	60.98	3.18	1.7	26	0.39	1.17	1.48	0.02	4521	4416	6.67	3.7	5613175	69	33983	165	14467
Beaufort West	5	17	96	86.25	3.84	2.39	41	0.43	1.43	2.04	0.02	4806	4851	6.67	0.8	8745919	50	119236	73	19203
Oudsthoorn	4	15	159	70.62	4.11	1.76	80	0.5	1.83	5.7	0.04	10164	9664	4	0.89	23114258	64	69131	334	40984
Stellenbosch	1	20	95	77.95	3.61	1.07	91	0.96	2.76	9.05	0.1	7698	7593	4.76	3.7	17406444	81	98767	176	28166
Caledon	3	6	71	49.66	3.62	1.4	30	0.42	1.51	1.31	0.02	3586	3468	5.56	1.59	6552358	51	18315	358	12870

Appendix 8: Output of variance inflation factor test for multicollinearity

. vif

(vif is Variance inflation factor), a regression diagnostic statistic to test for multicollinearity.

Variable	VIF	1/VIF
beds	27.10	0.036894
bed2	25.26	0.039589
efficpl	1.97	0.508398
bedocy	1.93	0.519465
hownerp	1.43	0.700812
Mean VIF	11.54	

The above output gives test for multicollinearity between variables in the regression analysis (Table 11) that evaluates influences of efficiency indicators on hospital cost.