University of Southern Queensland

Faculty of Engineering and Surveying

Mapping the distribution of general practitioners and their billing pattern in the Toowoomba District.

A dissertation submitted by

Salem almenhali

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Abstract

General practitioners in the medical field are one of the most important services required for the treatment of different illnesses. However, due to the shortage of general practitioners in rural towns across Australia, a more even ratio of doctors to residents may ease the pressure on doctors as is the case in Toowoomba.

This project investigates the current state of the general practitioner distribution and population density in Toowoomba using GIS technology. A survey of the Toowoomba region provided information with respect to the location of the doctors, the population that each doctor, hypothetically would need to tend to, and the doctors' consultation charges. An analysis of the general practitioners' distribution considered spatially-related factors, including traffic density near the surgeries, transportation facilities, proximity to commercial centres and the population density surrounding the surgery, to explain the distribution of doctors in the Toowoomba region. Spatial proximity of general practitioners to the Central Business District (CBD), commercial centres, and the associated transportation facilities affect the distribution of patients per doctor, with the analysis providing evidence that patients are more likely to take advantage of the convenience of these services. Also, demographic activity was identified as a significant factor which impacted on the distribution of general practitioners. These significant factors have contributed to the issue of a shortage of doctors within the region, which may be alleviated with the application of GIS technology for the future planning of a more effective distribution of general practitioners within the population, taking into consideration the above factors that the general public value.

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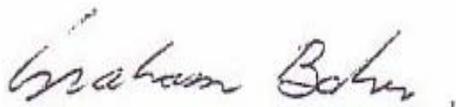
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SALEM ALMENHALI

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Glossary of Terms

Arc View

GIS software selected for use in this research.

Central Business District (CBD)

Certificate of Need (CON)

Environmental Systems Research Institute (ESRI)

fee payment

A fixed charge for a privilege or for professional services.

general practitioner (GP)

A physician whose practice is based on a broad understanding of all illnesses and who does not restrict his/her practice to any particular field of medicine.

geocoding

The process that assigns a latitude-longitude coordinate to an address. Once a latitude-longitude coordinate is assigned, the address can be displayed on a map or used in a spatial search (MapQuest.com, 2004).

Geographic Information System (GIS)

A computerized data management system used to capture, store, manage, retrieve, analyze, and display spatial information. The spatially related sets of data in a GIS are usually referred to as themes or data layers.

Medicare

A federal program that provides basic health care and limited long term care for retirees and certain disabled individuals without regard to income level. Beneficiaries must pay premiums, deductibles and coinsurance.

pensioners

People who receive a fund set up by the government as income for a person after retirement.

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CHAPTER 1

INTRODUCTION

1.1 Introduction to Project

Ninety-three general practitioners may seem like too many in one rural city, as is the case in Toowoomba. However, many Toowoomba surgeries have been unable to cope with the population, necessitating the refusal to provide services to some patients.

The services provided by general practitioners are not as efficient as they could be, due to the doctor shortage throughout the district and the resulting limited access to the GPs.

This particular topic has been chosen as the number of general practitioners in the medical industry throughout Toowoomba is lacking per head of population, when this issue could be addressed more efficiently. In recent years the medical field has undergone, and is continuing to undergo, major changes in the distribution of medical practices in Toowoomba. The reflection of the industry at the moment is showing that the ratio of doctors in comparison to the population is truly less than required as the city has expanded geographically without experiencing the equal dispersion of general practitioners over time.

Not only do the limited services have to address medical problems from the residents of Toowoomba, they have to also provide service to the smaller towns on the outskirts of the city, such as Charlton, which do not have medical services in that area.

Through the eyes of the public, doctors are the key to wellness. Everyone, at one stage of their lives, has been to visit a general practitioner, either accompanying a patient, or being a patient themselves. The scope of the treatments offered by general practitioners extends from curing common colds and administering immunisations to organizing X-rays and other medical scans.

During the course of a workday, general practitioners are required to give patients a minimum of 10 minutes of consultation (Department of Health and Ageing 2003). This limits the number of patients to six or less per hour, and during a working day between 8am and 6pm, 60 patients or less per day.

With the demand on Toowoomba's doctors being much larger than this, and including the population of the surrounding districts, all visitors to their medical practices are not being provided with the adequate medical attention that they need. To ease the demand on doctors in the Toowoomba district, this project will recommend the use of GIS technology to improve this health care situation, as presented in later sections of this project.

1.2 Scope of the Project

The significant increase in population has had extreme impact on the public increasing the competition between patients to see a doctor. Unable to cope with the demand, doctors have been forced to refuse and cut patient numbers. The scope of this project will thus cover the various ways in which GIS technology may be used to contribute to alleviating this problem and assisting in achieving a better distribution of doctors to service the population.

GIS technology has already started to be implemented by Mapping Health Care networks to supply information to patients such as Mapping Patient and Provider Locations, Finding the Closest Doctor, Finding the Right Doctor and Charging Patterns and Fees of various doctors. Doctors will also benefit with information at their fingertips on their patients locations (ESRI 1999).

Other information which will be given in the spatial system to contribute data using GIS technology is Geo-referencing Health Data. This data will help present the names of doctors on maps as well as their locations throughout Toowoomba. GIS has several useful applications. In this project, GIS technology is used in conjunction with the spatial data to create maps that review the names of doctors, their locations and distribution. In the long term, these maps can assist doctors with regards to the evaluation of their situated location and distribution throughout an area for fair ratio to the public. Toowoomba is a regional town which has grown immensely (which will be discussed in greater detail

in chapter 1.4) both economically and physically (refer to Figure 1.1) (Toowoomba Fact and Figures 2004). The population is rapidly increasing with more people moving into the city, as more opportunities and different circumstances arise.

While this is good for the town financially with the introduction of more cash flow into the region, other complications are starting to emerge. Toowoomba's growth has not seen the various services available to the public expand with the population.

Population Toowoomba
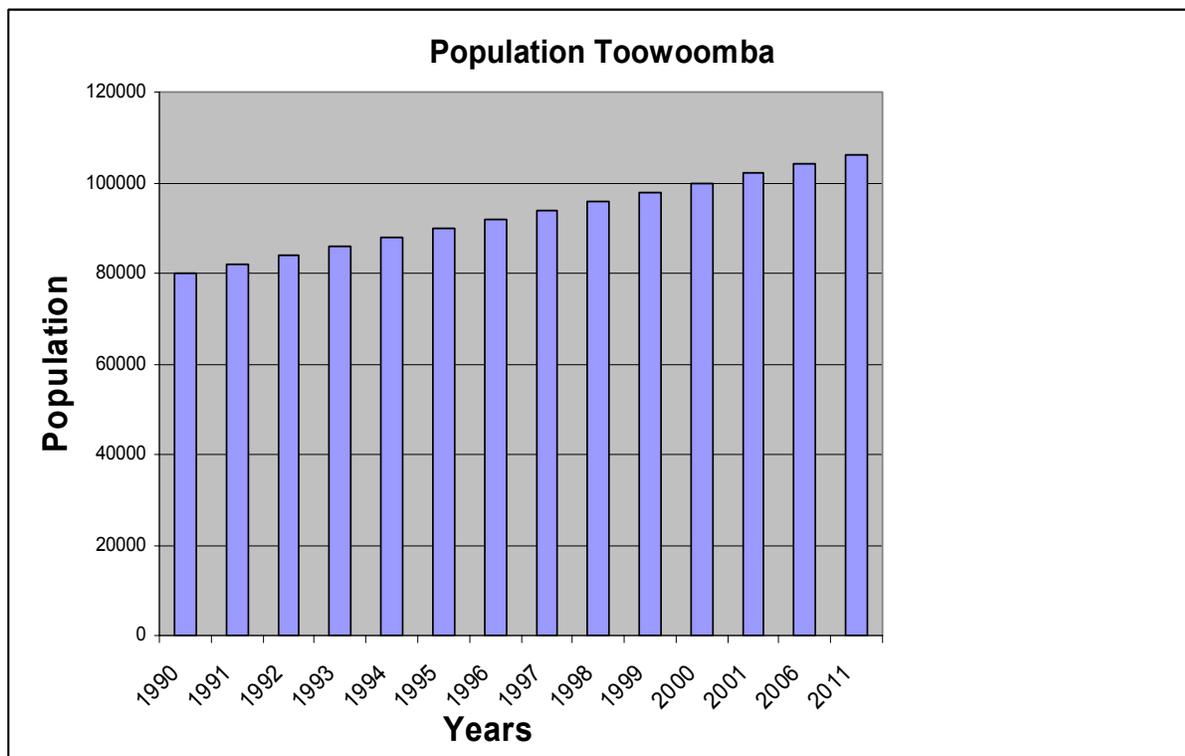
₁ Figure 1.1: Toowoomba Population Growth

(based on source: QRSIS and QLDGP projections (2004) cited in Toowoomba Facts and Figures 2004)

1.3 Objectives and Expected Outcomes

This projects aims to review the current spatial distribution, location and number of the general practitioners in the Toowoomba City. It will also examine whether the city provides a sufficient and fair number of general practitioners available to the public for medical services. The influencing factors contributing to the lack of doctors for the ratio of the population will be analysed and conclusions will be drawn upon the data analysis.

The specific objectives of this project are outlined as follows:

1. Research information about the distribution of doctors in Toowoomba, concentrating on their charging scheme and location.
2. Compare the data collected and analyzing costs and charging patterns, drawing conclusions on the maximum, average and minimum charges in the different areas of Toowoomba.
3. Develop a spatial information system in which data can be tabulated and analysed.
4. Map the distribution of doctors within the Toowoomba district.
5. Determine the impact of the spatial related factors (traffic patterns, charging patterns, commercial centre's location, convenience, and population density) on the distribution of medical centres and their significance.

1.4 The Study Area

This project focuses on the study of the charging patterns, fees and distribution of doctors, and whether the number of doctors is sufficient for the population within the Toowoomba city as well its surrounding areas. Toowoomba is Australia's largest inland regional centre and services the Darling Downs region (Figure 1.2). It is the economic and commercial foundation of the Darling Downs. Since 1996 Toowoomba's population has grown on an average rate of 0.5% per annum. Toowoomba City Council predicts that the population of Toowoomba will continue to increase at the rate of 0.5% per annum through to the year 2021 (Toowoomba City Council 2004).

The Study Area
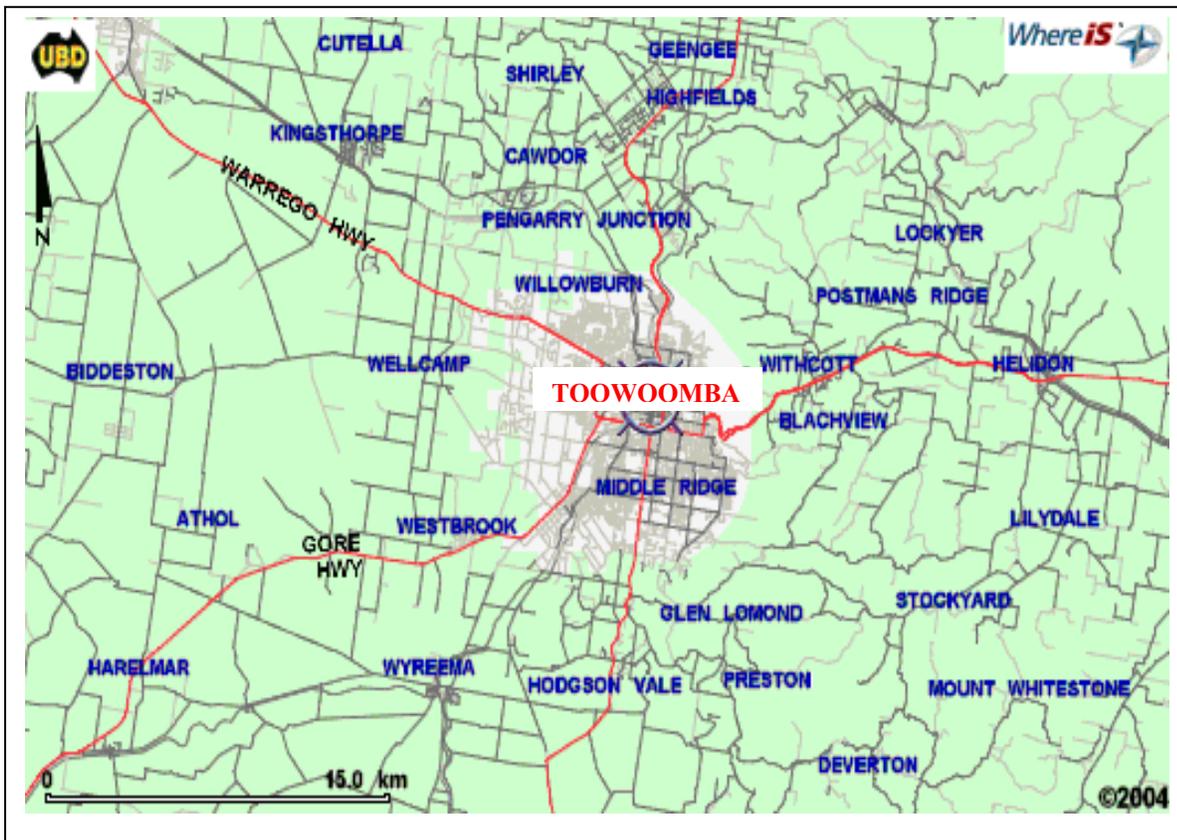
Figure: 1.2: Toowoomba City in Darling Downs Region
(Source: www.whereis.com.au)

The current population of Toowoomba stands at over 92,555 (Australian Bureau of Statistics 2004), with only 93 general practitioners serving the population. In this project the analysis is focused on the ratio of doctor-to-patients in the Toowoomba region, and the public concern on the shortage and poor distribution of general practitioners, which not only affect the residents of Toowoomba, but also the smaller surrounding communities such as Charlton, Jondaryon, Dalby and Pittsworth. These smaller towns do not provide general practitioners, thus resulting in their residents traveling into Toowoomba to seek medical attention. This factor contributes to the stress placed on the doctors due to the shortage and poor distribution of general practitioners in Toowoomba.

1.5 Dissertation Overview

Chapter One of this project introduces the topic which this dissertation will focus on, the distribution of general practitioners throughout the Toowoomba region. It gives an in-depth approach explaining the current situation of the issue, as well as the scope of the project. Medical terminologies used by general practitioners which will be used throughout this project are also defined in this chapter. The study area, objectives and outcomes of this project, and the reason for carrying out the investigation for this project is also stated.

Chapter Two of this dissertation identifies the background and includes a research into the literature review on the issue. This chapter takes an in-depth look at the definition of general practitioners, as well as the various factors which affect the way the general practitioner's service are offered to the public. The literature review outlines current news articles in circulation in the media relating to this project, and its hypothesis that Toowoomba does not have a sufficient number of general practitioners for the current and increasing population throughout the region.

Chapter Three identifies the methodologies implemented for this project. These include data analysis, conversation and conclusions drawn from the analysed data. GIS software required in this study is also outlined in this chapter, together with the various tools that it contains to be used in the investigation.

The overall results and drawn conclusions are presented in Chapter Four, which analyses the influencing factors of the charging patterns and fees, distribution and location of the general practitioners. The effectiveness of the current distribution will be examined and on the basis of analysis, suggestions for modifications for the current system will be reviewed for a more sufficient outcome available to the public.

Chapter Five concludes the project, consisting of comprehensive discussion making reference to the outcome of this dissertation. The achievement of the outcomes and objectives of this project are described in this chapter, together with the suggested recommendations for future work, giving examples of how GIS technology can be used to benefit the medical industry and its patients.

1.6 Summary

This chapter has given a brief introduction into the concerns that medical practitioners in Toowoomba are not providing adequate healthcare services to the city's population and to the smaller towns on the outskirts due to a variety of factors, one of which is the unequal distribution of medical practitioners. Although the medical field is continually evolving, the provision of adequate medical services to Toowoomba's residents continue to be overlooked especially in areas further from the city centre.

This problem is further aggravated by the allocated minimum consultation duration of 10 minutes per patient, thereby setting a maximum number of patients a doctor may treat in a day. While upholding the standard of care given to each patient, it also adds to the problem of the in availability of adequate medical services to the large number of patients.

This project proposes the use of GIS to improve the availability of medical services to residents all over Toowoomba via investigation into spatial distribution (which will be discussed in Section 4.5). A review of the current state of the GP distribution in Toowoomba, obtained by the collation, mapping and analysis of GP location distribution data will determine if Toowoomba is being adequately serviced by the local GPs.

This dissertation has also set out the scope and objectives for the project, stating the specific tasks and areas that will be covered, as well as the provision of a brief overview of each chapter.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

2.1 Introduction

It has been established that there is a need for more doctors to service the population or a better distribution of the location of doctors. This widespread problem has been highly publicised by the media through newspaper articles, interviews with members of the medical community, members of parliament and doctors, and discussions on radio programs. Interviews with key members of the parliament and the medical community have revealed methods that are being considered and implemented to ease and possibly solve the doctor shortage issue. Also, a research of academic literature will be reviewed to establish the current situation. It will also be determined if GIS can be used to assist in alleviating the present circumstance and make healthcare services more widely available throughout Toowoomba. GIS offers tools to assist in the planning for the future of rural areas and the necessary expansions in medical services to provide adequate care for all. Further, the current GIS technologies in use will also be evaluated.

2.2 General Practitioners

2.2.1 Definition of a general practitioner

Unlike doctors who specialise in a specific area of medical examinations, a general practitioner is a physician whose practice is based on a broad understanding of all illnesses and who does not restrict his/her practice to any particular field of medicine (Delaware Healthcare Association 1998*)*.

The general practitioner may be based at a single medical institution or may move around to attend to patients at several surgeries throughout a working week.

2.2.2. Functions of general practitioners

General practitioners are a necessity in society. The majority of people will need to visit a doctor at least twice in their lifetime, whether it is to treat a specific condition, such as a cold, to receive immunizations, or just as a simple check up. Their expertise area is not restricted to a specific field, instead they have a broad knowledge of all different medical areas and are trained to be able to recognize and treat patients for the more commonly occurring ailments according to their symptoms. Part of the job description of a general practitioner is to grant individuals referrals for more advanced medical attention from a specialist and to direct patients to have X-rays or magnetic resonance imaging. They are also responsible for issuing prescriptions for medications that cannot be bought under normal over-the-counter circumstances.

General practitioners are providing services to the public by selling their treatments for general ailments. As customers, the members of the public who use this service are charged for the consultation time with the general practitioner. Similar to any competitive business in the marketplace, different practices charge different rates according to the time spent with the doctor and the complexity of the diagnosis.

In an ideological society, there would be enough doctors to treat all people who may be in need of

their care. It only seems fair that general practitioners would be readily available to all. However throughout many areas of Australia, including Toowoomba, the medical services available to the public are lacking and have uneven distributions.

2.2.3 Services provided by general practitioners

General practitioners supply their knowledge to customers through two main means. The first, and most common, is where patients visit the general practitioners in at a surgery or office. The other mean consultation requires the doctor to leave the surgery and call at the patient's residential premises or hospitals. This means is reserved generally to those patients who are frail or immobile and cannot be transported to the surgery. Additional fees are usually incurred for this extra service, as the doctor also charges for traveling costs and the time lost for seeing other patients.

A third alternate option which can be used is a telephone consultation with a patient. This method of consultation is not preferred by most general practitioners as the integrity of the telephone diagnosis relies heavily on the patient's description of the location and severity of any conditions.

2.2.4 How the general practitioners role differs from that of a hospital

In non-emergency situations, the first contact point for treatment is the general practitioner. General practitioners are able to support a wide medical knowledge base and are equipped to provide treatments for a diverse range of patients. If the condition requires more specialized treatment the general practitioner will refer the patient to a specialist, who may or may not be based at a hospital.

General medical and surgical hospitals are staffed by a wider range of members from the medical community including general practitioners and specialists, to cater for all patients. The primary function of a hospital is to provide inpatient diagnostic and therapeutic services for surgical and non-surgical treatments to a wide variety of conditions. Most hospitals provide outpatient services, the most well-known being emergency care.

2.2.5 The importance of general practitioner's location

Location is a very important aspect of any business, whether the business is selling a product or offering a service. General practitioners are a business which offers services to the public. The demand for the business of general practitioners in this area is growing rapidly. Currently the volume of consumers is exceeding the providers of medical treatments. The general practitioners are struggling, and are unable to handle the large volume of patients who need their services.

In the past when Toowoomba's population was more centralized, the coverage area provided by the distribution of general practitioners was sufficient for the serving the public.

As the boundaries of Toowoomba have been expanding further away from the city centre, general practitioners have remained situated in the premises closer to the city centre. A result of this is that patients are required to travel further to meet with a doctor. This is exemplified further by people living in the districts outside Toowoomba who have no closer medical facilities available other than those in Toowoomba.

Competition is always an issue with any business. Often patients will ask themselves, "Which doctor is the closest or most convenient for me?", "Who can provide me with competitive charges for the services?", "Who can I trust to have adequate knowledge in the medical field to provide me with the best care?" and "Which GP is most popular?" etc.

While these questions dwell in the back of a patient's mind, it has come to the stage where the main question being asked to general practitioners is "Where can I go to seek medical attention sooner rather than later?" The lack of general practitioners has been dramatically affected by their distribution (refer to Section 2.3), and consequently as the population increases without a corresponding change in the medical community to expand with it, the doctors will not be able to cope with the demand.

2.3 Factors affecting the general practitioner service

The location selection for setting up a medical practice involves the complex analysis of location based information, including accessibility, demographics and convenience. These factors have the potential to positively alter the performance of a general practitioner and health care provided in that region.

2.3.1 Accessibility

The convenience of the general practitioner's surgery location is a measure of the ease with which the patients can travel to consult with the doctor. Factors such as the proximity to public transport facilities and the traffic density on the roads near to the surgery contribute to the accessibility to the general practitioner. Patients needing to consult with a doctor would need to consider the density of traffic flow to the surgery if they have access to a private vehicle, or plan the time and route to be traveled by public transport, such as buses and their scheduled times.

The majority of general practitioners throughout the Toowoomba area is situated in the city centre, along the main roads. This is a major weakness for the accessibility issue for patients, as it forces many patients to travel into the city centre to receive medical treatment. If general practitioners were located in the outer areas of Toowoomba, a more even distribution of doctors across the area would be achieved, thereby eliminating the need for much travel. This way, the reduced traffic congestion on the small roads will also reduce the travel time for a patient to reach a nearby surgery, providing patients with a more accessible way to reach the destination where their doctor is located.
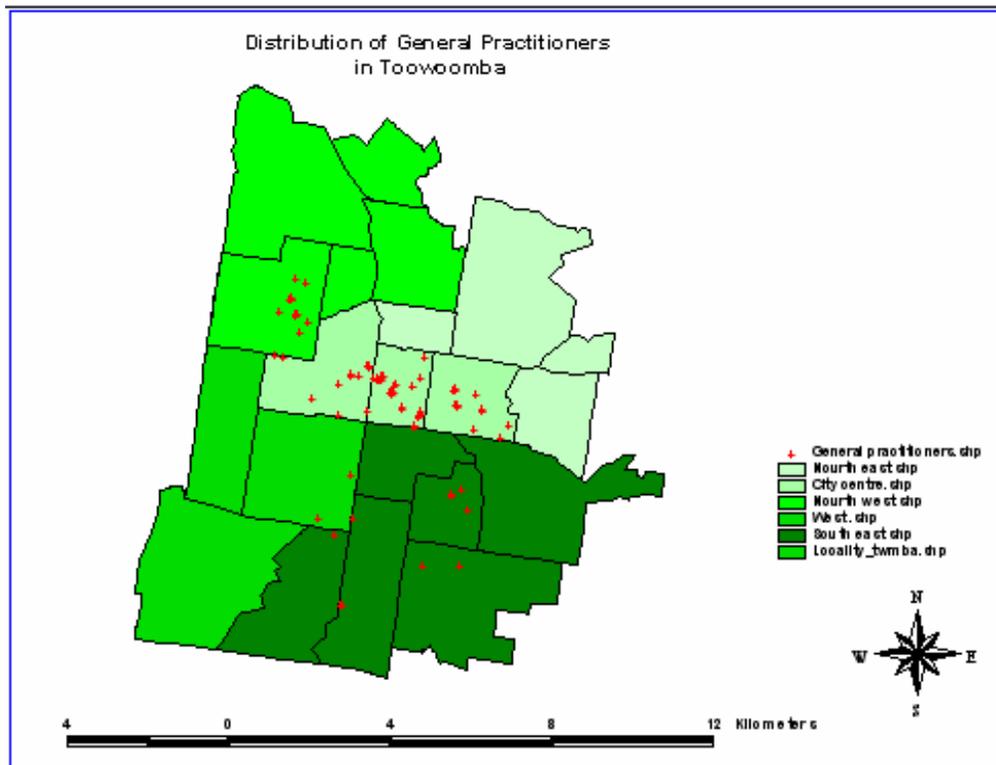
Figure 2.1: Location of general practitioners in Toowoomba District

2.3.2 Convenience

Further convenience to the patients will be achieved if the surgery has close proximity to a pharmacy or a shopping centre, from which prescriptions that are required can be purchased. Close proximity to such facilities will extend the convenience of the general practitioner beyond the appointment, as the patient will be able to visit the doctor, and continue on afterwards without much deviation from their errands, obligations, and the rest of their everyday lives.

2.3.3 Demographic

Assuming that patients will seek medical care from general practitioners that are close in proximity to their homes, then a doctor located in a high population density area will attract more patients from around that area, restricting the number of vacancies for patients from the more remote areas of Toowoomba. Therefore if the doctor can set up a practice in a location that will complement an even distribution of general practitioner across the areas, the unanswered demand for doctors has the potential to be satisfied.

2.4 Literature Review

2.4.1 Review of Media Publications

The Australian Broadcasting Corporation, ABC, has recently reported that while local governments all around Queensland say that they are addressing the issue as quickly and efficiently as they can, it does not seem to be the case (ABC Rural 2003).

Mike Montgomery, president of Rural Health, told ABC that "there was confusion over whether there were enough doctors to go around". Mr. Montgomery also told ABC that research by the Australian Medical Association and Access Economics reveals a national shortage of 2000 GPs; more than 700 of them are from rural areas (ABC Rural 2003).

ABC (2003) also comments that there is fury from various parties over the misconception on the shortage of doctors. Local governments seemingly have turned a blind eye to the public health needs, drawing assumptions that there are enough doctors to be evenly distributed to the ratio of people living in an area, especially in rural towns.

A report written by Andrew Kramer (Kramer 2003) explains some of the significant impacts on the residents of towns where the medical attention is lacking. The distribution of doctors is a very important issue. A sparse distribution of few doctors can dramatically affect the care of patients. Mr.

Kramer's report shows evidence of this theory. He says "people often have to travel long distances for care or wait weeks or months for appointments." (Kramer 2003). His report draws the conclusion that the growing communities in rural areas have not had a better distribution of medical services and that their calls for more health care services have not been answered. These two reports support the purpose of this project that the distribution of doctors is a significant contribution to the lack of medical services available to the public.

A plan to reduce the impact of the doctor shortage that is funded by the federal government implements that doctors are paid an additional $10 for every patient that the doctor treats after hours. As stated by General Practitioners Connections chair, Dr John Lamb, "Any funding for health is welcome, but we're going to be stuck with those (doctor) shortages in the medium term". Dr Lamb went on to suggest that "it could take between six and eight years before sufficient doctors were trained to cope with demand" (Chronicle 2004a).

However, additional support for Toowoomba doctors is being called in from surrounding districts and overseas to alleviate the current problem. Toowoomba Health Service's Chris Thorburn indicates that at the Toowoomba Base Hospital there are currently three general practitioners in the general practitioners section, when there are usually seven registrars practicing there. In order to ease this shortage, a doctor from Oakey Hospital has been temporarily treating these patients at the Toowoomba Base Hospital (Chronicle 2004b).

Furthermore, the Member for Groom, Ian Macfarlane, announced that an extra four overseas trained doctors will be treating patients in Toowoomba within six months. But General Practitioners Connections chairman Dr John Lamb says it will not solve the doctor shortage (Chronicle 2004c).

2.4.2 GIS in Health Services

Establishing an even distribution of General practitioners across Toowoomba, and across other rural districts, may be made possible through the use of Geographic Information System technology (GIS). GIS is a computer-based tool for mapping and analyzing data that exist and events that happen on Earth.

A GIS combines all the capabilities of display-only, thematic, and street based mapping systems along with the ability to analyse geographic locations and various information which is linked to these locations.

GIS technology has the capability to tabulate and analyse data from selected data warehouses. Using the process of geocoding, which involves assigning a geographic coordinate to an address, each record from the database is linked to a selected geographical point on the map. This provides a means of presenting the distribution of general practitioner's locations, charging fees, charging patterns throughout Toowoomba, allowing interested persons to see the areas in which general practitioners area situated now, and the areas where general practitioners may be situated in the future to supply medical services to the public.

If a general practitioner wants to open a new practice in Toowoomba, he/ she will need to select a location for its surgery. Through GIS technology, the new doctor can produce model locality data to provide a fast and cost effective site analysis for the new location.

Unlike other types of businesses, site analysis operates differently for medical centres. Medical locations continue to be dictated by Certificate of Need (CON) programs in many states. This program requires that the medical facility is inspected and approved by a qualified person to gain government issued certification that the proposed facility meets the needs of those for whom it is intended. The need may involve constructing a new health facility, offering new or different health services, or acquiring new medical equipment (Disability Insurance 2001). Using this program eliminates relocation as a method for improving the market from which general practitioners draw patients.

In Toowoomba, however, the concern is not so much drawing the patients to the general practitioners and increasing the volume of patients seen by the general practitioners. Instead, the main concern is that the area needs to establish more surgeries to provide a more even distribution of medical services to the residents to cope with the exceeding demand for general practitioners. This requires an effective site analysis using the GIS technology.

2.4.3 Application of GIS to the Monitoring in Health Care Services

Health care professionals were early adopters of GIS technology in the public health sector. As the technology becomes more up to date health care sectors are finding different uses for GIS. The use of GIS technology has grown substantially in the last decade throughout the medical world. GIS is used in capital cities as management for patient care (ESRI 1999).

"Using GIS for demographic analysis to estimate the demand for various types of services can benefit individual general practitioners. They are more effectively marketed by locating offices near residential areas of potential patients. This particular type of analysis can be extended for use by managed health care providers" (ESRI 1999).

Previous studies indicate that GIS can help general practitioners do analysis and make the best decision faster. In today's environment the amount of information that can be utilized by a GIS is vastly increasing. "The role of GIS will have greater importance due to its abilities to integrate a wide range of data sources, from legacy systems to image data, and to make complex data more quickly and easily understood" (ESRI 1999).

2.5 Summary

General practitioners are the first point of contact for many in the event of illness or to have routine checkups performed. Often approached and required to treat common ailments or to give immunizations, general practitioners offer a broad knowledge on a wide array of medical conditions rather than specialise in any one area. Moreover, they may receive patients either through clinical appointments, house visits, or even telephone consultations.

Different from the services available at hospitals, general practitioners consult patients to assess their conditions and prescribe necessary medications. If additional attention and tests are needed to be carried out, the patients will then be referred to the hospitals for further treatment.

Because doctors are providers of services, they tend to locate themselves in highly populated areas in order to get the highest volume of businesses. As Toowoomba's population and boundaries have expanded over the years, people have started living further away from the city centre. Medical practitioners, however, have not done enough to follow this growth pursuit, thereby resulting in the need for increased traveling to get to a doctor. In addition to that, factors such as accessibility, convenience and demographic density also affect the choice of medical practitioners' location of practice as discussed. Further, having proven that the issue of a lack of doctors to service the population has received much attention from the media and public, the use of GIS has been analysed to determine if it aids in alleviating or even solving this problem for Toowoomba.

GIS technology is a powerful tool in health services that is capable of presenting the locations, distribution and charging patterns in a comprehensive manner. Also, GIS technology is not limited to the display of spatial data and may be used to perform a spatial analysis that is capable of linking each of the factors together. Therefore, through the effective use of GIS, the city planner can overcome the problem of a doctor shortage both in Toowoomba and in smaller towns on its outskirts, via implementing a more even and accessible distribution of doctors to service the community.

CHAPTER 3

METHOLODGY

3.1 Introduction

The previous chapter reviewed the applications of GIS in the medical and health field that will be very useful in alleviating the problem of a shortage of doctors in Toowoomba or the need for better distribution of doctors. This current chapter will provide an outline of how similar methodologies will be applied for this project, in the data collection, conversions and procedures required to analyse the information in ArcView GIS software in a mapped distribution.

The literature review featured in Chapter 2 indicated that the distribution of general practitioners is insufficient for providing adequate health care services for Toowoomba. Contributing factors include the low number of general practitioners and uneven distribution of the GP's practices through Toowoomba. GIS technology can be used to show potential medical centre sites for Toowoomba and also display surrounding demographics, transportation facilities and patient locations. By displaying the information of current locations for general practitioners in the Toowoomba area, rational decisions can be made as to what can be done to improve the distribution of general practitioners throughout Toowoomba.

3.2 Toowoomba Population Data Collection

An insight into the current distribution of doctors in the Toowoomba region is obtained by inspecting the distribution of the Toowoomba population and comparing it to the locations of the doctors. Toowoomba population data was obtained from a Toowoomba City Council leaflet (Toowoomba Facts and Figures 2004). The current population, as at 12 May 2004, is standing at 92,555 residents in Toowoomba (refer to Section 1.4). The division of the Toowoomba population into districts was done according to information found from the Australian Bureau of Statistics, which has been tabulated below (Table 3.1).

Table 3.1: Population of Toowoomba by Regions

Region of Toowoomba	Region Population
North East	11 900
Central	14 990
North West	19 356
West	22 614
South East	23 690
Total	92 550

There are a total of 93 doctors serving the Toowoomba public this year. The locations of their practices have been mapped from data obtained from the Commonwealth Carelink Centre Information System website (2004). This data has been tabulated and appended in Appendix A. Superimposing this distribution of general practitioner's locations over the population distribution of Toowoomba indicates the potential patients to doctor ratio.

In this case, the population density of the various areas (commercial, non commercial and the city centre) should have an influence as to where the general practitioners are located. Hypothetically, high density areas should have more general practitioners evenly spaced over the area to service the highly populated district, whereas low density areas should have less, but evenly distributed doctors available to residents living in the area. This will allow the most effective and efficient provision of medical services to the community regardless of their divisional district. To investigate the population density-to-general practitioner ratio, the population density in different areas of Toowoomba will be calculated using the GIS software (as demonstrated in Figure 3.1).
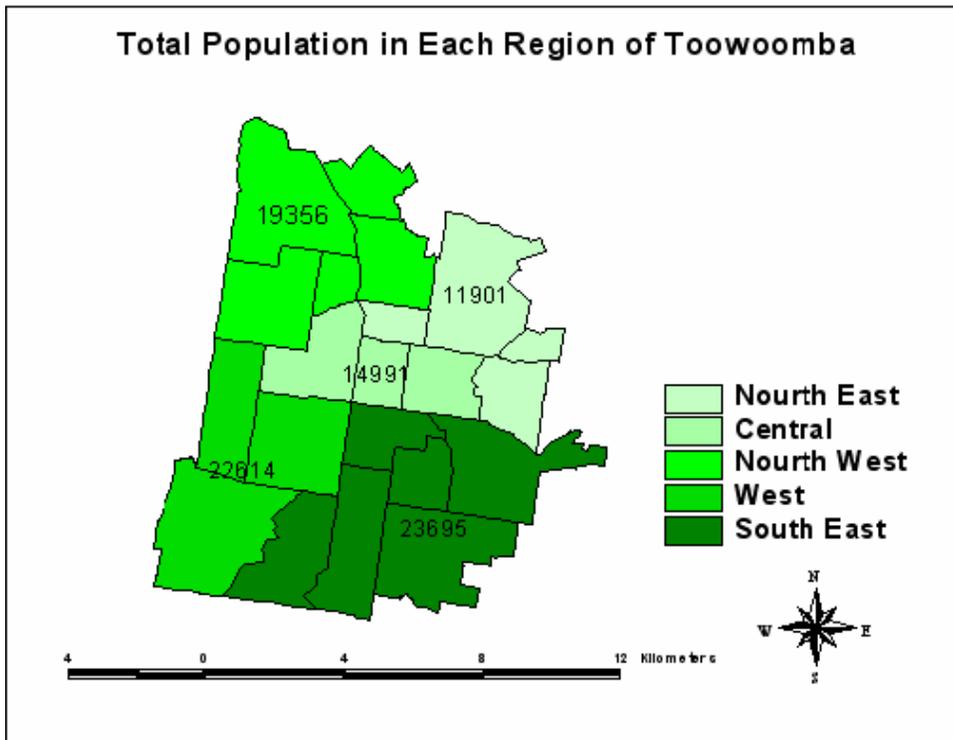
Figure 3.1 the Population density in each region of Toowoomba

3.3 GIS Software

In this research GIS technology is an effective tool to display the distribution of any business and, for this specific project; it is used to map the distribution of GPs in Toowoomba, as well as their charging patterns and fees.

GIS technology is an extremely efficient way of analysing the doctors' location information which can help determine a more effective distribution for the general practitioners Toowoomba and the surrounding areas.   The selected GIS software to be used in this research is ArcView Version 3.2. The choice of using ArcView was made due to the author's familiarity and the widespread usage of the program in industry.

From the objectives stated in Chapter One, the spatial distribution of general practitioners marked on the Toowoomba city map is required to gain an insight to the current distribution.

3.3.1 Data conversion in ArcView

GIS related data is available in several forms, depending on its application. These forms include spatial data, image data and tabular data. Spatial data is geographical data that stores the geometric location of particular features, along with attribute information describing what these features represent. Image data includes satellite images, aerial photographs and other remotely sensed or scanned data, while tabular data includes almost any data set. In the research carried out for this project, spatial data was the only format of data used, as it is the most crucial factor affecting the findings of the issue of unequal distribution of general practitioners in Toowoomba. In addition, it is also the most conveniently available form of data that is available.

The selected GIS software to be used (as mentioned in Section 4.3), ArcView Version 3.2, supports several formats of spatial data including ArcView shapefiles, ARC/INFO coverages, ARC/INFO GRID data, image data, CAD drawings, SDE data, StreetMap data, TINs and VPF data. For the purpose of this research project, shape files will be used in the investigation and analysis conducted.

3.3.2 Data acquisition and manipulation in ArcView

To meet the objectives of this project, among which is to determine the various patient-to-doctor ratio in each of the 5 districts in Toowoomba, many data sets will be collected for reviewing and analysing. Achieving this requires methodical processes, done by using the various extensions in ArcView previously listed.

3.3.3 Map layers required

The Toowoomba city was selected as the study area. Therefore the Toowoomba street map has been used as the base map. Throughout this project seven map layers were selected to generate information:

1. a Toowoomba base map,
2. maps of the surrounding areas on the outskirts of Toowoomba,
3. road maps of Toowoomba,
4. a map showing the location of general practitioners in Toowoomba,
5. a map showing the busiest medical centres,
6. a map showing the population in each region of Toowoomba, and
7. a map showing the distribution of general practitioners in Toowoomba.
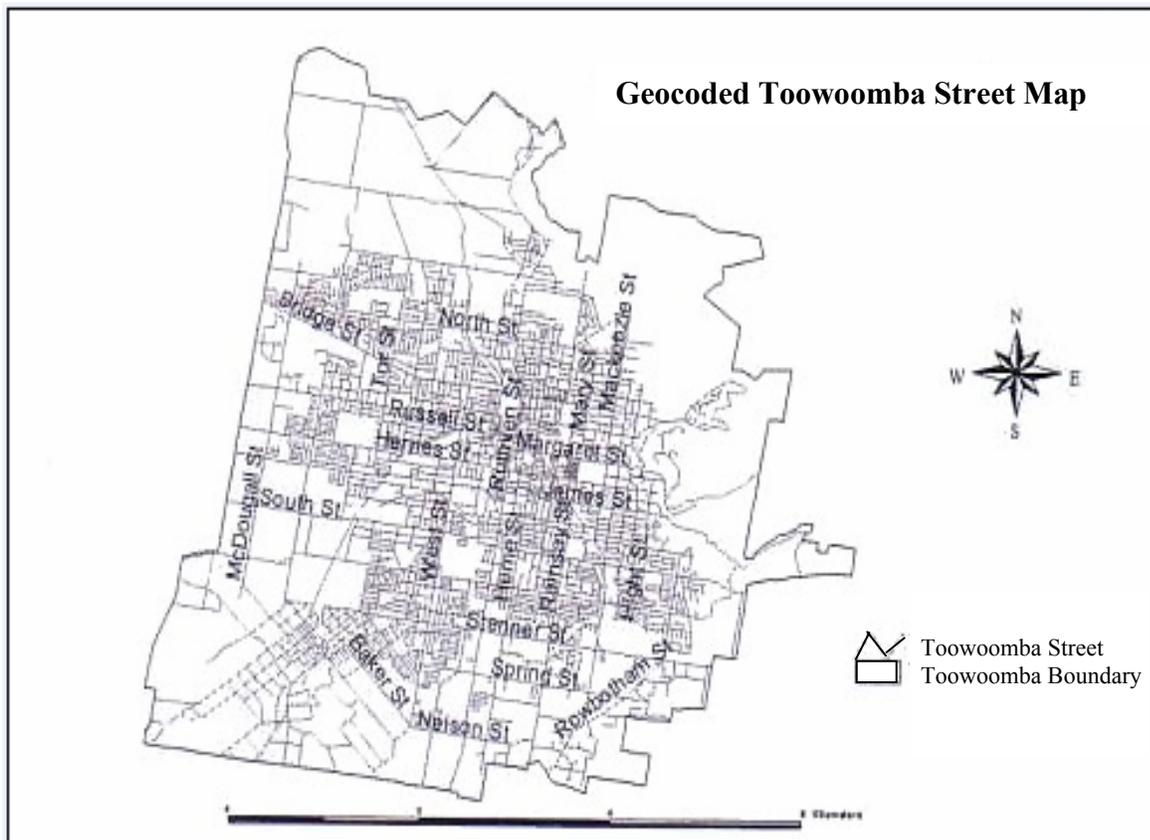
Figure 3.2: Toowoomba Street Map

The focus of this research is on Toowoomba, and while the surrounding areas on the Darling Downs do contribute to the doctor shortage in Toowoomba, the Toowoomba doctor distribution is the main priority; hence the Toowoomba street map is used as the base map.

3.3.4 Geocoding the Toowoomba maps

Geocoding is one of the GIS technology tools. This mechanism provides a very efficient way of establishing relationships between geographic location, street names and addresses. For this project geocoding is a very important tool. This technique is used to overlap two separate files, one of road names and the other of the road map. Geocoding combines the two create one file. This technique was also used to place the general practitioners names and their location. After the completion of geocoding the maps display relevant information to general practitioners in Toowoomba.

Figure 3.2 demonstrates the geocoded map of Toowoomba. ArcView's method of allocation, where the street names are loaded from a data file and attached to the map, was used to pinpoint and mark the locations of the GPs on the map.

The first step was to divide Toowoomba into five separate regions, Central Toowoomba, North West Toowoomba, North East Toowoomba, West Toowoomba and South East Toowoomba. The boundaries for these five regions corresponded to the statistical data obtained from the University of Southern Queensland database.

Next, the population living in each of the regions was represented on the map. This was done by placing all the statistical data into ArcView to create a map which displays the population of each region using colour codes to represent the density of each area. On the map the colour ranges from saturated green to unsaturated green to represent the most populated area of Toowoomba to the lowest populated region in Toowoomba, respectfully. The number of people traveling into Toowoomba for medical attention is not considered in the calculation of the population of the five regions due to the infrequent and unpredictability nature of these visits.

To provide a visual representation of the ratio of doctors to the district population, the locations of the doctor's surgeries are marked on the map. The figure below shows this distribution, and indicates that the distribution of general practitioners is not adequate for any of the regions' population density. Further analysis of this map is detailed in the following chapter.
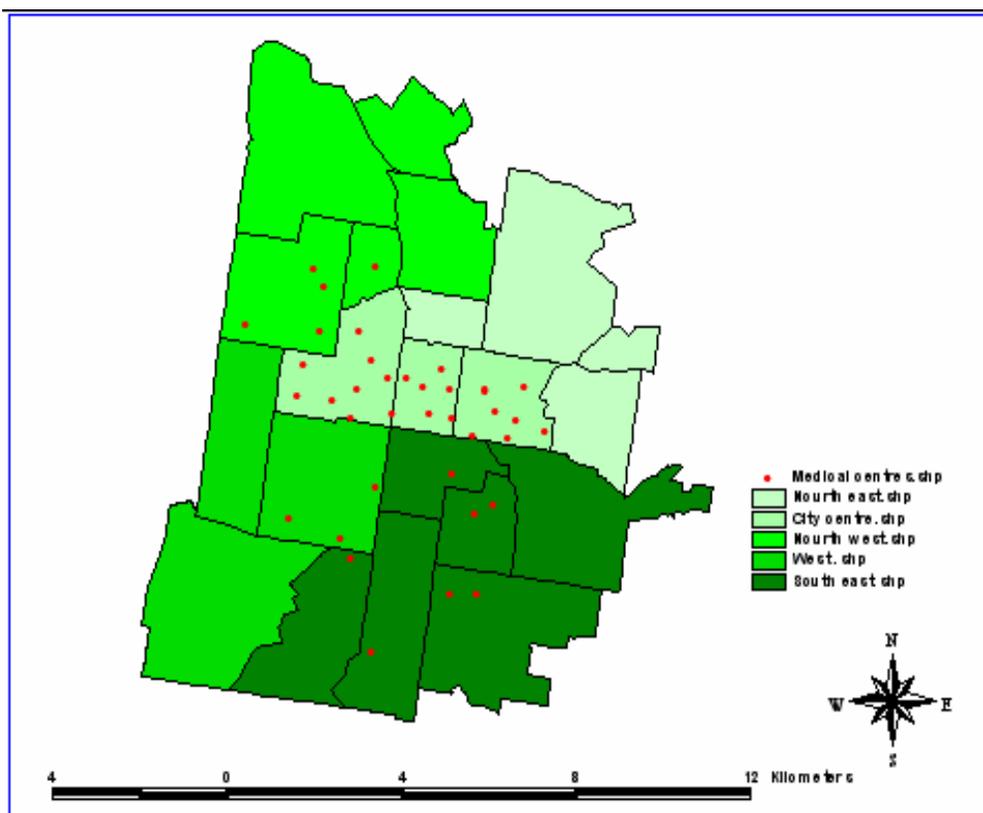
Figure 3.3: The current distribution of medical centre in Toowoomba

3.4 Survey of Doctors' Workloads

Under government medical regulations, doctors are only allowed to see a maximum of six patients per hour (refer to Section 1.1). However, due to the uneven distribution of general practitioners in Toowoomba, doctors may be seeing fewer patients than feasible in less populated areas, while people are struggling to get appointments with doctors in highly populated areas. From a study conducted at a number of local general practitioners' surgeries, results showed positive signs towards affirming this theory.

A survey investigating into this issue was conducted at selected medical centres which noted the number of patients each doctor received per hour. These numbers were collected from a field survey. However, due to time constraints the author limited the observation surveys to one hour periods at each medical centre selected for the survey.

The Wilsonton Medical Centre, Grand Central Medical Centre, the Hooper Centre Medical Centre, Uni Plaza Medical Centre and the general practices at 137 Mary Street and 126 South Street are the six medical centres chosen for sampling in this survey, which was carried out on weekdays with varying time frames in the mornings and afternoons. Therefore, this will form the boundary of the methodology employed in this investigation with regards of the current situation of securing appointments with general practitioners in the various regions in Toowoomba.

3.5 Summary

The methodology of conducting the collection of information and field survey is essential so as to set the boundaries of this research project. Information about the 5 Toowoomba districts is to be obtained from the Australian Bureau of Statistics and with the GIS software, the population density of each district will be calculated, thereby providing both an effective and efficient way of mapping the present spatial distribution of general practitioners found in the area.

While there are many GIS software packages available which would be useful in completing this research, ArcView Version 3.2 was selected due to the author's familiarity with the software. ArcView has been used in the analysis of the information to determine the various patient-to-doctor ratios in each of the five regions within Toowoomba, as per the project objectives. In ArcView, seven layers of the Toowoomba map will also be utilized to provide a clearer picture of the distribution of both the population and general practitioners' locations.

Further, geocoding will be a major part of the methodology, creating maps containing information put together from the various maps obtained. These tools and boundaries set for this project will then be used to collect information about both patients and doctors from six different medical centres (the Wilsonton Medical Centre, Grand Central Medical Centre, The Hooper Centre Medical Centre, Uni Plaza Medical Centre and the general practices at 137 Mary Street and 126 South Street) to provide sampling data that has been selected appropriate for this project.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 Introduction

Having provided an in-depth description of the methodology and various processes implemented for this project, this chapter will document the results obtained, followed by an analysis of those findings. The influencing factors and the efficiency of the current distribution of doctors throughout Toowoomba relative to the population will also be examined, accompanied by the outline of recommendations for any potential solutions available to correct the major shortcomings in the distribution of doctors.

4.2 Current distribution of general practitioners

Currently there are ninety-three general practitioners accommodating the medical needs of Toowoomba's population. A map displaying the current distribution of these doctors and the location of their medical centres were obtained by establishing their positions on a base map of Toowoomba, as shown in Figure 4.1. Upon inspection of the map, the distribution indicates that the majority of the doctors appear to be located close to the centre of the city, with the remainder scattered unevenly about the south-east and north-west districts of Toowoomba. Several factors have influenced the general practitioners' choice of location of their practices, just as there are many factors behind the patient's selection of doctor. This research project will examine the spatially related factors from both the patients' and the doctors' perspectives.
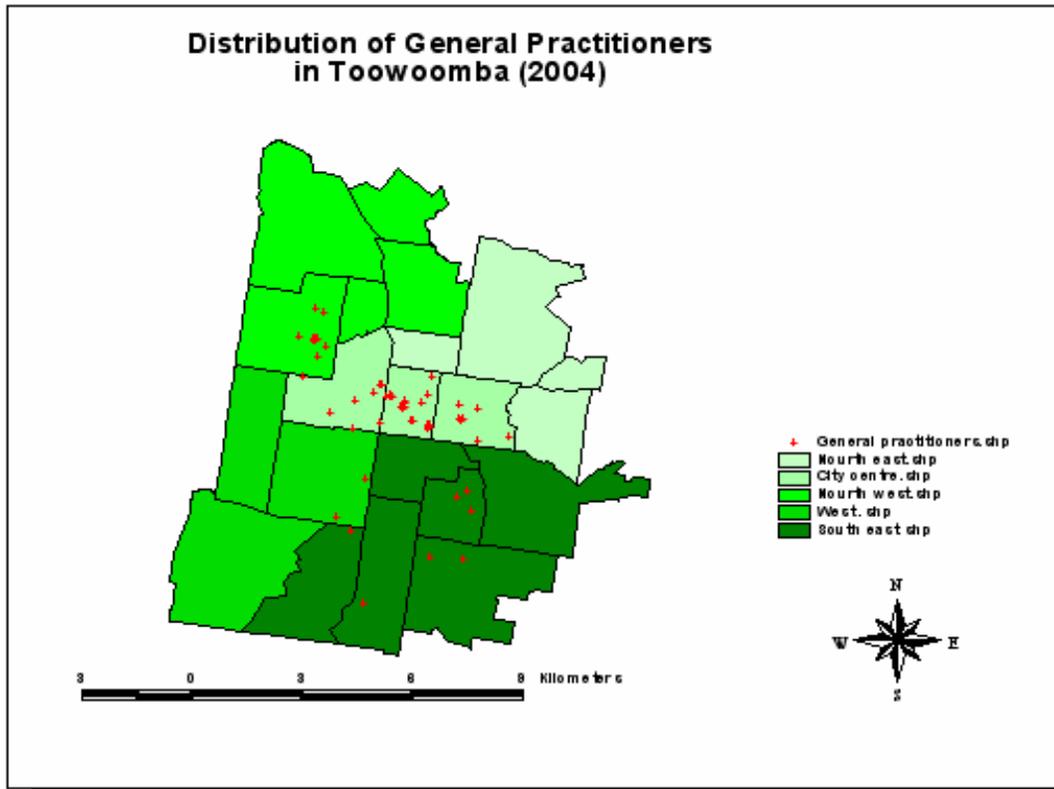
Figure 4.1: The Distribution of General Practitioners in Toowoomba

4.3 Analysis of current distribution of general practitioners in Toowoomba

Examining the current distribution of general practitioners provides an opportunity for the current shortcomings to be identified and, with the assistance of council city planners, the gaps in the distribution can be filled in the future to provide Toowoomba with improved general practitioner facilities.

From observations of the general practitioner distribution, the majority of the doctors were noted to be located in the central regions of Toowoomba city. Further insight is gained into the distribution is gained when dividing Toowoomba into areas based on their relative distance to the city centre. Figure 4.2 shows the calculated percentage of medical centres and doctors available to the public in the outer city, inner city and areas which are close to the city centre of Toowoomba.

Percentage Of Medical Centers and Doctors In The Various Areas Of Toowoomba

25%

41%

34%

- Outside City
- Close to City
- In the City
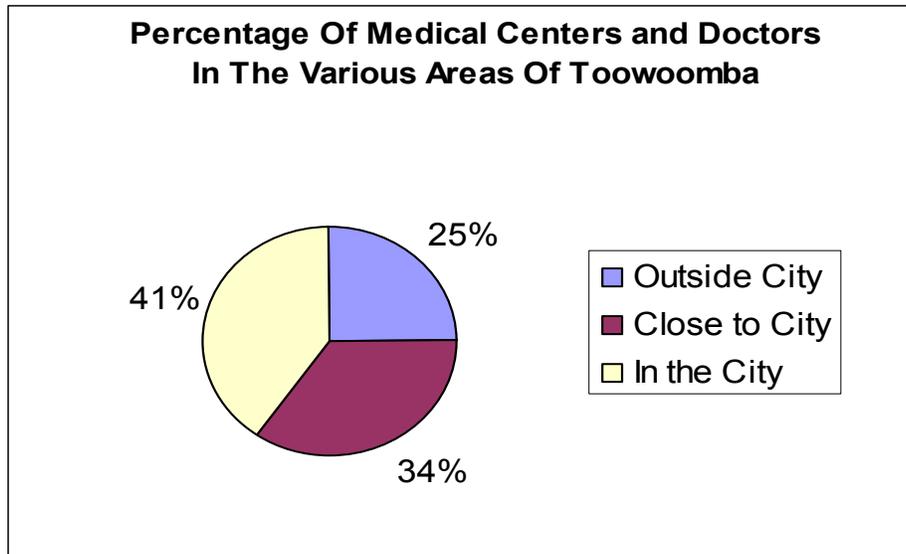
Figure 4.2: Percentage of General Practitioners in Various areas of Toowoomba

As illustrated above, the innermost part of the city is home to forty one percent of the medical assistance for Toowoomba even though it is the least populated area in the town.

This may be explained by a number of attractions which are keeping the general practitioners close to the city centre. The city centre accommodates the central business district (CBD) and shopping centres. Medical centres and doctors who are located in these areas tend to draw more patients because of the convenience factor. The people who are required to travel longer distances to see a doctor, as a consequence of there not being one near their residence, are more likely to bypass any remote surgeries situated enroute if they are not coupled with shopping facilities. More people will continue their travel to the inner city or go to large shopping centres to accomplish many things at once, rather than going to a medical centre and continuing on to the city to complete their errands and daily routines. However if the distribution was more evenly distributed and medical centres were located closer to major suburban areas in Toowoomba, people would find visits to the local medical centre to be a more convenient experience.

Another advantage of being situated in amongst the shopping centres and the CBD is the increased likelihood of there being a pharmacy close by, from which patients can obtain their medication and prescriptions at the same time.

Table 4.1 Number of Medical Centre in Various Area of Toowoomba

Commercial	Non Commercial	CBD
17	9	13

The trends of medical centre and general practitioner locations, in relation to their proximity to commercial centres, are displayed in Figure 5.4. Most medical centres and practices have been established in the CBD and in shopping centres as presented by the pie chart.
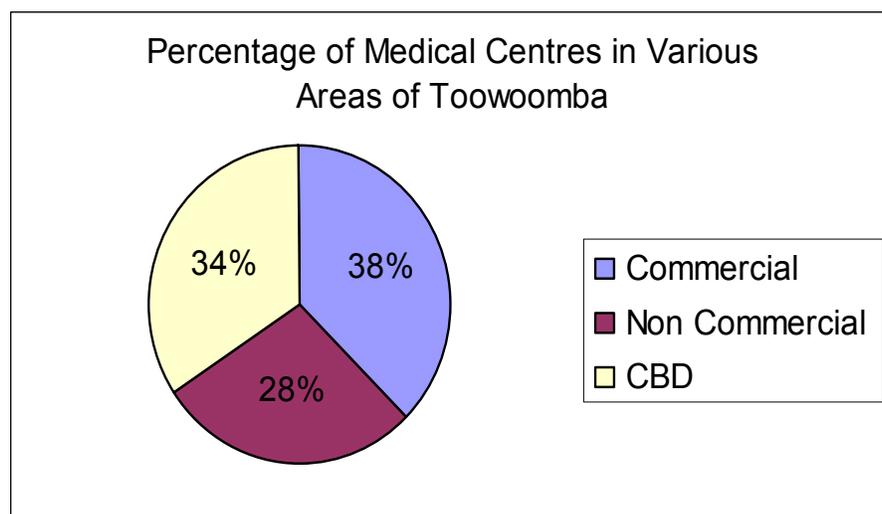
Figure 4.3: Percentage of Medical Practice in Various Areas of Toowoomba

4.3.1 Comparison of population density and general practitioners' locations

In comparison, there are only eleven medical centres in the most populated area of Toowoomba, with five of them located in close proximity and the other six located in pairs, across the region. One of the other more populated regions, in the south east of Toowoomba has only three medical centres while Central Toowoomba, one of the least populated regions, is where the majority of Toowoomba's general practitioners are situated when there is no need to have that amount of general practitioners in that region to cater for the relatively few residents living there. Population density indicates the amount of people living in an area. The higher the population density the more people living in an area and more patients in an area. These high population density areas, for example the areas of Toowoomba close to the city, then have extra patients on top of those residence which affect the

distribution for various reason. One of these reasons may be that the less populated areas do not have a medical centre near by, making them travel into populated areas to seek medical attention, as doctors are looking to establish their practices where the most patients can be seen.

Currently with the population standing at 92,555 residents in Toowoomba, and with only 93 general practitioners, this distribution is becoming a problem for patients. With the population distributed equally between 93 general practitioners the ratio indicates that each general practitioner may be providing health care for at least 1051 patients, which generally is impossible. On top of this large population, the 93 Toowoomba general practitioners also provide medical assistance to over 30,000 people who commute to Toowoomba from outer regions and beyond the outskirts of Toowoomba's city. The extra 30,000 people traveling into Toowoomba contribute to the shortage of doctors.

Some people are then traveling into Toowoomba to see doctors rather than seeing the closest doctor possible for reasons of convenience. However many other people living in areas where there is no medical assistance at all, are forced to travel even if there is no intention of doing so because there is no alternate option.

Upon closer inspection of the spread of people throughout the Toowoomba region, it is indicated that the distribution of doctors is not sufficient to cover the needs of those living in the same regions. In central Toowoomba the number of residents is 14, 991 with forty percent of the region's doctors found in this area. In the north eastern areas, twenty percent of the doctors are sharing the area with 11, 901 residents. The north western region of Toowoomba also has twenty percent of the doctors, but has residency of 19,356. However, both of the southern regions are where the majority of population lives, and they are also the two regions where the number of doctors lacks immensely in relation to the population. The south east region has a population of 23, 695 and only has eleven percent of doctors, while the south west area has a population of 22, 613, shares ten percent of Toowoomba's doctors. This then leads to complications for people who live in these populated areas and may be required to travel further to seek medical attention due to the uneven distribution of doctors in the area. This can be a major problem for elderly people who may find it hard to travel into an area with a larger percentage of doctors.

Ratio of Population of Toowoomba Districts to the Number of GPs in Each District

Ratio of People to GP (y-axis): 0, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000

NO GPs

Districts of Toowoomba (x-axis): North East, Central, North West, West, South West
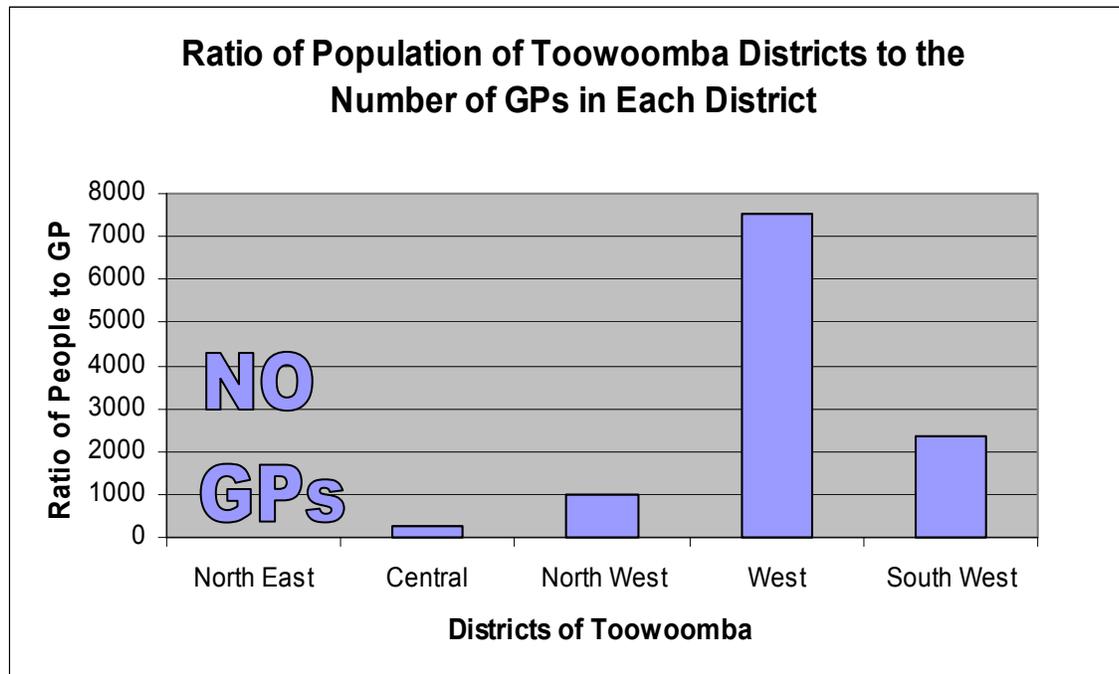
Figure 4.4: Ratio of patients to doctors in various areas of Toowoomba

Figure 4.4 gives a visual estimation of hypothetically how many patients a doctor each doctor may look after in a particular area, assuming they go to the nearest general practitioner.

The graph shows that the North-East area of Toowoomba is home to 10, 000 people yet there are no general practitioners in the area. While the city centre of Toowoomba is the least populated region it accommodates the majority of general practitioners within its boundary. The west region is also a highly populated area, but once again not enough general practitioners to serve the number of patients. If it were that people living in an area were only allowed to visit the general practitioners in the area the general practitioners in the Western region would have to see 7500 people per doctor, as shown by the graph, which is impossible.

4.4 Medical centre locations

A survey conducted with six medical centres, located as shown in Figure 4.6, The Wilsonton Medical Centre, Grand Central Medical Centre, The Hooper Centre Medical Centre, Uni Plaza Medical Centre and the general practices at 137 Mary Street and 126 South Street, provides supporting evidence of the above theory (see Table 3.2). The three highest ranking medical centres with the highest number of patients were either near or in shopping complexes. The other four medical centres were in areas that did not have shopping facilities close by.
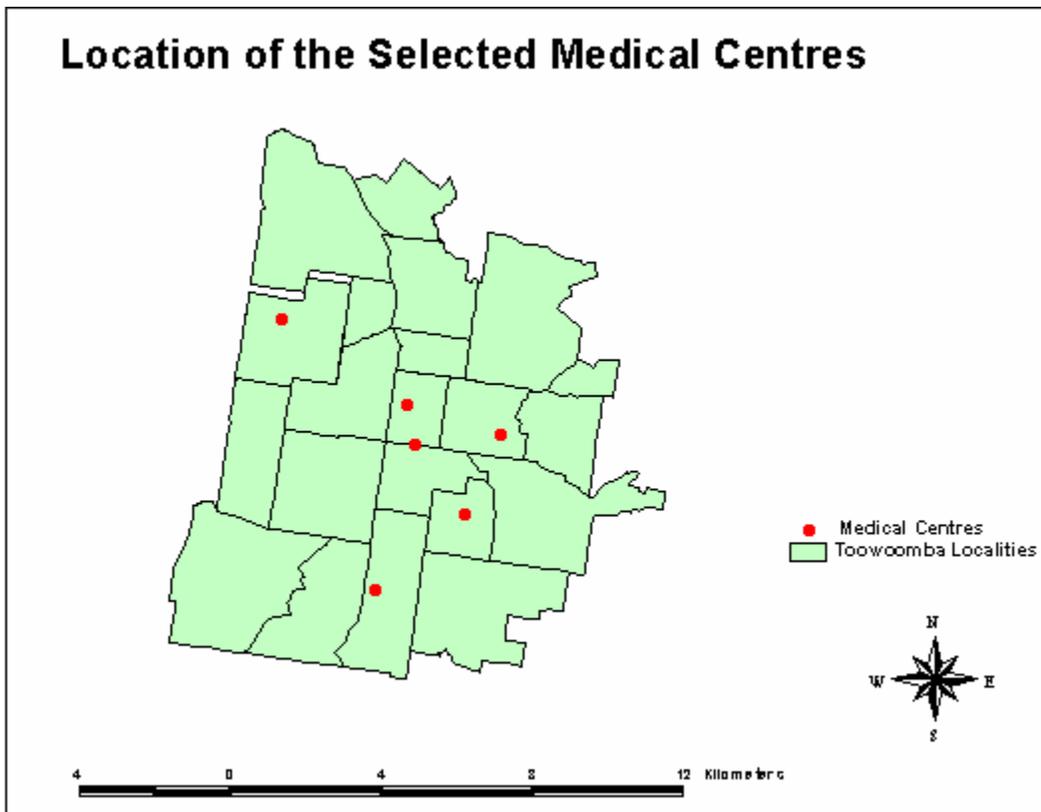
Figure 4.5: Location of the Surveyed Medical Centres

Table 4.2: Shows the number of patients visit each Centre a week

Centre Name	Number of Doctors	Average hour work	Number of patients per week
Wilsonton Medical Centre	8	9	1800
Grand Central Medical Centre	4	9	1080
Hooper Centre	3	9	720
137 Mary Street	1	9	275
126 South Street	1	9	270
Uni plaza Medical Centre	1	8	240

Also factored into the results was the consideration that Mondays may be a lot busier due to the two day weekend period when doctors are closed. Thursdays, a day which is traditionally busier at shopping centres than the rest of the weekdays, were also expected to be a lot busier with more patients traveling to the city especially from surrounding areas of Toowoomba, for this particular reason. These contributing factors are suspected to have an effect on the comparison between medical centres and have been taken into consideration.

During the busy weekday periods at medical centres such as Grand Central Medical Centre, other tactics are implemented to accommodate the increased number of visiting patients. In order to cope with this increase in the volume of patients, Grand Central Medical Centre increases the number of doctors working on Mondays and Thursdays. As such, rather than having one doctor sees six patients an hour, they can increase the number of patients being seen per hour with more doctors working.

(A sample of medical has been selected for survey)

Table 4.3: Show sample of Medical Centres selected for survey in Toowoomba

Medical Centre Name	Location	Number of GPs available a day	Average hour work	Number of patients visiting the Centre per week
Wilsonton Medical Centre	Richmond Drv	8	9	1800
Grand Central Medical Centre	Margaret St	4	9	1080
Hooper Centre	187 Hume St	3	9	720
137 Mary Street	137 Mary Street	1	9	275
126 South Street	126 South Street	1	9	270
Uni plaza Medical Centre	462 -472 West St	1	8	240

Table 4.3 shows the data collected from the survey for the number of patients per doctor per day as well as the calculated average visiting the medical centre per week.

4.4.1 Busiest medical centres

While the distribution of medical centres throughout the different regions are not evenly distributed for the population's needs, the busiest medical centres are located in less populated areas mainly situated in the city centre, or within other commercial areas such as shopping centres. The figure below displays all of the medical centres in Toowoomba in colour codes where the busier medical centres are represented by the blue dots and the less busy medical centres represented by the red dots.
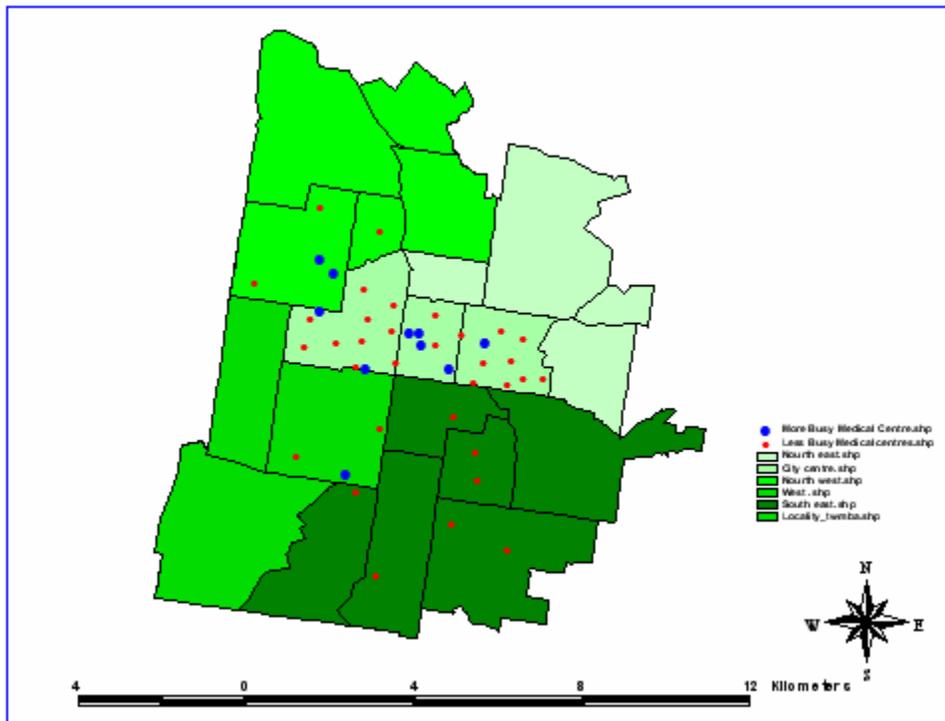
Figure 4.6: Location of the busiest medical centres

There are a few assumptions which are drawn to explain why these medical centres are the busiest. The first is convenience, as mentioned earlier (refer to Section 2.3), where residents are most likely to travel to a medical centre that is in or around shops if they have to travel to seek medical attention. This is because patients shop at the same time, thus making full use of one trip to town and not having to make several other trips to run errands. Patients can also purchase medication from pharmacies located near the medical centres in shopping centres or in the city centre, as not all medical centres have their own pharmacy.

The second factor which influences this trend is the ease of public transportation from the outskirts of Toowoomba to the city centre. The majority of Toowoomba's bus routes travel through the city centre. However, their routes keep to the main roads of Toowoomba. This means that medical centres located away from the main roads will not be passed by the public transport route.

The third factor which contributes to the exceeding demand experienced by the busiest medical centres represented by the blue dots is that these medical centres usually accommodate several general practitioners. This means that more patients can be seen at one time in one place.

4.5 Influence of spatial related factors

4.5.1 Spatially related factors.

The major spatially related factors considered in this project and that impacts on the patient-to-doctor ratio are the traffic conditions and travel distance to the practice, the existence of transportation facilities and other convenience factors, and the demographic activity in the area surrounding the practice and around Toowoomba (refer to Section 2.3).

4.5.2 Impact of travel aspects

The ease of travel to and from the general practitioners' surgery will certainly be considered by the patient prior to booking a consultation. This will especially be the case if the patient needed to travel from a remote district beyond Toowoomba or if special travel arrangements are necessary for a patient to visit the general practitioner at the surgery. Several aspects of the travel conditions impact on patients. Among them, traffic density and patterns at different times of day, and the availability of proximate public transport facilities are those that will be considered in this project.

Traffic patterns have an impact on the distribution of doctors. Many customers travel to medical centres located in the city because of the convenient public transport that is available. Patients with access to a private vehicle may prefer appointments with the doctor at non-peak times to avoid the increased traffic density associated with peak hour traffic in the city.

The location of medical centres at a commercial centre is the main spatial related factor which affects the distribution of patients among the doctors. This is due to convenience that people seek as they travel to the city to accomplish multiple tasks on a single trip, such as going to the doctor, getting their medication and shopping, rather than traveling to a medical centre that is not in or near a shopping centre.

The population density should influence the distribution of doctors in each area. However, the maps constructed in ArcView (Figure 4.1) indicate that this is not the case. The maps suggest that there is an imbalance in the distribution of general practitioners in Toowoomba and upon further analysis, potentially provides proof that the distribution is inadequate for the population.

4.6 Analysis of general practitioner's charging rate

An investigation was undertaken to discover whether a general practitioner location influenced the billing rates paid by a patient. Interviews with several members of the medical community yielded no specific charging practices by general practitioners based on their locations. However, general practitioners may follow guidelines specified in Australian Government Department of Health and Ageing (2003), for billing payments based on the location of the patients and the time required for examination of the patient and diagnosis of the condition.

The billing rates recommended by the guidelines based on the location of the patients are categorized into the following groups:

*   Surgery consultation
*   Home visit
*   Consultation at an institution other than a hospital or residential aged care facility
*   Consultation at a hospital
*   Consultation at a residential aged care facility

The time spent for examination of the patients and the level of complexity of the diagnosis is a major factor influencing the billing rate. The guidelines have categorized the time spent on each patient into four groups, as defined by the guidelines:

<u>Level A</u>

Professional attendance for an obvious problem characterized by the straightforward nature of the task that requires a short patient history, and if required, limited examination and management.

<u>Level B</u>

Professional attendance involving taking a selective history, examination of the patient with implementation of management plan in relation to one or more problems, or a professional attendance of less than 20 minutes duration involving components of a service to which items 36, 37, 38, 40, 43, 44, 47, 48, 50 or 51 applies.

<u>Level C</u>

Professional attendance involving taking a detailed history, an examination of multiple systems, arranging any necessary investigations and implementing a management plan in relation to 1 or more problems, and lasting at least 20 minutes, or a professional attendance of less than 40 minutes duration involving components of a service to 44, 47, 48, 50 or 51 applies.

<u>Level D</u>

Professional attendance involving taking an exhaustive history, a comprehensive examination of multiple systems, arranging any necessary investigations and implementing a management plan in relation to 1 or more complex problems, and lasting at least 40 minutes, or a professional attendance of at least 40 minutes duration for implementation of a management plan.

Table 4.4.1: Level A Billing Rates, based on data from Australian Government Department of Health and Ageing (2003)

Level A Billing Rates			
Item Number *	Location	Number of Patients (n)	
		$n \leq 6$	$n > 6$
3	Surgery consultation	$13.80	
4	Home visit	$13.80 + $21.10/n	$13.80 + $1.50 x n
13	Institution other than hospital or residential age care facility		
19	Hospital		
20	Residential age facility		

*as defined in Medical Benefits Schedule Book

Table 4.4.2: Level B Billing Rates, based on data from Australian Government Department of Health and Ageing (2003)

Level B Billing Rates			
Item Number *	Location	Number of Patients (n)	
		$n \leq 6$	$n > 6$
23	Surgery consultation	$30.20	
24	Home visit	$30.20 + $21.10/n	$30.20 + $1.50 x n
25	Institution other than hospital or residential age care facility		
33	Hospital		
35	Residential age facility		

*as defined in Medical Benefits Schedule Book

Table 4.4.3: Level C Billing Rates, based on data from Australian Government Department of Health and Ageing (2003)

Level C Billing Rates			
Item Number *	Location	Number of Patients (n)	
		$n \leq 6$	$n > 6$
36	Surgery consultation	$57.35	
37	Home visit	$57.35 + $21.10/n	$57.35 + $1.50 x n
38	Institution other than hospital or residential age care facility		
40	Hospital		
43	Residential age facility		

*as defined in Medical Benefits Schedule Book

Table 4.4.4: Level D Billing Rates, based on data from Australian Government
Department of Health and Ageing (2003)

Level D Billing Rates			
Item Number *	Location	Number of Patients (n)	
		$n \leq 6$	$n > 6$
44	Surgery consultation	$84.45	
47	Home visit	$84.45 + $21.10/n	$84.45 + $1.50 x n
48	Institution other than hospital or residential age care facility		
50	Hospital		
51	Residential age facility		

*as defined in Medical Benefits Schedule Book

In determining the billing rates, doctors have guidelines which are available from the Australian Government Department of Health and Ageing (2003). These billing rates are only a guideline and there are no regulations that require the doctors to follow these rates. The doctor may charge a patient a rate which is greater than these base rates. The billing rates depend largely on the consultation time and the complexity of the diagnosis. An additional fee is applied when the doctor needs to visit his patients outside his practice. This may include visits to the patient's home, hospital, age-care facility or other institution.

With only guidelines to follow, a patient's payment can vary from one general practitioner to another. The billing rates of different general practitioners also help to explain why some doctors in some areas of Toowoomba receive more patients than the other doctors. This in turn contributes to the problems in relation to Toowoomba's unequal distribution of general practitioners.

Information gathered from doctors and the Australian Government Department of Health and Ageing (2003) indicate that the location does not influence the billing rates. Instead, billing rates tend to depend on and vary according to the time spent with the doctor and the duration of the consultation with the doctor.

4.7 Summary

After gathering the information on maps, the current distribution of general practitioners have been found to be mostly located close to the city centre, with a scatter of others found distributed unevenly in the south-east and north-west districts of Toowoomba. This finding is disturbing because population density is a key factor to determining the required spread of general practitioners in the region. However, the city centre has the highest density of general practitioners despite being the least populated area.

Several reasons contributing to this trend include the finding that many people would like to accomplish several things at once, choosing to bypass remote surgeries on their way to the doctors in the city centre, so as to accomplish several things at once with the facilities found there. Pharmacies, for instance, may also be unavailable near their local suburban surgeries which is a major inconvenience. These problems, however, may be alleviated if more medical centres were located nearer to major suburban areas in Toowoomba, where people will experience greater convenience visiting doctors and obtaining medication in closer proximity.

The severity of this issue is intensified by the derived ratio of one doctor to 1051 patients, which is an alarming figure notwithstanding the 30,000 people commuting to and fro Toowoomba. Further analysis shows that the distribution of general practitioners is independent of the population density of the various regions in Toowoomba, which is the root of the problem, forcing ill patients to travel over longer distances to get to the nearest doctor in areas sparsely occupied by general practitioners, such as in the north-eastern or western regions of Toowoomba.

However, because the remotely located surgeries are sometimes bypassed, doctors in the CBD area do participate in anticipating larger volumes of patients during certain periods of time, and have a few more doctors available at the surgeries than usual. This increase in patients may be partly attributed to greater accessibility by public transport especially via bus routes, and in addition to that, other spatial related factors and travel agents have also shown significant influence on the patient-to-doctor ratio.

General practitioners' charging rates, on the other hand, have not been found to differ on the basis of location. Instead, doctors may follow the guidelines found in the Australian Government Department of Health and Ageing for billing practices that have been separated into four different categories of recommended billing rates.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

After collecting and analyzing the data relating to the doctor distribution in Toowoomba, it has been proven that the distribution of general practitioners is inadequate for the residents of Toowoomba due to a wide variety of factors including spatially-related factors. Moreover, this finding also has the support of several key members of the medical community, as found in the literature review conducted in Chapter 2 (ABC Rural 2003).

Specific conclusions with reference to the original project research objectives regarding the distribution of Toowoomba are drawn throughout this final chapter. The prospects for future work relating to the synchronizing of GIS technology and medical services in Toowoomba will also be introduced together with some recommendations for further research.

5.2 Conclusions

This study successfully uses GIS techniques to visualise the distribution of general practitioners and medical centres throughout the Toowoomba region. The distribution examined compared the concentrations of doctors and population of Toowoomba regions and found evidence of the inadequate distribution of general practitioners. The contributing factors in the analysis included traffic patterns, proximity to commercial centres, charging patterns and population density (refer to Chapters 2 and 5).

The researched outcome was that these underlying factors had a significant impact on patients' choice of general practitioners due to a wide array of reasons such as convenience, additional shopping facilities, convenience on bus routes and cheaper billing rates.

This project has demonstrated that GIS can be implemented as a useful tool for handling spatial and non-spatial data. Various spatial techniques were used throughout this project to assist in the analysis of different raw data collected. The main spatial technique used in this project to assist with the creation of maps was geocoding. The process of geocoding has proven to be very successful, providing much help in the form of references in the analysis (refer to Section 4.3).

ArcView GIS was also used to construct maps of the distribution of general practitioners and medical services throughout the Toowoomba city (refer to Chapter Five). The use of GIS is very beneficial not only for the general practitioners in locating their patients, but also for patients as they can clearly view which medical centre is located closest to their residence for greater convenience. The maps created for this project can be used as guidelines which allow us to see the current distribution of general practitioners. These maps then become especially beneficial for the future planning of the location of new general practitioners in the area. Therefore with these maps, a more efficient distribution can be constructed using the GIS technology.

The examination of the medical centres and locations of general practitioners have shown that the medial centres located within the shopping centres in the city heart of Toowoomba receive an overwhelming number of patients waiting to be seen each day. This is due to the ease of traveling to these locations via public transportation (for example buses) and the convenience of the availability of additional facilities near the surgeries. Patients prefer to travel into the city to see a doctor and be able to shop at the same time to save an extra trip into city.

Another aspect of these medical centres in commercial centres being much busier is the close proximity of pharmacies to where the surgeries are located, as not all medical centres have their own pharmacies. Shopping centres, on the other hand, tend to have chemists nearby which provide prescription medication to patients with great convenience.

This research also examined the impact of all these crucial factors mentioned above, such as traffic patterns, charging patterns, commercial centre locations and population density, on the pressing issue with the help of GIS technology. From this examination it became evident that each spatial related factor had varied impacts on the medical centres throughout Toowoomba.

Therefore, the use of GIS technology in the future will greatly assist better town planning assures that the distribution of general practitioners is appropriate and adequate for the population. This program can be also be used for such purposes within any medical or health organisation for decision making practices.

5.3 Achievement of objectives

This project was successful in achieving the objectives set in Chapter One. The objectives achieved were as follows:

1. Based on information collected, reviewing the population growth in Toowoomba, determine whether general practitioners experienced the same growth and if this contributed to the lack of doctors in the region;

2. Determine whether there are benefits of using GIS technology in the collection and analysis of data, particularly in the distribution of general practitioners;

3. Analysis and comparison of the data collected from the field, including location and distribution of the general practitioners as well as their charging patterns and fees, drawing graphs on the maximum, average and minimum charges in the different areas of Toowoomba, in relation to spatial related factors which impact upon the distribution of general practitioners.

4. The development of a spatial information system, in which data can be tabulated and analysed, and the creation of various maps of the distribution of doctors and medical centres within the area to assist with the analysis of the spread.

5. Through analysis and comparison the construction of maps and the research conducted for the recommended spread for general practitioners throughout Toowoomba, the impact of the spatial related factors (traffic patterns, charging patterns, commercial centre's location, convenience, and population density) are determined.

The objectives outlined for this study were achieved with results providing information for decision making for the distribution of medical centres and general practitioners throughout the Toowoomba region. It has been shown although the population in Toowoomba has grown over the years and expanded geographically, the distribution of general practitioners continue to be most available only around the CBD area (refer to Chapter One). This research has also shown that GIS technology processing adequately assists in the analysis of various forms of data (refer to Chapter Two). The data examined from the processes of using GIS has given comprehensive evidence that the distribution of doctors in the city is not as sufficient for the population as it could be, as the outer region of Toowoomba does not have adequate medical services in close proximity.

The five spatial related factors including traffic patterns, charging patterns, commercial centre's location, convenience and population density, were analysed using GIS technology in ArcView (refer to Chapter Four). The overall benefit from using GIS in this particular situation is that it can be adopted and applied to other towns or it can be scaled down using analysis of the various Toowoomba suburbs. It is evident that these five spatially-related factors create different impacts on the distribution of medical centres and general practitioners throughout Toowoomba.

The analysis of the five spatial related factors showed that commercial centres locations had the most impact on the distribution, with many patients preferring to visit general practitioners within shopping centres or within the city centre of Toowoomba. However it was found that if the recommended distribution of doctors was implemented this would not be the case, and thus eliminate the issue of overcrowding surgeries in the CBD area.

5.4 Recommendations for further research

The period this project was carried out was a short period of time. However this is a project which will continue to change with the growth of the population thus further study can be carried out with results being enhanced in some ways.

Throughout this project population density was the basis of the key factors in consideration. Further analysis could be done if more information can be obtained, such as the population density of different regions of Toowoomba at different times of the day.

The distribution of general practitioners and medical centres was researched to determine the spread of medical services available throughout their cities. The United Arab Emirates has a general practitioners connection which allocates blocks in areas evenly distributed in relation to the population specifically for general practitioners to practice medical services. Unlike Australia, general practitioners cannot setup a practice in any vacant block; they are allocated according to the population density within a region. This system implemented by the United Arab Emirates proves to be successful with the way its general practitioners are distributed for the population in the specified areas, because it takes into consideration the key considerations (the five spatial related factors refer to Chapter Five) in providing adequate services for the population density. Thus I have implemented similar tactics for recommendations for the general practitioners and locations of medical centres throughout the Toowoomba region.

The figures below (Figure 5.1) show a comparison between the current distribution of medical centres and general practitioners in Toowoomba, as well as the generated recommendation for the areas they should be located to create an efficient distribution of doctors. From these maps it can be easily seen that the recommended distribution would prove to be more adequate for the population. General practitioners are evenly spread throughout the regions, making it easier for patients to access general practitioners without hassle, as opposed to the current distribution which does not allow patients easy access, as evidenced by some areas of the five regions having no general practitioners at all.

However, the recommended distribution of general practitioners and medical centers is likely to change over time. This is due to the rapid growth of Toowoomba's population. However the same tactics and methods used in this project can be adopted and implemented in further research to assist in keeping the distribution of medical centers and general practitioners adequate for the population of Toowoomba region, as well as the smaller regions who travel into Toowoomba to seek medical attention.
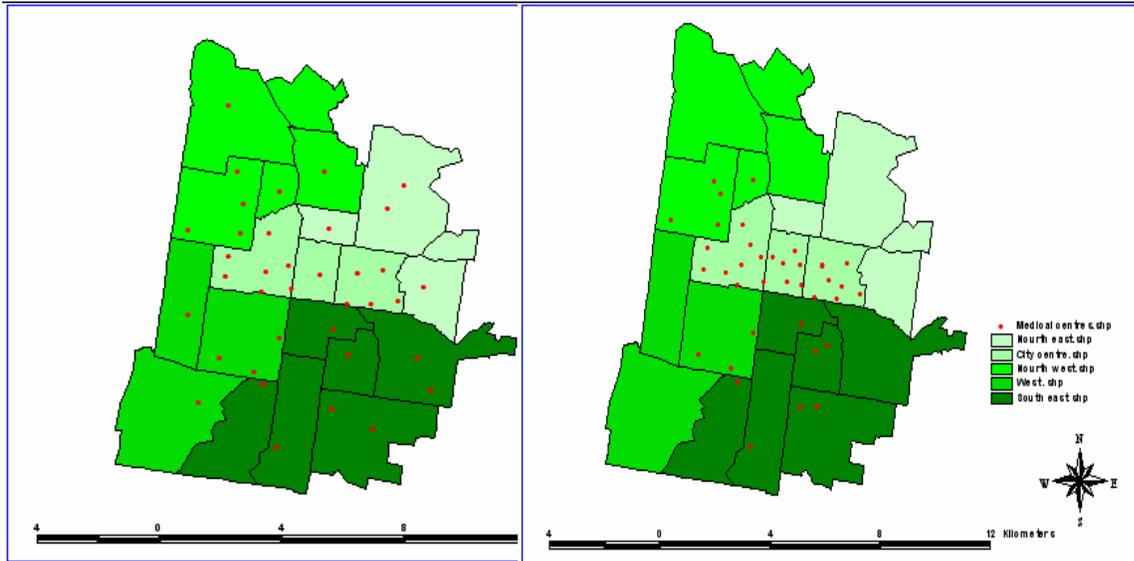
Figure 5.1: Comparison between the current location and the recommended location

5.5 Future research

Further study using the tactics and objectives of this project may include solving city planning
distribution issues relating to the allocation of:

1. Distribution of doctors practices
2. Distribution of medical centres
3. Distribution of Hospitals
4. Distribution of Surgeries
5. Patients can locate nearest doctor with ease.

6. Doctors can locate patients with ease.

Implementing tactics such as the processes undertaken in this project using GIS technology will
benefit many people. In the long term the even spread of the locations of medical practices will not
only be beneficial to the general practitioners and medical centres, but also the populations of the
regions surrounding them. In addition, patients can also benefit by using the GIS software to locate the
nearest medical centre or general practitioner with great ease. It can also work for general practitioners
in helping them easily locate their patients for house call visits.

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Appendix A

Project Specification

University of Southern Queensland

FACULTY OF ENGNEERING AND SURVEYING

<u>ENG4111/4112 Research Project</u>
PROJECT SPECIFICATION

FOR: SALEM ALMENHALI

TOPIC: Mapping the Distribution of Doctors and their Charging patterns throughout the toowoomba District.

SUPERVISOR: Dr Yan Liu

ENROLMENT: ENG 4111 – S1, D, 2004
ENG 4112 – S2, D, 2004

PROJECT AIM: This project aims to produce a case study about distribution and charging patterns in the Toowoomba District. The project will concentrate specifically on two main details.

        * The number of doctors available to the public in Toowoomba.

        * The different charging processes and amount to   be paid by patients.

PROGRAMME: **Issue A, 3rd March 2004**

1. Research information about the distribution of doctors in Toowoomba Concentrating on their charging scheme and location.
2. Compare the data collected and analysing costs and charging patterns, drawing conclusion on the maximum, average and minimum charges in the different areas of Toowoomba.
3. Develop a spatial information system, in which data can be tabulated and analysed.
4. Map the distribution of doctors within the Toowoomba district.
5. Research whether the distribution of doctors is enough for the Toowoomba community

AGREED:
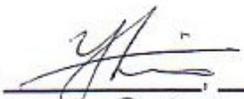
S. Almenhal (Student) _____ (Supervisor)
21/07/04   21/07/2004 _/_/_

Appendix B

Names of the General Practitioners and the Medical Centres

Names of the General Practitioners and the Medical Centres

Name	Address	Suburb	Region
Bakers Family Medical Centre	69 Taylor Street	TOOWOOMBA	QLD:DARLING DOWNS
Bridge Medical Practice	369-371 Bridge Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr A Lee Peng Keenan	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Andrew Whittaker	Bridge Medical Practice	TOOWOOMBA	QLD:DARLING DOWNS
Dr Anthony Ferris	137 Mary Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Benjamin Griffin	Mackenzie house	TOOWOOMBA	QLD:DARLING DOWNS
Dr Bill O'Reilly	Bakers Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Carol Cox	137 Mary Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Colin Goodchild	231 West Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Cormac Carey	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr David Bilbrough	Bakers Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr David lee	164 Ramsay Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr David Simson	Hume St Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr David van Gend	Mackenzie house	TOOWOOMBA	QLD:DARLING DOWNS
Dr Debra Carroll	Mackenzie house	TOOWOOMBA	QLD:DARLING DOWNS
Dr Dilip Dhupelia	62 Lindsay Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Donna Purcell	Toowoomba Medical Service	TOOWOOMBA	QLD:DARLING DOWNS
Dr Elizabeth Thorne	126 South Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Ellis Gibson	Taylor Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Felicity Rea	Family planning Association	TOOWOOMBA	QLD:DARLING DOWNS
Dr Gabriella Gillmore	Koinonia Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Gary Porter	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Graham Emblen	Koinonia Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Greg Howland	Grand Central Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Greg Steel	Bridge Medical Practice	TOOWOOMBA	QLD:DARLING DOWNS
Dr Heather Fogerty	Clifford Chambers Clinic	TOOWOOMBA	QLD:DARLING DOWNS
Dr Hume Rendl-Short	Koinonia Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Ian Mitchell	Grand Central Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Imelda O'Loughlin	St Vincent Breast	TOOWOOMBA	QLD:DARLING DOWNS
Dr Jill Guard	Family planning Association	TOOWOOMBA	QLD:DARLING DOWNS
Dr Jim McCnochie	7 Day Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Jock Lambie	819 Ruthven Street	TOOWOOMBA	QLD:DARLING DOWNS

Dr Joe Tarn	Hooper Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr John Morgan	Hooper Centre Medical Practice	TOOWOOMBA	QLD:DARLING DOWNS
Dr Julie Crozier	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Kate Craft	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Kenneth White	7 Day Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS

Name	Address	Suburb	Region
Dr Kym Butt	3 Leichhardt Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Leiza Siebuhr	Koinonia Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Leonard Knott	Range Shopping Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Loretto Wainwright	Mackenzie house	TOOWOOMBA	QLD:DARLING DOWNS
Dr Louisa Birkett	Goondir Health Service	TOOWOOMBA	QLD:DARLING DOWNS
Dr Lynne King	137 Mary Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr M Ratnapala	Armstrong Clinic	TOOWOOMBA	QLD:DARLING DOWNS
Dr Margaret Franklin	70 Margaret Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Margaret Gibson	238a Taylor Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Marilyn Kingsford	462-472 West Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Mark MacDermott	128 Russell Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Mary Woodward	Uni Plaza Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Michael McDonnell	4 Mylne Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Michael Reid	Iona Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Michelle Dahl	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Neil Cradick	Iona Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Neil Parker	Darling Downs Public Health Unit	TOOWOOMBA	QLD:DARLING DOWNS
Dr Neville Lutton	7 Day Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Noel Gowland	Grand Central Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr patricia Stuart	Stenner Street medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Paul Layton	Middle Ridge Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Pauline Young	Iona Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Beeston	126 South Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Bourne	Skin Cancer Clinic	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Harding	369-371 Bridge Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Hopson	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Schindler	Toowoomba Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Sklavos Pty Ltd	Russell Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Peter Taylor	62 Lindsay Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Philip Stark	Cnr West and Stenner Streets	TOOWOOMBA	QLD:DARLING DOWNS
Dr Phillip Keller	West Toowoomba Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Rhonda Greensill	Iona Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Richard Grundy	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Richard Juhasz	70 Margaret Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Richard wagner	36 King Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Robert Burns	Range Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS

Dr Robert Gillespie	Cnr West and Stenner Streets	TOOWOOMBA	QLD:DARLING DOWNS
Dr Robert Greenhill	Range Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Robert Jones	3 Leichhardt Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Robert Rimmer	Iona Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Robin Alexander	Iona Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Robin Maffey	7 Day Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Name	**Address**	**Suburb**	**Region**
Dr Rosalyn Dunlop	70 Margaret Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Russell domrow	137 Mary Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Scott Peters	Westridge Shopping Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Shane Sullivan	82 Bridge Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Shirley Butler	128 Russell Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Shirley Chapman	70 Margaret Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Stuart Whitehead	Shop 7	TOOWOOMBA	QLD:DARLING DOWNS
Dr Tim Reye	71 Hill Street	TOOWOOMBA	QLD:DARLING DOWNS
Dr Vicki steele	Bakers Family Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr Vida salehi	Grand Central Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
Dr William Beattie	Iona Centre	TOOWOOMBA	QLD:DARLING DOWNS
Gp Connections Toowoomba and District Division of General Practice	Suite 18 St Andrews Hospital	TOOWOOMBA	QLD:DARLING DOWNS
Iona Medical Centre	Iona Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS
James Neil Medical Plaza	Cnr James and Neil Street	TOOWOOMBA	QLD:DARLING DOWNS
Koinonia Family Medical Practice	Koinonia Family Medical Practice	TOOWOOMBA	QLD:DARLING DOWNS
Lindsay Street Medical Centre	62 Lindsay Street	TOOWOOMBA	QLD:DARLING DOWNS
Mackenzie House Family Medical Centre	Mackenzie House	TOOWOOMBA	QLD:DARLING DOWNS
Southern Qld Rural Division of General Practice	St Andrews Hospital	TOOWOOMBA	QLD:DARLING DOWNS
The Range Medical Centre	Range Shopping Centre	TOOWOOMBA	QLD:DARLING DOWNS
The Travel Clinic (108802)	Lindsay Street Medical	TOOWOOMBA	QLD:DARLING DOWNS
Travelers Medical and Vaccination Cener	Wilsonton Medical Centre	TOOWOOMBA	QLD:DARLING DOWNS